CHAPTER VIII

SUMMARY AND CONCLUSIONS

8.1 SUMMARY

Local-scale integrated surface water and groundwater coupled model was developed for the Paya Indah wetland catchment using a physically-based, three-dimensional model MIKE SHE and MIKE 11 modelling system. Input data including meteorological parameters (i.e. rainfall and potential evapotranspiration), topography and river cross-sections, soil hydraulic properties, landuse and vegetation cover, channel and hydraulic structure, and hydrogeology were used to establish the model. The hydrology of the Paya Indah wetland catchment has been conceptualized prior to the model development. A comparison of simulated and observed instantaneous for all the calibration targets including surface water level, channel flow and groundwater potential head was performed successfully. Total water balance was computed for the Paya Indah wetland catchment. The model results were used to assess the impacts of various anticipated land-use changes and groundwater over-extraction scenarios on the hydrology of the catchment.

8.2 CONCLUSIONS

The primary objective of this study was to gauge the model's ability to produce surface and subsurface hydrodynamic processes at the watershed scale. This objective was first accomplished by calibrating the surface water level for, apart from the inlet (SWL1) and outlet (SWL2), 10 lakes and channel flow while simultaneously matching the steady-state subsurface portion of the system to 8 observation wells where potential head data were available. The calibration process covered the period from July 1999 to October 2004 which was chosen due to the availability of calibration data. The level of agreement between the observed and simulated groundwater head values, channel flow and the spatial pattern of the surface drainage network indicated that the model captured the essence of the surface-subsurface hydraulic characteristics of the modelled catchment. The model was, therefore, validated against data of surface water level, discharge and groundwater head for the period August 2007 to August 2008 to represent a complete climatic cycle.

Results of the multi-criteria evaluation showed that both the calibrated and validated models performed satisfactorily. However the hydrographic visual judgment revealed that the dynamics characteristics, especially for the surface water were well represented by the validated model rather than the calibrated one. The latter noticeably influenced by the unscheduled flow operation of the controlled gate at the Lotus-Outlet. Conversely, during the validation the groundwater dynamics, in the area between the Lotus Lake and Langat River, remarkably influenced by the groundwater abstraction at the Megasteel Co. Ltd property. The results also showed that the simulated channel flow for both calibrated and validated models responded fairly well to the input rainfall data. Potential evapotranspiration, overland flow and groundwater abstraction represent the most sensitive input parameters that control both surface and subsurface flows. Generally speaking, the spatial and temporal responses of the catchment with respect to the overland flow areas contributing to streamflow and the surface-subsurface exchange flow through recharge and evapotranspiration process and subsequent fluctuations in the groundwater head demonstrated the dynamic nature of the interaction occurring between the surface and subsurface hydrologic regimes.

Annual water balances errors for both calibration and validation simulation periods were less than 1%. The seasonal water balance demonstrates that the model was able to simulate all the hydrological processes (evapotranspiration, baseflow, recharge and surface runoff) satisfactorily. Evapotranspiration loss is higher than other components representing about 60% while as the recharge is about 22% of the total rainfall. The higher rate of Evapotranspiration was obtained in the dry season (April to August). The baseflow simulated by the model represent ~ 9% of the total runoff and ~ 2% of the total rainfall. Results also revealed that 15% of the rainfall recharges the saturated zone however, due to the extensive exfiltration mechanism; two magnitudes volumes of this rechargeable water are lost.

The occurrence of low permeability of an average value of 4.8E-7 m/s acts as natural barrier that seals the bottom of the Paya Indah Lakes system. Furthermore, the adverse impact of the groundwater abstraction influenced a wide zone which covered almost the entire area between the Lotus Lake and the Langat River. Bearing in mind the fact that the pumping caused the groundwater head to drop some 4 – 12 m below the sea level, and the ground around the Megasteel is subsidizing, this situation should be taken as an alert to avoid: (1) - further collapse of the deep aquifer and (2) - an anticipating seawater intrusion that might occurred as consequence of long-term pumping.

The Paya Indah wetland catchment model was developed to assist in water management of the catchment. The model was found to simulate the water level and discharge, groundwater head and some more the water balance with a satisfactory accuracy to be used for impact assessments focusing on future development incorporating management initiatives to improve the water resources situation in the catchment. Various scenarios that simulated by the baseline scenario indicated that the rapid urbanization within and adjacent the modelled catchment had the greatest impact on the surface water level through reduction of depletion the inflow of the Cyberjaya city.

The scenario of completion of phase II of Cyberjaya development may result in dropping of groundwater table in the peat layer about 0.1 m to 0.5 m depending on how far the location is from the proposed development zone.

The scenario of completion of Cyberjaya and E-village full development clearly influences both surface and subsurface hydrological regimes in that the water level of most of the Paya Indah lakes system (excluding the sub-catchment of Tin Group) which can drop up to 0.6 m; while the shallow groundwater table of the peat layer drops up to 0.5 m mainly along the NSECL highway. This situation will accelerate peat subsidence and increase the risk of peat fires along the entire length of the NSECL highway. On the other hand there is a significant drop in the surface water level of about 0.2 m to 0.65 m in the main Paya Indah lakes system.

The scenario of removal of the entire peat layer causes the groundwater head in the deep aquifer has dropped dramatic to an average level of ~1.5 m; while as the water level in the Tin Lake slightly drops up to 0.1 m which indicates that the peat layer, might partially recharge this lake as well as the deep aquifer.

All the sub-scenarios of groundwater abstraction scenario were coincided with the baseline scenario as regards the drop of the groundwater head up to ~ 4.0 m below the sea level which indicates that the current groundwater head is within the critical zone of the pumping impact. Thus, maps of the groundwater head during dry and wet seasons can be used for water management for determination of suitable time for groundwater abstraction in order to avoid both saline water intrusion and the aquifer collapse. In general, groundwater abstraction is highly recommended to be during periods when the groundwater level is higher than the sea level.