Modelling ecological and human exposure to Persistent Organic Pollutants in the Venice lagoon through the application of the MERLIN-Expo tool

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MERLIN-Expo is a new modelling tool, recently developed in the framework of the EU-funded project "4FUN" (www.4fun-project.eu), aimed at simulating ecological and human exposure to environmental pollutants in complex scenarios. MERLIN-Expo library provides a set of fate&transport models for different environmental compartments (e.g. freshwater, soil, atmosphere, vegetables, etc.) that can be easily combined to create several scenarios, and then coupled to a human intake and a physiologically-based pharmaco-kinetic (PBPK) model to simulate human internal exposure (i.e. chemical concentrations in human tissues and organs). This novel tool is suitable for a wide set of organic and inorganic chemicals (e.g. PCBs, PCDD/Fs, PAHs, biocides) and can cover different temporal and spatial scales, therefore it may address many assessment goal in different regulatory contexts. Moreover, MERLIN-Expo incorporates advanced functionalities for uncertainty and sensitivity analysis.

MERLIN-Expo was applied to assess the ecological and human exposure to PCBs in the Venice lagoon (Italy). The Phytoplankton, Aquatic invertebrate and Fish models implemented in MERLIN-Expo library were combined to create an aquatic food web and to dynamically simulate the bioaccumulation in different aquatic species and the biomagnification along the food chain. Concentrations of PCB in water, reconstructed from concentrations in dated sediment cores from the lagoon, were used as time-series inputs to run long term simulations. The estimated concentrations in edible aquatic species were then used to estimate daily human intake through the consumption of local fish and seafood, and through the combination with literature data on other diet items (e.g. meat, dairy products), to estimate the total dietary intake of residents in the area. Finally, the application of the PBPK model allowed to explore the time dependent accumulation of PCB congeners in human tissues for several decades.

The performance of the proposed modelling framework implemented with MERLIN-Expo was evaluated using PCB concentrations measured in aquatic species, as well as human biomonitoring data (i.e., concentrations of PCB in serum), available from past environmental and health surveys conducted in the area. Moreover, the possibility to run probabilistic simulations allowed to explore the uncertainty associated with the reconstruction of exposure history of target local populations.

The results of the study can help the characterization of potential ecological impacts due to PCB contamination and support the identification of human health concerns associated with the consumption of local seafood, and they provide useful insights for supporting the testing and validation of MERLIN-Expo modelling tool.