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ARTICLE

The Impact Of Oil Spill To The Total Petroleum Hydrocarbon (Tph) Concentration In Fishes At North Coastal Of Karawang Regency, West Java Province

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ABSTRACT

The coastal area is one of the areas that is quite vulnerable to the threat of pollution caused by human activities, including pollution caused by oil spills (hydrocarbons) in the sea. The incident can be caused by several factors including the explosion, leakage of petroleum pipelines on the seabed, leakage of tanks or petroleum tankers at sea and disposal of waste petroleum products into the environment. Oil spills continuously can cause environmental contamination and pollution both aquatic and terrestrial. If the petroleum hydrocarbons enter sea waters, some of them will be absorbed by aquatic organisms because the nature of the petroleum hydrocarbons is difficult to decompose in waters. The intentional and unintentional entry of hazardous and toxic substances into marine ecosystems such as petroleum hydrocarbons and chemical solvents resulting from industrial wastes has become a serious problem for human health and the environment. The purpose of this study was to determine the concentration of Total Petroleum Hydrocarbon (TPH) contained in fish in coastal waters of Karawang Regency, West Java Province. This research was conducted in September-November 2019 by taking several fish samples at Ciparage Jaya Fish Auction Place, Betok Mati and Sungai Buntu Rive with a total sample of 24 fish, and taking seawater samples in the three study sites. TPH analysis was carried out at the Integrated Chemistry Laboratory, Bogor Agricultural University. TPH values in fish at Ciparage-1, Ciparage-2, Betok Mati and Sungai Buntu stations, in general, have different mean values but are almost uniform, each at 6.82; 6.82; 7.45 and 5.12 mg/kg. Based on the average TPH concentration in fish, it can be said that the average TPH in fish at Betok Mati station is relatively higher compared to other stations. TPH values in all fish samples exceed the safe threshold, which is a maximum of 0.002 mg/kg. Based on the results of the Bioaccumulation factor (BAF) analysis showed that the average TPH in fish was 6.55 mg/kg and the average TPH in the waters was 11.23 mg/l, so the BAF value was 58.35 which means that the absorption rate of TPH by fish organisms against the concentration of TPH in the waters of 58.35%. The analysis shows that the value of Ecological Hazard Assessment (EHA) is 3743.33 which means that the level of influence of the hazard on ecosystems and organisms is 3743.33. This value exceeds the recommended threshold according to the European Union, which is a maximum of 0.002 mg/l.

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1. Introduction

The coastal area is one of the areas that is quite vulnerable to the threat of pollution caused by human activities, including pollution caused by oil spills (hydrocarbons) in the sea. The incident can be caused by several factors including the explosion, leakage of petroleum pipelines on the seabed, leakage of tanks or petroleum tankers at sea and disposal of waste petroleum products into the environment [1]. Oil spills continuously can cause contamination and environmental pollution both aquatic and terrestrial. If the petroleum hydrocarbons enter sea waters, some of them will be absorbed by aquatic organisms because the nature of the petroleum hydrocarbons is difficult to decompose in waters [2]. The intentional and unintentional entry of hazardous and toxic substances into marine ecosystems such as petroleum hydrocarbons and chemical solvents resulting from industrial wastes has become a serious problem for human health and the environment [3,4].

Pollution of oil in the sea can cause changes in the structure and function of natural ecosystems, as well as disrupt the metabolic processes of aquatic organisms, reproduction and can even cause mass death of certain species, reduce the diversity of species composition, structure until it can lead to loss of ecosystem stability [5,6]. Petroleum can have different effects on several species, depending on the physiological state, chemical composition, and the size of the petroleum concentration, where oil that enters the waters with a concentration of 0.001 mg / dm3 can accelerate the death of plankton [6].

Total Petroleum Hydrocarbon (TPH) is defined as the measured amount of petroleum-based hydrocarbons in environmental media. Called hydrocarbons because petroleum is only hydrogen and carbon compounds. Total petroleum hydrocarbon (TPH) is released into the environment through several cases of accidents, industrial waste discharges, as well as byproducts from the use of human activities. When TPH is released directly into the water through spills or leaks, certain TPH fractions will float in the water and form a thin film layer on the surface of the water. The greater impact can be deposited and accumulated in sediments and bottom waters so that it can affect benthic organisms [7].

Several oil spill events have occurred in Indonesian waters, especially in the seaport area or around the oil mining exploration area. Moreover, Indonesia is a shipping lane known as the Indonesian Archipelagic Sea Lane (ALKI) which is often passed by tankers and cargo ships, so that if a ship collision occurs, the potential to cause oil spills. These conditions require the government to be ready to anticipate oil spills quickly. Like the oil spill incident in the coastal waters of Karawang Regency, West Java Province, which occurred in July 2019, where the oil pipeline off the coast of Karawang experienced leaks, causing oil spills in the sea even to enter the river estuaries and fishponds. One of the causes of the leakage of oil pipelines off the coast of Karawang is when PT. Pertamina (Persero) conducted a re-entry of the drilling activity at YYA 1 well, gas bubbles appeared. The incident caused the area of operations in the Offshore North West Java Block (ONWJ) to stop, then there was an oil sheen or oil layer at sea level and around the platform. The oil layer slowly and continuously reaches the coast and estuaries of rivers and fishing pond areas [8].

The impact of the oil spill in Karawang Regency spread to the coast of the Karawang coast, Bekasi, to the Thousand Islands. One of the highest impacts is on the Buntu River area, Pedes Subdistrict, Karawang Regency which has beach tourism, salt ponds, Vaname shrimp cultivation centers, and in the fisheries sector such as fishermen, boat owners, and fish traders at the Auction Place Fish (TPI). Some of the losses caused by oil spills in Karawang waters are losses in the ecological and social-economic sectors of coastal communities. The ecological sector has a direct loss because it is directly exposed to oil so that organisms such as plankton, nekton, fish, benthos and other fishery biological resources suffer damage or even mass death. Potential economic losses to the community are also experienced by farmers in milkfish and vaname shrimp ponds, where yields have dropped dramatically both in terms of quantity and price. Besides, the fishermen who depend on their lives every day from the sea, for weeks they cannot go to the sea. For example, fishermen in Sungai Buntu Village, with a total number of 864 fishermen with a fleet of 197 vessels [9] cannot operate fishing, so they do not have income for their daily needs. Other economic impacts are felt by fish traders at the Fish Auction Place in Karawang Regency, where people are less interested in buying fish because fish from Karawang waters smell of diesel oil and have been contaminated with petroleum. Therefore, it is necessary to do research related to the concentration of TPH found in fish in the TPI Karawang Regency. Thus, this study aims to determine the concentration of Total Petroleum Hydrocarbon (TPH) contained in fish in several TPI Karawang Regency, West Java. By knowing the concentration of TPH in fish, it is hoped that it can become a recommendation to the government, and especially to the community to be careful in consuming fish that have been contaminated with TPH at a safe threshold level for consumption. Since the first oil spill occurred

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in July 2019 in the coastal waters of the Karawang Regency, there have been several studies at that location, but no research results have been published in scientific journals. The purpose of this study was to determine the concentration of Total Petroleum Hydrocarbon (TPH) contained in fish in several coastal waters Karawang Regency, West Java Province.

2. Methodlogy

2.1 Time and Location of Research

This research was conducted in September-November 2019 by taking several fish samples and sea waters at Ciparage Jaya Fish Auction Place, Betok Mati, and Sungai Buntu. The selection of the three Fish Auction Places is based on the assumption that the three location statoins have a high enough risk due to oil spills on the Karawang coast, compared to other stations, and to be able to represent fish samples in coastal waters Karawang Regency. The location of research on fish and sea waters sampling is shown in Figure 1.

2.2 Tool and Materials

Some of the equipment used are cool boxes, surgical instruments, freezers, analytical scales, glassware (Pyrex), and Atomic Absorption Spectrophotometer (AAS) (Shimadzu type AA-7000, Japan). While the materials used in this study include several fish species and sea waters sample in the Ciparage Jaya, Betok Mati and the Sungai Buntu, and Nitric Acid (HNO_3).

2.3 Taking Samples

A fish sampling at Ciparage Jaya was carried out 2 (two) times, namely in August and October 2019. Fish sampling in August aims to better determine the significant effect due to oil spills that occurred in July 2019, while fish sampling in October to find out the extent of changes in TPH concentrations since the first oil spill occurred. While taking fish samples at Betok Mati and Sungai Buntu was done once, namely in October 2019. The number of fish samples for each station was as many as 6 species so that the total fish samples analyzed for TPH concentration were 24 species. Seawater samples are taken at each observation station, which aims to determine the TPH concentration in seawater. Before the fish sample was analyzed for TPH concentration, the fish sample was measured in length and weight of the fish using a digital analytical scale. TPH concentration analysis was conducted at the Integrated Chemistry Laboratory, Campus of IPB Baranangsiang, Bogor Agricultural University.

2.4 Data analysis

Data analysis in this study is the analysis of the total petroleum hydrocarbons (TPH) concentration in fish, analysis of bio-accumulation factors to determine the extent of TPH absorption in seawater into organisms, especially fish and ecological hazard assessment analysis, which aims to determine the extent of hazard concentration TPH on aquatic ecology.

Bioaccumulation Factor (BAF) often occurs when a chemical is absorbed and stored in an organism exposed to natural ecosystems. BAF in organisms is determined based on the comparison of TPH concentrations that are exposed to organisms against TPH concentrations found in waters with the formula [10]:

$$Bioacumulasi\ Factor\left(BAF\right)=\frac{Concentration\ of\ \ pollutans\ in\ organism\ \left(\frac{mg}{kg}\right)}{Concentration\ of\ \ pollutans\ in\ water\ \ \left(\frac{mg}{l}\right)}$$

A high level of ecological danger occurs when the concentration of chemicals in the aquatic environment is above the quality standard threshold. Therefore EHA is calculated based on the comparison of the concentration of TPH in the waters against the recommended quality standard, using the formula [10]:

$$Ecological\ Hazard\ \ Assessment\left(EHA\right)=\frac{Concentration\ of\ \ pollutans\ in\ water\ \left(\frac{mg}{l}\right)}{Quality\ standard\ threshold\ \left(\frac{mg}{l}\right)}$$

Figure 1. Map of the research location

3. Results and Discussion

3.1 Diversity of Fish Samples

To find out the TPH concentrations that have accumulated in the waters of the Karawang regency, fish samples are taken as representatives of the existing population. Fish samples were taken as many as 6 (six) species of fish at

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each station. Before the fish was analyzed for THP content, each fish sample was measured in length and weight. Fish samples at Ciparage-1 Station with an average fish length of 23.20 cm and an average weight of 211 grams. While the average length and weight of fish at Betok Mati station are 29.33 cm and 175.33 grams, respectively. Then the average length and weight of fish at the Sungai Buntu station were 41.83 cm and 383.67 grams, respectively. Data on the length and weight of fish samples for each station are shown in Table 1 and Figure 2.

Table 1. Fish length and weight at each station

a. Ciparage-1 Station

No	Species		Length (cm)	Weight (gram)
	Latin	Local		
1	*Lates carcarifer*	Kakap putih	48	1040
2	*Psettodes erumeri*	Sebelah	19	56
3	*Euthynnus affinis*	Tongkol	17	58
4	*Restelliger sp*	Kembung	16	44
5	*Selaroides leptolepis*	Selar kuning	16	34
6	*Loligo sp*	Cumi-cumi	16,5	34
		Average	23.20	211.00

b. Ciparage-2 Station

No	Species		Length (cm)	Weight (gram)
	Latin	Local		
1	*Loligo sp*	Cumi-cumi	46	122
2	*Etelis coruscans*	Kakap merah	23	140
3	*Restelliger sp*	Kembung	20	76
4	*Selaroides leptolepis*	Selar kuning	18	70
5	*Euthynnus affinis*	Tongkol	20	90
6	*Loligo sp*	Kakap putih	22	126
		Average	24.83	104.00

c. Betok Mati Station

No	Species		Length (cm)	Weight (gram)
	Latin	Local		
1	*Psettodes erumeri*	Sebelah	24	202
2	*Etelis coruscans*	Kakap merah	20	114
3	*Selaroides leptolepis*	Selar kuning	20	98
4	*Sepia sp*	Sotong	51	162
5	*Netuma thalassina*	Manyung	26	178
6	*Dasyatis sp*	Pari	35	298
		Average	29.33	175.33

d. Sungai Buntu Station

No	Species		Length (cm)	Weight (gram)
	Latin	Local		
1	*Psettodes erumeri*	Sebelah	30	336
2	*Netuma thalassina*	Manyung	40	706
3	*Chirocentrus dorab*	Golok-golok	45	242
4	*Dasyatis sp*	Pari	46	146
5	*Strongylura incisa*	Julung-julung	78	860
6	*Fenneropenaeus merguiensis*	Udang jerbung	12	12
		Average	41,83	383,67

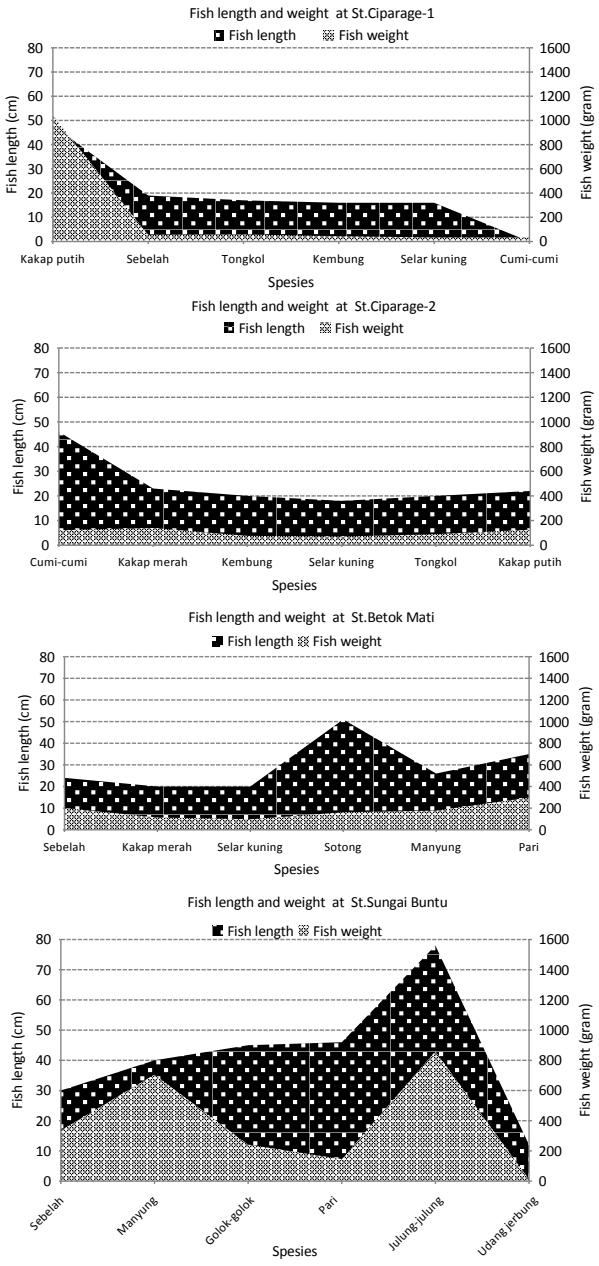

Figure 2. Fish length and weight at St. Ciparage-1, St. Ciparage-2, St. Betok Mati and St. Sungai Buntu

3.2 TPH Concentration in Fish

Based on the results of TPH analysis on fish samples at Ciparage-1 Station, Ciparage-2 (Tempuran District), Betok Mati and Sungai Buntu Station (Pedes District), the TPH concentration values were generated in fish samples and each station with different values. At Ciparage-1 Station the highest TPH concentration values were in Restelliger sp which was 9.99 mg/kg, and the lowest was in Selaroides Nephrolepis which was 2.16 mg/kg, and the average TPH at 6.83 mg/kg. While at the Ciparage-2

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station the highest TPH value was found in squid (Loligo sp) which was 10.96 mg/kg, the lowest in Selaroides Nephrolepis was 4.38 mg/kg, with an average THP is 6.82 mg/kg. If the TPH value between the Ciparage-1 station is compared to the Ciparage-2 station, it can be seen that the average value at Ciparage is almost the same. Fish sampling in Ciparage was carried out in 2 stages, first in August 2019 (Ciparage-1) and second in October 2019 (Ciparage-2). With the difference in time and interval of the first 3 (three) months, the TPH value in fish in Cipagare is not too different, or in other words, the concentration of TPH in the Ciparage region absorbed by fish in Ciparage is almost the same. When viewed from fish species exposed to TPH at Ciparage station, the highest TPH value in Cipagare-1 is found in Restelliger sp and in Ciparage-2 found in squid (Loligo sp), where both fish species are pelagic. With these considerations, it is likely that crude oil, besides being present in the surface layer, also begins to settle to the lower layer so that it is absorbed by pelagic fish.

TPH values for fish at Ciparage-1, Ciparage-2, Betok Mati and Sungai Buntu stations, in general, have different mean values but are almost uniform, each at 6.82; 6.82; 7.45 and 5.12 mg/kg. Based on the average TPH concentration in fish, it can be said that the average TPH in fish at Betok Mati station is relatively higher compared to other stations. TPH values in all fish samples exceed the safe threshold, which is a maximum of 200 µg/kg (0.002 mg/kg) [11]. The results of TPH concentrations in fish at each station are shown in Table 2 and Figure 3. The level of TPH accumulation and uptake into fish bodies at each station may vary due to the distribution pattern and movement of oil spills. Based on the analysis of Landsat imagery from LAPAN 2019 (Figure 4) [12] shows that in July-September 2019 the movement of oil spills headed west following the movement of winds and ocean currents. Oil spillage is not only offshore, but it is also concentrated up to the coast and even into the terrestrial area and shrimp pond area on the coast of Karawang Regency. Thus it can be said that the pattern of oil spill movement moved from the Ciparage area to the Betok Mati station and the Sungai Buntu station.

he impact of oil spills into sea waters will affect some fish resources, among which is an increase in fish mortality [13], can kill and or cause damage to fish eggs and larvae, morphological abnormalities, reduced feeding and growth rates, and increased susceptibility to predators [14,15], habitat degradation, loss of ability to hatch eggs, gill fouling structures, reproductive processes will be disrupted, and result in growth, development, food nets, and respiratory process [16]. Thus oil spills can result in decreased availability (stock) of fish resources and damage to marine ecosystems [13].

Susceptibility due to oil spills to fish organisms is mostly experienced in the early stages ie. eggs and larvae [17] due to their underdeveloped membrane and body structure, and detoxification structure [18]. Early stages of fish life are very susceptible to polycyclic aromatic hydrocarbons even if available in even small concentrations can cause death, morphological structural defects, circulation failure, stunted development and low appetite. Furthermore the impact of crude oil on fish is affecting the genes that act as ion controllers so that changes in these genes will cause changes in expression and behavior of fish. [14]. Besides, the impact of aromatic polycyclic hydrocarbons also disrupts heart function which can further cause speed and weakness of cardiac contractility, which can cause circulation failure, and that TPH with concentrations <10 µg / l can cause fish mortality [13,19].

3.3 Bioaccumulation Factor (BAF)

Bioaccumulation Factor (BAF) often occurs when a chemical is absorbed and stored in an organism exposed in the natural ecosystem. BAF in organisms is determined based on the comparison of TPH concentrations on organisms, where this study uses fish samples against TPH concentrations found in the waters. Based on the results of the BAF analysis showed that the average TPH in fish was 6.55 mg/kg and the average TPH in waters was 11.23 mg/l, so the BAF value was 58.35 which means that the level of TPH absorption by fish organisms against the concentration of TPH in the waters of 58.35%.

BAF value in fish is influenced by several factors including the nature of the organism which is easy to absorb pollutants, and or related to the food chain in the waters. Trophic level position can also affect the level of bioaccumulation [20,21]. However, long-term exposure to aquatic biota to chemicals may cause bioaccumulation and biomagnification, which harms aquatic species and the overall ecosystem.

3.4 Ecological Hazard Assessment (EHA) Analysis

A high level of ecological danger occurs when the concentration of chemicals in the aquatic environment is above the quality standard threshold. Therefore EHA is calculated based on the comparison of the concentration of TPH in the waters against the recommended quality standard. Based on the quality standard TPH concentration in waters according to the European Union/EU

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(2017) is 300 µg/l (0.003 mg/l). The analysis shows that the EHA value is 3743.33 which means that the level of influence of the hazard on ecosystems and organisms is 3743.33. These effects can cause ecological changes such as changes in the structure and function of ecosystems, reducing the distribution and dominance of aquatic organisms, discomfort, and reducing the potential for breeding and possibly causing damage and destruction of fisheries resources, stopping breathing, and lack of food supply both in the water column and in sediment, as well as lack of oxygen [22].

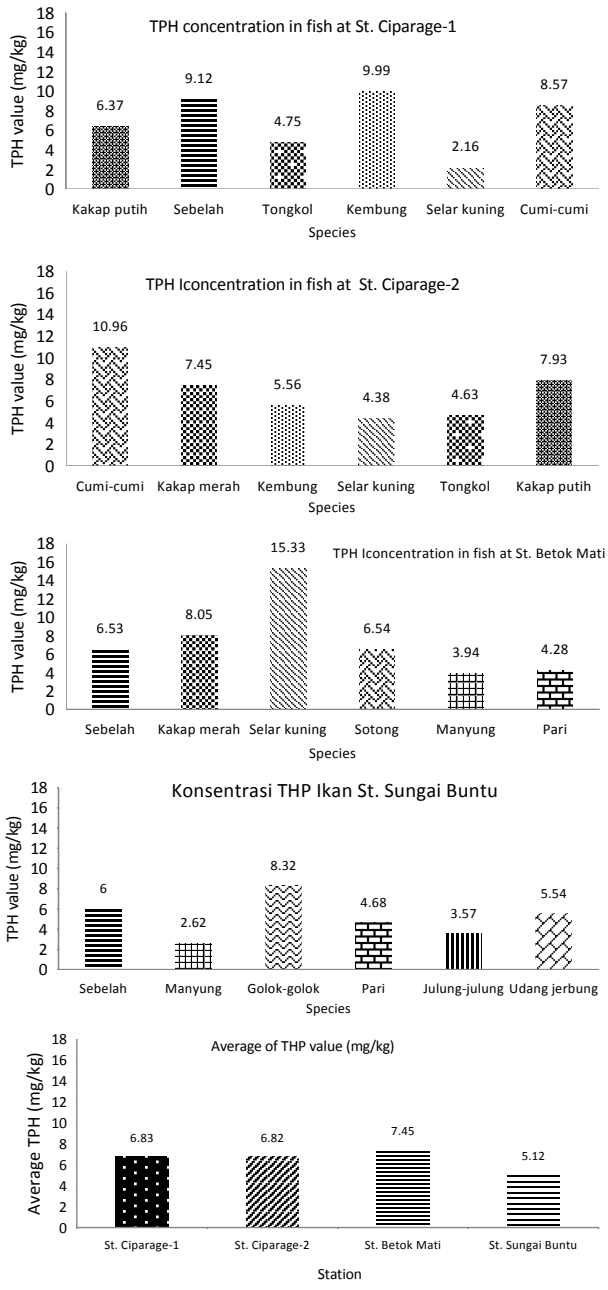

Figure 3. TPH Concentration in Fish at each Stations

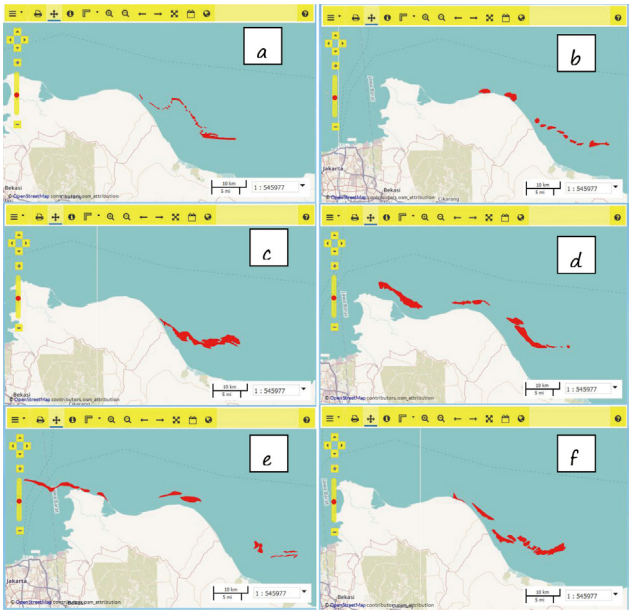

Figure 4. Pattern of Oil Spill Distribution on the Coast of Karawang Regency

Note: (LAPAN, 2019). (a). 18 Juli 2019, (b). 23 Agustus 2019, (c). 28 Agustus 2019, (d). 31 Agustus 2019, (e).1 September 2019, (f). 4 September 2019.

4. Conclusion

TPH values for fish at Ciparage-1, Ciparage-2, Betok Mati and Sungai Buntu stations, in general, have different mean values but are almost uniform, each at 6.82; 6.82; 7.45 and 5.12 mg/kg. Based on the average TPH concentration in fish, it can be said that the average TPH in fish at Betok Mati station is relatively higher compared to other stations.

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Bioaccumulation Factor (BAF) often occurs when a chemical is absorbed and stored in an organism exposed in the natural ecosystem. BAF in organisms is determined based on the comparison of TPH concentrations on organisms, where this study uses fish samples against TPH concentrations found in the waters. Based on the results of the BAF analysis showed that the average TPH

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in fish was 6.55 mg/kg and the average TPH in waters was 11.23 mg/l, so the BAF value was 58.35 which means that the level of TPH absorption by fish organisms against the concentration of TPH in the waters of 58.35%.

A high level of ecological danger occurs when the concentration of chemicals in the aquatic environment is above the quality standard threshold. Therefore EHA is calculated based on the comparison of the concentration of TPH in the waters against the recommended quality standard. Based on the quality standard TPH concentration in waters according to the EU (2017) is 0.003 mg/l. The analysis shows that the EHA value is 3743.33 which means that the level of influence of the hazard on ecosystems and organisms is 3743.33.

Recommendation

To better represent pollination of fish exposed to hydrocarbons, it is necessary to sample fish and more seawater, both in quantity and frequency of sampling.

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