

Fostering environmental innovation programs in Madiun Regency, East Java, Indonesia

Chanel Tri Handoko, Setya Nugraha, Suryanto Suryanto, Nugroho Andi Purnomo, Hadi Wiwit Hendro Cahyono, Jesica Viona Setiawan, Sovia Wijayanti

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Keywords: Madiun; innovation programs; environmental sustainability; waste management; community participation.

Abstract. *Madiun Regency faces numerous challenges in maintaining environmental sustainability amidst economic development in the region. To address these challenges, well-planned collaborative and innovative efforts are required, prioritizing environmental protection and sustainable development. This study examines the implementation of regional innovation programs related to the environmental sector in Madiun Regency. Data collection was conducted through Focus Group Discussions (FGD) and primary source searches from relevant local agencies. The study found that the Madiun Regency Government has implemented several regional innovation programs, including turning waste into gold (Merubah Sampah Menjadi Emas/MERAMBAH EMAS), organic fertilizer processing unit (Unit Pengolahan Pupuk Organik/UPPO), recycling waste into handicrafts and public facilities, biological agent, green public open spaces, and the city without slums (Kota Tanpa Kumuh/KOTAKU). These programs have contributed to the promotion of a smart environment which focuses on utilizing technology to manage resources efficiently, promote sustainability, and mitigate environmental impacts. However, to enhance community participation, the Regional Government should increase efforts in socialization and the formation of environmental cadres. This will facilitate the supervision of environmental protection and management functions in Madiun Regency.*

1. Introduction

Environmental management has become a crucial issue globally as awareness of the need to preserve and safeguard the environment grows. Countries and regions are developing innovative approaches to address this challenge (Yakthi et al., 2023). As an archipelagic nation rich in diverse natural resources and ecosystems, Indonesia faces unique environmental management challenges and opportunities (Supriyanto, 2017). Regencies and cities across Indonesia are actively working to implement effective environmental measures. The urgency of addressing global climate change and environmental degradation is recognized

due to their significant impacts (Wibowo & Jundiani, 2023). It is essential for the government to work with various stakeholders to adopt cross-sectoral strategies and enhance community involvement, aiming to maintain a balance between economic development, social welfare, and environmental health (Hasan & Syahrudin, 2022; Mahmood et al., 2023; Panuluh & Fitri, 2016).

Madiun Regency, also known as Kabupaten Madiun, as a complex region, faces a series of pressing environmental challenges that demand thorough attention and effective solutions. In this context, the most prominent issue is waste management. The rapid population growth and accelerated urbanization have significantly contributed to the increase in waste generation, including both domestic and industrial waste (Hanifah, 2017). Within the scope of Madiun Regency, waste management issues take centre stage. The main challenges include the solid waste management system, which currently grapples with inadequate capacity and efficiency. Furthermore, medical waste management also comes under scrutiny due to its limited handling capabilities, which could potentially pose serious health risks to the community.

The current waste management infrastructure in Madiun Regency operates on a multi-tiered system that includes collection, transportation, processing, and disposal. However, inefficiencies and capacity issues plague this system, hindering its effectiveness. For example, the implementation of waste banks, intended to promote recycling and reduce landfill use, has not yet achieved the desired outcomes. Cahyani et al. (2022) note that although waste banks have been set up in several localities, the lack of community participation and inadequate support systems limit their effectiveness. Similarly, Zulfawati et al. (2020) highlight that there must be a comprehensive strategy that includes education on waste segregation, incentives for participation, and improved regulatory frameworks to enhance waste bank operations.

Apart from waste-related issues, land use conversion also presents a significant challenge in Madiun Regency. Urban growth and the conversion of agricultural land into residential or industrial areas can disrupt the natural ecosystem and upset the environmental balance. Ignoring principles of land use conversion can lead to negative environmental impacts, such as the deterioration of water quality (Susanti & Miardini, 2017). Waste originating from industrial and domestic activities, when discharged into water bodies, can lead to water contamination and a decline in water quality (Ningrum, 2018). Furthermore, this issue may serve as a principal factor in the diminishing availability of clean water in the future if it is not addressed swiftly (Juniatmoko & Erikania, 2020).

In response to these challenges, Smart Agroforestry (SAF) practices emerge as a viable solution, promising enhanced profitability for farmers alongside sustainable landscape management and climate change mitigation efforts (Octavia et al., 2022). The significance of understanding and finding solutions to these issues reflects the urgency of addressing environmental challenges in Madiun Regency. Achieving harmony between economic development, environmental protection, and social well-being stands as the primary goal in these endeavours.

Madiun Regency serves as a recent example of how a holistic and synergistic approach among various societal and local governmental aspects can yield positive innovations in environmental management. By focusing on proper waste management, planned land use conversion, and the protection of natural ecosystems, the region has made significant contributions to efforts aimed at achieving environmental sustainability (Jazuli, 2015).

This study aims to explore and analyse the diverse innovations in sustainable environmental management undertaken by the Madiun Regency Government and its community. By detailing the approaches, strategies, and outcomes of addressing environmental management challenges, this paper enhances the knowledge of integrated waste management approaches within regional governance structures, showcasing a successful example of environmental innovation that can be adapted and further developed in various regions. Grounded in a conceptual framework that integrates technological, socio-economic, and institutional perspectives, this paper will elucidate the impact of environmental management innovations on community well-being and sustainability in Madiun Regency, providing a comprehensive overview of local-level innovations that support environmental sustainability.

2. Methodology

The research was conducted in Madiun Regency from February to June 2022. The region is located in East Java Province, with coordinates ranging from 111°25'45" to 111°51' East Longitude and 7°12' to 7°48'30" South Latitude. It shares borders with Bojonegoro Regency to the north, Jombang Regency to the east, Ponorogo Regency to the south, as well as the Magetan and Ngawi Regencies to the west as can be seen on Figure 1. Administratively, Madiun Regency covers an area of 1,010.86 km², comprising 15 sub-districts and 206 village/kelurahan administrative areas (Pemerintah Kabupaten Madiun, 2022).

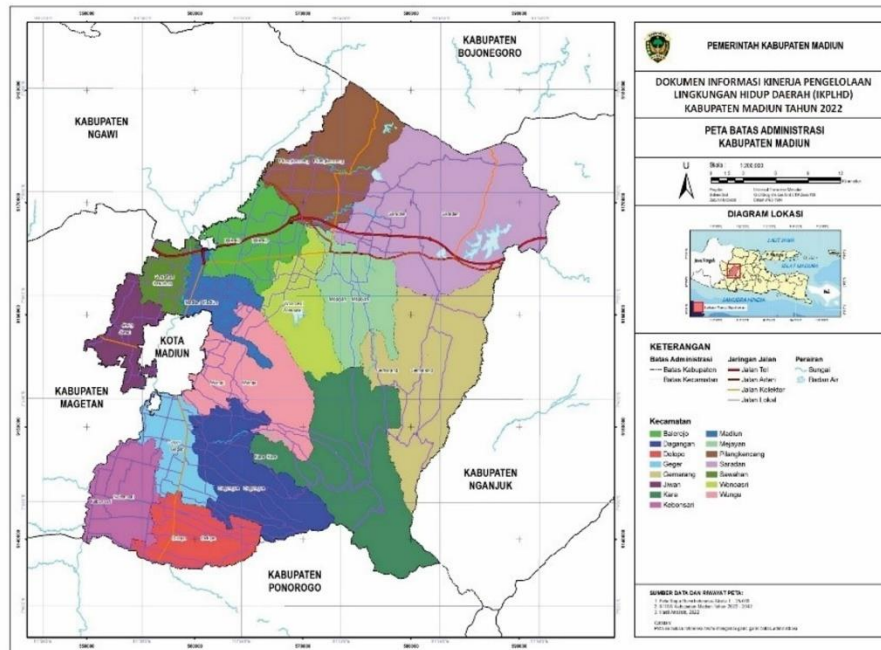


Figure 1. Administrative area of Madiun Regency.

2.1 Research method

The research methodology employed in this study encompasses two primary approaches: Focus Group Discussion (FGD) and the collection of primary sources from relevant agencies. The FGD approach was utilized to gain profound insights from diverse stakeholders. These discussions focused on official data and perspectives regarding environmental management concepts, challenges faced, and contributing factors to the sustainability of environmental management in Madiun Regency. The FGDs were conducted in accordance with ethical guidelines and informed consent was obtained from all participants.

2.2 Collection of primary sources

The primary sources were identified from key departments that have direct involvement and impact on environmental management. These include the Central Statistics Agency, Population and Civil Registry Service, Environmental

Service, Public Works and Spatial Planning Service, Forestry Service, Health Service, Agriculture Service, Regional Disaster Management Agency, and various non-governmental organizations operating within the regency.

The selection of documentation and reports from these departments was based on their relevance to the study's focus on environmental management initiatives. Specific criteria for source selection included:

- a. Relevance
The source must provide data or insights directly related to environmental management practices, challenges, or outcomes.
- b. Authenticity
Only official documents and reports published by the recognized agencies were considered to ensure accuracy and reliability.
- c. Recentness
Documents were chosen from the last three years to ensure the data reflected current conditions and practices.

2.3 Data analysis

Data from the primary sources were analyzed using a combination of qualitative and quantitative methods. Qualitative data, especially from reports on program evaluations and policy outcomes, were analyzed to extract narratives and case studies relevant to the sustainability of environmental management. While quantitative data were used to perform statistical analysis to identify trends and patterns.

In the FGDs, data were collected and then analyzed to identify priority issues in the environmental sector of Madiun Regency using scoring techniques. These priority issues were subsequently used as a basis for identifying and implementing an environmental innovation program tailored to address these specific concerns. The criteria for determining priority issues included: (1) affecting the lives of many people; (2) high relevance to regional interests; (3) potential for cross-sectoral or cross-regional collaboration; (4) likelihood of causing long-term negative impacts if not addressed promptly; (5) potential to cause cumulative impacts and multiple effects; and (6) potential to disrupt the implementation of sustainable development.

2.4 Identification of environmental innovation program

For the development of the environmental innovation program in Madiun Regency, the study incorporated a conceptual framework that integrated various dimensions of environmental management, such as technological, socio-economic, and institutional approaches.

3. Results and Discussion

The vision of the Madiun Regency Government is to realize a safe, independent, prosperous, and ethical region. One of the key missions that elaborates on this vision focuses on enhancing independent economic development through agribusiness, agro-industry, and sustainable tourism (Pemerintah Kabupaten Madiun, 2022).

3.1 Priority issues

Based on the findings from the FGDs, the Madiun District has identified four priority issues in the environmental sector for 2022. These issues include waste management, degradation of water quality, land damage, and land conversion and hold paramount importance for the Madiun Regency Government.

3.1.1 Population growth

The population of Madiun Regency has shown a tendency to increase over the past five years. Figure 2 shows the highest population increase occurred between 2019 and 2020, with a percentage increase of 9.13% (Badan Pusat Statistik Kabupaten Madiun, 2023).

This population growth has led to an increased demand for natural resources, including water, land, and energy. Consequently, there is a risk of over-exploitation of these resources, such as land conversion, excessive water usage, and increased reliance on fossil fuels. These activities can result in environmental degradation, including deforestation, drought, and pollution. Additionally, the growing population often triggers urbanization and infrastructure development, which necessitates more land. As a result, there is a conversion of forested or agricultural land into urban or industrial areas (Weber & Sciubba, 2019).

3.1.2 Increase in economic activity

Economic development in Madiun Regency is frequently accompanied by an increase in the consumption of goods and services, subsequently leading to increased waste generation. The heightened demand for products results in a rise

in both domestic and commercial waste. Inadequate waste management systems can lead to waste accumulation in landfills, causing environmental pollution and posing public health risks.

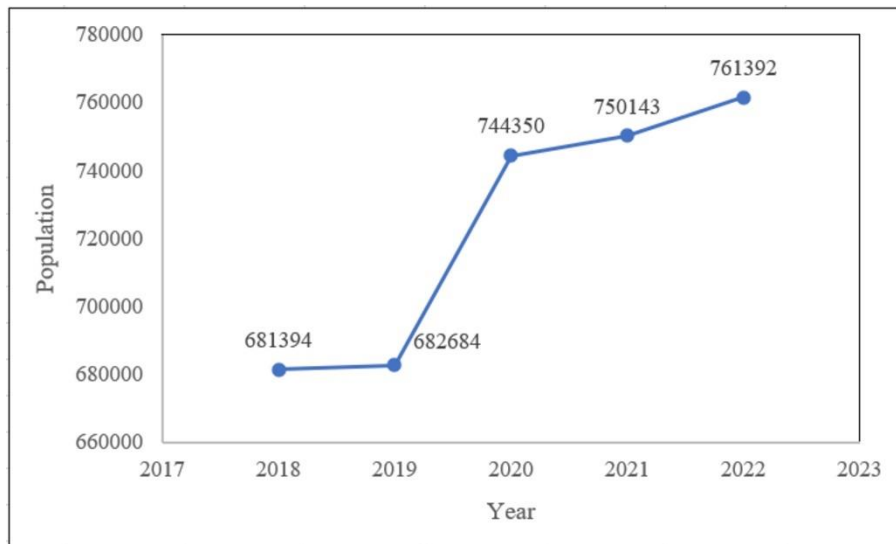


Figure 2. Total population of Madiun Regency 2018-2022.

Furthermore, the escalation of industrial and agricultural activities to meet economic demands can lead to a decline in environmental quality. Industrial activities contribute to air and water pollution, the generation of toxic industrial waste, and greenhouse gas emissions. Intensive agricultural practices involving the use of pesticides and chemical fertilizers can contaminate soil and water sources. Economic progress also frequently triggers changes in land use, with agricultural lands and forests being converted into urban, industrial, or infrastructure areas. This alteration in land use can result in deforestation, the loss of natural habitats, and harm to ecosystems. Additionally, changes in land use can heighten the susceptibility to natural disasters such as floods, landslides, and droughts (Acheampong & Opuku, 2022).

3.1.3 Geographical and topographical conditions of Madiun Regency

Madiun Regency is situated amidst the slopes of Mount Wilis and the Kendeng Zone Mountains in the north, while the western sub-districts of Madiun Regency are still influenced by Mount Lawu. The topography of Madiun Regency exhibits significant diversity, characterized by mountainous terrain in the south, plains in the central region, and hills in the north. This varied topography poses risks such as landslides, floods, and droughts (Afandi et al., 2020). Among the most prevalent natural disasters in Madiun Regency are floods and landslides, which are categorized into three hazard classes: low, medium, and high (Pemerintah Kabupaten Madiun, 2022).

3.1.4 Behaviour of Madiun Regency residents

Madiun Regency is encompassed within the Madiun Watershed, a vast lowland area with residents living near the watershed. The presence of settlements in riparian zones or near rivers, reservoirs, and springs, coupled with the habit of indiscriminately disposing of garbage into these water bodies, exacerbates water quality issues, particularly surface water quality. This issue arises from a lack of public awareness and knowledge regarding the detrimental consequences of such activities. Assessment of water quality using parameters such as biochemical oxygen demand (BOD), chemical oxygen demand (COD), pH, temperature, and ammonia-nitrogen highlights the importance of monitoring these parameters to evaluate the impacts of waste disposal on river water quality (Kasmuri et al., 2021).

Figure 3 provides an example of the findings obtained from monitoring the biochemical oxygen demand (BOD) parameters of river water in Madiun Regency. The dumping of untreated domestic wastewater and solid waste into water bodies accelerates the degradation of water quality, obstructing water flow and causing shallowing of the river. Consequently, this diminishes the river's capacity, leading to stagnant water and subsequent flooding.

3.2 Environmental innovative programs

After identifying the four environmental priority issues in 2022, Madiun Regency has developed and implemented some environmental innovative programs to achieve ecological sustainability. The following are six innovation programs in the environmental sector in Madiun Regency.

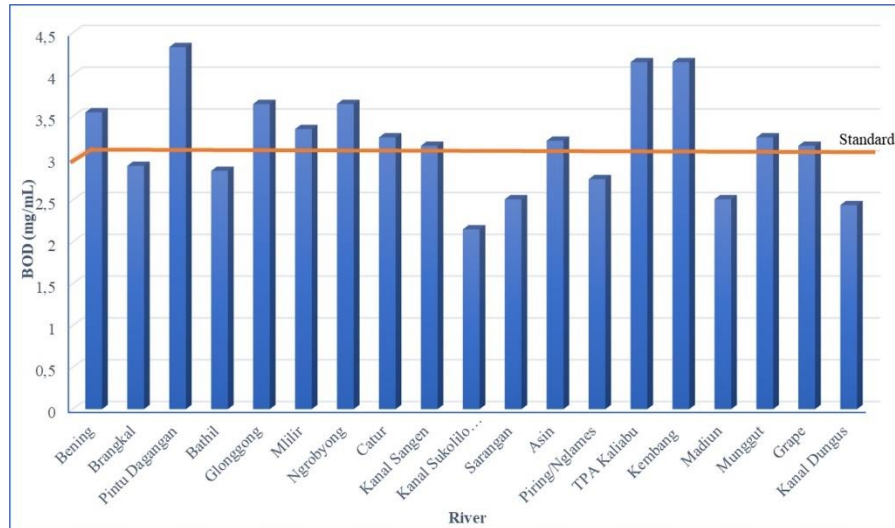


Figure 3. BOD Parameters of river water in Madiun Regency taken in the first semester of 2022.

3.2.1 Merubah Sampah Menjadi Emas (MERAMBAH EMAS)

The Madiun Regency Government currently operates one final waste processing site known as Tempat Pembuangan Akhir (TPA) called Kaliabu TPA, located in Kaliabu Village, Mejayan District. The landfill area spans 5 hectares and has a waste storage capacity of 260,000 m³ (with two layers of levels). Currently, the Kaliabu TPA contains approximately 174,882.77 m³ of waste, reaching around 70% of its capacity. It is projected that the landfill will reach its full capacity within the next few years. To prolong the storage period, various measures have been undertaken by the relevant authorities, including optimizing the role of waste banks throughout Madiun Regency. The waste bank operates as a waste management initiative that involves the repurchase of waste through a deposit-based system, similar to the banking concept (Wulandari et al., 2017). Studies show a strong correlation between the number of waste banks and waste reduction, indicating their effectiveness in decreasing landfill waste volumes (Susilowati & Herdiansyah, 2019).

Madiun Regency is home to 220 waste banks, distributed across 15 sub-districts. Among these, 130 waste banks are actively engaged in fostering and supervising waste management, while the remaining banks are still in the developmental

phase, requiring continuous guidance. To enhance the development of waste banks and generate greater community interest, innovative approaches and breakthroughs are necessary. In this regard, the Madiun Regency Government has introduced the "MERAMBAH EMAS" program, which involves exchanging waste for gold savings, as shown in Figure 4 below.



Figure 4. Garbage bank customers receive gold savings.

The "MERAMBAH EMAS" program in Madiun Regency is an innovative initiative that aims to convert waste into gold savings through the operation of waste banks. The program is based on Government Regulation of the Republic of Indonesia Number 81 of 2012, which focuses on waste bank management using the reduce, reuse, recycle system. The objective of this regulation is to enhance coordination and establish a sustainable strategy for managing household waste, while also strengthening the capabilities of waste bank administrators.

The program has been successful in several aspects, including the increase in the number of waste banks, job creation for waste bank administrators, a reduction in waste volume at temporary disposal sites known as Tempat Pembuangan Sampah (TPS), and an increase in the number of waste bank customers. It has also improved the welfare of waste bank management and customers, as well as raised public awareness of organic and inorganic waste management. The program has been particularly impactful for housewives, and it has led to a significant decrease in waste residue at TPS and an increase in community participation as waste bank customers. Waste banks can become economic institutions where waste can be a transaction tool used in their activities, because like conventional banks that use money as the instrument, the waste bank emphasizes its focus on waste management, which is the current environmental problem (Ansyar, 2020).

The implementation of the "MERAMBAH EMAS" innovation involved several stages, including community outreach, the establishment of a Memorandum of Understanding (MoU), and the inclusion of waste banks in the Database and WhatsApp Group of the Madiun Regency Main Waste Bank. The program has been sustained through monthly evaluations, which ensure the ongoing success and sustainability of the initiative.

The Madiun Regency Environmental Service collaborated with the Head of Village, Family Welfare Movement Team, and PT. Pegadaian Madiun Branch to conduct community outreach. Subsequently, a MoU was established between the Department of the Environment, Family Welfare Movement Team, and PT. Pegadaian Madiun Branch. The final stage entailed the establishment of a Waste Bank and its inclusion in the database and WhatsApp Group of the Madiun Regency Main Waste Bank.

The "MERAMBAH EMAS" program is an effort by the Madiun Regency Government to address waste management challenges and promote environmental sustainability. It has not only contributed to waste reduction and job creation but has also provided an innovative way to incentivize and engage the community in waste management practices. The "MERAMBAH EMAS" innovation was initially implemented in Tiron Village and Sendangrejo Village in 2019. Customers' waste savings, originally intended for holiday, education, and social savings, were converted into gold savings. Each month, customers receive a savings book indicating the amount of gold. The proceeds from the sale of waste, valued at IDR 10,000 are converted into gold savings of 0.001 grams (based on an estimated gold price of IDR 800,000 per gram).

The introduction of the "MERAMBAH EMAS" innovation yielded several improvements in environmental management performance, including:

- 1) An increase in the number of waste banks from 11 units in 2016 to 196 units in 2019.
- 2) Job creation for Waste Bank administrators, with the number of personnel rising from 376 to 1,176.
- 3) A reduction in waste volume by approximately 30% at TPS.
- 4) An increase in the number of Garbage Bank customers.

This program has had a significant impact on society, particularly for housewives. The innovation has successfully improved the welfare of waste bank management and customers, while also raising public awareness of organic and inorganic waste management. Additionally, the program has led to a decrease in waste residue at TPS and an increase in community participation as waste bank customers, with the number of customers rising from 26 to 136.



Figure 5. Waste bank administrative activities.

The activities of the Waste Bank commence with the weighing, recording, and sorting of waste based on its classification. The waste is then collected by the main waste bank. The proceeds obtained from customers' waste sales are coordinated and transferred to PT. Pegadaian Madiun Branch as gold savings. In order to ensure the ongoing sustainability of this innovation, monthly evaluations are conducted. These evaluations take place when the Village Waste Bank sells waste to the Main Waste Bank. Figure 4 and Figure 5 illustrate the activities and

impact of the "MERAMBAH EMAS" program, providing visual support for the program's implementation and outcomes. Following the evaluation, appropriate measures are taken, such as providing guidance to existing waste banks, conducting comparative studies with other waste banks, or rewarding waste banks that demonstrate proper management.

The program's impact and success demonstrate the potential for similar initiatives to be implemented in other regions facing waste management issues. By exchanging waste for gold savings, the "MERAMBAH EMAS" program has effectively transformed the perception of waste from a disposable material to a valuable resource, contributing to both environmental and social benefits. This program also serves as a model for sustainable waste management and community engagement, and its expansion and replication in other areas could further contribute to the advancement of waste management practices and environmental conservation efforts. This program is a notable example of innovative waste management practices, and its success in Madiun Regency holds promise for the broader advancement of sustainable waste management initiatives.

3.2.2 Unit Pengolahan Pupuk Organik (UPPO)

UPPO as the organic fertilizer processing unit program in Madiun Regency is an initiative implemented by the local government to effectively manage organic waste by converting it into organic fertilizer (Herdiansyah et al., 2022). This program aims to mitigate the adverse environmental impacts of organic waste while supporting the advancement of sustainable agriculture. The implementation of the UPPO Program in Madiun Regency involves several key steps:

1) Organic waste collection

This program entails the systematic collection of organic waste from various sources, including agricultural waste, kitchen waste, market waste, and livestock waste. The local government collaborates with the community, farmers, and entrepreneurs to establish an organized system for collecting organic waste.

2) Organic waste treatment

The collected organic waste undergoes composting or fermentation processes. To facilitate this, the local government has established an organic fertilizer processing unit equipped with the necessary equipment and infrastructure. The processing methods employed are environmentally friendly and adhere to organic fertilizer processing standards.

3) Processing and storage

The organic fertilizer produced undergoes further processing to optimize its quality and nutrient content. The processed organic fertilizers are then stored under appropriate conditions to maintain their stability and quality before being distributed to the agricultural and plantation sectors.

4) Farmer empowerment

This program also focuses on empowering farmers in the effective use and management of organic fertilizers. The local government provides training and assistance to farmers, enabling them to understand the benefits, application, and proper management practices associated with organic fertilizers. The objective is to enhance agricultural productivity, reduce reliance on chemical fertilizers, and promote sustainable agricultural practices (Gaina et al., 2021).

5) Distribution of organic fertilizers

The organic fertilizers produced through the program are distributed to farmers and plantations in Madiun Regency. The local government collaborates closely with the Department of Agriculture and relevant institutions to ensure the availability of organic fertilizers in sufficient quantities, at affordable prices, and in a timely manner. This distribution contributes to the development of environmentally friendly agriculture and enhances the yield and quality of crops.

The UPPO program in Madiun Regency plays a crucial role in promoting sustainable organic waste management and supporting organic-based agriculture. Through the conversion of organic waste into organic fertilizer, this program has the potential to reduce the reliance on chemical fertilizers, thereby mitigating their detrimental impact on the environment. Additionally, it aims to enhance the well-being of farmers in the region. Figure 6 serves as proof that the Madiun District Government actively supports community groups in implementing the UPPO program by providing infrastructure and equipment grants.

The Madiun Regency Government has set a target to establish 21 UPPO units, which consists of the following components:

- 1) Compost houses equipped with fermentation tubs.
- 2) Cage buildings with drainage channels.
- 3) Livestock (8 cows/buffaloes).
- 4) Organic fertilizer processing equipment.
- 5) Three-wheel vehicles.



Figure 6. Documentation of the UPPO Program at the Margo Utomo Farmer Group, Gandul Village, Pilangkenceng District.

The UPPO program is designed as a community-based empowerment initiative. Therefore, it is essential to increase community participation by forming environmental cadres and fostering community organizations in the environmental sector. These efforts will facilitate the supervision of environmental protection and management functions within Madiun Regency (Kusuma et al., 2023).

3.2.3 Recycling Waste into Crafts and Public Facilities

In 2022, Madiun Regency implemented a waste recycling program that transforms waste into crafts and public facilities as part of its commitment to sustainable and innovative waste management, which can be seen on Figure 7.

This program aims to minimize environmental pollution caused by waste, raise public awareness about the significance of recycling, and generate handicraft products and useful public amenities. The implementation of the program includes the following steps:

1) Waste sorting and collection

The residents of Madiun Regency are educated and encouraged to segregate waste at home and in public areas. The waste is sorted into organic, inorganic, and hazardous categories, and then collected separately by sanitation workers or other relevant parties. A study highlights the importance of efficient waste management systems that balance economic, environmental, and social factors, supporting the initiatives undertaken by Madiun Regency (Harijani et al., 2017).



Figure 7. Recycling waste products into handicrafts and public facilities in Madiun Regency.

2) Recycling centre

The Madiun Regency Government established a recycling centre equipped with the necessary facilities and equipment to process waste into new raw materials. This centre employs a skilled workforce trained in waste processing techniques for creating handicraft products and building materials.

3) Creativity in recycling

The collected waste is processed and transformed into various handicraft products, such as bags, wallets, accessories, and home decorations. Additionally, certain inorganic waste is utilized to construct park benches, fences, and other public facilities. This recycling process involves collaboration with local artists and craftsmen to produce high-quality products from waste materials.

4) Community training and empowerment

This program also includes training and empowering the community in waste management and the conversion of waste into economically valuable products. Community members are provided with opportunities to learn techniques for processing waste into crafts, including the selection process, cleaning methods, and techniques for creating aesthetically pleasing and marketable products.

5) Integration in public facilities

Craft products made from recycled waste are integrated into the construction of public facilities. For instance, park benches, trash cans, and wall decorations are created using recycled materials. This not only enhances the aesthetic appeal of these facilities but also conveys an important message about responsible waste management to the community.

The program to recycle waste into crafts and public facilities in Madiun Regency in 2022 represents a tangible effort to reduce waste, generate economically valuable products, and raise public awareness about the significance of sustainable waste management.

3.2.4 Biological agent program

Excessive use of pesticides is one of the key factors contributing to the decline in water quality, particularly in agricultural areas. The widespread application of synthetic pesticides, which often contain hazardous chemicals, poses risks to environmental health when misapplied or used in incorrect dosages. These chemicals can leach into water bodies, causing pollution. For instance, studies highlight the extensive use of agricultural pesticides affecting downstream water quality and the pervasive impact of these chemicals on ground water and surface water quality (Rad et al., 2022).

To address this issue, the implementation of natural and environmentally friendly pesticides, known as "biological agents", can help mitigate pollution caused by synthetic pesticides (Budiman et al., 2019). Biological agents are a means of controlling plant pests through the use of natural enemies. The introduction of biopesticides, which includes various natural enemies of plant pests, not only helps in mitigating pollution but also enhances sustainability in agriculture. For example, the implementation of biopesticides has demonstrated significant reductions in environmental contamination, providing a viable alternative for managing pest populations in an eco-friendly manner (Swapan et al., 2023).

The objectives of implementing a program for the control of plant pest organisms for food crops, horticulture, and plantation in Madiun Regency are as follows:

- 1) Enhance farmers' skills and knowledge in integrated pest management techniques using biological agents (natural enemies) for food crops, horticulture, and plantations.
- 2) Motivate and mobilize farmers and agricultural businesses to achieve self-sufficiency in rice production while maintaining stability in food crop production.
- 3) Foster the development of independent farmers capable of producing biological agents/natural enemies as alternatives to chemical pesticides.
- 4) Reduce production costs through cost-effective and affordable pest and plant disease control methods.
- 5) Minimize environmental damage caused by the use of harmful chemical fertilizers and pesticides, as evidenced by reduced pollutant levels in water from alternative farming practices (Oquist et al., 2007).
- 6) Improve the welfare of the farmers group known as gabungan kelompok tani (Gapoktan) members by utilizing organic fertilizers with the assistance of biological agents.

By implementing these biological agent activities, Madiun Regency aims to promote sustainable and eco-friendly practices in pest control, reduce environmental pollution, enhance agricultural productivity, and improve the well-being of farmers and agricultural communities by conducting a training session regarding the making of biological control agents as shown on Figure 8.

3.2.5 Green open space/Ruang Terbuka Hijau (RTH)

"Green open space" refers to designated land areas dedicated to greening and improving environmental quality. These spaces include parks, city parks, recreational parks, and urban forests that serve as sources of oxygen, absorb air pollution, and provide natural air conditioning (Zaitunah et al., 2021). Green open spaces also play a crucial role in maintaining ecosystem aesthetics and balance (Harjanti & Anggraini, 2020). In Madiun Regency, green open spaces are designed to provide comfortable and healthy public spaces for local residents, contributing to an enhanced quality of life. These spaces offer green, refreshing environments that serve as places for relaxation, socialization, and activities that

support a healthy and sustainable lifestyle. It is essential to maintain and care for green open spaces to ensure their long-term benefits for the community.



Figure 8. Training on making biological control agents in Ngetrep Village, Jiwan District.

Currently, only four sub-districts in Madiun Regency have public green open spaces: Dolopo, Wungu, Mejayana, and Nglames. These spaces typically take the form of city parks and recreational parks, equipped with facilities such as children's play areas, walking paths, seating areas, and shaded plants. They are designed to accommodate recreational and sports activities, with sports fields, jogging areas, bicycle paths, and spaces for various physical activities. Figure 9 exemplifies the largest green open space in the Caruban District, frequently used for various communal activities. In addition to providing tourism and recreational opportunities, green open spaces also contribute to economic development by creating job opportunities for local residents.



Figure 9. Green open space condition in Caruban Square, Madiun Regency.

In addition to expanding the capacity of green open spaces, the Madiun Regency Government conducts an annual tree seed planting program. This program aims to prevent natural disasters and maintain water availability. For instance, a tree planting event took place on Wednesday (30/03/2022) in the reservoir border area of Sareng Village, Geger District. Tree planting activities also occurred at other locations, including the reservoir in Sareng Village, Geger District, Jegglik Village, Kare Village, and Morang Village, Kare District. A total of 12,500 seeds were planted with the intention of preventing natural disasters. The tree species planted include rambutan, jackfruit, mango, and others.

3.2.6 City without slums/Kota Tanpa Kumuh (KOTAKU)

The KOTAKU program is a government initiative aimed at addressing the issue of slum settlements in Indonesia, including Madiun Regency (Triastuti et al., 2023). This program focuses on improving the quality of settlements, enhancing accessibility, and empowering communities to create better and more sustainable cities. In Madiun Regency, the KOTAKU Program encompasses several activities, including:

- 1) Slum rehabilitation.

This program aims to rehabilitate and develop slum settlements into habitable and improved settlements. Rehabilitation efforts include enhancing basic infrastructure such as clean water supply, sanitation facilities, electricity, and improving road access to the settlements.

- 2) Provision of infrastructure and public facilities.

The KOTAKU program also emphasizes the provision of necessary public infrastructure and facilities for the community. This includes constructing and repairing roads, drainage systems, parks, green open spaces, as well as social facilities like places of worship, health service centres, and community activity centres.

3) Community empowerment.

The KOTAKU program promotes community empowerment in the management of settlements. It encourages active participation of residents in the planning, implementation, and maintenance of settlement facilities. Communities are encouraged to form participatory groups that are involved in decision-making and program implementation.

4) Capacity building and education.

The program incorporates an educational approach and capacity building activities to enhance settlement management. Training and outreach programs are conducted to raise public awareness about the importance of hygiene, sanitation, and sustainable practices.

5) Supervision and monitoring.

The KOTAKU program includes continuous supervision and monitoring to ensure the success of the program and the quality of rehabilitated settlements. Effective supervision helps identify and address any issues that may arise during the implementation process.

The KOTAKU program in Madiun Regency aims to create healthy, livable, and sustainable settlements. Its implementation involves collaboration between local and central governments, communities, and other relevant stakeholders. One of the areas in Madiun Regency that has experienced the implementation of the KOTAKU program is Kincang Wetan Village and Sambirejo Village, Jiwan District as can be seen in Figure 10.

KOTAKU activities in these villages include:

- 1) Construction of a 270-meter-long water canal in RT 13 RW 6, with a budget of IDR 150,000,000.
- 2) Rehabilitation of Uninhabitable Houses (Rumah Tidak Layak Huni/RTLH) in Phase I, targeting houses belonging to Misran in RT 2, Slamet in RT 12, Simin in RT 8 RW 2, Gunirah, and Sutopo in RT 20 RW 4. Then in Phase II, RTLH rehabilitation was carried out on the Sukiran house.

- 3) Rehabilitation of Uninhabitable Houses for the houses of Sumadi in Wayut Village, Wiji Riono in Bibrik Village, Riman in Klagen Serut Village, and Cikrak in Kwangsen Village, Jiwan District, with each rehabilitation costing IDR 20,000,000.



Figure 10. Inauguration of the KOTAKU Program in Kincang Wetan Village and Sambirejo, Fiscal Year 2022.

3.2.7 The importance of environmental Cadres' roles

In Indonesia, the establishment of environmental cadres is governed by the Minister of Environment and Forestry Regulation Number 8 of 2022, which addresses Initiating the Development of the Environmental Generation. This regulation emphasizes the advancement of environmental stewardship through a grassroots management approach as a key strategy to achieve sustainable environmental development. The goal is to foster a clean and healthy living environment through consistent and continuous community engagement.

The formation of environmental cadres in Madiun Regency is a strategic step in enhancing community participation and empowerment in environmental

management and protection. Through education, awareness, and sustainable environmental management practices, environmental cadres can play a significant role in ensuring the sustainability of the environment for future generations.

Madiun Regency has initiated the formation of environmental cadres in each village/sub-district, as confirmed by the enactment of Madiun Regent Regulation Number 14 of 2022 on Waste Management in Villages. This regulation stipulates that waste management should ideally be handled at the community level within villages/sub-districts. As such, it is encouraged for every village or smaller community unit to establish environmental cadres and waste banks. The organizational structure of environmental cadres at the village level typically comprises the following positions: Chairman, Secretary, Treasurer, and sub-sectors for Waste Management, Greening, Energy, Health and Hygiene, and Cooperation.

Several recent studies highlight the critical role of community-based empowerment initiatives in environmental protection management. These initiatives focus on establishing environmental cadres and fostering the development of community organizations. Key elements include active stakeholder participation, the implementation of effective environmental law enforcement mechanisms, and the creation of synergy between community engagement and environmental legal awareness. These aspects are vital for integrating environmental interests into the legal framework and securing justice for nature through community-based empowerment programs (Insani & Karimullah, 2023).

In the realm of environmental education and capacity building, the Learning Institute for Environment (LIFE) project at Eastern Visayas State University in the Philippines stands out as a significant example. This project prioritizes training for leadership roles and the cultivation of a culture of excellence in environmental science and rural development. It aims to equip professionals with the necessary skills for effective environmental protection management (Cadiz & Aguirre, 2021).

4. Conclusions

The Madiun Regency Government has implemented numerous innovative programs aimed at environmental preservation, notably transforming waste into valuable resources. This study has highlighted key initiatives such as the

MERAMBAH EMAS program, which focuses on waste conversion, the establishment of organic fertilizer processing units (UPPO), and the creative reuse of waste in crafts and public facilities. Further efforts include promoting biological agents, developing green open spaces (RTH), and executing the KOTAKU program to eradicate slums. These strategies have effectively intertwined economic development with environmental management and social welfare improvements. The establishment of environmental cadres in each village underlines the government's commitment to fostering a prosperous community that values cleanliness, effective waste management, and eco-friendly practices. These cadres play a pivotal role in enhancing air and water quality, boosting public awareness about environmental health, and promoting sustainable consumption. Collectively, these measures underscore a significant advancement in Madiun Regency's approach to environmental stewardship and community engagement. This study contributes to the scientific understanding of integrated waste management strategies within regional governance frameworks, demonstrating a successful model of environmental innovation that could be replicated and further innovated in other regions. Further research is necessary to explore the long-term impacts of these environmental innovation programs on waste management practices, which will help in refining and expanding their application and efficacy across different contexts.

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Authors

Chanel Tri Handoko (*corresponding author*) chanel.handoko@gmail.com
<https://orcid.org/0000-0001-6743-7459>

Environmental Science Department, Graduate School, Universitas Sebelas Maret, Surakarta 57126, Indonesia.

Center for Environmental Research, Universitas Sebelas Maret, Surakarta 57126, Indonesia.

Setya Nugraha setyanugraha@staff.uns.ac.id

Geography Education Department, Faculty of Teacher Training and Education, Universitas Sebelas Maret, Surakarta 57126, Indonesia.

Center for Environmental Research, Universitas Sebelas Maret, Surakarta 57126, Indonesia.

Suryanto Suryanto suryanto_feb@staff.uns.ac.id

<https://orcid.org/0000-0002-3763-9639>

Development Economics Department, Faculty of Economics and Business, Universitas Sebelas Maret, Surakarta 57126, Indonesia.

Center for Environmental Research, Universitas Sebelas Maret, Surakarta 57126, Indonesia.

Nugroho Andi Purnomo nugrohoandi12@gmail.com

Center for Environmental Research, Universitas Sebelas Maret, Surakarta 57126, Indonesia.

Hadi Wiwit Hendro Cahyono hadiwiwithc@gmail.com

Center for Environmental Research, Universitas Sebelas Maret, Surakarta 57126, Indonesia.

Jesica Viona Setiawan jesicaviona@gmail.com

<https://orcid.org/0009-0004-5991-1631>

Environmental Science Department, Graduate School, Universitas Sebelas Maret, Surakarta 57126, Indonesia.

Sovia Wijayanti soviawijayanti@student.uns.ac.id

Environmental Science Department, Faculty of Mathematics and Natural Science, Universitas Sebelas Maret, Surakarta 57126, Indonesia.

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Competing Interests

The authors hereby declare that there are no financial or non-financial competing interests.

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