

Environmental monitoring during beach nourishment using relict sands (central Tyrrhenian sea)

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Abstract

This paper aims to underline the importance of monitoring studies during the execution of activities, like beach nourishment using relict sands, that plan the use of innovative technology. In fact, environmental monitoring studies allow prompt intervention in the case of unexpected events or interference factors. Potential negative repercussions on the marine environment could not be estimated through characterization studies carried out *ante operam*. This paper reports the monitoring study carried out for beach nourishment along the South Latium coasts (Tyrrhenian sea). In this area *Posidonia oceanica* meadows are present. In this context, a detailed and updated cartography and the knowledge of the *P. oceanica* beds distribution (a “priority habitat” in the UE Habitats Directive) allowed prompt identification of potential effects on the seagrass caused by specific technical procedures of the beach nourishment, not well-known in the planning phase of the project.

Keywords: environmental monitoring, beach nourishment, Tyrrhenian sea.

1 Introduction

Among the different experimented technologies to control coastal erosion, beach nourishment with relict sands is considered a useful method to protect beaches, often preferable to the coastal defence structures (seawalls, groynes, emerged breakwaters) [1–3].

Nowadays, marine sand deposits exploitation is a very common technology both in Europe and in the rest of the world. The first documented beach nourishment project took place in USA during 1922-1923 at Coney Island,



New York [4], while in Italy the first beach nourishment activity with relict sands took place at Pellestrina and Cavallino (Venice, Italy), and later on along the Ostia coast (Rome, Italy) [5–8].

Relict sands are constituted by marine deposits no more in equilibrium with the actual coastal sedimentary dynamics (paleo-beaches), occurring offshore and at great depth. Because the relict sand removal does not interfere with the coastal dynamics, the dredging of great volumes of sediments does not compromise the beach equilibrium. The employment of considerable volumes of sediments, together with the high biodiversity of the Mediterranean Sea, determines that for beach nourishment activities particular attention must also be paid to marine environmental characteristic, as well as to technical and economic aspects of the Project.

It is known that dredging activities involve physical and biological effects on marine environment. The physical effects are related to the substratum alterations (sediment morphology and granulometry) and to the resuspension of bottom sediments into the water column with a consequent increasing of suspended particulate matter (turbidity) [9–11]. The most relevant biological impacts are related to the benthic community and to the demersal fish assemblages, both closely associated to the sea bottom [11–19]. The increasing of suspended particulate matter, related to the increase of turbidity, could be very dangerous in case the dredging and beach nourishment take place in the presence of sensitive habitats (like *Posidonia oceanica* meadows, coralligenous biocoenosis, etc.) and/or of very sensitive species to abiotic parameters variations and to environmental stress (natural and anthropogenic).

In this context, a particular attention is paid to *P. oceanica* meadows, a mediterranean endemic species, considered as a “priority habitat” in the UE Habitats Directive (92/43/EEC), and listed in the “Natura 2000” like a Site of Community Importance (pSCI).

This paper reports the methodological approach used by ICRAM to plan and improve the environmental monitoring study carried out off the coast of southern Latium (Tyrrhenian sea) for a beach nourishment operations with relict sands. *P. oceanica* meadows are present along this coast in shallow waters (between 15-30 m depth).

2 Study area

The study area is located in the central Tyrrhenian sea, along the Latium coasts from San Felice Circeo (Latina, Italy) to Sperlonga (Latina, Italy), fig.1.

The shore is predominantly characterized by sandy sediments and by a gentle-sloping sea-bed (1.3-2.2 %), with the presence of submerged bars. Between Terracina (Latina, Italy) and Lago Lungo (Latina, Italy), the superficial sediments show a finning seawards of the granulometry, following the bathymetry. Locally, the presence of *Posidonia oceanica*, make this sediment distribution irregular [20, 21].



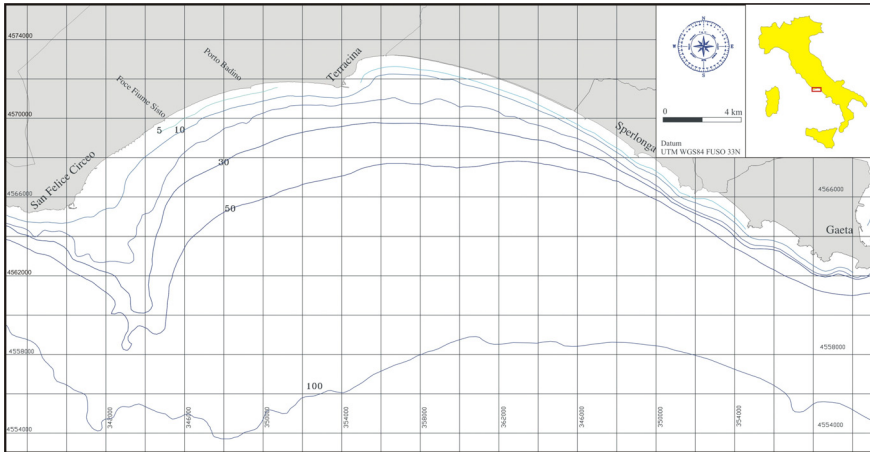


Figure 1: Study area.

In the study area the presence of *P. oceanica* seagrass identified two Sites of Community Importance (pSCI) according to the Directive 92/43/EEC: IT6000013 “Fondali tra Capo Circeo e Terracina” and IT6000014 “Fondali tra Terracina e Lago Lungo”.

3 Characterization study *ante operam*

ICRAM, in 2004, has been entrusted by the regional authority “Regione Lazio” to carry out the environmental monitoring study on an area located in the central Tyrrhenian Sea (southern Latium, Italy), off the coast of Terracina (Latina, Italy) in order to evaluate the environmental compatibility of the planned beach nourishment activities with relict sands.

On the basis of the experience developed by ICRAM in the last years in planning and realizing environmental studies related to these activities, the monitoring sampling plan and the environmental parameters to study (benthic communities, demersal fish assemblages, superficial sediments and water column characteristics) have been defined. Recently, ICRAM’s studies and experiences allowed the realization of an environmental monitoring protocol related to relict sands dredging for beach nourishment [11].

Considering the presence of two pSCI characterized by *Posidonia oceanica* meadows in the study area, the characterization study *ante operam* has also involved an appropriate assessment of implications for pSCI sites according to the Directive 92/43 ECC (article 6, 3), in order to highlight potential effects of beach nourishment on *P. oceanica* beds and on their state of conservation.

Analysis of bibliography regarding the *P. oceanica* meadows distribution in the study area has revealed the presence of old data and at an unsuitable scale [22]. For this reason, ICRAM and Regione Lazio has entrusted the University of Rome “La Sapienza” to map the shallow *P. oceanica* meadows. Data obtained on physiographical and structural descriptors of *P. oceanica* seagrass (bed

density, upper and lower limits, bed typology), were confronted with the technical aspects of the nourishment working plan (volumes and type of sediments, period of activities, closure depth).

Results showed that the most relevant effects, normally expected for this activities like the increasing of turbidity (with a possible regression of *Posidonia* limits) and burial events (due to beach nourishment), would have not caused relevant impacts on the meadows. In fact, the temporary increase of turbidity would have been limited to the utilization of sandy sediments and to the short period estimated for these activities. Besides, the greater depth of *Posidonia* upper limit (13–15 meters) compared to the maximum closure depth estimated by the Project (7 m) assured the absence of over-sedimentation.

Therefore, in this specific case beach nourishment carried out according to technical specifications of the Project would have not caused relevant effects on *P. oceanica* meadows and on their state of conservation, ensuring environmental compatibility. Anyway, considering the innovative characteristic of this technology and the presence of *P. oceanica*, ICRAM decided to carry out a specific monitoring study during the execution of beach nourishment in order to intervene promptly in case of unexpected events.

4 Monitoring study during the activities

Beach nourishment was carried out in May-June 2006 using relict sands (a volume of 600.000 m³ sediments) dredged from a marine sand deposit located offshore Lavinio (Rome, Italy) in water deep between 80 and 100 m. These sandy sediments were carried to the nourishment shores (in water deep approximately 15 m) by means of a trailer suction dredge. For the replenishment of sediments on the beach a pipe about 1,5 km long and 90 cm in diameter was used.

Direct observations made during the monitoring study in order to evaluate the evolution and the dispersion of the turbidity *plume* caused by the nourishment, identified some technical procedures, not predictable in the planning phase of the Project, capable of generating significant effects on marine ecosystems.

In particular, during the beach nourishment the following was observed:

- the need of an anchorage zone for the dredge during the hooking phase of marine pipes for the dumping of relict sands;
- some anchorage zones were located upon *P. oceanica* meadow;
- the use of dredge engines, necessary to stand the position during the dumping operations, also due to the low depth of bottom, created a significant dispersion of fine sediments in the water column near *P. oceanica* beds, fig. 2.

All these observations, together with the knowledge of the real technical procedures used for the dumping, allowed prompt interventions fixing some additional technical instructions in order to protect the *P. oceanica* beds present in coastal shallow waters. In this case, it has been possible to provide some specific indications as the identification of some potential anchorage zones for the dredge. Besides, the use of the detailed and updated cartography of

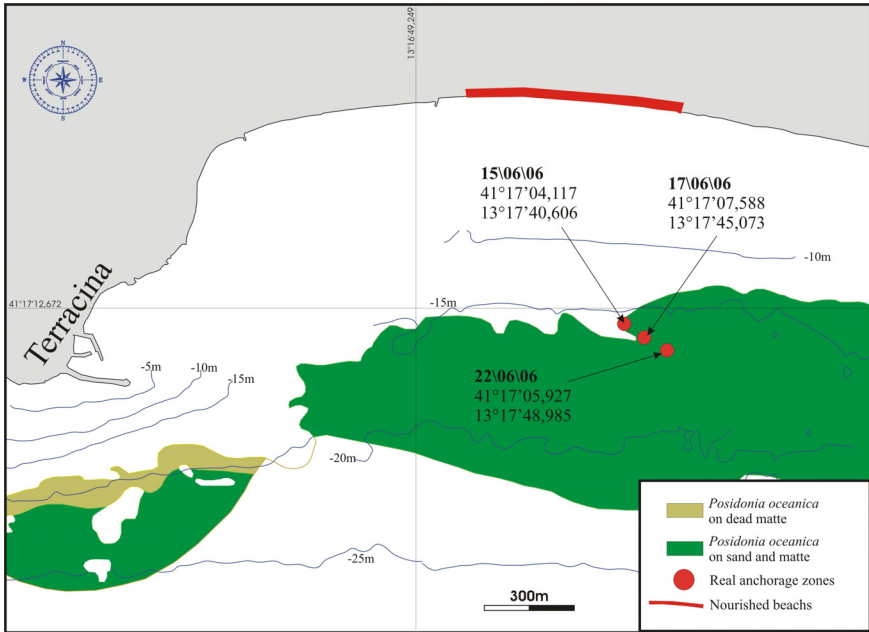


Figure 2: With red points the real anchorage zones of the dredge during beach nourishment are reported.

P. oceanica meadows realized by the University of Rome (fig. 3) suggested to use a support ship during the nourishment to obviate the driving of propellers, necessary to stand the dredge position during this activities, avoiding the dispersion of fine sediments near the *Posidonia*.

5 Conclusions

In the study case reported in this paper, the environmental monitoring plan arranged for the beach nourishment operations allowed prompt identification of potential effects on *P. oceanica* meadows caused by specific technical procedures of the activities, not well-known in the planning phase of the Project. In particular, considering the real technical procedures using for the nourishment and by means of a detailed and updated cartography of *P. oceanica* beds, it has been possible to propose some additional technical instructions in order to minimize effects on *Posidonia* seagrass in the shallow coastal waters.

Our study indicates that the use of cartography and the knowledge of the marine benthic biocoenoses distribution, mainly of *P. oceanica* beds distribution (a “priority habitat” in the UE Habitats Directive) represent an essential instrument for planning environmental monitoring studies related to the beach nourishment.

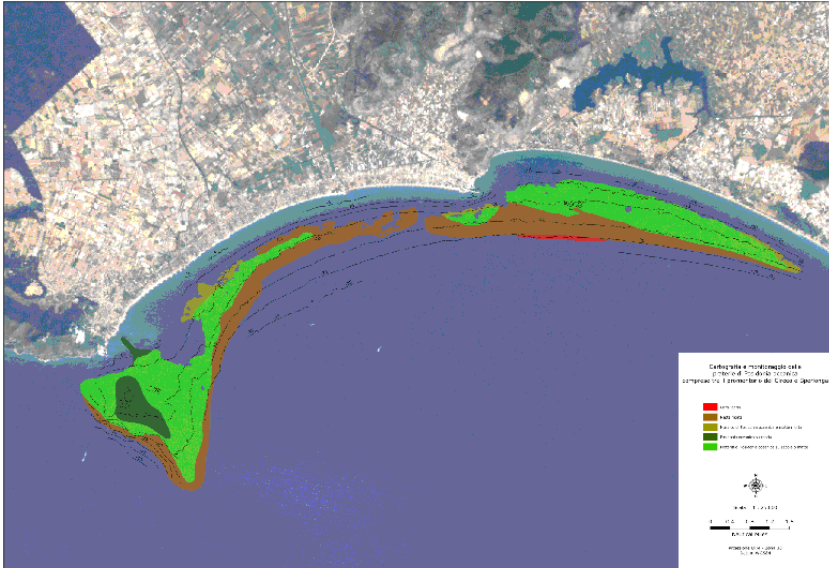


Figure 3: Distribution map of *Posidonia oceanica* meadows present from San Felice Circeo to Sperlonga (Latium, Central Tyrrhenian sea) (reduced scale).

In general, this paper aims to underline the necessity to plan specific monitoring studies in presence of sensitive habitat (monitoring during the execution of the activity), above all in the case of use of innovative technology, not yet well-established, that can generate unpredicted effects on marine environments.

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