ENVIRONMENTAL IMPACT MODELING OF SEMI-ENCLOSED COASTAL SEAS: THREE CASE-STUDIES IN MALAYSIA

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INTRODUCTION

Preserving the natural environmental in the coastal seas has become an important component in the development strategy for Malaysia. This strategy has mandated the formulation of and constant amendments to the Environmental Quality Act (EQA) enacted in 1974 under which all estuarine and coastal developments that are perceived to have significant environmental impacts on coastal water quality must receive prior approval from the Department of Environment (DOE) to have satisfied the stipulations of the Environmental Impact Assessment (EIA) Regulations (DOE, 1995) before project implementation. In the past ten years, many EIA's were conducted for proposed development projects sited around Malaysian coastal waters. This paper describes the EIA conducted for several development projects situated in three separate coastal areas with the aims to illustrate the prime importance of utilizing the facility of mathematical modeling and simulations to deduce quantifiable impacts due to proposed coastal development projects as an integral part of the EIA procedures.

MAJOR FINDINGS

Of major concerns are the fate and effects of pollutants arising from the discharge of sewage, organics, sediments and industrial wastes into the riverine environment and the coastal seas. In a recent annual, water quality monitoring program, it was found that 78 out of the 116 major rivers were polluted and that 62% and 58% of coastal waters were polluted by suspended solids (SS) and *E. coli* respectively.

The EQA had adopted the approach of using effluent standards as a means of controlling pollution in the receiving waters without any reference to the assimilative capacity of the receiving waters. The approach has been found to be ineffective in ensuring appropriate water quality standards in the receiving waters. With a view to rectify this rather undesirable situation, a new approach entitled the Interim National Water Quality Standards (INWQS, 1994) is proposed whereby usage of receiving waters is classified into five classes of beneficial uses. This approach will soon be extended to cover marine and coastal waters. Class I waters have the most stringent water quality standards, being intended for portable water intake, while class V the least stringent, suitable for navigation only.

The linkage between the effluent standards and the receiving water quality standards may be appropriately established only with the help of mathematical modeling of water quality. Hence in a recent review of the EIA Procedures completed in March 1997 by DOE, it was decided to make water quality modeling a mandatory step in the preparation of the EIA Reports. This is deemed essential since it has been observed that compliance of effluent standards has not been successful in protecting intended river and marine water quality standards. This paper briefly discusses a few studies that have concurred, in part, with the above observation.

Johor Estuary

Discharge of sewage and organics into the Johor Strait near the existing causeway in Johor Bharu has resulted in gross pollution for a large stretch of the strait even though the effluent satisfies the Standard B quality status meant for non-catchment. Mathematical modeling was then used to propose several mitigation measures which include adequate treatment and the removal of the causeway (Koh *et al.*, 1991). Implementation of these mitigation measures is being planned.

Nearby in another estuary, discharge from an palm-oil refinery satisfying the more stringent Standard A quality status meant for catchment did not ensure adequate water quality in the estuary. The use of modeling helps to identify some key contributing factors, including the discharge from unlicensed backyard industries and benthic contributions that adversely affect water quality in the estuary (Koh *et al.*, 1995).

Penang Straits

Large stretches of the Penang Straits are grossly polluted by sewage discharged from several outlets. A comprehensive sewage treatment system is being planned to ugrade the present system to cater up to the year 2030 and a preliminary EIA was completed in 1992. Modeling was used to identify appropriate discharge locations, assuming the adoption of secondary treatment, that would achieve designated water use including recreational waters and shell-fish harvesting (Koh *et al.*, 1997). Effluent standards were found to be not relevant to achieve required water use in this case.

Langkawi Estuary

The fast pace of coastal development in the resort island of Langkawi has the great potential of degradating marine water quality around the island. A recent study (Koh *et al.*, 1996) has identified BOD and SS as two key parameters relevant to the protection of coral community located some 15 km away. Control measures are expressed in terms of total BOD mass loadings at specified locations and specified SS concentrations in the coastal water around project sites. Once again, effluent standards were not used in the simulations that accompanied the study.

CONCLUSION

Studies conducted in three coastal seas in Malaysia are briefly discussed to illustrate the effective use of water quality modeling to assess mitigation measures needed to achieve designated water use standards.

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REFERENCES

Department of Environment, "A Handbook of Environmental Impact Assessment Guidelines", Kuala Lumpur, 1995.

INWQS, "Classification of Malaysian Rivers, Volume 1, Executive Summary", Department of Environment, Malaysia, 1994.

Koh, H.L., Lim P.E. and Zamali, M., "Management and Control of Pollution in Inner Johor Strait", Environmental Monitoring and Assessment, Kluwer Academic Publishers, The Netherlands, 1991, pp.19: 349-359.

Koh, H.L., Lim, P.E. and Lee, H.L., "Water Quality Modeling in an Estuary in Johor", Water Qual. Res. J., Canada, 1995, pp.45-52.

Koh, H.L., Lim, P.E. and Lee, H.L., "Impact Modeling of Sewage Discharge from Georgetown of Penang, Malaysia on Coastal Water Quality", to appear in Environmental Monitoring & Assessment, Kluwer Academic Publishers, The Netherlands, 1997.

Koh, H.L., Din, Z. and Lee, H.L., "EIA Study of the Proposed Pan Asian Resort Development, Kuah, Langkawi: Modeling of Suspended Sediments and BOD-DO Dynamics", Final Report submitted to Department of Environment, Malaysia, April 1996, approved by DOE.