

Commentary

Seasonal Waste Management in the Southern Coasts of Bali, Indonesia

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1. Introduction

The current waste problem in Indonesia has drawn serious attention from the local, national, and international communities. According to [Jambeck et al. \(2015\)](#), Indonesia produces 0.48 to 1.29 million metric tons of waste to the oceans every year. It makes the country become the second-largest marine debris contributor after China ([Jambeck et al., 2015](#)). Marine waste is defined as any manufactured or processed solid material produced by humans which is discarded or disposed of in the marine and coastal environment ([Jeftic et al., 2009](#)). The population growth and the changing lifestyle of modern Indonesian society have increased waste production, especially in urban areas ([Prajati & Pesurnay, 2019](#)). Floating marine debris is distributed and deposited along the coastlines due to the dynamic aspects of oceanography, i.e., currents, waves, and wind ([Galgani et al., 2015](#); [Tong et al., 2021](#)). Seasonal changes influence the movement patterns and the speed of currents and wind, which will affect the volume of marine waste deposited in the coastal areas.

The high rainfall during the rainy or monsoon season (November-April) increases the amount of waste washed into waterways (sewers and rivers), increasing marine debris. During the rainy season, the currents and wind speed on the surface tend to be strong, washing the floating marine debris, especially plastic, ashore ([Tong et al., 2021](#)). The nature of plastic waste, which tends to be lightweight, buoyant, and easy to be carried away by currents, wind, and tides, contributes to this debris accumulating along the coastlines ([Lavers & Bond, 2017](#)). This has caused a growing volume of plastic waste on the coasts of Indonesia every year.

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This phenomenon of seasonal waste increase occurs in the coastal areas of Indonesia, including Bali (Maharta et al., 2021; Putra & Christiawan, 2019). For a few years, the seasonal waste accumulating on Bali's coastlines, especially on the beaches in the south, has garnered growing concerns from various communities, including local and international. It is because the beaches in south Bali are known as popular tourist destinations for domestic and international visitors. The beaches in south Bali frequently polluted by seasonal waste are the beaches in Kuta District, namely Seminyak, Legian, Kuta, Jerman, Kedonganan, and Kelan Beach (Putra & Christiawan, 2019). The most significant volume of seasonal waste on Bali's southern beaches is usually recorded during the monsoon season (November-April) (Husrin et al., 2017). According to the research by Putra and Christiawan (2019), from 2017 until 2018, the volume of seasonal waste deposited on the southern coasts of Bali ranged from 21 tons to 2,176.5 tons. This waste is in the form of plastic debris, organic materials, foams, household appliances, and so on (Husrin et al., 2017). The volume of seasonal waste is likely to increase along with the growing population and community needs if it is not handled appropriately from the source.

This paper will discuss the causes and sources of seasonal waste events that occurred on the southern coast of Bali. The land waste that leaks to the ocean is caused by the lack of waste management on the land (Jambeck et al., 2015). Proper and adequate waste management is essential when looking at the impacts caused by marine waste that littering the coasts. Especially for Bali Island, which relies heavily on the tourism sector, source-based waste management becomes urgent. To reduce the amount of ocean waste in Bali, it is crucial to know the extent of waste management that the Bali Provincial Government has implemented. This paper then further reviews the waste management that has been implemented through formal regulation and waste management facilities.

2. The causes and sources of the seasonal waste on Bali's southern coasts

Garbage originating from land-based activities is the primary source of waste polluting the ocean. Research showed that the waste from land accounts for 80% of the total composition of ocean waste. According to Jambeck et al. (2015) and Lebreton et al. (2017), the population growth and rapid economic activity in the urban areas, if not accompanied by adequate waste management infrastructure, are primary causes of waste leakage from land to the ocean. Another primary cause is the lack of knowledge and understanding in the community about the importance of managing waste locally, which could be done through sorting, recycling, and reducing the use of synthetic products such as plastic. In addition, insufficient public knowledge about the dangers posed by ocean waste to marine life and the coastal environment contributes to the lack of public awareness of these problems.

In the case of Bali's seasonal waste that piles up on the southern coasts of the island, most of the waste is predicted to come from the garbage floating in the Bali Strait, which occurs during the rainy season (Husrin et al., 2017; Yunanto et al., 2014). According to Husrin et al. (2017), the volume of deposited trash quadruples during the rainy season. So far, most studies report that marine debris in the Bali Strait is washed towards the coastlines in southern areas of Badung Regency, especially Kuta Beach (Maharta et al., 2021; Putra & Christiawan, 2019). Based on the analysis of the hydrodynamic model that simulated trash movement by Diastomo et al. (2021) and Maharta et al. (2021), marine waste piling up at Kuta Beach is dominated by the debris drifting from the rivers into the Bali Strait. From the results of the trajectory model, it is also known that during the rainy season, rivers that are closest to Kuta Beach can deposit up to 68% of the garbage, with the approximate time of just 1 – 2.5 days for the waste to reach Kuta Beach (Maharta et al., 2021).

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the coastlines. By the end of 2015, a total of 6 – 10 tons of seasonal waste was cleaned up from Kuta Beach by the local Government every day (Husrin et al., 2017).

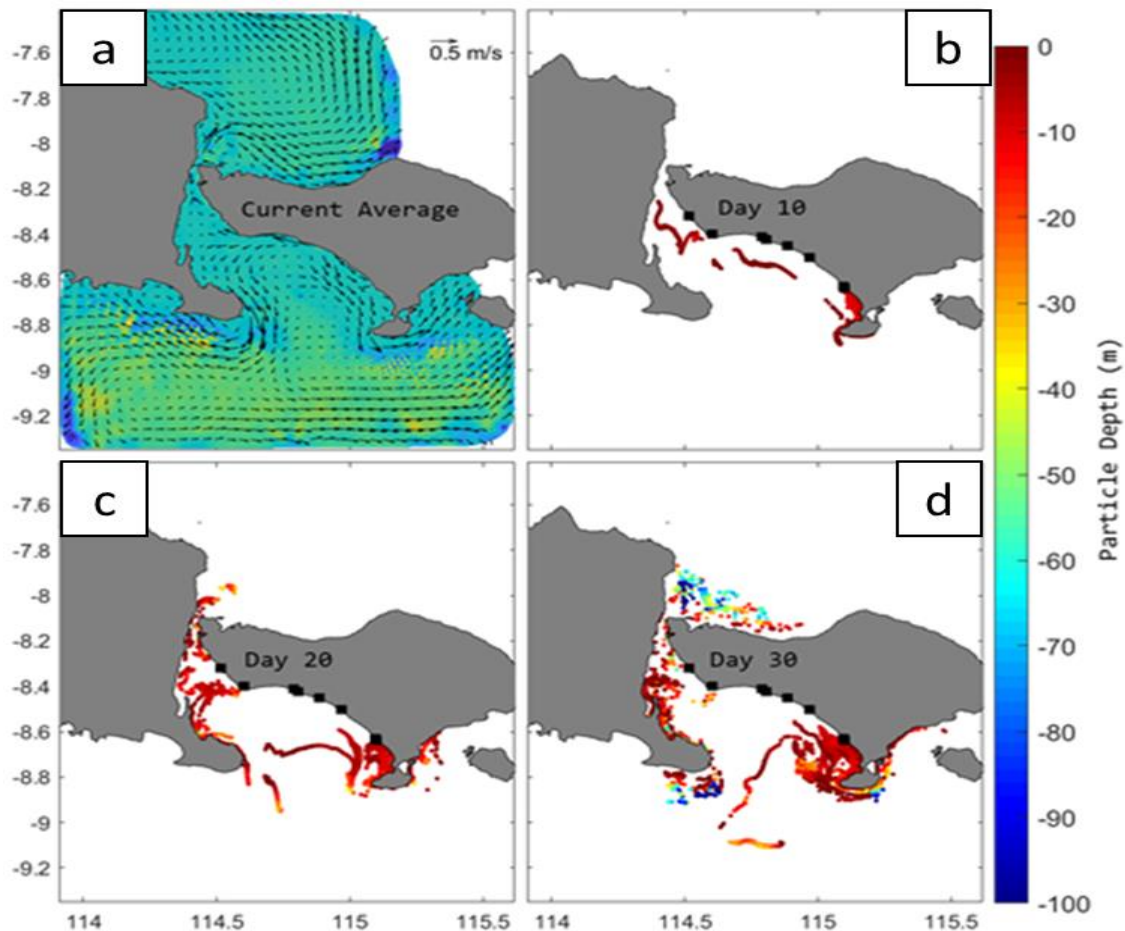


Figure 1. The hydrodynamic model of particle movement from the river to Bali Strait simulated by Maharta et al. (2021). Black box: river source, (a) Current average, (b) Particle movements on day 10, (c) Particle movements on day 20, (d) Particle movements on day 30.

3. Waste management in Bali

As regulated in Indonesian Government (2008) and the Minister of Public Works of Indonesia Regulation No. 03/PRT/M/2013, the waste management facilities generally comprise temporary disposal sites, 3R waste disposal sites, and final processing sites or landfills. These facilities are available in the coastal areas in Bali. The waste management flow in Bali still utilizes the old system, which is collecting, transporting, and disposing of the garbage. This same system is also implemented on Bali's southern coasts. Based on the data collected by Widyarsana et al. (2020) in 2018, the waste management facilities in south Bali (Denpasar City and Badung Regency) consist of 45 temporary disposal sites and 28 temporary disposal sites for 3R, and one final processing site known as Suwung Landfill. The data also shows that the highest garbage transporting service is in Denpasar City, reaching 83.5% compared to 40% in Badung Regency. This situation affected the waste management status between these two areas. Based on the latest data collection during the Bali Partnership program (Bali Partnership Platform, 2019), a total of 96% (1,360 tons/day) of produced waste in Denpasar City was already handled, with 94% being done at the temporary disposal sites and 2% was recycled. While, the amount of waste managed in the Badung Regency was only 73% (599 tons/day), with 67% done at the temporary disposal sites and 6% recycled. The volume of unmanaged waste was 286 tons every day combined between Denpasar (64 tons/day) and Badung Regency (222 tons/day). This unmanaged waste was either burned, discarded to the environment, or washed away in the water streams. This shows that the waste management operation in Bali is still really not optimal. Even though, the implementation of waste management in south Bali is relatively in

accordance with the laws and regulations set by the national and regional governments, yet the waste management from the source, especially in household level, is still very low.

Another main factor of mismanaged waste is low public awareness at the household level to manage their waste before being transported to the waste management facilities (Hendra, 2016). The locals mindset remains that the final stage of waste management still relies on the landfill, which has a limited waste storage capacity, or littering in the environment, including in river. As a result, many of waste are leakage to the environment. In response to the issue, the Governor of Bali issued another written regulation on source-based waste management under the Bali Government (2019) concerning Source-based Waste Management. The regulation highlights the obligation of managing waste from the very base level, such as from household level. However, the effectivity of the regulation is not assessed yet since it was released in 2019. The Government should conduct a regular evaluation on the implementation of the regulation. The evaluation will help to identify the changes in public awareness and behaviour. Therefore, a better strategy can be formulated to optimize the waste source-based management

4. Strategies to reduce seasonal waste generation

Bali Government strongly supports better waste management to reduce the waste leakage from the waters to the environment. The Government has issued several laws related to the issue. Referring to Indonesian Government (2008) on Waste Management, the Bali Government issued a written regulation in the form of Bali Provincial Government (2011) concerning Waste Management. Due to the increasing amount of plastic waste compared to other types of waste in Bali, the Governor of Bali then issued a specific regulation to limit plastic waste generation, regulated in the Bali Provincial Government (2018) concerning the Limitation of Single-use Plastic Waste Generation. In 2019, the Governor of Bali issued another written regulation on source-based waste management under the Bali Government (2019) concerning Source-based Waste Management.

Although the waste management operation needs to improve, the main problem in waste management on the southern coasts of Bali lies in the lack of public awareness to manage the waste from its source, which is at the household level. Even though the written regulations have been established, the waste problem will keep on rising if there is no cooperation between the community and the Government. Therefore, the strategy formulated to deal with the waste problem should focus on the community level. In a quick study conducted by the World Bank about the condition of solid waste in Indonesia (World Bank, 2018), some strategies which can be taken to increase public awareness include:

- Collaborate with local Government, NGOs, residents, religious leaders, and local entrepreneurs to carry out campaign programs that support raising public awareness at the local scale.
- Collaborate with primary and secondary schools to increase the awareness on the importance of waste management from an early age for the younger generations. These activities to raise awareness for students can be included in the school curriculum so the students can practice them directly.
- Initiate voluntary clean-up movements on the coastlines led by the community to reduce the mounting trash at the beach.
- Implement strict sanctions on the community members for neglecting or violating waste management.

In addition to the above strategies, it is also essential to formally establish cooperation between the city and regency-level leaders since ocean waste does not come from one particular area only. Especially regarding the seasonal waste problem in south Bali, the local Government in the western region of Bali and the eastern region of Java should draw up a cooperation agreement on land waste management in their respective areas. This inter-regional agreement will enable the regional leaders to harmonize their land waste management programs. The followings are some programs that can be carried out in each region, namely:

- Educate domestic and international tourists about the seasonal waste problem occurring on the coasts
- Do regular beach and river clean-up activities by involving the local community
- Increase the number of waste management facilities, including recycling posts and waste banks

- Work with NGOs/communities that are concerned about river and ocean waste issues, such as Sungai Watch, Komunitas Peduli Sungai, and Trash Hero.

To developing strategies to increase the awareness of the local community, evaluating the policies that have been implemented is also very important. Monitoring and evaluating the policies, such as limiting the use of single-use plastic (Bali Provincial Government, 2018) and reducing waste generation from the source (Bali Government, 2019), can provide information and data on the effectiveness of the said policies. This will assist Bali's Government in determining the next steps in improving the waste management efforts on the island, including the coastal areas of Bali. In policy monitoring and evaluation, determining the evaluation method is crucial. Therefore, a collaboration with academics, researchers, and other relevant stakeholders is the key to success in monitoring and evaluating policies.

Conclusions

Most of the seasonal waste deposited along the coastlines in south Bali is predicted to come from the floating ocean waste in Bali Strait, which occurs during the rainy or monsoon season. Seasonal waste can negatively impact the local and regional economies in Bali. The Government of Bali has addressed the seasonal waste problem by issuing several new regulations to reduce single-use plastic waste and manage waste from the source to reduce the waste leakage in the environment. However, the waste management operation is still not optimal, leaving a considerable amount of unmanaged waste. Therefore, handling the waste from the source, whether at the household level or other economic activities (for example, industry and tourism), is crucial to reduce waste leakage into the environment and waste accumulation in landfills. The strategy formulation of waste management should focus on the community aspects, which includes raising public awareness through collaborative efforts between local Government, NGOs, and other local stakeholders targeting the local community and younger generation—also initiating voluntary clean-up campaigns and implementing strict sanctions on those who violate the regulation. Lastly, establishing a collaboration and agreement with other city and regency-level leaders in Bali and other regions, such as east Java, will significantly help cut the waste leakage to the environment, especially marine environments.

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