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Dispersant approval procedures in France and Italy: A comparative ecotoxicity study

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ABSTRACT

A research project has been performed to the request of the RAMOGE Executive Secretariat to identify differences between dispersant approval procedures in France and Italy and propose ways to harmonize them.

A collaborative study has been conducted by CEDRE (Centre of Documentation, Research and Experimentation on Accidental Water Pollution) and ISPRA (Italian Institute for Environmental Protection and Research) to: a) compare current approval procedures in Italy and France with identification of differences and commonalities; b) carry out toxicity tests using both procedures on two selected dispersants; c) propose a common approach between Italy and France.

The results showed that, because of the differences in ecotoxicological tests and in the evaluation criteria used, the outcomes on the same products could be different in Italy and in France. Both tested dispersants met the French requirements for approval ($LC_{50} \geq 10$ times reference toxicant), while only one dispersant met the Italian approval criterion ($EC_{50} > 10$ mg/L). A possible way of harmonizing the approval procedures could be to increase the number of test organisms in the French procedure, which currently only uses one crustacean species. Furthermore, a common criterion for toxicity assessment should be discussed and agreed.

1. Introduction

Dispersants are chemical agents or biological products used to mitigate the petroleum hydrocarbon contamination in case of accidental oil spills at sea. They break spilled oil into small droplets that are transferred from the sea surface to the water column (Yamada et al., 2003). Their dispersion by waves and wind action and the natural degradation process by bacteria may prevent serious damage to coastal areas and marine life. The aim of dispersants' use is to facilitate the dispersion of spilled oil in the water column, thus preventing oil from reaching the shorelines (Wise and Wise, 2011).

Today's products are less damaging for the environment than the toxic solvents used in earlier spills, but their toxicity is still not negligible, especially when products are used in large quantities (Cressey, 2010). The total dispersant stockpiles in Europe in 2015 has been estimated to be approximately 6800 m^3 (EMSA, 2016); so far no products have been used in Italian marine waters.

In recent years, the use of dispersant has been an issue of renewed attention within the EU countries and some have established national policies to authorise products' use at sea. The approval procedures differ among the EU countries: most countries require an ecotoxicological assessment of dispersants products (France, Greece, Italy, Norway, Spain), but only in the United Kingdom dispersant toxicity is tested on a mixture of chemically dispersed oil and it is compared to that of mechanically dispersed oil (EMSA, 2016). Most of the studies are related to short-term (≤ 96 h) biological effects of dispersants and few data are available on long-term toxicity on marine organisms (see reviews Wise and Wise, 2011; Lewis and Pryor, 2013; Garr et al., 2014). At the policy level, a short-term toxicity assessment is required for dispersants because their concentrations rapidly decrease in the envir-

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onment due to dilution in the water column (National Research Council, 2005). In fact, the dispersant concentration in the water column is estimated to become less than 1 mg/l within a few hours (George-Ares et al., 1999; ITOPF, 2011).

The present work reports the results of a comparative study on the approval procedures currently used in France and Italy for chemical dispersants to be used at sea, with reference to the ecotoxicological assessment. In France, the CEDRE Institute (Centre of Documentation, Research and Experimentation on Accidental Water Pollution) is responsible for carrying out the tests and the subsequent evaluation of the products' suitability. The dispersant is tested for efficiency, biodegradability, and its acute toxicity on the marine shrimp *Paleomonetes varians* (http://wwz.cedre.fr/content/download/5605/92350/file/bull32.pdf). France estimates the intrinsic acute toxicity of the product and compares it with a reference toxicant, the cationic surfactant Noramium DA50 ($C_{21}H_{38}ClN$: benzyl-dodecyl-dimethylazanium chloride, CAS number 95078-12-9). The evaluation requirement to fulfill is that the Noramium DA50's toxicity must be at least 10 times higher than the dispersant's toxicity.

In Italy, any laboratory, public or private, can conduct the tests if accredited by the ISO/IEC 17025 (2005). The Italian Directorial Decree 2/25/2011 provides detailed specifications on how the tests are to be conducted and on the data to be provided. The results are evaluated by ISPRA and by the Human Health Institute for the subsequent decision on the approval by the Italian Ministry of the Environment (MATTM). The Italian legislation requires an evaluation of efficiency, biodegradability and bioaccumulation of dispersant products and an evaluation of their toxicity by using at least three marine species belonging to three trophic levels (algae, crustaceans and fish). Each toxicity test has to fulfill the evaluation requirement, that is $EC_{50} > 10$ mg/L. Therefore, in Italy and France the dispersant ecotoxicological assessment has a common biological model (a marine crustacean), but the Italian procedure also requires the use of a primary producer (alga) and a predator (fish) to evaluate the toxic effects of dispersants.

In this study, the two different national procedures have been applied to two unknown dispersants, one chosen among those approved in Italy and one chosen among those approved in France. The products have been tested by CEDRE and ISPRA using the French and Italian national procedure, respectively. The aim of the study was to compare procedures and results with a view to highlight the main differences and evaluate possible ways to harmonize the approaches for dispersant ecotoxicity assessment in Italy and France.

2. Materials and methods

The two unknown dispersant products used in the study have been named dispersants A and dispersant B and were sent to ISPRA and CEDRE by the RAMOGE Secretariat.

CEDRE has performed the acute mortality test on the shrimp *P. varians* according to the French national procedure for dispersant testing. ISPRA has performed the algal growth inhibition test with *Phaeodactylum tricornutum* and the acute mortality tests with the crustaceans *Tigriopus fulvus*, *Artemia franciscana* and the fish *Dicentrarchus labrax*. All Italian tests are among those included in the Italian Decree (D.D. 12/23/2011).

2.1. Preparation of dispersants

The dispersant products were provided in dark glass bottles. The stock solutions were prepared in dilution water and used to provide different dispersant concentrations (Table 1).

Preliminary range-finding tests for each dispersant and each test species were conducted to identify the appropriate concentration range for the definitive assays.

According to the Italian procedure, the degradability of the dispersant product under testing conditions needs to be known: if the

Table 1
Dispersant A and dispersant B concentrations (mg L^{-1}) tested in bioassays for each test-species.

Test-species	Dispersant A test conc. (mg L^{-1})	Dispersant B test conc. (mg L^{-1})
P. tricornutum	0–6.25–12.5–25–50–100	0–10–20–40–80–160
P. varians	0–57.8–109.6–250.6–502.8–1000.1–2504.3–5000.3–10000.8–15001.3–20004.7–25000.7	0–54.1–102.1–250.6–514.3–1000.4–2503.7–5001.4–10000.1–15004.3–20003.1–25002.6
T. fulvus	0–3.0–6.0–12.0–24.0–48.0–96.0	0–7.5–15.0–30.0–60.0–120.0
A. franciscana	0–0.78–1.56–3.12–6.25–12.5	
D. labrax	0–9.4–20.7–45.4–100	0–25.1–39.8–63.1–100