STUDY ON WATER AND SOIL QUALITY, SOURCE APPORTIONMENT OF POLLUTION LOADING AND COMMUNITY ENGAGEMENT FOR INTEGRATED CATCHMENT MANAGEMENT OF GEBENG INDUSTRIAL ESTATE, PAHANG, MALAYSIA

SALAH MASOUD SALEH GABAR

DOCTOR OF PHILOSOPHY

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR'S DECLARATION

We hereby declare that We have checked this thesis and, in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Satu kajian telah dijalankan untuk menilai air permukaan dan kualiti tanah, sumber pembahagian pencemaran pemuatan kawasan perindustrian Gebeng dan peserta tempatan untuk mencadangkan model untuk pengurusan tadahan bersepadu di kawasan ini. sampel air telah diambil dari air permukaan Tunggak dan Balok sungai untuk tempoh dari Oktober 2016 hingga Ogos 2017 dari 10 stesen persampelan. Sampel tanah juga dikumpulkan dari 10 stesen dua kali pada musim kering dan basah. Seramai 15 parameter air dengan sepuluh logam berat, dan sifat-sifat tanah dengan sepuluh logam berat telah dianalisis mengikut prosedur kaedah standard. Analisis data dijalankan dengan menggunakan SPSS 21.0 perisian statistik. Semua parameter kualiti air 25, 16 parameter didapati di luar syor (EQR) Malaysia. Kepekatan pH adalah dalam julat keasidan (6.61) dan DO sangat rendah (4.39 mg / L) ke seluruh kawasan. Oleh itu, TDS, TSS, EC, BOD, COD, AN, TP, O & G, Cd, Co, Cu, Pb, Mn, dan Ni diperhatikan dalam kepekatan yang lebih tinggi kerana air sisa industri. Keputusan keseluruhan DOE-WQI mendedahkan bahawa air permukaan kawasan Gebeng itu dikelaskan sebagai kelas III. Keputusan harta tanah menunjukkan bahawa tanah yang lebih rendah pH, OM, dan SPR dan sebahagian besar daripada saiz zarah tanah kawasan Gebeng adalah kelodak dan tanah liat. Pencemaran tanah dinilai oleh indeks risiko ekologi seperti indeks geo-pengumpulan (Igeo), faktor pencemaran (CF), dan indeks beban pencemaran (PLI). Tanah Igeo dan CF mendedahkan bahawa zon perindustrian telah tercemar oleh lima logam berat iaitu: As, Cd, Co, Cu, dan Pb. Keseluruhan PLI di stesen zon perindustrian adalah lebih besar daripada 1, yang menunjukkan bahawa ada tanah logam berat pencemaran di zon industri. Sumber kajian pembahagian air permukaan dan parameter tanah mendedahkan bahawa sumber penting pencemaran adalah disebabkan oleh aktiviti antropogenik. Sumber pencemaran air adalah terutamanya disebabkan oleh efluen industri yang berkaitan dengan air sisa domestik, pertanian dan larian bandar sebagai tambahan kepada sumber semula jadi. Dua jenis kaji selidik telah diedarkan kepada tiga kumpulan yang berbeza. Pengetahuan, Sikap dan Amalan tinjauan (KAPS) telah diedarkan pada orang masyarakat setempat dan pekerja industri untuk mengetahui pengetahuan, sikap dan amalan orang-orang ini mengenai isu pencemaran industri. Tinjauan umum telah diedarkan kepada pihak berkuasa (JAS) untuk memahami kesanggupan mereka untuk mengambil bahagian dalam usaha sama dengan orang-orang masyarakat setempat dan pekerja industri. Demografi ciri-ciri masyarakat dan industri pekerja tempatan menunjukkan bahawa orang yang lebih tua, orang yang mempunyai tahap pendidikan yang lebih tinggi, penduduk lama, tahun pengalaman kerja adalah orang yang paling penting yang memelihara perubahan air permukaan dan kualiti tanah. Seramai skor hasil kajian KAP mendedahkan bahawa penduduk tempatan mempunyai pengetahuan yang baik, sikap, dan amalan untuk isu ini, manakala pekerja industri mempunyai pengetahuan yang baik, sikap dan amalan buruk. Ketiga-tiga kumpulan yang berbeza teruja untuk mengambil bahagian dalam usaha bersama untuk melindungi kawasan itu daripada pencemaran. Oleh itu, gabungan hasil penemuan saintifik dengan masyarakat setempat dan kajian industri pekerja menunjukkan persatuan yang penting dan memberikan visualisasi akhir bagi mencadangkan pengurusan tadahan bersepadu model (Program Kawalan Alam Sekitar ECP).

ABSTRACT

A study was carried out to evaluate the surface water and soil quality, source apportionment of pollution loading of the Gebeng industrial area and local participant to propose a model for integrated catchment management of the area. Water samples were collected from the surface water of the Tunggak and Balok rivers for a period from October 2016 to August 2017 from 10 sampling stations. Soil samples were also collected from 10 stations two times in the dry and wet season. A total of 15 water parameters with ten heavy metals, and soil properties with ten heavy metals were analysed according to the standard method procedures. Data analysis was conducted using SPSS 21.0 statistical software. Of all the 25 water quality parameters, 16 parameters were found to be beyond the recommendation of the (EQR) Malaysia. The concentration of pH was in acidity range (6.61) and DO were very low (4.39 mg/L) over the whole area. Accordingly, TDS, TSS, EC, BOD, COD, AN, TP, O&G, Cd, Co, Cu, Pb, Mn, and Ni were observed in higher concentration due to industrial wastewater. The overall results of DOE-WQI revealed that the surface water of the Gebeng area was classified under class III. The results of soil properties indicated that lower soil pH, OM, and EC and most of the particle size of the Gebeng area soils were silt and clay. The soil pollutants were assessed by ecological risk index such as geo-accumulation index (*Igeo*), contamination factor (CF), and pollution load index (PLI). The soil *Igeo* and CF revealed that the industrial zone was contaminated by five heavy metals which are: As, Cd, Co, Cu, and Pb. The overall of PLI at the industrial zone stations was greater than 1, which indicated that there is soil heavy metals pollution at industrial zone. Source apportionment study for surface water and soil parameters revealed that the significant sources of pollution were due to anthropogenic activities. The sources of water pollution were primarily due to the industrial effluents associated with domestic wastewater, agriculture and urban runoffs in addition to the natural sources. Two types of the survey were distributed to three different groups. Knowledge, Attitude, and Practices survey (KAPS) was distributed on local community people and industries employees to know the knowledge, attitude, and practices of these people about industrial pollution issue. A general survey was distributed to authorities (DOE) to understand their willingness to participate in a collaborative effort with the local community people and industries employees. Demographics characteristics of the local community and industries employees showed that older people, people with higher education level, old residents, years of work experience were the most important people who observe the change of the surface water and soil quality. A total score of KAP survey results revealed that local people have good knowledge, attitude, and practices to the issue, whereas the industries employees have good knowledge, attitude, and bad practices. All three different groups were excited to participate in a collaborative effort for protecting the area from contamination. Consequently, combined the results of the scientific findings with local community and industries employees survey showed significant associations and gave the final visualization for suggested integrated catchment management (Environmental Control Program ECP) model.

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LIST OF SYMBOLS

%	Percentage
Ni	Nickel
Hg	Mercury
Cd	Cadmium
Zn	Zinc
Cr	Chromium
Pb	Lead
Cu	Copper
As	Arsenic
Ba	Barium
Co	Cobalt
Mn	Manganese
℃	Degree Centigrade
µs/cm	Micro siemens/ Centimeter
mg/L	Milligram/Liter
SO^{-2}_4	Sulfate
NO^-_3	Nitrogen Ion
NTU	Nephelometric Turbidity Unit
Ppm	Part Per Million
Km	Kilometer

LIST OF ABBREVIATIONS

AN	Ammonical-Nitrogen
AOAC	Association of Official Analytical Chemists
APHA	American Public Health Association
CA	Cluster Analysis
CF	Contamination Factor
DOE	Department of Environment
EC	Electric Conductivity
EF	Enrichment Factor
EF	Environmental Footprint
EQR	Environmental Quality Report
EPA	Environmental Protection Agency
GEMS	Global Environmental Monitoring System
GIE	Gebeng Industrial Estate
GPS	Global Positioning System
HCA	Hierarchical Cluster Analysis
ICPMS	Inductively Coupled Plasma Mass Spectrophotometer
I_{geo}	Geo-accumulation Index
NRC	National Research Council
NSF-WQI	National Sanitation Foundation-Water Quality Index
NWQS	National Water Quality Standard
O&G	Oil and Grease
OECD	Organization for Economic Co-operation and Development
OM	Organic Matter
PCA	Principal Component Analysis
pHBC	pH Buffering Capacity
PLI	Pollution Load Index
SI	Sub-Index
SPSS	Statistical Package for the Social Sciences

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