Marine Aggregates Prospecting and Exploitation (MARE project) in Greek waters: Methods, Environmental Impact and Usage possibilities

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Abstract

The main objectives of the MARE project are: (i) compilation and integration of the available information concerning prospecting, dredging, and usage of MAs in Greece and in Europe; (ii) MA prospecting techniques and methods (transfer of knowledge); (iii) sedimentological characteristics of the MAs occurring in Greek waters; (iv) an assessment of the environmental issues related to MA prospecting and dredging in Greece; (v) the exploitation of the project's results (e.g. industrial use); and (vi) the training of young researchers in innovative related research aspects.

Keywords: Marine Aggregates, Thales-Mare Project, Aegean Sea, Greece

1. Introduction

1.1 Background

The progressive depletion of land sources of construction materials poses increasingly acute supply problems to the construction industry. Besides, in several places around the world, including Greece, mining activities and tourism have come into conflict. In addition, environmental regulatory may cause exploitation schemes to evolve towards alternative sources that include also the exploitation of marine deposits of sand and gravel (e.g. Smith & Collis, 2001).

Nowadays more than 50 Mm^3 are extracted annually, offshore the NW European countries with more than the half in UK and The Netherlands (Velegrakis et al., 2010). In 2004 59 Mm^3 of marine aggregates were extracted, totally from European Countries, which 23.6 Mm^3 from the Netherlands and 13 Mm^3 from United Kingdom. (Lindsay, 2009). Comparing the land-laid and the marine deposits, an advantageous feature of many marine sands is the low silt content, especially in dredged aggregates, where much of the fine material is washed out by the dredging (Prentice, 1990). Disadvantageous features are the presence of salts -halite [NaCl]- and shell fragments. Halite is a non-desirable constituent in the construction materials, so the sea-dredged aggregates have to be washed out with freshwater, before use.

Generally, the aggregate extraction may cause, direct (mainly arising from dredging which disturb the seabed when passing over it or from the removal of deposits and the creation of the suspended sediment plumes in the water column during sediment into the vessel), indirect (as a result from the subsequent deposition of sediment particles from the water column on to the seabed. The effects of shipping activities such as vessel movements, boat noise and vibration on marine wildlife, arising from extraction are also classified as indirect impacts, but tend to be very minor. The main cumulative effects relate to the removal of seabed deposits, particularly as removal, is focused on a relatively small number of habitat types (Tillin et al., 2011) Furthermore, offshore dredging has in some cases triggered accelerated beach erosion; this combined with the general rise of sea-level, and the consequences of exceptional-strength storms, have worsened erosion and greatly disturbed (occasionally irreversibly) the local sedimentary budget and transit.

In the case of Mediterranean countries, quantities of sand are extracted mostly from the sub-aerial part of the beach zone and related sand dune fields arbitrarily and for building usually purposes; this action is illegal, as it is related to the beach zone stability (Velegrakis et al., 2010). On

the other hand, the presence of relict sand deposits has been reported in the case of the continental shelf of the north Aegean Sea by Lykousis et al. (1981).

The present demand of Greek industry for MA (siliceous or calcareous) concerns the production of building and refractory materials, e.g. cement clinker, mortars, the use of silicate sands in various environmental applications, such as hydroponic cultivations/soil enrichment. Moreover, marine sands and gravels would be also used in beach zone replenishment in order to mitigate beach zone erosion (Alexandrakis et al., 2009).

1.2. Objectives of MARE project

The innovative research objectives of the project are:

- The identification of (possible) locations of MA deposits, on the basis of the geological and morphological evolution of the Greek continental shelf (and related subaqueous plateau), the lithology of the drainage river basins and sediment transport pathways.
- The development and application of innovative and most appropriate geophysical methods for the acquisition of seabed (and subsequence) data for MA prospecting, with reference to international practice and in relation to local marine/seabed conditions.
- A thorough investigation of the sedimentology (grain size, mineralogy, etc), composition (chemical) and other geotechnical characteristics of the identified MA deposits.
- The selection and application of the most environmental-friendly dredging techniques, according to Greek marine conditions, with reference to international experience.
- The development of a MA prospecting/dredging protocol on the basis of the international practice, European legislation, and in accordance to Greek Law.
- An economical assessment of MAs exploitation (in relation to market demands) in terms of their availability (quantity) and their particular sedimentological composition.
- The high level training of young researchers (MSc and PhD candidates and Postdoctoral researchers) in multi-disciplinary issues associated with MAs exploitation.

2. Project's materialisation and methodology

The project commenced since January 2012 and extends over 42 months. It is organised into 6 main and interrelated Work Packages (WP), which are presented schematically in Fig. 1.

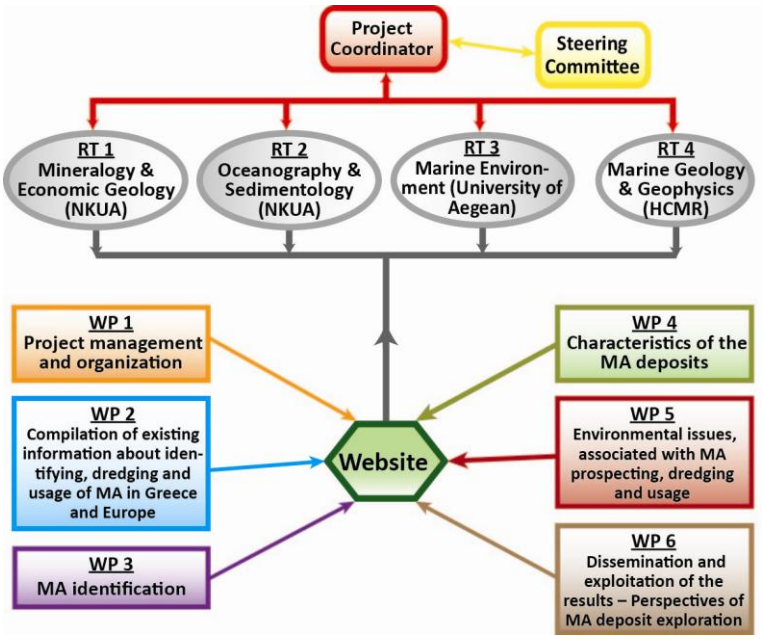

Fig. 1. Graphical presentation of the main structure of the project.

The implementation of the project, due to its multidisciplinary character, involves the following four Research Teams (RT):

RT-1: Mineral Deposits & Economic Geology - NKUA (Scientific Responsible (SR): Prof. M. Stamatakis);

RT-2: Oceanography & Sedimentology - NKUA (SR: Assoc. Prof. S.E. Poulos);

RT-3: Geo-Marine Environment - UOA (SR: Prof. A. Velegrakis); and

RT-4: Marine Geology & Geophysics - HCMR (SR: Dr V. Kapsimalis, Researcher).

On the basis of existing information regarding the geological environment of the inner continental shelf (including the Cyclades Plateau), coastal lithology and the locations of active river mouths, the locations of potential MA deposits are presented in Fig. 2, while the locations where field works took place are shown in Table 1.

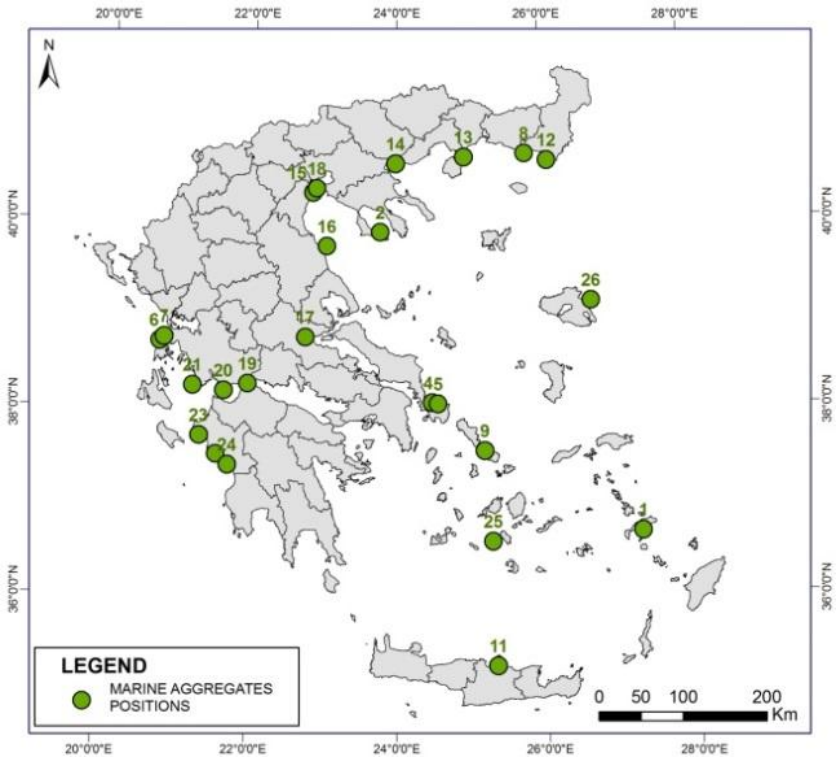

Fig. 2. Marine aggregates positions in Greek Marine Areas (1: Kos Isl. - Kardamena, 2: Chalkidiki - Pefkochori, 3: Naxos Isl. - Kleido, 4: Evoia - Akteo, 5: Evoia - Ag. Dimitrios, 6: Lefkada Isl. - Ag. Nikitas, 7: Lefkada Isl. - Ag. Ioannis, 8: Aleksandroupoli - Mesimvria, 9: Tinos Isl. - Rohari, 10: Tinos Isl. - Ag. Sostis, 11: Iraklio Gournes, 12: Evros Delta, 13: Nestos Delta, 14: Strimonas Delta, 15: Aliakmonas Delta, 16: Pinios (Th) Delta, 17: Sperchios Delta, 18: Aksios Delta, 19: Mornos Delta, 20: Evinos Delta, 21: Acheloos Delta, 22: Alfios Delta, 23: Pinios (Pel) Delta, 24: Kiparissiakos Delta, 25: Sikinos Isl. - Dialiskari, 26: Mitilini Isl.

Table 1. Summary of fieldwork campaigns for the MARE project.

AREA	SEABED MAPPING					WAY OF SAMPLING			LAB ANALYSIS	
	MB	SSS	3.5 KHz	CHIRP	BOOMER	B.C	G.C	G	Gr	Be
North Euboia	✓	✓	✓			✓	✓	✓	✓	✓
Lesvos island	✓			✓				✓	✓	✓
Crete island	✓			✓				✓	✓	✓
Rhodes island	✓			✓				✓	✓	✓
Acheloos River	✓	✓			✓			✓	✓	
Pinios River		✓	✓		✓			✓	✓	✓

Note: CRETE includes Kissamos Bay (SW CRETE) and Hersonisos (SW CRETE); Pineios River: deltaic front; Acheloos River: Underwater Deltaic deposits.

Key: MB: MultiBeam; SSS: Side Scan Sonar; B.C: Box Corer; G.C: Gravity Corer; G: Grab; Gr: Granulometry, Be:Benthos.

3. Results and concluding comments

The gathered information during the MARE project is promising towards the identification of MA deposits in Greek waters that may be proved suitable for exploitation, and in particular those that exist in the inner continental shelf. Thus, the expected benefits relate to both local communities and the overall national (Greek) economy, through the exploitation of MA deposits in relation to their industrial uses that include also beach nourishment; this could also create new working places (employment), since it requires scientific involvement (e.g. marine geologists), the use of specialized vessels and port facilities for the dredging and temporary storage onshore.

4. Acknowledgments

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