THE IMPACT OF THE CONSTRUCTION AND OPERATION OF LIQUEFIED NATURAL GAS (NLG) TERMINALS ON MERCURY MOBILITY AND REACTIVITY FROM POLLUTED COASTAL SEDIMENTS

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Abstract
The sediment of the Gulf of Trieste is heavily polluted by mercury (Hg) originating from Hg mining activities in the past. The construction of two gas terminals for LNG is planned in this heavily contaminated site. A simulation based on previously developed models and measurements indicated that due to the enhanced mobility and reactivity of Hg from the sediment, elevated mercury concentrations in fish are expected in the future.
Keywords: Coastal Management, Mercury

Mercury in the Gulf of Trieste is mainly present due to the discharge of the Soca river, which drains the area of the second largest mercury mine in the world, Idrija in Slovenia [1-5]. In 500 years of its operation, the mining activity discharged over 35.000 tons of mercury into the environment. A large quantity of this mercury is buried in the sediment of the Gulf of Trieste. Concentrations of Hg in sediment frequently exceed the limit value of 2 mg/kg. Due to the presence of methylating bacteria, mercury is transformed from inorganic form to monomethylmercury (MeHg) which is the most toxic compound of mercury [3]. Bioaccumulation and biomagnifications of MeHg in biota results in high concentrations of this toxic compounds in edible fish. Therefore, the reduction of MeHg in the environment is one of the primary objectives in remediation of mercury contaminated sites [4].

Based on the state of the art knowledge of mercury cycling the Gulf of Trieste, simulations of resuspension of the bottom sediments during construction and operation of the terminals were made by the 3D numerical model PCFLOW3D[6-9]. The PCFLOW3D is a non-steady state three-dimensional non-linear baroclinic z- coordinate model with hydrostatic approximation. The model was developed at the Faculty of Civil and Geodetic Engineering of the University of Ljubljana and consists of four modules: a hydrodynamic (HD) module, a transport-dispersion (TD) module, a sediment-transport (ST) module and a biogeochemical (BGC) module, in order to simulate the transport and transformations of mercury.

Besides the simulations of hydrodynamics and some basic pollutants, special care was given to the development of the module for the simulation of transport and fate of mercury. Initially, the seasonal (four seasons) hydodynamic of water was simulated based on measurement data of the temperature and salinity (3 D fields), the average seasonal wind directions and velocity, as well as water discharge of Isonco river. Taking the exact geographical position of planned NLGs, mercury concentrations in sediments, seasonal production of MeHg in sediments, the flux of inorganic Hg and MeHg into the water column was calculated. Specifics of seasonal variations in hydrodynamics and in particular biogeochemical cycling of mercury was taken into account. The calculations were mainly concentrated on the changes of MeHg release, which tends to bioaccumulate and biomagnify in food webs. MeHg production vary from season to season. The following relative intensity of MeHg production was taken into account: 2.5 for autumn, 1.5 for winter, 2.5 spring and 6 for summer. This ratios were experimentally determined in previous studies [3,4].

The model simulations showed that the construction of the two terminals would cause a resuspension of 75.000 tons of bottom sediment, and the ships transporting LNG would cause a resuspension of 175.000 tons of sediment per year. Based on the partitioning of mercury between sediment and water during different seasons and rates of mercury transformation from inorganic to organic mercury it was calculated that the highly toxic MeHg in the Gulf water would increase from the present 0.05 ng/L to about 0.09 ng/L and the concentration of MeHg in fish from the present 0.3 to 0.6 mg/kg. This raises a question of safe consumption of fish in the Gulf of Trieste.

Based on the methodology developed simulations of various scenarios were also proposed that would significantly reduce the production of MeHg during installation and operation of NLGs.

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