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Modelling sediment transport in coastal basins: The case of the Thermaikos Gulf

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The pollutants affecting marine environments are mostly associated with particulate matter, especially with fine sediments. As a consequence, knowing the motion and distribution of sediment particles coming from a given pollutant source is expected to provide the 'bulk' information on pollutant distribution. In that aim a numerical model has been developed to predict the fate of the sediments introduced to the seawater from different pollution sources, such as rivers, sewage and erosion of the seabed.

The three-dimensional transport model for 'ideal' particles passively advected and dispersed by the currents is based on the Lagrange - Monte Carlo Method. A large number of particles, each representing a particular amount of mass are presented to the flow domain through various sources. Their transport and fate is traced with time. The horizontal advection of the particulate matter is controlled by the local fluid velocity and the vertical advection is controlled by the local fluid velocity and the particle settling velocity. The turbulent diffusion is simulated by the random Brownian motion of the particles due to the turbulence. Thus the motion of each particle is analyzed into a deterministic part, which expresses convection and a stochastic part that accounts for diffusive processes. Input parameters of the model are hydrodynamic data and physical parameters of the seawater and hydrological data.

Once the cohesive sediment parcels are introduced to the coastal environment they undergo various processes that affect their properties and their movement. More specifically in relation to the physical parameters of the water they flocculate or deflocculate and gradually change density, thus altering their representative diameter and settling

velocity. Seawater stratification influences the vertical movement of the parcels by either intercepting or enhancing settling rates. Near-bed processes are included in the simulation, with the possibility of the parcels to settle onto the bed, consolidate or resuspend at a later time, and the introduction of eroded material from the sea bottom, according to the shear stress conditions.

One of the major advantages of the model is that many different sets of results can be extracted, such as “snapshots” of the aquatic environment with respect to suspended sediments, trajectories of the movement of specific parcels, concentrations of suspended or deposited matter, variation of sediment characteristics in time and in general the distribution of nutrients in every spatial and temporal point required.

The mathematical simulation, described above, is realized for the case of the real field of Thermaikos Gulf. The four rivers, Axios, Loudias, Aliakmon and Pinios that discharge along the west coasts of Thermaikos Gulf, supply the coastal basin with a large amount of fine-grained sediments. The coastal region of the study was extended from the near-shore region to the offshore region of the gulf.

The necessary hydrodynamic data, are obtained from the Northern Aegean shelf model, a three dimensional hydrodynamic model based on the well-known Princeton Ocean Model (POM). The shelf model obtains the boundary conditions (asynchronously nested) from the Aegean-Levantine area (so-called ALERMO) model (MFSTEP project).

The results from the sediment transport model used for quantitative information of the sedimentation - deposition in Thermaikos gulf and to study the sedimentation rate on the basin.