Article

Indonesia Tourism Pandemic Coastal Plastic Waste : a Comprehensive Review

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Abstract: Marine waste become more crucial when it came to tourism. Several studies indicate tourism in the world become strong benefactor of economic growth. Indonesia itself has many tourism spot. Being an archipelagic country with more than 17,000 islands and > 54,700 km coastline. Indonesia has many MD scattered in coastal area. This become more concern because lot of waste of tourism made of plastic. Plastic isn't easily degradable, even if it was degradeted, it only become microplastic. Microplastic can't be ingested by marine organism because they haven't enzyme to disgest it. When it forced to going in marine organism body, its characterization to accumulate work and become toxic compound for marine organism. Waste management become greatly purpose of this review paper. Plastic management for tourism is needed. Recycle action and green waste management should be conducted in respective area. Beside of management waste. There's also plastic substitute material such as Polyhydroxybutyrate (PHB). PHB is biodegradable with bacteria and fungi. If plastic can be made with this substitute material it will be great advance for plastic waste management around the world. One of Indonesia advantage is being an topical and archipelagic country, there's several studies of bacteria that can produce PHB material in Indoneisa, such as *B. megaterium* or *Halomonas elongate*. Sago starch also found in Indonesia as a primary raw material for bacteria to processed it into PHB material.

Keywords: Waste, Plastic pollution, Marine waste

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1. Introduction

Marine waste, marine debris or ocean garbage is "any persistent, manufactured or processed solid material discarded, disposed or abandoned in the marine and coastal environment regardless who disposed it. Marine waste impacts all ocean ecosystems, it start from the sea surface to the sea floor along coastlines all over the world. Marine waste posing threat to marine wildlife including marine mammal, crustacean, bivalve, gastropod, coastal aves, etc. Indonesia is the most largest archipelagic country with more than 17,000 islands scatter around Java Sea, its coastline extends > 54,700 km, it has area that going straight to equator, around Java Sea, there's the highest species abundance and diversity or marine biodiversity, lying at the center of the globally significant Coral Triangle ecoregion become focused epicenter of marine biodiversity in the world (Purba et al., 2019). Tourism is one of the contributing factors of major economic growth worldwide. A total of 1326 million international tourist arrivals were recorded around the world in 2017. However, this growth in tourism is also arrive by the increases in several environmental and socio-economic lethal impacts, unfortunately that impact isn't always positive. There is a high impact on natural resources worldwide, the more common negative impact like emissions from transport and the impacts of all necessary infrastructure (airports, hotels etc.) (Obersteiner et al., 2021). With concern of COVID-19, there's new environmental setting derived from the COVID-19 lockdown generated conspicuous changes in the biological community of tourist spot in coastal area, the tourist spot become more clean and less waste scatter around. The COVID-19 lockdown program drove a reduction of pollution such as noise, odor, and litter on the tourist spot. Different types of anthropogenic stressors produce different impacts on biota around (Soto et al., 2021). Once COVID-19 end, it will be a total exposure of tourist spot, more people will come back to generate waste in the coastal area. A review will be conducted to determine best way manage coastal waste by tourism action.

2. Materials and Methods

The data performed through review of the existing literature, mainly peer-reviewed papers, articles and research report, but also from government reports and assessments and other literature regarding of the marine waste, tourism in the world and Indonesia. We used this data to analyze lethal tourism waste and categorized into different level. Finally, this data will determine solution for healthy eco-tourism. After we decide what object can be replace waste consumption, we search for its development around Indonesia and detailed review it.

3. Results

3.1. Tourism waste: Chemical Compound

Chemical compound of waste will become danger to organism if they ingestion can't proceed it, one of the chemical compound of tourism waste is microplastic. Microplastics are a complex polymers containing additive chemicals, organic material and living substances that can interact with biotic and abiotic components of all marine environments. These small particles are recalcitrant materials under marine exposure conditions, and can be considered emerging for the marine ecosystems (Guzzetti et al., 2018). Plastic wastes are accumulated in the aquatic ecosystems directly and indirectly by different type of sources. Land and ocean-based sources are lethal sources of plastic pollution in coastal and marine ecosystems. Major land-based plastic pollution sources are freshwater input, residential & domestic activities, tourism, and other economic actions, including harbor operations. Over 75% of marine plastic litter items are accumulated from land-based sources (Thushari & Senevirathna, 2020).

Endangered Marine Organism: Waste Assessment

Several studies, have reported that a wide range of marine organisms from small invertebrates to large vertebrates are vulnerable to microplastics ingestion, with lethal effects under different coastal environmental conditions. Marine organisms interact with these small particles without apparent effects. The danger itself isn't appear immediately, once they ingested it, microplastics cannot be digested or absorbed, marine organisms do not have the specific enzymatic to breakdown the synthetic polymers. Additional danger is added to microplastic ability to absorb and accumulate metals and POPs, such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs) and dichloro-diphenyl-trichloroethane (DDTs), on their surfaces from the surrounding environment. It has been proved to marine organism such as Arenicola marina L. respiration rates, in response to high doses of PLA, HDPE and PVC in sandy sediments (Guzzetti et al., 2018).

3.2. Frekuensi Pendaratan Penyu

The waste categorized as lethal waste regarding of their ability to degradable in certain condition. Several studies explore the relative risk to marine birds from plastic debris, estimated relative exposure and sensitivity to debris for 19 marine bird species across eight families Large Marine Ecosystem. Sensitivity factors can be determined by calculating overall sensitivity index of marine organism regarding of their species.

Table 1. Exposure factor (Good et al., 2020)

Exposure	Low (1)	Moderate (2)	High (3)
Spatial overlap, extent of overlap of predicted distribution of a species with predicted density of plastic debris	Low spatial overlap (1st tercile) of species and plastic debris	Intermediate spatial overlap (2nd tercile) of species and plastic debris	High spatial overlap (3rd tercile) of species

			and plastic debris
Foraging behavior, potential change in threat impact due to foraging behavior of a species	Primary foraging mode reduces impact	Primary foraging mode does not change impact	Primary foraging mode increases impact
Residence time, relative time spent by a species over the course of a year in the Large Marine Ecosystem	Time in ecosystem low (up to 4 months/year)	Time in ecosystem intermediate (5–8 months/year)	Time in ecosystem high (9–12 months/ year)

They combined sensitivity factor and esposure factor to make spearman correlation into graph that represent marine waste danger towards marine organism.

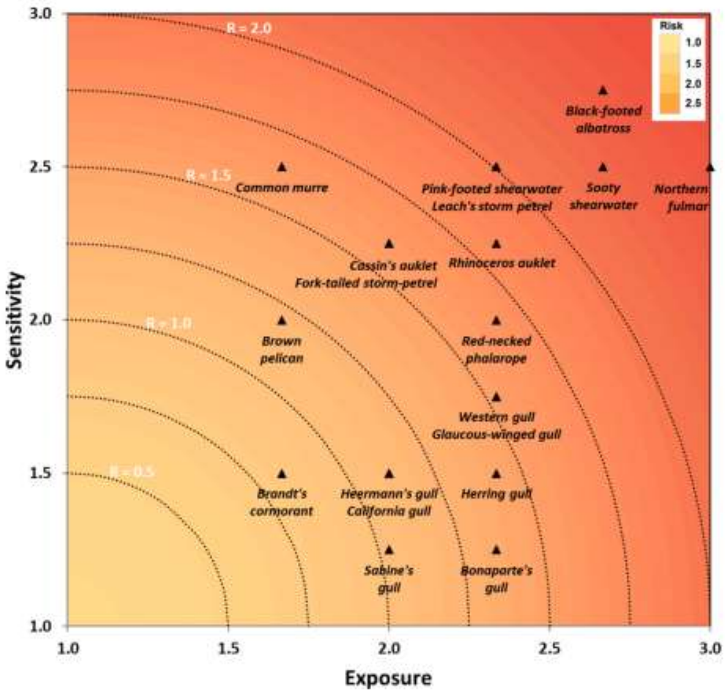

Fig 3. Estimated risk assessment score for marine organism

3.2. Mitigate The Impact

Green Waste Management

A low-carbon economy is an approach to resolving the sharp conflict between rapid economic growth and high CO2 emission. Tourism make another concern circumstance. Research found that tourism causes 5% of global CO2 emissions and these emissions are predicted to increase at an average rate of 3% per year up to 2035. Green waste (also called garden waste) biomass is ligneous in nature and is produced from various plant structures, including large tree branches from pruning, hedge cuttings, grass clippings, small branches, leaves, and other plant debris etc. The idea of using green waste biomass to produce bioenergy has been promoted in recent years study. A study estimates that green waste biomass from plant trimmings in Singapore could help offset 1.6% to 6.5% of the nation's fossil fuel consumption Generally, the green waste were scattered in space and differed in quantity. Green waste from tourist attractions, which can be centrally collected, is more suitable for bioenergy production (Shi et al., 2013).

Plastic Waste Substitute

Biopolymers are produced from carbon-neutral resources made largely of bio-polymers such as carbohydrates and proteins, which enhanced biodegradability relative to synthetic polymers (Kabir et al., 2020). There's biopolymer called polyhydroxyalkanoate (PHA). PHA is a polyester produced from fermentation of sugars or lipid (organic compounds) by certain microorganism, PHA also can be synthesized chemically. PHA is secondary metabolites produced by bacteria under limited nutrients, such as phosphorus, magnesium, and nitrogen (Hertadi et al., 2017). Biobased plastics can be used instead of polyethylene and polyethylene terephthalate in packaging. These are made up of raw materials such as sugarcane, maize, or potatoes. The agricultural materials are converted into chemical building blocks, which supply raw materials for the production of biobased plastic. Polyhydroxybutyrate (PHB) is one of polyhydroxyalkanoate (PHA), this biopolymer has properties which similar to common plastic, such as propylene. PHB become one of the most promising biopolymers, is a biogenic short-chain polyhydroxyalkanoate (PHA). Used as a carbon storage material and for storing intracellular energy in many microorganisms, including the bacteria Bacillus, Pseudomonas, and Alcaligenis euterophus (Awasthi et al., 2020). Degradation of biopolymers can be triggered by microbiota (e.g., fungi and bacteria) and/or other factors (e.g., hydrolysis, photolysis, mechanical, and/or thermal stress). The microbial degradation process involves excretion of extracellular enzymes that depolymerize the biopolymers. As extracellular enzymes are secreted outside the cell membrane, they allow microbes to derive energy and nutrients from polymers and catalyze the cycling of organic matter. During the depolymerization step, the biopolymer is decreased to a size that is water soluble and ready to be transported through the cell wall. After this it can be mineralized through microbial metabolic pathways, which involves chemical transformation and turnover of naturally occurring biopolymers (Kabir et al., 2020).

Indonesia Potential

There's several studies of bacteria that can produce PHB. Bacteria belong to Halomonas genus, such as H. boliviensis LC1, Halomonas sp. KM-1, and H. elongata BKAG 18 have been reported as the potential producer for PHB. What interesting in here is H. elongata BKAG 18 can be obtained from the unique terrestrial hypersaline environment, which was a salty mud crater located at Purwodadi-Grobogan, Central Java, Indonesia (Asyari et al., 2014). Further research was done, it determine H. elongate has enough potential to become PHB producer. Halomonas elongata BK-AG 18 was able to produce bioplastic in the modified high medium (HM) containing 5% NaCl with the yield about 21%. The structural analysis using FTIR and NMR to the bioplastic sample exhibited high similarity to the structure of (PHB). The bioplastic obtained by H. elongata had high mechanical property as concluded from the result of DSC analysis (Hertadi et al., 2017). Wherever it comes to bacteria, there's always question how much the cost to culture those bacteria until its produce more benefit than it cost. Then, how about starch. There's also several studies about starch potential in Indonesia that can produce PHB material. Sago starch is renewable carbon source for PHB production due to its high component of carbon, whereas nitrogen and phosphorous material are considerably low, sago is one of main resource of carbohydrate in Indonesia, it was found by east Indonesian and use mainly use sago as primary food resource. These process need enzymatic hydrolysis for degradation of the starch. A number of genus Bacillus have been reported as PHB producters, with the ability to produce 9-48% of PHB (Aslim et al., 2002). This PHB production from sago starch was carried by B. megaterium PSA10. After 72 hours of fermentation process, strain B. megaterium PSA10 can produce 52.28 % PHB of cell dry weight (CDW) using sago starch as carbon source,. The ability of strain PSA10 to produce PHB can provide a better alternative than two step of enzymatic hydrolysis (Yanti et al., 2015).

5. Conclusions

Tourism become more worldwide economic growth strong factor, lot of coastal area in the world have tourism spot. But the common circumstance of tourism can't let of their waste organize, especially chemical compound such as plastic. Several studies indicate plastic waste from tourism is 5% from all plastic in the world. Once the plastic digested by marine organism it accumulated in their body become toxic compound microplastic. A waste assessment to categorized plastic as danger material is based on their degradable ability. Our plastic isn't easily degradable. The solution of this problem come from management and substitute material for plastic. Waste management become crucial pattern for plastic recycle. Green waste management and plastic management separately can change environment to better place of living thing. Used plastic material will be recycled and will be used again to reduce production of plastic. Beside or recycling activity there's also biopolymer such as Polyhydroxybutyrate (PHB). PHB is one of promising biodegradable material. It's degradable by bacteria and fungi. If w can change plastic base material to such as PHB material, it will become great advance for waste management. PHB material made by bacteria as producer. One of Indonesia advantage is being an topical and archipelagic country, there's several studies of bacteria that can produce PHB material in Indoneisa, such as B. megaterium or Halomonas elongate. Sago starch also found in Indonesia as a primary raw material for bacteria to processed it into PHB material.

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