Solid waste characterization at Tanjungan dam ecovillage, Mojokerto, Indonesia

Solid waste characterization at Tanjungan dam ecovillage, Mojokerto, Indonesia

E Tarigan[1,2], T L Simangunsong[2,3*], A A Athaya[3], P D P Parapaga[3]

[1]Electrical Engineering Department, [2]Center for Environmental and Renewable Energy Studies, [3]Chemical Engineering Department, University of Surabaya

tuani@staff.ubaya.ac.id

Abstract. The aims of the study are to present waste composition and improve waste management at the tourism destination of Tanjungan Dam Ecovillage, Mojokerto. The sampling and interviews were conducted for estimating the characterization and management practice of solid waste. The results showed that the tourism destination generated solid waste of around 18.82 kg/day. The generation rate of organic waste was 1.68 kg/day and 5.94 kg/day of inorganic,. Another waste generated from this destination is yard waste, which was around 11.2 kg daily. The result of the interview with the ecovillage officers presented that the awareness of waste management was still low. The solid waste management of the ecovillage was collect-transport-dispose with low rates and efficiency. Furthermore, there is no segregation of the waste, no control of inorganic waste, no regular schedule of yard waste collection, and no education for the tourists to rising their awareness about solid waste. To improve the solid waste management system and ensure the ecovillage's sustainability, these facts had to be overcome.

1. Introduction

Mojokerto has developed dozens of ecovillages because it can become an income generation for the district or for the village itself. One of the ecovillages is Tanjungan Dam Ecovillage. Tanjungan Ecovillage fully operated in 2015 and the visitors reach thousands at weekends before the pandemic and decrease to hundreds after the pandemic. Tourism, one of the fastest-growing industries worldwide, significantly impacts environmental sustainability, particularly regarding waste generation. The country's socio-economic development depends on the tourism industry expanding. However, the amount of waste generated by tourism activities will undoubtedly rise [1]. Tourist areas tend to generate higher volumes and different types of waste compared to non-tourist areas due to factors such as increased consumption, varying tourist behaviors, and seasonal fluctuations.. Although tourism waste is systematically concealed behind residential waste flows, it makes a significant contribution to the generation of municipal solid waste. Municipal fees are set without accurate information about the contributions made by waste producers, which results in budget imbalances and cross-subsidies between residential and commercial activities [2].

Tourist areas face unique challenges in managing the inflow of solid waste, requiring specialized waste characterization strategies. Solid waste characterization is a central component in the pursuit of sustainable waste management. It provides the necessary understanding of waste composition, which aids in strategizing appropriate waste handling and treatment systems.

The heterogeneous nature and high variability in the waste composition, combined with transient population spikes, can make waste characterization a complex task. There are at least three reasons why investigating the connection between tourism and the generation of solid waste is worthwhile. First, solid waste generation is particularly high in the tourism industry. Second, as consumption occurs in the exporting nation, international tourist inflows constitute an additional source of solid waste in the tourist destination. As a result, international tourist inflows are a distinct type of export. Thirdly, improper solid waste management may decline a destination's reputation because the environment's resources are used in the production of the tourist experience [3].

The Tanjungan Ecovillage has not had a solid waste management system yet. So, it is needed to estimate solid waste generation and the composition of waste as the first step to developing a solid waste management system. Proper solid waste management is one strategy for preserving a healthy ecosystem. Solid waste management is calculated to be one of the most significant scope related to tourism activities. As part of the businesses, tourism industries utilize massive amounts of single-use packaging and consumer goods, same as large sums of organic and food waste [4]. Particularly in areas that are more rural or have a low population, waste can potentially overburden waste management systems. Because many cities have peak seasons, this increase is frequently seasonal.. Solid waste characterization is a crucial task with unique challenges. It provides the foundational knowledge necessary to develop tailored waste management strategies that can effectively mitigate environmental impacts. As the destination continues to grow, incorporating robust waste characterization studies and sustainable waste management practices will be essential for preserving the environment and ensuring the long-term viability of the area. Maintaining a clean and attractive environment is crucial in tourism areas. By effectively managing and reducing waste, tourist sites can remain clean, thus ensuring they continue to attract visitors..

The aims of the study are to present waste composition and improve waste management at the tourism destination of Tanjungan Dam Ecovillage, Mojokerto. The waste characterization survey will describe what types of components consist of significant parts of waste generation. Waste characterization data informs the planning and operation of waste management systems. This could involve determining the size and type of waste handling facilities needed, the frequency of waste collection, and strategies for handling peak tourist seasons. Proper waste characterization and subsequent management can significantly improve public health by reducing pollution, minimizing disease vectors, and creating a more pleasant environment for both locals and tourists. Waste characterization can also be used as an educational tool to raise awareness among visitors about the impact of their consumption habits and encourage more sustainable behaviors. The data can also inform policy development. For example, if a significant amount of waste is found to be single-use plastics, policymakers village level might introduce regulations to limit their use [5].

2. Method

Various methodologies exist for the characterization of solid waste. They usually involve collection, sorting, weighing, and laboratory analysis. In the study, the steps taken up to weighing.

2.1. Sampling area

The study was conducted at Tanjungan Dam Ecovillage, Mojokerto in March-April 2022. The research consisted of three main stages as below:

a. Sampling Waste samples are collected from different sources
b. Sorting and classification: The collected waste samples are sorted into various categories based on their type (organic and inorganic)
c. Weighing After sorting, each waste category is weighed to determine its proportion in the total waste stream

Ten spots around the destination were determined as collection points of waste sources. The spots were often visited by tourists. In the collection spots were provided trash bags so the tourists can dispose of the waste into it.

2.2. Solid waste sampling

Sampling methods and procedures for the characterization of the wastes were derived by using Standard Test Method for the Determination of the Composition of Unprocessed Municipal Solid Waste (SNI 19-3964-1994). Sampling was carried out for a period of twelve days all around the Tanjungan Dam Ecovilage in order to estimate the amount of solid waste. The initial sampling for the four days was intended to approximate the main waste portions. The goal was to make the segregation process clearer. The bulk of the waste sampling took place over the next eight days. In order to guarantee that the analysis results revealed the amount of waste generated by the ecovillage, all wastes were collected during the destination's operation hours. The total amount of waste at the collection site would be gathered and measured the following day. All samples were separated into organic and inorganic waste in the distinct area. One more waste that had been produced at Tanjungan Ecovillage was yard waste. Leaves and grass were the components of yard waste that are collected daily from the roads surrounding the ecovillage. The worker would remove the garbage from the destination. Yard waste generation was also estimated in this study. The study also included interview with officers of the ecovillage relate to their knowledge of solid waste management.

3. Results and discussions

Solid waste characterization is a critical component in the pursuit of sustainable waste management. It provides the necessary understanding of waste composition, which aids in strategizing appropriate waste handling and treatment systems. It also plays a vital role in shaping policies, guiding infrastructure development, and optimizing waste management systems to address the challenges posed by solid waste effectively.

3.1. Amount of solid waste generation

In order to accommodate the subsequent sustainable garbage disposal options and carry out additional research, it is essential to observe the characteristics (quantity and content) of waste in Tanjungan Dam Ecovillage. Research on waste estimation is crucial for improving opportunities to prevent solid waste generation in the future at every step. Table. 1 below presents the amount of waste in the study.

Table. 1 Amount of solid waste generation

Type of waste	Average generation rate (kg/day)
Organic	1.68
Inorganic	5.94
Yard	11.2
Sum	18.82

According to the study, 18.82 kg of waste is produced daily on average in the destination area. The majority of the waste produced is yard waste. Yard waste is one of the key components of municipal solid waste and can play a vital role in implementing a zero-waste strategy to achieve sustainable municipal solid waste management. Yard waste refers to organic materials generated from residential or commercial landscapes, gardens, and outdoor spaces. It includes various types of biodegradable materials commonly found in yards, including garden waste, leaves, and grass clipping [6]. In the destination area, there are a lot of plants and grass around the dam so street sweeping generates yard waste. The worker will sweep the fallen leaves and cut the grass. There is no specific landfill in the area so the waste will be disposed of in an open dumping area. Yard waste is typically composed of organic matter and can be beneficially managed through composting mulching, or other environmentally friendly practices. Proper yard waste management helps reduce landfill waste,

conserve resources, and promote sustainable landscaping and gardening. Composting is one of the strategies for effective yard waste management. Encourage residents to compost yard waste on-site. Composting allows organic materials such as grass clippings, leaves, branches, and garden trimmings to decompose naturally and produce nutrient-rich compost [7].

The food scraps left over from visitors make up the bulk of the organic waste. Food waste is the fundamental part of waste delivered by the objective, portraying 1.68 kg/day. This includes leftovers from lunch and breakfast packs. The sources of food waste vary greatly. The likelihood of recycling increases with the amount of food waste. Food waste management refers to the processes and strategies employed to reduce, recover, and properly handle food waste throughout its lifecycle. Prevention and minimization by encouraging tourists and hospitality establishments to reduce food waste at the source by promoting portion control, offering smaller serving sizes, providing clear information about menu items, educate and raising awareness among tourists and hospitality staff about the environmental and social impacts of food waste, emphasizing the importance of reducing food waste through responsible consumption [8]. Food waste recycling and composting are other strategies of food waste management, developing or supporting infrastructure for food waste recycling and composting, enabling the organic portion of food waste to be transformed into valuable compost or biogas. Promote the separation of food waste from other waste streams and facilitate its collection and processing at dedicated facilities.

3.2. Anorganic waste

Inorganic waste is the second-largest part of the waste created in the destination. Table, 2 represent the composition of anorganic waste.

Table. 2 Composition of anorganic waste

Type of waste	Average generation rate (kg/day)
Plastic bottle and glass	1.32
Beverage box	1.22
Food packaging	1.16
Plastic packaging	1.07
Plastic bag	0.86
Styrofoam	0.31
Sum	5.94

Plastic bottles and glasses are the highest amount of anorganic waste. The waste is always separated by tenants owner because it can be easily change with money. The majority of food packaging and beverage box are made to be used once. Because of the plastic coating on its surface, it cannot be recycled or reused. Food packaging and beverage box waste can be reduced by reducing the sources. When providing visitors with a meal, the canteen of the destination still uses food packaging and plastic bag. The only other option for reducing the waste is to stop using food packaging and plastic bag. Plastic packaging mainly creates from snacks brought by tourists. Styrofoam generally generates from food wrappers brought by visitors. .Inorganic waste management refers to the proper handling, disposal, and recycling of non-biodegradable materials generated by human activities. The best way to control waste is to avoid and reduce waste production, taking into account the extensive environmental impact of non-biodegradable products. The study of [9] highlights that awareness can make certain changes in plastic waste generation. Different awareness campaigns can be used to bridge the knowledge–practice gap. The circular economy may present an opportunity to transform plastic waste into a variety of useful and decorative goods that can both contribute to the reduction of plastic waste and generate revenue for the local community. The result of interview with officers of the ecovillage represents that the average number of destination visitors is 60 people per day. So the average waste generation of the eco village is 0.13 kg/cap/day.

3.3. Improving solid waste management

The officer ecovillage interview's findings indicate that the general waste collection method at the destination is unfavorable. It is also observed that open dumping is a prevalent practice. The ecovillage's solid waste management was collected, transported, and disposed of with low costs and effectiveness. In addition, no segregation of waste, no control of inorganic waste, no regular schedule of yard waste collection, and no education for the tourists to rising their awareness about solid waste. To accommodate the waste's quality, quantity, and composition, the waste handling system must be tmproved. Sustainable environment and sustainable tourism need the reduction, collection and disposal of waste properly [10]. According to the estimate, the following types of waste can be reduced: food waste and plastic. Composting food waste is possible because food waste accounts for the most waste. Organic food waste has the potential to be recovered and used to make fertilizers.

Effective waste characterization can guide sustainable waste management strategies in tourist areas, which may include:

1. Waste reduction program with a clear understanding of waste composition, authorities can design effective waste reduction programs targeting specific waste types. For example, initiatives to minimize single-use plastics can be formulated based on waste characterization data
2. Recycling and composting based on the waste characterization. Recycling programs can be customized to capture the most commonly disposed of recyclable materials. Additionally, organic waste, often abundant in tourist areas, can be composted, reducing the volume of waste directed to landfills**.** According to a study published in [11], the utilization of waste collection systems at tourist destinations has an impact on public health, the state of the area, and the recovery of materials for recycling and reusing.
3. Visitor education. Characterization data can support awareness campaigns that educate visitors about responsible waste disposal and the benefits of waste reduction, reuse, and recycling**.** Tourists and locals alike lack environmental education, which turns landscapes into dumps and poses a threat to tourism growth on a local or regional scale [12].
4. Policy formulation .Waste characterization can guide policy-making, such as implementing appropriate waste management policies and encouraging sustainable practices among businesses in the tourism sector. By utilizing the appropriate economic instruments and policies, it is essential to internalize the negative external effects that tourism has on the environment [13].

Particularly useful in the management of waste handling is the use of integrated strategies. Strong collaboration is required between the community, the government, businesses, and researchers in order to achieve the best path for waste management with government-friendly strategies, consumer responsibility, and advanced materials and methods [14]. The study directed by [15] recommends to better administration of strong squanders at the review region, the ecovillage official ought to work on the association of assortment and sanitization by the portion of more staff for expanding the recurrence of cleaning. In addition, the officer ought to reduce costs by charging extra for food and other items brought in from outside. It is necessary to use propaganda and education to make visitors more aware of their responsibility to protect the environment. The dissemination of solid waste management regulations to officials, employees, and tourists in a variety of formats is urgently required.

Conclusions

According to the findings, the tourist destination produced approximately 18.82 kg of solid waste per day. Yard waste was another type of waste produced by the destination, weighing approximately 11.2 kilograms per day. The interview with the officers revealed that there was still low awareness of waste management. In addition, no segregation of waste, no control of inorganic waste, no regular schedule of yard waste collection, and no education for the tourists to rise their awareness about solid waste The ecovillage's solid waste management was collected, transported, and disposed of low costs and

effectiveness. By improving solid waste management, these facts had to be overcome to improve the system for managing solid waste and ensure the ecovillage's sustainability.

References

[1] Pham Phu S T, Fujiwara T, Hoang Minh G, & Pham Van D 2019 *Waste Management & Research*, **37**(11), 1077–1088. doi:10.1177/0734242x19862042
[2] Diaz-Farina E, Díaz-Hernández J J, & Padrón-Fumero N 2020 *Waste Management* **102**, 587–597. doi:10.1016/j.wasman.2019.11.023More references
[3] Arbulú I, Lozano J, & Rey-Maquieira J 2015 *Waste Management* **46,** 628–636. doi:10.1016/j.wasman.2015.04.014
[4] Edmundo M, Rodrigo N 2015 *Waste Management and Research* **.33**, 593–594. DOI: 10.1177/0734242X15594982
[5] Arbulú I, Lozano J, & Rey-Maquieira J 2016 *Waste Management* **51**, 252–258. doi:10.1016/j.wasman.2016.03.007
[6] Islam M R, Kabir G, Wai Ng K T & Ali S M 2022 *Environmental Science and Pollution Research* **29**, 46859–46874
[7] Rahman M H A, Sadi T, Ahmad A A, Masri I N, Yusoff M M, Kamaruddin H, Shakri N A, Hamid M A K, Ab. Malek R 2020 *Heliyon*, **6**(7), e04486. doi:10.1016/j.heliyon.2020.e04486
[8] Wang L, Filimonau V, & Li Y 2020 *Journal of Cleaner Production*, 123890. doi:10.1016/j.jclepro.2020.123890
[9] Pandey P, Dhiman M, Chopra P, Adlakha A 2022 *Circular Economy and Sustainability* https://doi.org/10.1007/s43615-022-00216-3
[10] Perkumienè D. Atalay A, Safaa L, Grigienè J. 2023 *Recycling* **3**, 8, 56. https://doi.org/10.3390/recycling8040056
[11] Rodrigues S, Martinho G, Pires A 2016 *Journal of Cleaner Production* **113**, 374-387 https://doi.org/10.1016/j.jclepro.2015.09.143
[12] Mihai F C 2013 *Present Environment and Sustainable Development* **7** (1), 214-221. Hal-01150675
[13] Martins A M, Cró S 2021 Sustainability **13**, 5238. https://doi.org/10.3390/su13095238
[14] Mehran M T, Naqvi S R, Haider M A, Saeed M, Shahbaz M, Al-Ansari T 2021 *Energy Sources: Part A Recover. Util. Environ. Eff.*, 1–10, DOI: 10.1080/15567036.2020.1869869
[15] Giao, N.T. 2022 *International Journal of Environment, Agriculture and Biotechnology*, **5**(4)

IOP Conference Series: Earth and Environmental Science

Table of contents

Volume 1257

2023

← Previous issue Next issue →

The 5th Symposium of International Waste Working Group - Asian Regional Branch (IWWG-ARB) 06/03/2023 - 08/03/2023 Nusa Dua, Bali, Indonesia

Accepted papers received: 12 October 2023
Published online: 07 November 2023

PAPER • **OPEN ACCESS**

Preface

To cite this article: 2023 *IOP Conf. Ser.: Earth Environ. Sci.* **1257** 011001

PREFACE

The 5th Symposium of International Waste Working Group – Asian Regional Branch (IWWG-ARB) is a forum to provide an academic discussion to encourage and support economic and ecological (sustainable and integrated) waste management worldwide and to promote scientific advancement in the field. This symposium was held at Mercure Hotel, Nusa Dua, Bali, Indonesia, starting from 6th to 8th March 2023. More challenges emerge in a current more volatile, uncertain, complex, ubiquity environment, so it needs innovation and new approach. Innovation and a new approach to overcoming challenges should also be informed for decision-makers, aimed at influencing legislation, education, or providing practical applications. This purpose will be accomplished by learning from the past and analyzing the present, so that it will develop new ideas, scenarios, and visions for the future.

With those objectives, the IWWG was conceived as a think tank based on scientific principles but essentially application-oriented. In addition, the IWWG has a light, non-bureaucratic organization which allows us to focus on a variety of subjects, react efficiently to relevant problems in the field of solid waste management, and communicate effectively within the professional community. We would like to thank the keynote and invited speakers for their contributions to this symposium. The following is:

Prof. Pinjing He (Tongji University, China)

Prof. Jae Young Kim (Seoul National University, Republic of Korea)

Prof. Agamutu Pariatamby (Sunway University)

Prof. Evangelos Gidarakos (IWWG President)

Dr. Costas Velis (University of Leeds, UK)

Prof. William Clarke (University of Queensland, Australia)

Prof. Sandyha Babel (SIIT Thammasat University)

Dr. Benno Rahardyan (Bandung Institute of Technology)

The entire organizing committee that made this event successful was:

Organizer

Bandung Institute of Technology

Co-Organizers

Sepuluh Nopember Institute of Technology

Udayana University

Islam Indonesia University

Outline of Committee

Steering Committee:

Chairman	Prof. Dr. Ir. Enri Damanhuri (Institut Teknologi Bandung)
Members	Prof. Pin-Jing He (Tongji University, China)
	Prof. Jae Young Kim (Seoul National University, Republic of Korea)
	Prof. Toshihiko Matsuto (Hokkaido University, Japan)

Organizing Committee:

Chairman	Ir. Emenda Sembiring, ST., MT., M.Eng.Sc., Ph.D
Vice-Chairman	Dr. Ir. I Made Wahyu Widyarsana, ST., MT
Secretary	Elprida Agustina, ST., MT Dinda Annisa Nurdiani, ST., MT Dinan Anshary, S.Pd
Treasurer	Dr. Opy Kurniasari, ST., MT
Vice-Treasurer	Ricky Wahyu Nugraha, A.Md
Program	Dr. Benno Rahardyan, ST., MT Dr. Hijrah Purnama, ST, MT (UII) Dr. Ni Dwipayanti (Udayana)
Logistic	Attar H. Ramadhan, ST., MT Deni Eriyanto Iqbal Fauzi, S.Si

	Eef Sutisna
Documentation and website	Nugi Nugraha, ST

Scientific Committee:

Chairman	Dr. Ir. Tri Padmi
Members	Dr. Moch. Chaerul, ST., MT Sukandar, S.Si., MT., Ph.D IDAA Warmadewanthi, ST, MT, PhD (ITS)

This event was held with a hybrid concept in which some of the keynote or invited speakers delivered virtual presentations. Through this hybrid method, participants at the event venue can watch discussions via Zoom from several Keynote or Invited Speakers who were unable to attend due to travel restrictions or tight schedules. The online speakers were Prof. Pinjing He (Tongji University, China) and Dr. Costas Velis (University of Leeds, UK). At the beginning of each event, it will be opened with talks from the Keynote Speaker in the main atrium, followed by parallel sessions which were divided into two rooms according to the theme and sub-themes set for this event. The following details the main themes and sub-themes of The 5th IWWG-ARB:

Theme

"Solid Waste Technology and Management Challenges in Post-Covid and Plastics Treaty"

Topics

1. Solid Waste Management
2. Generation and Waste Characterization
3. Waste Policy and Education
4. Economic and Environmental Assessment
5. Waste Treatment and Technology

Each keynote speaker has time to deliver their talks for 30 minutes including a Q&A session, while invited speakers and participants have time to deliver their talks for 20 minutes and 5 minutes for Q&A. Each of the talks from keynote speakers invited speakers, and participants will be guided by a moderator. Furthermore, during the virtual talks there were not many significant technical problems. However, it is necessary to pay attention to the time zone of each speaker's country of origin and then a rehearsal must

also be held before D-day to avoid fatal technical errors. The 5th IWWG-ARB was attended by around 60-70 participants from various countries around the world such as Greece, Australia, Thailand, Malaysia, Korea, Taiwan, Philippines, Japan, and China.

For Bandung Institute of Technology, it is an honor to be the host of the 5th Symposium of the International Waste Working Group – Asian Regional Branch (IWWG-ARB) in Bali, Indonesia. Hence, we would like to thank all the participants and speakers for joining the 5th Symposium of the International Waste Working Group – Asian Regional Branch (IWWG-ARB).

Table of contents

Volume 1257

2023

← Previous issue Next issue →

The 5th Symposium of International Waste Working Group - Asian Regional Branch (IWWG-ARB) 06/03/2023 - 08/03/2023 Nusa Dua, Bali, Indonesia

Accepted papers received: 12 October 2023
Published online: 07 November 2023

Open all abstracts

Preface

Papers

Role of Wind, Ground Surface, and Slope in Plastic Waste Movement on Terrestrial Environments

Z B A Khoeriyah and E Sembiring

View article PDF

OPEN ACCESS 012008

Socio-behavioral assessment of household solid waste management: The case of Barangay Calicanto, Philippines

A C Treyes, E Osorio, M A Tanchuling, M D Andal, B Requejo, B Inocencio and C Panopio

View article PDF

OPEN ACCESS 012009

Post Consumed Textile Waste Management and its Impacts on the Environment and Economy in Bandung City

A D Prayuda and E Sembiring

View article PDF

OPEN ACCESS 012010

Comprehensive assessment of solid waste management of a highly urbanized city in Metro Manila, Philippines during the COVID-19 pandemic

E Osorio, L Bularan, M Tanchuling, S Ty, B Inocencio, P Lu, B Requejo and L Caraan

View article PDF

OPEN ACCESS 012011

Sustainable Leachate Treatment Plant System at Landfill Site: A Multicriteria Analysis Approach

Mochammad Chaerul, Gina Mauluddina, Elprida Agustina and Dinda Annisa Nurdiani

View article PDF

OPEN ACCESS 012012

A sustainable approach to managing city park waste through biochar as a renewable energy source

F Hasfita, E Sembiring and E Damanhuri

View article PDF

OPEN ACCESS 012013

Estimation and Spatial Analysis of Agriculture Plastic Waste Case Study: Karangdowo Subdistrict, Klaten Regency, Central Java Indonesia

S. Rahmawati, Y. Yuriandala, Ega and H. P. Prakoso

View article PDF

OPEN ACCESS 012014

The Influence of Pandemic COVID-19 on Hazardous Waste Management from Hospital A in Yogyakarta

F B Maziya, R S Luthi, F M Iresha, A U Abidin and Kasam

View article PDF

OPEN ACCESS 012015

Recycling Potential and Processing Technology of Plastic Waste in Indonesia's Metropolitan City (Case Study: Bandung City, West Java, Indonesia)

I M W Widyarsana and D A Nurdiani

View article PDF

OPEN ACCESS 012016

Solid waste characterization at Tanjungan dam ecovillage, Mojokerto, Indonesia

E Tarigan, T L Simangunsong, A A Athaya and P D P Parapaga

View article PDF

JOURNAL LINKS

Journal home

Journal scope

Information for organizers

Information for authors

Contact us