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Numerical 3D modelling of oil dispersion in the sea due to different accident scenarios

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The purpose of the study has been the development of a methodology, based on a numerical 3D approach, for the analysis of oil dispersion in the sea, in order to simulate with a high level of accuracy the dynamic behavior of the oil plume and its displacement in the environment. As a matter of fact, the numerical simulation is the only approach currently able to analyse in detail possible accident scenarios, even with an high degree of complexity, of different type and intensity, allowing to follow their evolution both in time and space, and to evaluate the effectiveness of suggested prevention or recovery actions. The software for these calculations is therefore an essential tool in order to simulate the impact effects in the short, medium and long period, able to account for the complexity of the sea system involved in the dispersion process and its dependency on the meteorological, marine and morphological local conditions. This software, generally based on fluid dynamic 3D simulators and modellers, is therefore extremely specialized and requires expertise for an appropriate usage, but at the same time it allows detailed scenario analyses and design verifications. It takes into account different parameters as the sea current field and its turbulence, the wind acting on the sea surface, the salinity and temperature gradients, the local coastal morphology, the seabed bathymetry and the tide. The applied methodology is based on the Integrated Fluid Dynamic Simulation System HyperSuite developed by RSE. This simulation system includes the consideration of all the parameters previously listed, in the frame of a 3D Eulerian finite element fluid dynamic model, which accuracy is guaranteed by a very detailed spatial mesh and by an automatically optimized time step management. In order to assess the methodology features, an area of more than 2500 km2 and depth of 200 m located in the middle Adriatic Sea has been modelled. The information required for the simulation in different environmental conditions, have been collected from RSE proprietary and public databases directly connected to the model. Finally, the possible pollution source has been chosen in correspondence with the offshore drilling wells for the exploitation of the “Ombrina Mare” oil field, located at a distance of 6 km from the coast, and the project includes a FPSO unit. A number of different scenarios have been simulated using the 3D model created by HyperSuite, in different environmental conditions and considering emission events of low intensity and long period or of high intensity and short period, located near the sea surface or near the sea bottom. For each scenario, a preliminary initialization in the fluid dynamic unperturbed conditions at the starting date has been carried out, from which the emission period followed by a properly duration of diffusion period of the pollutant has been simulated. The results allowed to evaluate the relevance of the effects due to the environmental parameters as the wind, sea current and tide, putting in evidence the capability of the methodology to support the safety requirements in the frame of off shore oil exploitation provided that a dynamic characterization of the environment parameters is accounted for a sufficient detail.