Circulation and Pollutant Dispersion in Masan-Jinhae Bay of Korea

SEE WHAN KANG
Korea Ocean Research and Development Institute, Ansan, P.O. Box 29, Seoul 425-600, Korea

Circulation and dispersion of pollutants in the Masan-Jinhae Bay, Korea were studied through numerical experiments as well as hydrographic field survey. The field survey includes the measurements of water-level, currents, temperature, salinity and chemical oxygen demands(COD). To simulate the circulation and dispersion of pollutants discharged into the Bay, a two-dimensional finite element scheme was employed. The calculated tidal currents were consistent with the current-meter measurements. Using the circulation model, dispersion of pollutants was estimated resulting in very slow mixing with the open waters due to near-stagnancy of the inner bay waters.

The Masan-Jinhae Bay in the southeastern part of Korea is one of the most polluted water body in Korea(Fig. 1). A semienclosed bay with its mouth opened to the Korea Strait has the area of approximately 500 Km^2 with mean water depth of 5m in the inner bay and of 25m in the central part. Along the bay inner of Modo(Fig. 1), industrial complex has been built since the past two decades. Once the bay area was very attractive to the locals as well as to the tourists due to its natural beauty of coastline and clean waters. However during the last decades, untreated or inadequately treated sewages of municipal and industrial wastes have influenced severely on water quality.

The COD load discharged from the Masan area was estimated as the amount of 38,185Kg/day (Lee & Min, 1990), consequently the average concentration of the COD reaches up to 6 mg/l.

Considering the harzadous water quality endangering to ecosystems in the area and to fishery/aquaculture, numerous studies have been carried out to reduce the impact and to improve the water quality. Among them, many environmental approaches considering the dispersion processes in relation to the water movements have been a part of the studies. The present paper is dealing with the estimation of pollutant dispersion that is brought by hydrodynamic processes.

There are strong semi-diurnal tidal currents with speed of approximately 100 cm/s along the deep channel at the bay mouth, while very weak currents less than 10 cm/s are observed in the inner bay where most of the pollutants are loaded in. The water column represents a well-mixed during winter, while strong stratification develops during summer indicating little vertical mixing. The mean tidal range in the bay is about 180 cm and 45 cm during Spring and Neap tides respectively. In this study, a two-dimensional numerical model was

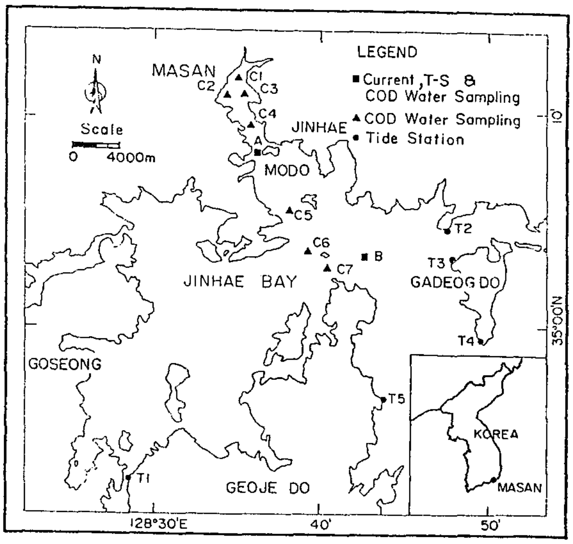

Figure 1. Location map of hydrographic survey stations.

Marine Pollution Bulletin, Vol. 23, pp. 37–40, 1991.
Printed in Great Britain
0025-326X/91 $3.00+0.00

Two cases were examined. The first case was such that pollutants were dispersed only by the tidal action. The second allowed the streams A and B in Fig. 3b to discharge freshwater of 10 m^3/s with each of 5 m^3/s. The amount of freshwater discharge was equivalent to the stream discharge into the bay during the summer monsoon. Introducing the freshwater discharge for the rainy season did not show a big difference with the fluctuation without the freshwater discharge. Figure 5 represents the spatial distribution of pollutants with time for case 1 (without freshwater discharge) and for case 2 (with freshwater discharge) respectively. The overall pattern between two case studies are the same except that the downbay dispersion of pollutants with freshwater discharge is marginally faster. However it is clear from the simulation that appreciable masses are remained to a limited area around the source under the tidal action as considered in this study.

The average concentration of the COD loads which was measured over the year at major inflowing streams was approximately 330 g/sec. Using the average COD load, the second case study for continuous release was conducted. The model was run until the steady state is reached. Table 1 represents the calculated COD concentration which is conistent with the observation. Comparing the results of the instantaneous release with heavy source (Fig. 5) and of the continuous release with light source levels (Table 1) reveals that the impact of pollutants onto the water quality seems much severe for the continuous release with light source loads due to the accumulation in the Masan Bay.

The observed currents (lower plots in Fig. 2) deviate considerably from the typical tidal currents. Relatively strong currents throughout the water column on 16-17 October 1987 are associated with strong winds. It is noticeable that the COD concentration in the bottom layer is high due to the resuspension of bottom sediment arising from the wind agitation. Considering the episodic three dimensionality, numerical modelling in 3 dimensions is preferred. Our efforts for the 3-D approach are continuing.

Table 1. Comparison between the observed and calculated COD concentrations in Masan-Jinhae Bay on October 24, 1987.

Station		C1	C2	C3	C4	C5	C6	C7
COD	Observed	5.8	5.8	5.0	6.4	1.4	1.2	1.9
mg/l	Calculated	5.9	4.3	4.5	3.6	-	-	-

The research upon which this paper is based was sponsored by the Ministry of Science and Technology, Korea. The work of T.S. Jung and J.C. Lee in deploying instruments, implementing the numerical modelling is very gratefully acknowledged. A big debt of gratitude is owed to Dr. Chang S. Kim, with whom longstanding discussions were held for this study.

Hydrographic Office. 1982. Tidal current charts, Hydrographic Office Pub. No. 1420, Ministry of Transportation, Republic of Korea, PP 20.

Kang, S.W., T.S. Jung and J.K. Choi. 1986. Ciculation and dispersion of pollutant in the Nakdong river estuary. Intl. Symp. Physical Processes in Estuaries. The Netherlands, p 19.

Kang, S.W. and T.S. Jung. 1988. A study of circulation and dispersion phenomena in an estuary. Proceedings of 1st Korea-Japan Envir. Sci Tech Symposium.Seoul. P 157-164.

Lee, C.W. and B.Y. Min. 1990. Pollution in Masan Bay, a Matter of Concern in South Korea. Marine Pollution Bulletin, 21(5), PP 226-229.

Steele, J.G, Pearce, B.R., Wang, J.D. and Connor, J.J. 1977. Finite-Element Modelling of Moreton Bay, Australia. Tech. Note No. 20, MIT, MA. PP 62

Wang, H.P. 1976. Multi-leveled finite element hydrodynamic model of block Island Sound. Ph.D. dissertation, Univ. of Rhode Island, RI, U.S.A.