

# Sediment quality classification based on Weight of Evidence approach in the recent Italian regulation

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**Introduction:** The Decree of Italian Ministry of Environment n. 173/2016, which entered into force on 21 September 2016, establishes criteria and methodological procedures for characterizing marine and brackish sediments to be dredged, their classification and identification of appropriate management options and monitoring. According to details provided in the technical annex, sediments must undergo a physical, chemical and ecotoxicological characterization, followed by their integration through a Weight of Evidence (WOE) approach to provide the different destinations of the materials as a function of their quality.

**Methods:** Chemical Action Levels (L1 and L2, for several trace metals and organic pollutants) and ecotoxicological results are elaborated by specifically developed weighted criteria, which allow abandoning the *pass-to-fail* or the *worst result* approaches, respectively. The chemical classification (Tab. 1) is based on the development of a Chemical Hazard Quotient (HQ<sub>C</sub>) which considers the typology and number of parameters exceeding limits of L1 and L2, the magnitude of such exceedances and type of contaminant (priority or priority hazardous substances, according to Annex II of Directive 2008/105/EC). Six classes of HQ<sub>C</sub> are obtained: Absent (0 - 0.7), Negligible (0.7-1.3), Slight (1.3 — 2.6), Moderate (2.6 - 6.5), High (6.5 - 13), Severe (≥13).

Similarly, the results of ecotoxicological analyses are assessed as a whole at the level of "battery" (not of single bioassay), weighting the biological relevance of the measured effects, the sensitivity of organisms, the statistical significance of measured results, the assay conditions in terms of tested matrix and duration of exposure. Chronic bioassays (generally more sensitive than acute) have been introduced as mandatory in the battery. The ecotoxicological classification (Tab. 1) is based on the Ecotoxicological Hazard Quotient (HQ<sub>battery</sub>) provided by the weighted integration of the results of the battery of bioassays: Absent (<1), Slight (≥1-1.5), Moderate(≥1.5 - 3), High (≥3 - 6), Severe(≥ 6 - 10). The elaboration of the entire set of physical-chemical and ecotoxicological data is performed by a software-

assisted tool [1, 2] specifically adapted for the purpose (SediquaSoft 109.0<sup>®</sup>), that can be requested at ISPRA webpage. Six classes of sediment quality, each corresponding to a management option, can be obtained (Tab.1): A (sands mostly for beach nourishment, coastal habitat restoration, or dumping at sea); B (mostly for dumping at sea with environmental monitoring); C (disposal in confined facilities or capping, with environmental monitoring); D (disposal in completely sealed confined facilities, with environmental monitoring); E (material subjected to special environmental safety procedures).

Some examples of application of this new approach in Italian ports are reported.

**Tab. 1:** Quality classification using the integrated weighted criteria

Ecotoxicological hazard	Chemical hazard	Quality classes
Absent	HQ <sub>C</sub> (L2) ≤ Negligible	A
	Slight ≤ HQ <sub>C</sub> (L2) ≤ Moderate	B
	HQ <sub>C</sub> (L2) = High	C
	HQ <sub>C</sub> (L2) > High	D
Slight	HQ <sub>C</sub> (L1) ≤ Slight	A
	HQ <sub>C</sub> (L1) ≥ Moderate and HQ <sub>C</sub> (L2) ≤ Slight	B
	Moderate ≤ HQ <sub>C</sub> (L2) ≤ High	C
	HQ <sub>C</sub> (L2) > High	D
Moderate	HQ <sub>C</sub> (L2) ≤ Slight	C
	HQ <sub>C</sub> (L2) ≥ Moderate	D
≥ High	HQ <sub>C</sub> (L2) ≤ Slight	D
	HQ <sub>C</sub> (L2) ≥ Moderate	E

**References:** [1] Piva et al. (2011) *Chemosphere* 83:475-485. ; [2] Benedetti et al. (2011) *Environ International* 38:17-28.