LEACHATE MIGRATION PATH ESTIMATIONS AND GROUNDWATER QUALITY ANALYSIS NEAR A SOLID WASTE DUMPING SITE AT KAMPONG KELICHAP, BATU PAHAT

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For

My husband

Md. Rithauddin bin Yatni

&

My parents

Jalil bin Dahlan

Waghaiba binti Hj. Abu Yaman

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ABSTRACT

The impact of Kampong Kelichap solid waste dumping site on groundwater of an unconfined aquifer was investigated. The investigation involved the analysis of groundwater quality and the estimations of leachate or contaminants movement which included the flow direction and velocity. The leachate or contaminants movement were assumed to be similar to the groundwater movement in the study area. Groundwater level and water quality were monitored from August of 2003 to June of 2004 in nine wells (S1 to S9) located upstream and downstream of the study area. The measured water quality parameters were pH, temperature, turbidity, conductivity, dissolved oxygen (DO), total dissolved solids (TDS), ammonia nitrogen (NH_3-N), sulfate, biochemical oxygen demand (BOD_5), and chemical oxygen demand (COD). Contaminants concentration distribution in groundwater has been mapped or contoured using geostatistical analysis. Groundwater and contaminant movement or flow characteristics were estimated using water table contours, correlation surface analysis, and numerical models. The numerical modeling was conducted by using MODFLOW in conjunction with MODPATH and MT3D. Field and laboratory results showed high concentrations of conductivity, COD, NH_3-N and TDS in the downstream groundwater. Field measurements, laboratory analyses, and simulated models showed similar results in which the contaminated wells were S3, S4, S5, and S6. Conductivity, COD, and NH_3-N concentration contours suggested the dumping site as the main source of groundwater contamination in the study area. The changes in the patterns on COD concentration contours, the water table contours, the correlation surface analysis, and the numerical models showed that the contaminants and groundwater were traveling mainly toward the southwestern boundary with an average direction of 196 °, 199.5 °, 242.7 °, and 228.4°, respectively, as measured clockwise from the north. The estimated contaminated groundwater velocities from the correlation analysis and numerical model were ranging from 315.5 to 359 m/yr and 174 to 284 m/yr, respectively.

ABSTRAK

Kesan tapak pelupusan sampah Kampung Kelichap ke atas air bumi di dikaji. Kajian ini meliputi analisis kualiti air bumi (akuifer tak terkurung) dan anggaran arah dan halaju pergerakkan air kurasan atau bahan pencemar. Pergerakkan air kurasan atau bahan pencemar dari tapak pelupusan sampah tersebut di andaikan menyerupai pergerakan air bumi di kawasan kajian. Aras air bumi dan kualiti air bumi di ukur mulai Ogos, 2003 sehingga Jun, 2004 di sembilan buah telaga (S1-S9) yang terletak di hulu dan di hilir kawasan kajian. Parameter-parameter kualiti air yang dikaji adalah pH, suhu, kekeruhan, konduktiviti, oksigen terlarut, ammonia nitrogen (NH_3-N), sulfat, keperluan oksigen biokimia (BOD_5) dan keperluan oksigen kimia (COD). Pemetaan taburan kepekatan bahan pencemar di dalam air bumi di kawasan kajian di lakukan melalui analisis geostatistik. Pergerakan air bumi and bahan pencemar di anggarkan menggunakan kontur paras air bumi untuk akuifer tak terkurung, analisis korelasi, dan model simulasi. Model simulasi dilakukan menggunakan MODFLOW bersama dengan MODPATH dan MT3D. Air bumi yang terletak di hilir kawasan kajian didapati mengandungi kepekatan konduktiviti, COD, NH_3-N dan TDS yang tinggi. Hasil kerja lapangan, makmal and model simulasi menunjukkan bahawa telaga yang telah dicemari air kurasan dari tapak pelupusan sampah tersebut adalah S3, S4, S5, dan S6. Corak taburan konduktiviti, COD, dan NH_3-N mencadangkan tapak pelupusan sampah tersebut sebagai punca pencemaran utama air bumi di kawasan kajian. Perubahan corak taburan kepekatan COD, kontur paras air bumi, analisis korelasi, dan model simulasi menunjukkan aliran utama bahan pencemar dan air bumi adalah ke arah sempadan baratdaya masing-masing dengan purata arah yang diukur mengikut arah jam dari utara, 196 °, 199.5 °, 242.7 °, dan 228.4 °. Halaju air bumi tercemar yang terhasil melalui analisis korelasi dan model simulasi masing-masing adalah di dalam lingkungan 315.5 hingga 359.2 dan 174 hingga 284 m/yr.

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LIST OF ABBREVIATIONS

BOD	-	Biochemical oxygen demand
CB	-	Background concentration of an element
Cd	-	Cadmium
CF	-	Contamination factor
CM	-	Concentration of an element measured in a determined sample
CH_4	-	Methane
CO_2	-	Carbon dioxide
COD	-	Chemical oxygen demand
Cu	-	Copper
Cr	-	Chromium
$Cr_2O_7^{2-}$	-	Dichromate ion
Cr^{3+}	-	Chromic ion
DO	-	Dissolved oxygen
EC	-	Electrical conductivity
FTU	-	Formazine turbidity unit
Fe	-	Iron
Geotrans	-	Geographic translator software developed by NIMA
GMS	-	Groundwater modeling system
GPS	-	Global Positioning System
MODFLOW	-	USGS groundwater flow simulation code
MODPATH	-	Particle tracking post-processing package
Mn	-	Manganese
MSE	-	Mean squared error
MT3D	-	A modular three dimensional multi species transport model
NH_3-N	-	Ammonia nitrogen
Ni	-	Nickel
NIMA	-	National Imagery and Mapping Agency

NTU	-	Nephelometric turbidity unit
PAEE	-	Percentage average estimation error
Pb	-	Lead
RMSE	-	Relative mean squared error
TDS	-	Total dissolved solids
TSS	-	Total suspended solids
USGS	-	U.S. Geological Survey
WHO	-	World Health Organization
Zn	-	Zinc