Tri Hita Karana Perspective in Waste Disposal from a Seaweed Processing Factory Eucheuma cottonii at Jumpai Beach, Bali

Riana Adhyaksari*, Lita Tyesta ALW, and Maryono

Abstract. The name Tri Hita Karana comes from Sanskrit: Tri means three, Hita means happiness/prosperity, and Karana means cause. Seaweed is one of the abundant natural resources of Indonesia. In the processing which can significantly affect the quality of the final product obtained. The results of this research observed effluent waste was observed to be discharged freely from a pipe exiting the rear factory wall directly onto the beach, or into the sea at high tide. This material was collected and analysed. The processing of seaweed (Eucheuma cottonii) in this factory uses ≥ 90% Potassium hydroxide (KOH) as a raw material (as evidenced by the numerous empty sacks of KOH 90% strewn around the site, as well as direct reports from workers). This concentrated KOH is highly hazardous and is used to boil the seaweed with water. The average of a continuous concentration in different time (three hours) of K+ detected were 1000 ppm or 1% and 939 ppm or 0.939%, while the concentration of other elements detected was Cl with an average of a continuous concentration in different time (three hours) were 759.3 ppm or 0.759% and 581 ppm or 0.581%. This indicates that this factory waste contains KOH and has the potential to pollute the environment, especially sea water and the adjacent beach ecosystem. The results showed that the pH of the waste-water was 10.34 and 9.25. This indicates an alkaline pH almost certainly due to factory processing with KOH in the factory, exceeding the ideal pH value for sea water. A high concentration of KOH will cause the pH of the waste-water to shift towards alkaline and kill marine life and poison the beach ecosystem. This is worrying as the area supports a rural population who depend on fishing for much of their livelihood. The researcher concluded that the waste-water contains KOH and has highly potential to pollute the environment, especially sea water and it has not in accordance with the Balinese people, especially the Palemahan and this study indicate that the waste management process at the Jumpai Beach has not fully implemented the Laws and Regulations concerning waste management.

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1 Introduction

The philosophy of Tri Hita Karana (THK) is basically contains the purposes of harmony and togetherness between all the aspects of community life. In essence, the THK implies the harmony between human and God (teophocentric), human and fellow humans (anthropocentric), human and natural environment (cosmophodentric), respectively parhyangan, pawongan, and palemahan in a coherent way in order to create prosperity as well as spiritual and material happiness. Although the Balinese in the villages are already living centuries long in harmony and peace with each other, respecting God, human and nature, the name of THK has only been utilized since 1969 [1]. It defines that in the history of human thought developing three broad themes affect the technology and science development to the present, that is nature, God, and humans. In short, the principles of nature, the principles of moral and religious principles much coloring social theories, among classical, modern, contemporary [2].

Based on the concept of harmony, the Bali Government launched the official development philosophy known as Bali Dwipa Jaya based on THK to achieve prosperity and happiness of the people throughout the island in 1969. By way of explanation, this development philosophy should be fully supported by the whole Balinese society as it was in tune with the THK philosophy as a way of life of the Balinese community. It is carried out by encouraging the whole community of Bali to implement the THK philosophy individually and professionally in order to accelerate the realization of harmony, prosperity and happiness of society.

In 2017, Bali’s Government launched official document which indicate that the government of Bali and Indonesia are really motivated to direct and control the development activities and the daily activities of the people to be in line with the THK Philosophy, namely Peraturan Daerah Provinsi Bali Nomor 11 Tahun 2017 about Bendega. This means that the environmental, economic/social, and cultural/spiritual interests have to be developed in coherence with each other. THK is not so much the single relationships to God, nature and human, yet much more the interaction and balance between these relationships. That is the real message and value of THK [1].

Seaweed or commonly known as sea algae is a microalgae that grows naturally in coastal areas and has good resistance to salinity [3]. Seaweed is an important asset for the people of Bali, especially in Kemojan Island [4], Coastal area of Pandawa Beach [5], and Lembongan, Bali, both in terms of tourism and local community income because seaweed has many benefits for humans. For instance, seaweed contains bioactive compounds for dietary fiber such as sulphated polysaccharides, peptides, minerals, vitamins and fiber in order to against various disease which are not included by terrestrial plants in general.

Seaweed is also the most significant contributor to Indonesia’s total aquaculture production which up to 80% of seaweed exports to China, South Korea and Vietnam [6]. In the early 1980s, most seaweed farming in Bali has occurred in the Nusa Dua region and across the Badung strait-about 12 km long narrow sea strip that separates the mainland from the southern islands of Nusa Lembongan, Nusa Penida, and Nusa Ceningan, which fall within Bali’s Klungkung regency, Jumpai Beach since its introduced. Klungkung regency is the location where 90 percent of Bali’s seaweed was harvested since then. Based on Kiteartika’s study in 1987, the production from Eucheuma culture in Bali Province is around 73,899.40 MT. Those production has been obtained from an area of 179.1 hectares and has come from three main places, including Badung (5,070.00mt), Jemberana (39.40 mt) and Klungkung (68,790.00 mt and 73,899.40 mt) [7]. The farmers supply the seaweed and it proceed for almost a week, depending on the weather. Even the location is located in a smallest regency, it has been very well received by various seaweed farmers in Bali to improve their product since it has brought about positive economic outcomes. Seaweed has a very important value
in this region because most of the seaweed production from Bali Province was marketed to other districts especially in Java (Jakarta and Surabaya), with the exception of *Eucheuma* which is exported. The trade in this commodity is able to accelerate the socio-economic development and create a wide spectrum of related economic activities for whole villages [8]. Based on the Packard Report (2018), seaweed employs approximately 3.3 million workers. Most of them used traditional ways to process seaweed [6].

Carrageenan is a strong binder for food proteins which is the high-value products of seaweed. It is a generic name of viscosifying and gel forming polysaccharides family. It can be extracted through alkaline treatment such as KOH and Ca(OH)\(_2\) and followed by KCL precipitation with lower percentage [6]. In fact, the process of cooking and drying *Eucheuma cottonii* in the Klungkung regency seaweed industry so far uses Potassium Hydroxide (KOH) \(\geq90\%\) [9]. Based on the survey, the liquid waste which produced in this process has no treatment before being distributed to the Jumpai offshore. Additionally, human activity around the factory also contributed beach pollution. This volume continues to increase in line with the increase of product order and population growth which lead to extremely volume of waste.

Although THK was officially acclaimed by government as a kind of state philosophy in 1969, this still caused concern because THK was not implemented fully in society, neither by individuals nor by government, especially in Bali. Its significance was apparently more theoretical than practical and the development in society, especially in the field of seaweed industry, went gradually from bad to worse year by year.

Therefore, the study aims to overlook how THK is implemented in seaweed industry. Through this study, it is hoped that it can be provide recommendations regarding the implementation of THK in seaweed industry, especially in Klungkung, Bali in overcoming the waste disposal disaster.

### 2 Study region and data

The study of Tri Hita Karana Perspective in waste disposal from a seaweed processing factory *Eucheuma cottonii* at Jumpai, Beach was carried out at PT. Indonusa Alga Prima, Bali. The location of PT. Indonusa Alga Prima is in Jumpai, Klungkung, Bali.

![Fig. 1. Map of research locations](image-url)
Observation location coordinates:
1) PT. Indonusa Alga Prima → Latitude: 8°34'27.97"S, longitude: 115°25'16.26"E
2) Para-para drying spot 1 → Latitude: 8°34'23.89"S, longitude: 115°25'12.32"E
3) Para-para drying spot 2 → Latitude: 8°34'16.91"S; Longitude: 115°25'12.52"E

3 Methods

The methods used in this research are first, descriptive qualitative (with primary and secondary data collection). Primary data collection is done by field observation and gathering data directly from the source. Methods include surveys, data collection, examination (both direct and lab purpose), interviews, observation, and focus groups. Examination data is done by rapid screening using XD-Prime XRF. XD Prime can measure the concentration of elements in a product’s paint and base material separately. This tool is ideal for quick screening and precise determination of toxic elements in water, cost-effective manner and does not require costly and time-consuming sample preparation. Secondary data collected by document review. Data gathered from published sources meaning that the data is already gathered by researcher and used for other purposes in a research as well [10]. The data obtained is then analyzed for the level of compliance with the regulations and legislation on waste management for industry. The observation method is carried out by observing, evaluating, drawing conclusions, and providing comments on interactions that occur in the field [11]. Observations must be carried out directed, systematically, and on a scientific basis [12].

4 Results and Discussion

4.1 Seaweed Factory Waste Management

Seaweed processing industry processes raw seaweed material from the farmer into food and beverages. In this process, it produces high quantities of wastewater that contains residual chemicals that can pollute the environment around the factory, including KCL, NaOH, H2O2, and KOH (Sedayu et al., 2007) [13].

PT. Indonusa Alga Prima has no treatment of seaweed waste management. It can be seen in Figure 2., when the effluent waste was observed to be discharged freely from a pipe exiting the rear factory wall directly onto the beach, or into the sea at high tide. As a result, it producing an offensive odor with brown-like grey foam pollution which is seen on Jumpai beach from time to time. The material from a pipe was collected and analysed. It found that pollutant loads are higher than threshold level. For example, in Table 1. sample which collected both in different times pH is counted passing through the threshold level by 10.34 (13.00 WITA) and 9.25 (16.00 WITA). Afterwards, the BOD level is tripled after the lunch time and it move upward sextuple. Furthermore, COD level counted around twice from the limit at the same day.

The processing of seaweed (Eucheuma cottonii) in this factory uses ≥90% Potassium hydroxide (KOH) as a raw material (as evidenced by the numerous empty sacks of KOH 90% strewn around the site, as well as direct reports from workers). This concentrated KOH is highly hazardous and is used to boil the seaweed with water (Fig. 3 & Fig. 4). By using HD-XRF, the average of a continuous concentration in different time (three hours) of K+ detected were 1000 ppm or 1% and 939 ppm or 0.939%, while the concentration of other elements detected was Cl with an average of a continuous concentration in different time (three hours) were 759.3 ppm or 0.759% and 581 ppm or 0.581%.
This indicates that this factory waste contains KOH and has the potential to pollute the environment, especially sea water and the adjacent beach ecosystem. The results showed that the pH of the waste-water was 10.34 (13.00 WITA) and 9.25 (16.00 WITA) (Table 1). This indicates an alkaline pH almost certainly due to factory processing with KOH in the factory, exceeding the ideal pH value for sea water. A high concentration of KOH will cause the pH of the waste-water to shift towards alkaline and kill marine life and poison the beach ecosystem. This is worrying as the area supports a rural population who depend on fishing for much of their livelihood.

Table 1. Pollutant loads between three hours

<table>
<thead>
<tr>
<th>POLLUTANT LOADS</th>
<th>UNIT</th>
<th>RESULTS</th>
<th>THRESHOLD LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>13.00 WITA</td>
<td>16.00 WITA</td>
</tr>
<tr>
<td>pH</td>
<td>-</td>
<td>10.34</td>
<td>9.25</td>
</tr>
<tr>
<td>BOD</td>
<td>mg/L</td>
<td>97</td>
<td>121</td>
</tr>
<tr>
<td>COD</td>
<td>mg/L</td>
<td>217</td>
<td>290</td>
</tr>
<tr>
<td>TSS</td>
<td>mg/L</td>
<td>61</td>
<td>259</td>
</tr>
<tr>
<td>Amoniak</td>
<td>mg/L</td>
<td>0.03</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Fig. 2. Effluent waste from seaweed factory
Fig. 3. KOH detection by XD-Prime XRF at 13.00 WITA

Fig. 4. KOH detection by XD-Prime XRF at 16.00 WITA.
4.2 **Tri Hita Karana Perspective**

The philosophy of THK is universal in emphasizing the principles of togetherness, harmony and sustainability, so that it can be accepted by anyone, regardless of different background with regard to religion/faith, race/ethnicity or class/country of origin, including in the industrial activity. The official document, namely Regional Regulations of Bali Province Number 11 year 2017 was established six years ago which indicate that the government of Bali and Indonesia are really motivated to direct and control the development activities and the daily activities of the people to be in line with the THK philosophy. It means that economic/social, environmental, and cultural/spiritual interests have to be developed in coherence with each other. In fact, the official document has not be supervised by Dinas Lingkungan Hidup (DLH) Bali.

The natural law (law of *rta*) influenced by the relationship of human to nature (*palemahan*). This law states that humans (microcosm) and nature (macrocsm) are composed of five main elements of nature (*pancha mahabhutha*), namely light or heat (*teja*), wind or breath (*vayu*) earth and solids (*perthiwi*), water and blood (*apah*), sky and ether (*akasha*). Therefore, nature and humans on must respect each other love each other but also be themselves without unnecessarily disturbing each other. THK puts humans on the point of equilibrium; this position can cause harmony and disharmony, but various cosmological provisions and religious guidance can lead to the balance between human and nature [14].

Energy and natural resources (land and water) should be used wisely and efficiently. Hazardous and toxic like KOH should also be managed. The management involves the ability to reuse, reduce, and recycle the waste water. This policy will be monitored and evaluated systematically in order to achieve an eco-friendly status.

Then, the company must have a commitment to maintain and improve environmental quality, especially for waste management system in accordance with laws and local positive values. The company should have its commitment outlined in the action plan yearly and implemented in the programs in collaboration, both within and outside the company such as THK foundation.

Regarding the natural environment (*palemahan*), the company of seaweed must comply with certain criteria. Ten criteria are assessed:

1. commitment of the company to environmental quality;
2. implementation of style and concept of Balinese architecture (*tri mandala, tri angga*);
3. preservation and development of the ecosystem;
4. waste management for liquid, solid and gas waste as well as hazardous and toxic waste;
5. participation of the company in environmental issues locally, nationally and internationally;
6. clear organization of environmental management;
7. saving of energy and natural resources;
8. naming of the rooms, buildings, etc. in accordance with Balinese culture;
9. environmental management in accordance with positive or applicable law;
10. implementation of regular monitoring and evaluation in environmental management.
5 Conclusion

The seaweed production in Jumpai Beach, Bali has not yet fully implemented the THK, laws and regulations related to waste management because the waste-water contains KOH and has highly potential to pollute the environment, especially sea water and it has not in accordance with the Balinese people, namely Palemahan. The waste management process at the Jumpai Beach has also not fully implemented the Laws and Regulations concerning waste management and Regional Regulations of Bali Province Number 11 year 2017 namely Bandega. The company should use energy and natural resources wisely and efficiently and handle waste (including hazardous and toxic waste) properly. The company should manage, monitor and evaluate the environment if necessary, in order to assess whether it is environmentally friendly or not. The company management can take necessary actions to minimize the negative impacts on the environment. Thus, sustainable improvements can be expected from time to time. Then, for the Balinese, it is not easy to make a choice around economy, social and environment. They would probably prefer to stay in harmony in THK. This is the general attitude, but it is also the worst for the future of Bali and the identity of the Balinese. If the Balinese and local government do not choose, the environment will be lost.

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References


