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Marine Pollution Trend Analysis of Tourism Beach in Peninsular Malaysia

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Abstract: The focus of this research was to study the problem of marine pollution that is occurring on the east coast of Peninsular Malaysia. The research area covered three major tourism beaches namely Pantai Cahaya Bulan (Kelantan), Pantai Batu Buruk (Terengganu) and Pantai Teluk Chempedak (Pahang). This study attempted to identify the parameters of the existing major pollutants and their trends from 2000 to 2006. This study also identified the causes of marine pollution occurring at the research area, evaluating and comparing the level of marine pollution among the three research sites. Results showed that the TSS, E. coli and OandG parameters are always above the Standard Interim of Marine Water Quality suggested by DOE for three selected areas. Heavy metals parameter such as Pb, Cd and Cu are also above the standard set by DOE. Anthropogenic activities such as land banked up or land use development in the coastal zone, untreated domestic waste effluent and oil spill incidents were partly due to ship collision or unlawful discharge oil effluent that contributed to the degrading water quality. In conclusion, although, several pollution parameters in the study area are decreasing the amount is still above the set standard.

Key words: Trend · Marine Pollution · Tourism Beach

INTRODUCTION

It has been established that marine and river pollutions are inter-related. If river has been polluted, the coastal sea water will also face the pollution problem [1]. Some people belief that Malaysia which received plenty of rainfall will then dilute the pollution substance that going to the river. They also think that sea water are capable to absorb and neutralize the pollution substance that coming from the river and drain to the sea. These popular belief are not become right since the development activities are to hasty specifically in the coastal zone with the agriculture sector, logging, industrializations, urbanization, settlement and tourism are giving the impression nowadays that the sea water are capable to swallow plenty of the pollution load until marine pollution problem occur [2]. Marine pollution has been regarded as a global issue in particular for countries with coastal zone.

According to Garrison [3], more that three quarter of marine pollution occurred was due to substance from various human activities derived inland. Pollution sources derived from land are coming through rivers (44%), followed by sources from land and coastal (33%), ship infringement and oil spilled (12%), direct wastage disposal to the sea (10%) and oil and gas mining in the offshore (1%). The similar situation also happened in Malaysia and the responsible party to monitor the marine pollution is Department of Environment (later referred as DOE). In the case of marine pollution, it can be shown with the value of some indicators or parameters such as Oil and Grease (OandG), Total Suspended Solid (TSS), *Escherichia coli* (E. coli) and a few heavy metals such as Copper (Cu), Mercury (Hg), Lead (Pb), Cadmium (Cd), Arsenic (As) and Chromium (Cr). In relation to this, the main purpose of this study was to identify the main pollutant parameters in the coastal zone for various study areas and its cause and impact upon local communities. Moreover, this study also tried to assess and compare the pollution levels that occur in three study areas during 2000 and 2006.

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MATERIALS AND METHODS

Data on marine pollution are obtained from the Marine Data Management Section, DOE, Ministry of Natural Resources and Environment, Putrajaya. Three monitoring stations have been identified and used: Station 3833910 at Pantai Teluk Cempedak (PTC), Station 5331935 at Pantai Batu Buruk (PBB) and Station 6122903 at Pantai Cahaya Bulan (PCB). The data for all stations are between 2000 and 2006.

The parameter applied in this study have been restricted to *E. coli*, OandG, TSS and a few heavy metals such as Cu, Hg, Pb, Cd, As and Cr. Some of these parameters are simplified in order to meet the public needs with regard to the water quality status from the yearly report produced by DOE in the Malaysia Environment Quality Report 1996-2008 [4- 17].

RESULTS AND DISCUSSION

Results from the DOE monitoring data from the year of 1992 to 2006 showed several beaches in Malaysia are facing with the higher value set in interim marine water quality standard as shown by the OandG, TSS and *E. coli* parameters in figure 1. The pollutant sources for OandG parameter mainly from oil spilled from the oil tanker either spilled during ship cleaning or from the oil tanker itself. On the other hand, most of the pollutant parameter for TSS and *E. coli* are from the development activities in the coastal areas such as building activities, industry, domestic and livestock activities [18]. According to Jamaluddin and Kadaruddin [19], the development of tourist attraction sites in the coastal areas are laying the negative impact not only in term of pollution but also from the potential of beach erosion to occur in that area.

The mean of parameter purity clearly showed that the three pollution parameters are with high value i.e. OandG, TSS and *E. coli*. These parameters are constantly higher and above the marine water quality interim standard as mentioned in 1992 to 2006. For the OandG mean purity, the highest value was recorded in 1992 with the value of 4.2mg/l which surpasses the standard interim value 0 mg/l. The years of 90's are higher purity mean recorded with above 2 mg/l value. But, it seems becoming much better in the year of 2000's which recorded purity was less than 1.2 mg/l. This showed the decreasing trend and could be interpreted with higher awareness and control steps done by the authorities to lower the effluent level of OandG into the sea water.

In the mean while, the status of marine water quality in Malaysia which based on percentage is still above the standard given by the DOE interim standard as shown in table 1. Moreover, table 2 clearly shows the present marine pollution is due to the existing of OandG, TSS and *E. coli* parameters. OandG parameter indicate that the 50% of it value occurred before the year of 2000 but the value are becoming lower after that year. On the other hand, TSS parameter is becoming higher than 50% from the year of 1991 till 2006 in term of percentage. For *E. coli* parameter, even though the relative percentage are not more than 50 %, it is still considered as high and would be considered as a fluent effect to marine pollution problems. For the heavy metals, parameters such as Cu, Hg and Pb showed higher percentage compare to Cd, As and Cr (Table 1).

People could not deny that the pollution exist because of the human actions by dumping all kind of pollutant substances from development activities such as agriculture, industrial, manufacturing, livestock, settlement, infrastructures, domestic residue and etc [20]. Beside the inland sources, pollution also occur from the oil spilled or oil disposal from the cruise that pass through the Straits of Malacca, the Johor Straits and the South China Sea [21]. In 2006 alone, nine cases of oil spilled incident were recorded in the South China Sea and this is higher compared to past year incident, for example 2003 (5 cases), 2004 (seven cases) and 2005 with seven cases reported [22]. The situation happened mostly because of the spilled from oil platform and shipping activities that were detected such as the unlawful oil disposal happened in the open sea. Mean while, based on information from Department of Statistic Malaysia [17] indicate that out of 27 cases of oil spilled in Malaysia water, 21 cases (78%) are because of unlawful oil disposal by the ships.

Eastern states of the Peninsular of Malaysia are also not spare from marine pollution problem. The South China Sea with large area of sea is also affected with this problem and it also contaminates the beaches in these states such as a popular tourism beaches. Table 3 clearly indicates the higher value of parameter i.e. TSS, OandG and *E. coli* and the value are above the standard value by DOE. Even some of the heavy metals parameters also indicate the high value such as Cd, Pb and Cu.

The information clearly indicated that beaches in eastern states such as Kelantan are facing with marine pollution mainly from the OandG, TSS and *E.coli* parameters and Pb, Cu and Cd for the heavy metals parameters. Even the OandG parameter also recorded

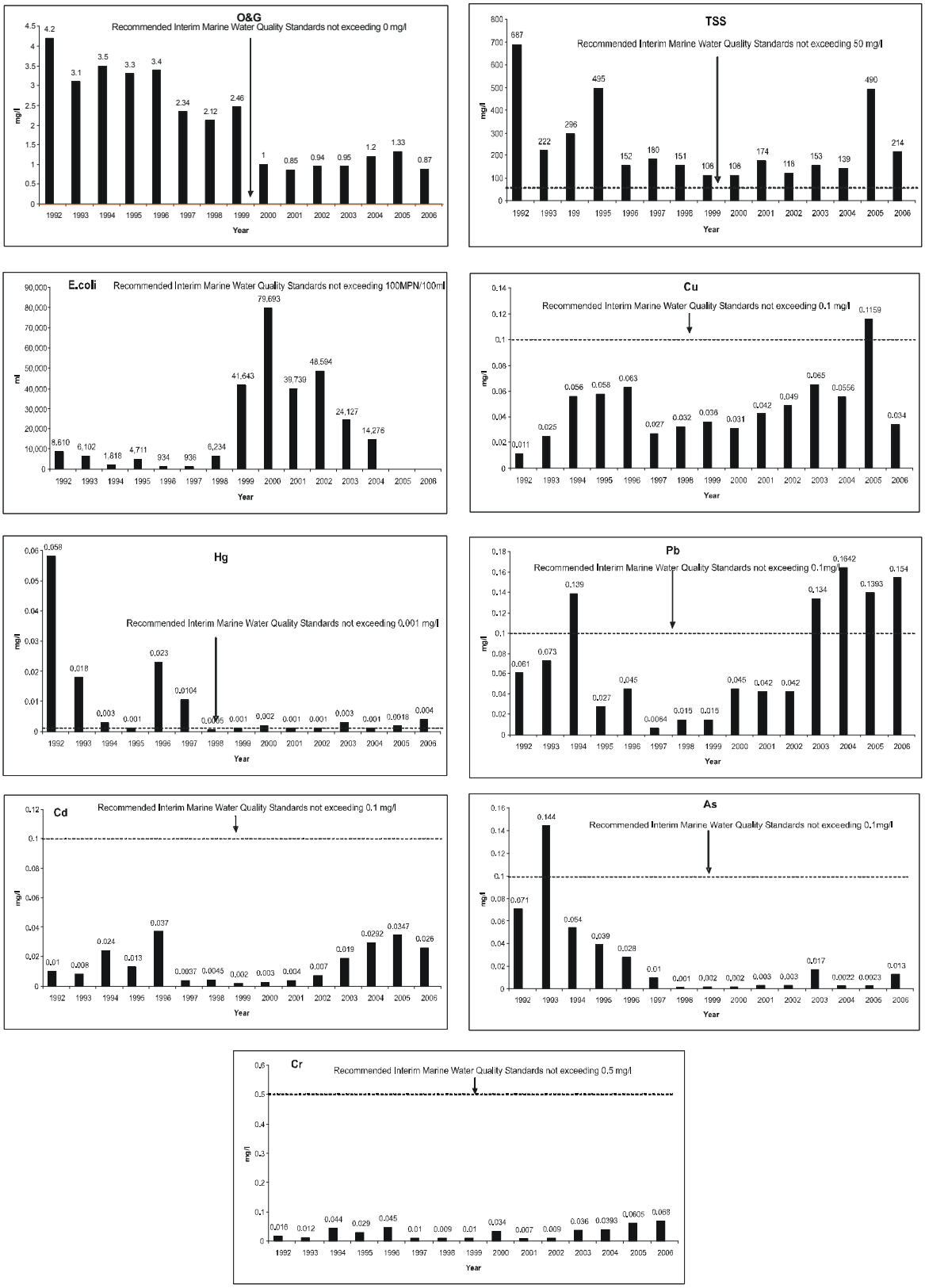

Fig. 1: Average Concentration OandG, TSS, *E. coli* and Heavy Metals in Marine, Malaysia 1992-2006

Table 1: Malaysia Marine Water Quality Status (Parameter Exceeding Interim Standard in Percentage), 1991-2008

Parameter	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
OandG	97	79	83	94	95	72	83.7	94.5	49.8	53.3	34.7	50.5	34.7	49.1	45.1	35.4	43.6	47.9
TSS	68	60	59	64	65	54	60.7	73.7	71.1	74.3	74.3	75.7	72.1	76.9	80.2	74.7	56.9	63.5
E. coli	43	40	61	44	37	30	21.9	29.7	49.4	46.9	34.7	42.6	48.2	50.1	48.5	54.9	44.1	55.1
Cu	2	5	2	8	8	<20	8.0	7.7	6.7	7.1	11.1	22.4	30	15.9	20.7	6.4	6.7	4.7
Hg	80	25	10	18	8	<20	4.1	2.8	6.5	17.3	8.7	12.6	12.7	10.8	7.6	18.2	8.5	13.0
Pb	7	1	20	30	8	<20	0.4	2.0	7.5	18.3	14.6	13.6	16.1	29.2	27.4	20.3	24.2	15.3
Cd	NA	NA	NA	NA	NA	<10	0	0	0.2	1.8	1.7	1.9	6.7	9.1	9.9	1.9	4.5	2.8
As	NA	NA	NA	NA	NA	<10	2.6	0	0	0.0	1.0	0.1	0.5	0.0	0.0	0.9	0.0	1.1
Cr	NA	NA	NA	NA	NA	<10	0	0	0	0.1	0.1	6.7	0.2	0.1	2.2	1.9	0.6	0.7

*NA (Not Available)

Table 2: Eastern Peninsular Malaysia Marine Water Quality Status (Parameter Exceeding Interim Standard in Percentage) 2000-2008

States	Year	No. of Stations	No. of Samples	TSS	OandG	*E.coli*	Cd	Cr	Hg	Pb	As	Cu
Kelantan	2000	10	45	65	53	33	0	0	0	73	0	0
	2001	10	40	65	55	0	0	0	0	83	0	0
	2002	10	30	43	100	47	0	0	0	7	0	3
	2003	10	30	67	43	53	43	0	0	73	0	63
	2004	10	40	60	93	50	68	0	0	78	0	48
	2005	10	40	60	82.5	32.5	62.96	0	0	71.79	0	46.15
	2006	10	40	73	59	43	10	0	3	78	10	30
	2007	10	40	73	88	45	20	0	0	68	0	0
	2008	10	40	68	89	60	15	0	33	63	15	0
Terengganu	2000	16	64	47	73	58	0	0	2	61	0	0
	2001	16	53	50	45.3	55.8	0	0	0	79	0	6
	2002	19	72	44	47	55	0	0	0	65	0	0
	2003	19	76	65	57	51	58	1	18	70	0	58
	2004	19	76	43	100	36	63	0	1	83	0	43
	2005	19	76	65.79	73.33	59.21	64.47	1.32	1.32	82.89	0	36
	2006	19	76	74	93	46	11	0	2	86	0	42
	2007	19	76	45	59	36	41	0	13	80	0	25
	2008	19	76	24	60	47	13	8	5	61	0	0
Pahang	2000	14	35	100	0	10	0	NA	NA	6	NA	0
	2001	11	44	100	9.1	0	15	0	0	0	0	0
	2002	11	44	95	50	16	0	0	NA	NA	NA	2
	2003	11	80	14	34	13	0	0	0	1	0	1
	2004	11	80	NA	92	32	6	NA	NA	72	0	0
	2005	11	80	8.11	100	16.22	1.35	0	6.76	0	0	0
	2006	11	80	19	80	10	0	0	0	40	0	0
	2007	11	80	6	83	31	0	0	14	48	0	0
	2008	11	80	6	28	16	0	0	33	0	0	0

*NA (Not Available)

100 percent of total samples are above the temporary standard set by DOE in the year of 2002. According to DOE, tar substance is the main cause for marine pollution in Kelantan's water. The tar substance problems are connected to the oil spilled especially from the commercial ships in the South China Sea and it began to affect the coastline through out eastern part in the Peninsular of Malaysia.

A similar trend also found in Terengganu water especially for TSS and OandG parameters. But it seems like the *E. coli* parameter show a little bit high percentage compares to Kelantan. According to DOE, most of the data recorded especially from river estuarine areas indicate the higher value of TSS and OandG. The high value of TSS parameter has been found related to the land use development activities which occur inland. While for parameter OandG it can be relate to the activities of fisherman boats. The boats with petroleum are been widely use in this area and contribute to scattered oil spilled in the marine water. The heavy metals parameters indicate a high percentage from the year of 2000 to 2006 for Pb and being accumulated every year. Tar balls also been detected in the area of Rantau Abang and Cenderiang coastline and it can relate to the gas and petroleum activities operation in the Terengganu water.

A pollution also been detected for the Pahang marine water with the TSS, OandG and *E. coli* parameters. Heavy metal parameters indicate a lower percentage and were not higher than temporary standard set. TSS percentages show the decreasing pattern while OandG parameter illustrate the increasing pattern. *E. coli* parameter indicate lower percentage compare to TSS and OandG parameters but it also been found to affect the tourism locations in PTC. High percentage of *E. coli* has been found to relate to the unsatisfied domestic waste system, while high percentage of TSS are relate to forest exploration for development activities. The existing of OandG parameter found along the Pahang state coastline are related to the oil mining activities which occurred in the South China Sea. These activities also contributed to the pollution of beach with tar ball.

Generally, the TSS parameter showed the value above the standard determines by DOE in the three mentioned beaches (Figure 2A). The values at the PCB are always surpassing the standard value as been observed from the year 2000 till 2006 with the highest value recorded in 2006 (127 mg/l). However the highest TSS value recorded are detected at PTC from the year 2000 (130 mg/l), 2001 (146.75 mg/l) and 2002 (138 mg/l). Meanwhile, PBB showed some slight decrease in 2004 and 2005 but went up again in 2006. Recommended Interim Marine Water Quality Standard for TSS is 50 mg/l. The higher amount of TSS in PCB and PBB can be related to the erosion and sedimentation problems at the beaches. Apart from that, the highest amount recorded at PBB from 2000 to 2006 can be connected to the effort of the authorities in developing the beaches with variety of infrastructure and rapid growth especially urbanization at the city centre of Kuala Terengganu. On the other hand, PTC has been affected with erosion and it has caused beach rehabilitation activity before the year 2004. The Department of Irrigation and Drainage of Pahang has made an effort to rehabilitate the beach with sand nourishment method and that has caused the higher reading of TSS the year before.

The OandG parameters also showed the value that above the standard for the three beaches (Figure 2B). The Recommended Interim Marine Water Quality Standard for OandG is not exceeding 0 mg/l. PCB and PTC have indicated an increasing trend compared to PBB. However, PBB has recorded the highest amount in 2003 with 2.28 mg/l. The problem of OandG in the recreational beach can be trace to the disposing of oil from ships, fisherman's boat and also from the oil affluent from land through rivers. The open and vast area of South China Sea makes it more susceptible to the beaches either from purposely or accidently oil spill due to the collision of the ships. According to DOE [2], PTC was one of the beaches that were monitored with tar ball parameter as it is one of the most popular recreational beaches.

One of the parameter examined that continuously above the standard is *E. coli* especially in PBB. Although the trend at PBB is showing a decreasing of *E. coli*, the highest amount of *E. coli* were recorded at PBB still higher than PCB and PTC from 2000-2006 (Figure 2C). The highest record at PBB was in the year 2004 (2032.67 MPN/100ml) and 2005 (1059.67 MPN/100ml) whereas, the recommended standard is not more than 100MPN/100ml. PTC did not show an amount of *E. coli* that exceed the standard, while PCB has shown an increasing trend from 2004 to 2006. In general, the cause of *E. coli* pollution is either from untreated human or other animal residue which was directly emptied to the sea through the rivers. The domestic and industrial wastes from an urban area may also contribute to an increasing of *E. coli* parameter especially in PBB where, it is located near to the city centre of Kuala Terengganu.

For heavy metals, three of the parameters have shown a trend that exceed the standard while, three other parameters did not exceed the standard. The parameters that exceed the standard include Cd, Pb and Cu (Figure 2D, 2G and 2I). Pb has showed a value that constantly above the standard which is 0.1 mg/l, PBB has recorded the highest value in 2004 (0.715 mg/l). The trend is also similar at the PCB, except the year 2002, which was below the standard (0.04 mg/l). The condition at PTC is much bettered where the value did not exceed the standard, except for the year 2004 (0.385 mg/l) and 2006 (0.14 mg/l). Obviously, the trends of Pb parameter at the beaches are rising in parallel with the increasing standard percentage for Pb in the Malaysian's water from 1991-2006.

In the meantime, the Cd parameter of the three beaches has not exceeded the standards from 2000 to 2002. After that, Cd has showed an increasing trend which exceeding 0.1 mg/l. The highest ever recorded Cd was at PTC in 2005, which is 0.334 mg/l. After the year 2004, Cd has showed a decreasing trend. For Cu parameter, the PTC did not record any value that exceeds the standard, while PCB has recorded some value that exceeds the standards. Cu parameters have showed an increasing trend at all three beaches.

TSS enters the coastal water through the river network. Towns situated at the coastline are becoming vast in term of development such as Kuantan and Kuala Terengganu and contribute to the marine pollution problem in coastal areas especially from domestic waste

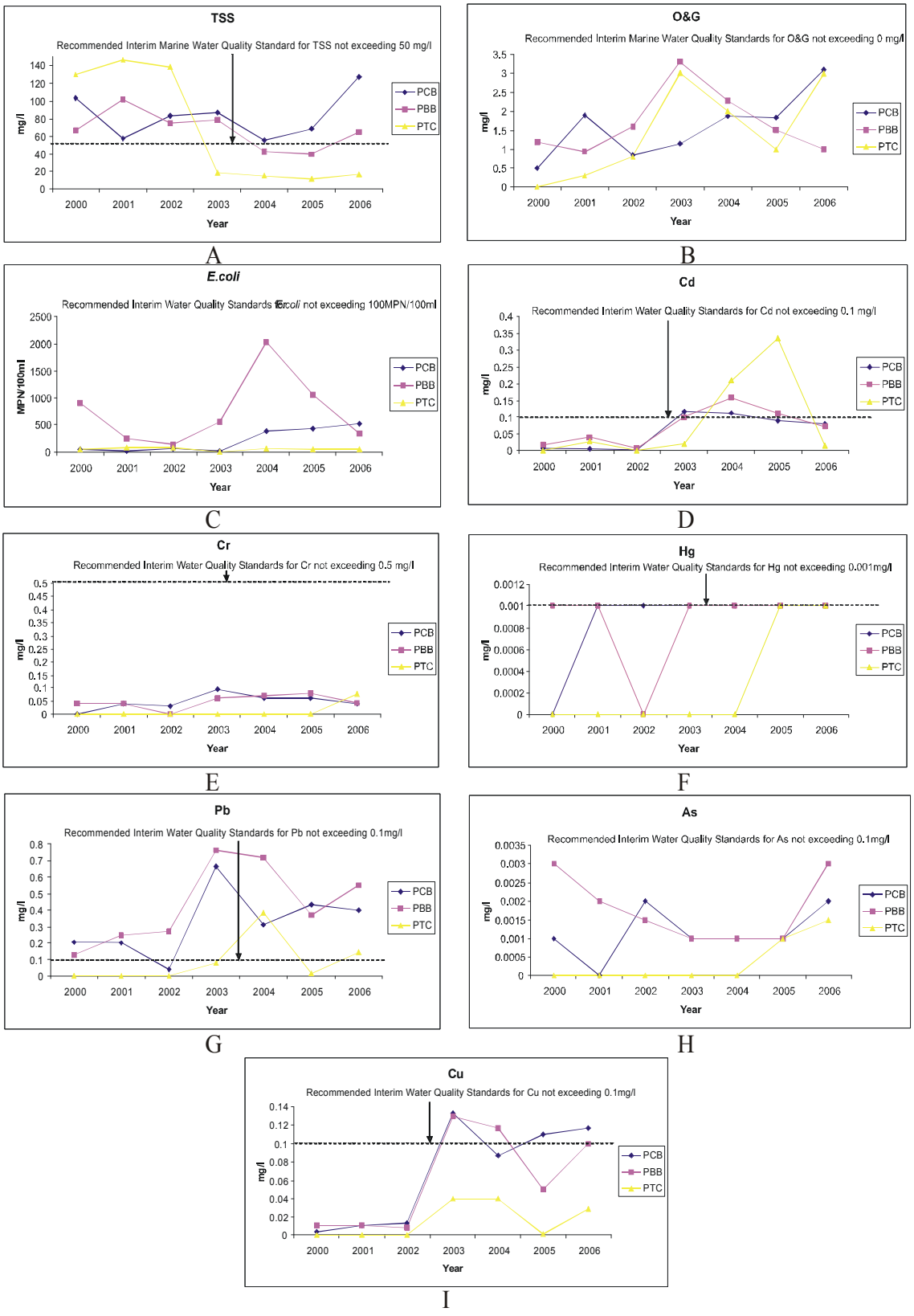

Fig. 2: PCB, PBB and PTC Average Concentration of Multiple Pollutants Trend, 2000-2006

disposal from the business, settlement and services activities. The used of pesticide and chemical fertilizer in agricultural area, farming and industrial activities have contributed to the heavy metal pollution problems in marine area. In general, the pollution of TSS, OandG and *E. coli* are very serious in all three beaches. The pollution of heavy metals can't be taken into granted, in view that it has a consequences in human health if precaution has not been applied.

CONCLUSION

As a conclusion, the level of pollution within all study areas can be considered as slight. The TSS parameter for all sites has showed the trend of exceeding the national water quality interim standard. Nevertheless, the amounts of pollutant slowly decrease particularly at PTC. OandG pollution parameters also exceed the national standard and the beaches that have been identified to be extremely polluted are PCB and PBB.

Meanwhile, the heavy metal did not show an extreme level of pollution except for several parameters such as Cd, Pb and Cu. It is becomingly clear that human activities in costal zone area have been identified to be the major contributor to the water marine pollution. An extensive development such as infrastructure facilities in coastal zone area has impacted the quality of marine water in those areas. Although the trend of pollution level has reduced significantly, but it is still exceed the interim standard that has been set up by DOE in particular for TSS parameter. In order to overcome this problem, several stern actions such as monitoring and enforcement involving all parties need to be implemented continuously.

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