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Sediment characterization of Favignana Harbour, Egadi Island, Italy

Sergio CAPPUCCI [1], Floriana LAMARCA [2], Massimo MAFFUCCI [1], Riccardo FERRANTINI [3]

1 ENEA, Via Anguillarese, 301, 3 – 00123 Roma, Italy. *sergio.cappucci@enea.it*
2. Dep. of Chemical Engineering, Materials & Environment, Univ of Rome "La Sapienza", Italy. *floriana.lamarca@uniroma1.it*
3. Ergon Group S.r.l., Italy. *riccardo.ferrantini@gmail.it*

Abstract:
Italy is a country where multiple activities are located along the coast. Those activities make the handling of marine sediments a topic of particular interest with high relevance from the socio-economic point of view (sednet.org). In this paper the sediment characterization of the Favignana Harbour (Egadi Archipelago) is presented by describing the site-specific conceptual model of contamination and by referring the results of analytical tests carried out on superficial sediment samples. Low level of contamination was found but a potential source of contamination was relocated and an innovative management option was implemented by using sediment to facilitate tourism through creation of sport facilities on shore.
Keywords: Sediment characterization, Contamination, Conceptual modeling, Harbour.

1. Introduction

The Favignana Harbour (Fig. 1) is developed in the sheltered inlet of Cala Principale (north central of Favignana Island). It is equipped with a pier about 110 m in length, which extends to northwest. The smaller Molo S. Bernardo stretches for about 85 meters in a southerly direction. About 100 berths are available, 30 of which are dedicated to boats of travellers/navigators. On the sea bottom of the Harbour the *Posidonia oceanica* meadow is present and it is located within the Marine Protected Area of Egadi Archipelago defined as "*the buffer zone between the valuable natural areas and external unprotected areas, where the activities of enjoyment and sustainable use of the sea of low environmental impact are permitted*". Frequent siltation of the structure is due to the anticlockwise circulation inside the harbour generated during mistral winds. The objectives of the present work are the description of the conceptual model of potential sediment contamination within the Harbour, the identification of contamination's sources and determination of of contaminant's concentration within superficial sediments. Further investigation are in progress and some result on sediment contamination, remediation technologies to be adopted, relative cost to be considered,

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sediment management option to be use in the area will be published soon by CAPPUCCI et al. (in press).

2. Materials and methods

Based on the complexity of sediments management and the necessity to guarantee periodical dredging, a simple and straightforward method was implemented by developing the following three steps: (1) implementation of the conceptual model; (2) superficial sediments sampling; (3) laboratory analysis.

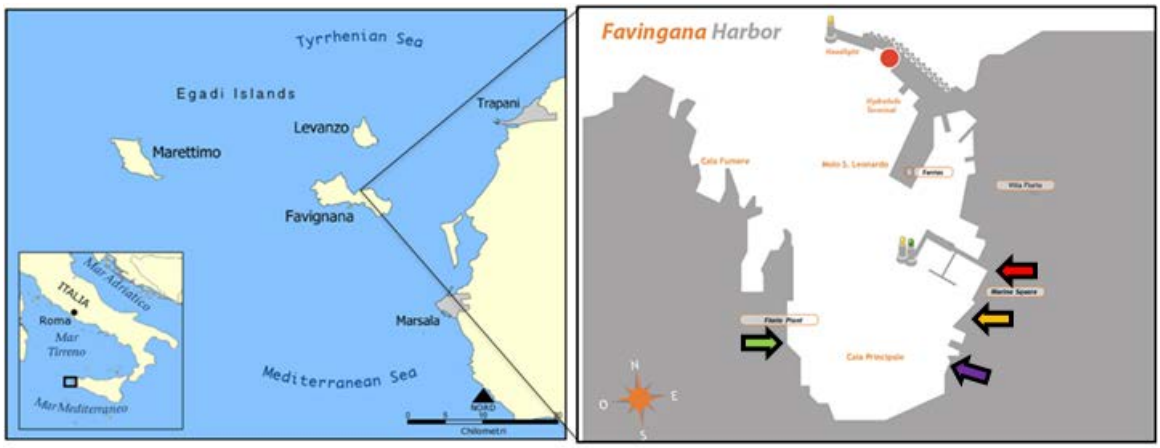

Figure 1. Egadi archipelago and Favignana Harbour. Coloured arrows show sources of contamination (see Fig. 3 for details).

2.1 Implementation of conceptual model

Since marine sediments are potential targets of intentional or accidental contamination, a detailed conceptual model has been implemented (BORTONE & PALUMBO, 2007; IMO, 2000). Four main contamination sources were identified around the harbour basin (Fig. 1; EPA, 2005). For each of the potential sources of contamination, the transfer model and the final targets have been identified (MUNASINGHI, 1998). For each source, a schematic table describes the route of transfer and the following information: (1) Name of the company; (2) Site and type of business/production; (3) Description of the area; (4) Description hydrogeological; (5) Type of pollutants (current and previous activities); (6) Conceptual Model (sources, transfer and targets); (7) Results of available preliminary analysis of soils, land, groundwater, marine waters.

2.2 Sediment characterization

In the present work a deterministic strategy (MAFFIOTTI & BONA, 1997) was chosen, which provides the positioning of sampling stations in areas where accumulation of pollutants takes place. Four sampling stations were chosen near the dock in front of Piazzale Marina (Fig. 2), which is the first barrier hindering the deposition of coastal

sediments. A small Van Veen grab was used for sampling of superficial sediments. Then sterile polystyrene/glass containers were used for storing samples at 4 °C until laboratory analysis.

2.3 Laboratory analysis

Grain size distribution was determined by using the UNI EN 933-1 method, through sieves type ASTM (American Society for Testing and Materials) E 11-70. All particle fractions were subsequently dried at 105 °C, weighed and classified.

The chemical analysis were carried out in order to determine heavy metals, TriButylTin (TBT), Polycyclic aromatic hydrocarbon (PAHs), PolyChlorinated Biphenyl (PCBs) and hydrocarbons (C > 12) concentrations. A detailed description of the methodology used in the present paper is reported in the work of FERRANTINI (2012).

Figure 2. Sampling strategy for characterization of about 10.000 m^2 of harbour seabed.

3. Results

The implementation of the conceptual model allowed the identification of four potential sources of contamination, facing the harbour basin: (1) the gas station in front of the quay, (2) the Florio industries where tuna processing was performed, (3) the *Camperia*'s building (where boat's storage and maintenance was performed) and (4) a discharge of untreated waste water. A flow diagram of conceptual model for contamination is reported in Fig. 3. The characterization of superficial sediments allowed to determine both physical and chemical properties of particles. The grain size revealed a percentages of silt and clay of about 1% (which increase with depth) and a D_{50} of approximately 0,215 mm. The analytical tests detected a moderate exceedances of limits indicated in column A and B of Annex 5 to Part IV of Legislative Decree 152/2006, for Cadmium, Arsenic, Lead, Tin, ΣPAH and TBT. The exceedances have led to classify sediments with "yellow" color, when they fall within the 90% limit imposed by the column 5 of Annex B to Part IV of LD n. 152/2006.

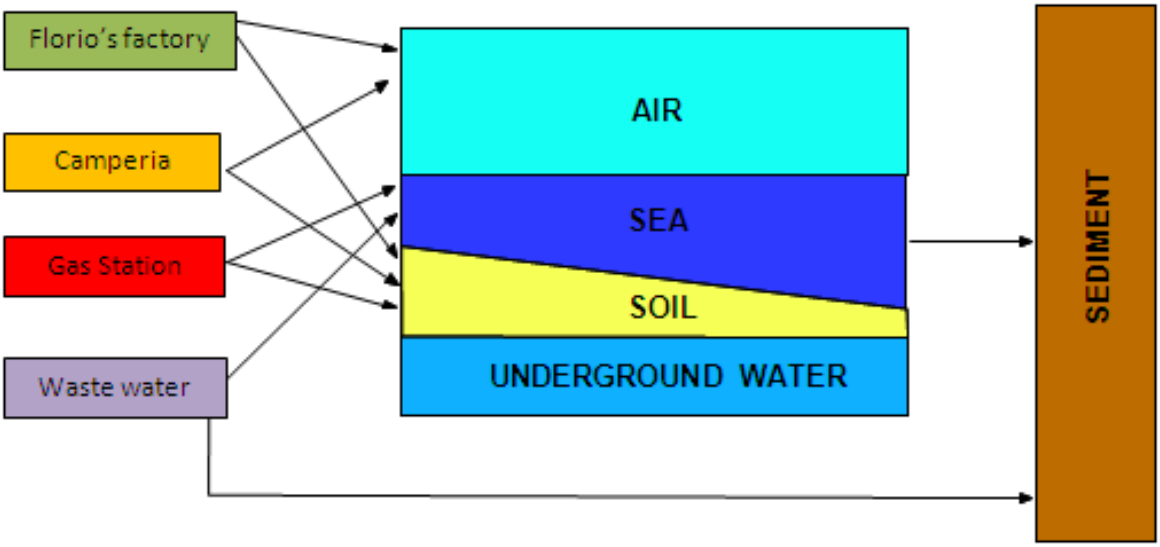

Figure 3. Conceptual model of sediment contamination within Favignana Harbour.

4. Conclusion

Dredging within the Favignana Harbour is periodically needed to ensure the safety of navigation and an adequate depth through time. With the present layout, the entrance to the harbour is often compromised by the waves and their propagation within the basin, particularly during Mistral winds. Navigation is limited, especially close to the docks, due to sand transport under the effect of anticlockwise circulation that reduces the depth of the seafloor up to the point that sometime during winter part of the sand emerge from the sea and form a small emerged beach. Handling, treatment and reuse of sediments are topics that encompasses many disciplines, which are necessary for the successful implementation of the dredging operations aimed at a beneficial reuse of sedimentary natural resource. In Favignana, where the Marine Protected Area is almost uncontaminated, dredging of sediment from the Harbour whit low contamination levels is necessary to facilitate tourism.

After presentation of preliminary results obtained in the present study, the local authorities were informed by the moderate exceedances of some contamination threshold, but showed interest for the following management scenarios:

a) nourishment along the coast; these sediments should be classified with a "light green" color, due to concentration levels similar to those indicated for quality standard of marine waters or otherwise some treatment should be adopted;
b) on shore recreational activities like soccer and beach volley fields; these sediments should be classified with a "dark green" color, due to concentration of contaminants below threshold indicated for public and private soils and chlorides should be previously reduced to avoid aquifer salinization.

In addition, thanks to the results of the present investigation, the city council of Favignana in 2013, moved the gas station from the harbour to a new and safer site located in the central part of the Island in order to reduce traffic and potential risk of contamination of marine sediment.

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5. References

BORTONE G., PALUMBO L. (2007). *Sustainable management of sediment resources: sediment and dredged material treatment*. Elsevier, 209 p.

CAPPUCCI S., LA MARCA F., FERRANTINI R., MAFFUCCI M. (in press). *Characteristics and possible reuse of Favignana Harbor's sediments*. Energia Ambiente ed Innovazione, 10 p.

FERRANTINI R. (2012). *Caratterizzazione e Gestione dei sedimenti nell'Area Marina Protetta delle Isole Egadi*. Tesi sperimentale per la Laurea Magistrale in Ingegneria per l'Ambiente ed il Territorio, A.A. 2011-2012, 213 p.

EPA - Environmental Protection Agency- (2005). *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*. Office of Solid Waste and Emergency Response, EPA-540-R-05-012, 236 p.

IMO -International Maritime Organization- (2000). *Specific Guidelines for Assessment of Dredged Material. Technical Committee on Dredged Material of the Hafenbautechnische Gesellschaft e.V.* (HTG)

MAFFIOTTI A., BONA F. (1997). *Metodi per la selezione delle aree di campionamento, raccolta, trasporto, conservazione e manipolazione del sedimento*. In: Analisi e recupero dei sedimenti marini. Q.d. ambientale, a cura di Pitagora Editore, 57.

MUNASINGHI M. (1998). *Climate change decision making*. Intl. J. of Environment and Pollution, Vol. 10(2), pp 188-239. http://dx.doi.org/10.1504/IJEP.1998.005270