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MARINE RADIOACTIVITY STUDIES IN THE SUEZ CANAL: MODELLING HYDRODYNAMICS AND DISPERSION[1]

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This paper comprises the work carried out under the IAEA Technical Co-operation Project EGY/07/002 [1,2]. The main goal was to develop a modelling study on the dispersion of radioactive pollution in the Suez Canal. This effort is in connection with the increased public concern about radiation safety in transport through this important trade route. A model of the whole Suez Canal was necessary to follow the fate of radioactive wastes along this waterway. The model had to solve the hydrodynamics of the water governed mainly by tides, but also including atmospheric forcing and the drift currents produced by horizontal salinity gradients and by differences in MSL at the two entrances of the Canal. A modelling study, by using a 1D approach, has been carried out from available data. The basic hydrodynamic features of the Suez Canal resulted reasonably reproduced, despite some important lacks of information. The computed transit times vary enormously along the year, ranging from few days to several months, depending on the differences in MSL between the two entrances of the Canal.

In the second part of this work we took advantage of the two field tracing experiments carried out under the IAEA Project[i]. From their results, we developed a modelling study on the dispersion of radioactive pollution in the Taufiq-Gineva area. The experiments were accomplished by using rhodamine B as a tracer. During experiments, water levels, velocities, wind and other physical parameters were recorded to supply appropriate information for the modelling work. From this data set, we could reasonably describe the hydrodynamics of the studied area by means of a 1D-model. Then we are applying a 1D-Gaussian approach to predict the position and the spatial shape of the plume. Nevertheless, the required diffusion coefficient was strongly dependent on initial conditions. By means of a 2D-simplified model for dispersion, we are proving that a single formulation of diffusion, acting over a 2D structure with lateral velocity gradients, can satisfactorily explain the both two different observed dispersion patterns (see Fig. 1).

For the Bitter Lake area, where the previous method is useless, we are developing a 2D hydrodynamics and dispersion model to study the fate of any radioactive discharge. The bathymetry of the lakes is partially unknown and, consequently, the calibration of the hydrodynamic model from available data is only tentative. Nevertheless, and even with these limitations, the model is reproducing the basic observational hydrodynamic features. To solve 2D dispersion we are using the formulation of diffusion coefficients we previously studied from field tracing experiments in the southern Suez Canal area. In this way, we study different scenarios of discharges.

The main conclusion is that the dilution of concentrations will be a very slow process within this waterway where the tidal amplitudes of velocities are few cm/s in most of the Canal. This situation is specially critical in the Bitter Lake area. On the other hand, the seasonal changes in MSL at the Read Sea are greatly affecting the hydrodynamics of the whole system.

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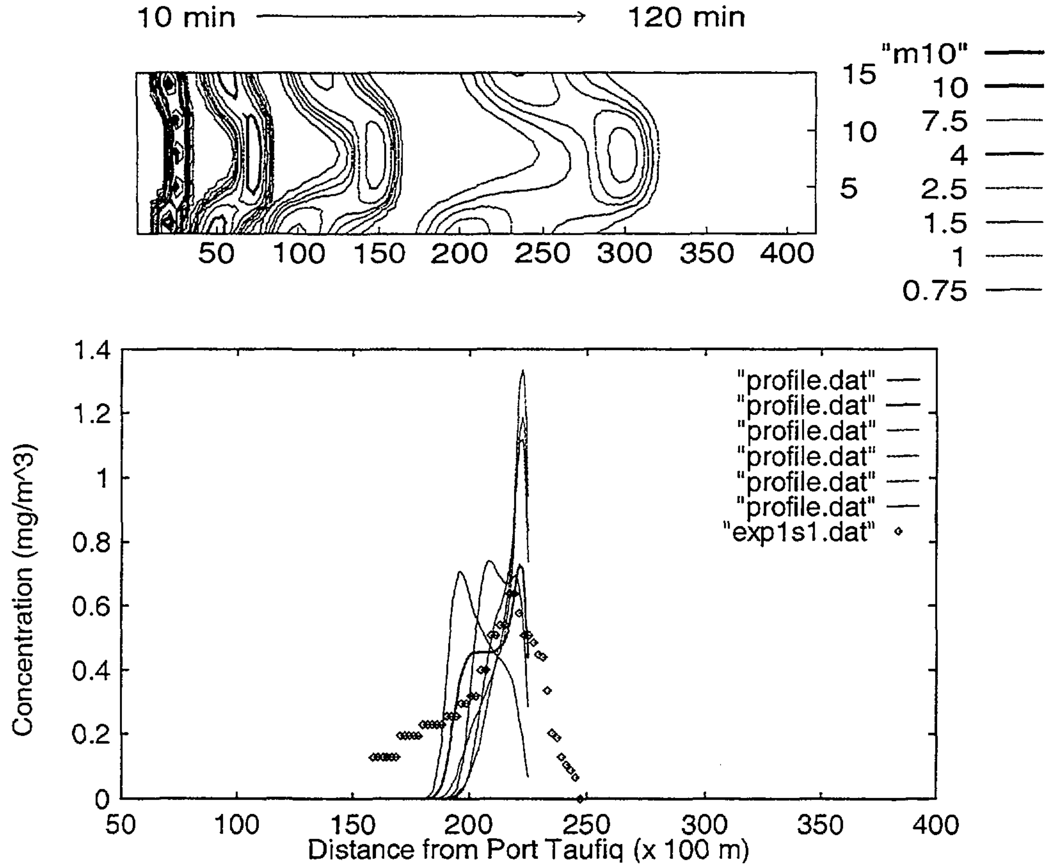

FIG 1 Simulation of the time and spatial evolution of the plume during the first tracing experiment. X and Y coordinates are grid positions, with grid length of 21 m, and Sallufa station corresponds to x=5 (km 146.2). The contour-lines for concentrations have units of mg/m³. The plume moves northwards (positions at time 10, 30, 60 and 120 minutes after injection). The second figure shows a comparison between the measured and the computed concentrations of rhodamine B (these last along several longitudinal sections of the canal), at t= 170 minutes after injection.

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References

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