

## O-VI8

### 3D Mathematical Modelling of currents and dispersion in the Northern Adriatic

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Among the different measures for water-quality improvement in the Northern Adriatic, mathematical modelling plays a significant role. Some measurements of current velocities, temperature, and salinity were also executed in 1984-86, mainly in the Piran and Koper Bays.

The mathematical model is three-dimensional, nonlinear, and includes equations simulating dispersion of heat, salinity or contaminants. These parameters affect the density according to the equation of state and variable density in return influences the velocity field (For details see Rajar, 1989). A one equation turbulence model is used for the vertical distribution of the "turbulence viscosity", (based on the eq. for turbulence kinetic energy) including the influence of stratification which is expressed by the Richardson number (Rajar et al, 1989).

The possibility to simulate the transport of contaminants gives the possibility to extend the present hydrodynamic model into a water-quality model. The model is used also to simulate circulation in lakes.

With the model we have simulated the circulation in the whole Northern Adriatic and especially in the Trieste Bay (Fig. 1) and Piran Bay and Koper Bay, which are parts of the Trieste Bay, where the water quality is most endangered.

The results of the modelling show that the very polluted water from the Italian po river reaches the Yugoslav coast at different meteorologic conditions. For the Trieste Bay (Fig. 1) many simulations were made and compared with the results of measurements. It was shown that the tidal forcing and the wind forcing are of the same order of magnitude. Fig. 1 represents simulation of currents during falling tide, with the wind increasing during the day up to 4,5 m/s. A relatively strong stratification took place (9°C and 1,6 ‰ difference in temperature and salinity at the surface and at the depth of 22 m). The bulk movement of the water is out of the region (during falling tide), with the right deflection due to the Coriolis effect.

Weaker winds (Fig. 1) cause only the surface layer to move with the wind; no destratification takes place. The measurements confirm this fact. Simulation and also the observations show that more than two days of strong "Bura" wind are necessary to "mix" the stratified layers.

In the smaller Piran Bay and Koper Bay, the tidal influence is small compared with the wind forcing. However, we have studied the circulation due only to tidal forcing, since conditions for dispersion of contaminants are the worst in windless days. Summarized results of measurements during the periods of week winds ( $v < 2$  m/s) show a cyclonic circulation during rising tide in both bays. During falling tide, anticyclonic circulation is formed in the Piran bay, but in Koper bay again a kind of cyclonic vortex is formed, presumably due to flow out of the Trieste bay and around the cape, which closes the Koper Bay at the North.

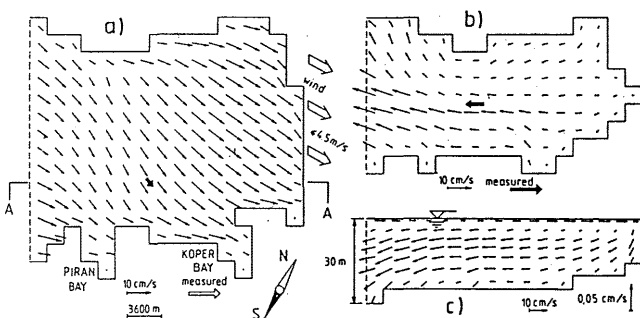


Fig. 1 Computed currents in the Trieste Bay a. Surface currents b. Bottom currents c. Vertical cross-section A-A

#### REFERENCES:

RAJAR, R., ČETINA, M., TONIN, V., 1989. Influence of linearisation and of Vertical Distribution of Turbulent Viscosity on 3D Simulation of Currents, Hydrocomp Conference, Dubrovnik, June, 13.-16.

RAJAR, R., 1989. Three Dimensional Modelling of Currents in the Northern Adriatic Sea, XXIII Congress of IAHR, Ottawa, August 21.-25.

RAJAR, R., 1990. Three Dimensional Mathematical Model of Currents and of Transport of Pollutants in the Adriatic. VIII. Congress CMWR, Venezia, June, 13.-16.