Radiotracer Studies for Coastal Zone Management

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SUMMARY:

Coastal engineers and coastal zone managers increasingly rely on numerical models of fluid, sediment and contaminant dynamics. These are used to underpin coastal structure design and to predict environmental response to specific events such as storms or pollutant spills, and gradual changes such as sea-level rise or changes in bathymetry. Radiotracer techniques can be used to provide dynamic data on the movement of a specific patch of water, sediment or pollutant over time, which can be compared with model predictions. Two case studies are presented where radiotracer studies were used to improve confidence in numerical models of: (1) 2D hydrodynamics and sediment transport at the Port of Songkhla, Thailand; and (2) 3D hydrodynamics and algal bloom transport in Manila Bay, Philippines.

1. RADIOTRACER STUDY OF BEDLOAD TRANSPORT AT THE PORT OF SONGKHLA, THAILAND

Radiotracers may be used to validate models of bed load transport with a range of applications in coastal engineering including: optimisation of the alignment of dredging channels and the location of dredge spoil grounds; the development of ports and harbours and the fate and behaviour of contaminants associated with particulates.

Sedimentation of the dredged shipping channel at the Port of Songkhla, Thailand, poses a significant economic problem affecting Thai shipping. To assist in addressing this problem a numerical model of the port entrance was developed and validated using radiotracer studies of actual sand transport in the area.

The principal aim of the investigation was to validate the model prediction of the bedload transport in the vicinity of the Port of Songkhla using tracer techniques.

Two dimensional hydrodynamic model RMA-2 was used to model flow patterns around the port entrance and used to select radiotracer injection sites (Figure 1). Modelling showed locations where ebb tide eddies result in net flow towards the channel during most tides (Nielsen et al, 2001). These sites were chosen for tracer studies.

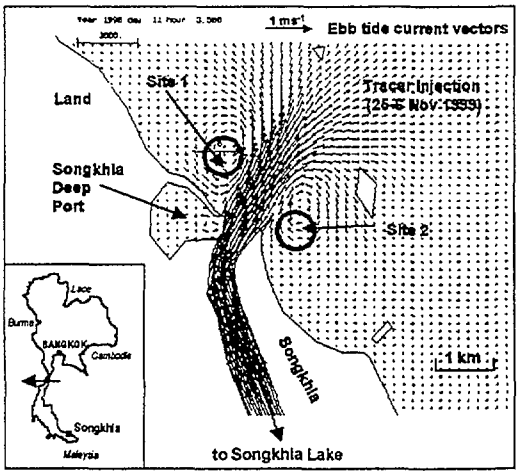

Figure 1: Superimposed on the ebb tide current vectors in the vicinity of the Port of Songkhla are the locations of the two tracer injections made on 25 November 1999.

The tracer was ^{192}Ir incorporated within glass beads with the same density and particle size distribution as the sand. Dispersion of the ^{192}Ir glass tracer was monitored and compared with the mass and direction of sediment transport predicted by the model.

The tracer distribution following injection and the location of the plume after six weeks (7 January 2000) are depicted in Figure 2. As shown in Table 1, very satisactory agreement between the observed and predicted values was found (Nielsen et al, 2001). This enhanced the

confidence with which the model could be used to plan on-going Port development.

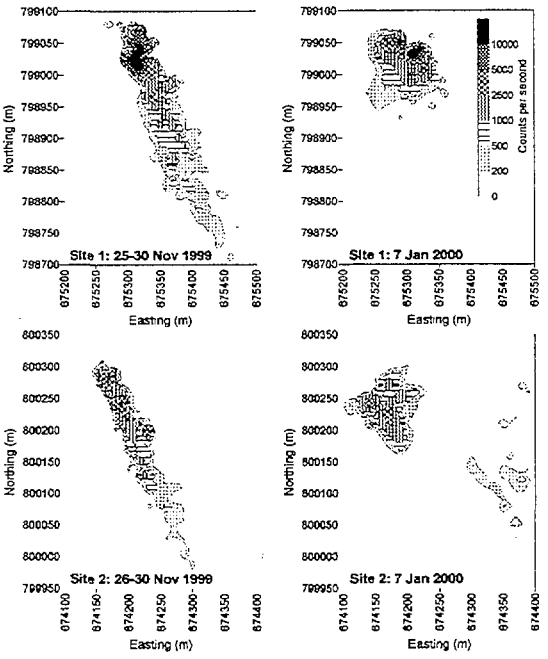

Figure 2: Decay and background corrected tracer distribution immediately following injection and six weeks later (from Nielsen et al, 2001)

Table 1: Tracer and modelling results.

	Transport (kg/m)		**Bearing**	
	Model	Tracer	Model	Tracer
Site 1	16,560	22,400	321°	333°
Site 2	4,337	1,470	162°	168°

2. HYDRODYNAMICS AND HARMFUL ALGAL BLOOM TRANSPORT IN MANILA BAY, PHILIPPINES.

Flow circulation within Manila Bay, Philippines, has a significant impact upon the water quality and sediment transport processes occurring in the bay. Over the last decade, red tides or toxic algal blooms have occurred causing risk to human health and major economic downturn to the fishing industry.

A study has been undertaken of contaminant transport within Manila Bay within the framework of the IAEA/RCA Project: *Managing the Marine Coastal Environment and its Pollution.* The overall aim of the study was to contribute to the much wider challenge of minimising the frequency of occurrence of harmful algal blooms which have a major effect on the local fishing industry.

As a contribution to this program, an investigation was undertaken of the sources and transport of nutrients in the Bay. A three dimensional model of the Bay was developed by the UNSW Water Research Laboratory. This model was validated using radiotracer techniques by the Philippines Nuclear Research Institute and ANSTO. In this case, technetium-99m tracer was used eluted from a 300 GBq Gentech® medical generator.

Details are described in Miller et al. (2001). During the period studied in December 2000, solute transport was dominated by the effect of winds. The tracer data greatly enhanced the quality of the modelling by providing direct measurements of dispersion both on the surface and at depth under the influence of a wind field.

The importance of using a three dimensional model as opposed to a two dimensional depth averaged model was demonstrated by both tracer and modelling results. Winds force surface currents to move in one direction while water flows in the opposite direction at depth to replace it.

3. REFERENCES

Miller, B M., Chadwick, M J., Kluss T,. C Hughes, C., and Duran, E. (2001). Three dimensional numerical modelling of circulation in Manila Bay, Philippines. *Proc Ports and Coasts 2001*, Surfers Paradise, Australia.

Nielsen, A.F., Kluss, T., Hughes, C.E., Sojisuporn, P., Chueinta, S., and Adamantidis, C.A. (2001). Field verification of formulations for sand transport under wave and current action. *Proc Ports and Coasts 2001*, Surfers Paradise, Australia.

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