Journal of Coastal Research	23	1	275–276	West Palm Beach, Florida	January 2007

DISCUSSION

Discussion of: ANFUSO, G. and GRACIA, F.J., 2005. Morphodynamic Characteristics and Short-Term Evolution of a Coastal Sector in SW Spain: Implications for Coastal Erosion Management. *Journal of Coastal Research*, 21(6), 1139–1153.

J.J. Munoz-Perez[†], G. Gomez-Pina[‡], and L. Moreno[§]

[†]Applied Physics Department
CASEM
University of Cadiz
11510 Puerto Real
Spain
juanjose.munoz@uca.es

[‡]Coastal Department
Ministry of Environment
Marianista Cubillo n. 7
11071 Cadiz
Spain
ggomez@mma.es

[§]Department of Civil Engineering:
Transportation Infrastructure
EUIT Obras Públicas, Alfonso XII, 3-5
28071 Madrid
Spain
luisjuan.moreno@upm.es

ANFUSO and GRACIA (2005) performed an excellent beach monitoring program consisting of topographic levelings carried out with a monthly periodicity from March 1996 to May 1998. They used 13 cross-shore profiles distributed along the study area, from Chipiona, at the Guadalquivir River mouth, to Rota, north of the Bay of Cadiz. Between April 2000 and October 2002, monitoring was complemented by profiling of only five transects every two months. Furthermore, some quite interesting conclusions about the morphodynamic characteristics of this coastal stretch and their possible implications for coastal management were proposed. However, as the engineers responsible for the beach nourishment projects performed in the Gulf of Cadiz for the last two decades, we consider that some remarks should be made in order to avoid any undesirable misunderstanding.

The authors stated that "In general, nourished beaches have not shown great endurance. The limited success of the works had a number of causes (ANFUSO *et al.*, 2001), including the lack of basic information on the coastal morphodynamics of the zone." To begin with, according to the SPANISH SHORE ACT (1988), bathymetric levelings and biological and littoral dynamics studies are mandatory before initiating each nourishment project. Such studies are only excluded in emergency cases. Furthermore, analysis of field data and aerial photographs from 1956 had shown that the coastline was retreating at a rate of approximately 1 $m \cdot y^{-1}$ in some points of the Gulf of Cadiz (MUNOZ-PEREZ and ENRIQUEZ, 1998). Because of this reason, leaving aside the economic importance of the beaches for the touristic incomes in Spain, the Ministry of the Environment decided to start a coastal protection program based on the most natural way to solve the erosion problem: sand replenishment (GOMEZ-PINA, 1999). Monitoring tasks have been performed since the first nourishment, each of which has lasted for at least two years. It is true that the cost of beach maintenance in a few cases became excessive, but they were in a minority. Comparison of the data about the different erosion rates and other related parameters (MUNOZ-PEREZ *et al.*, 2001) showed that small yearly renourishment, similar to the yearly losses, instead of greater nourishment performed with a periodicity of many years, would lead to economic savings, as well as to a better use of the natural resources. Moreover, although an impartial judgement is always difficult on one's own work, autocritical reviews of beach nourishment projects are sometimes made (*e.g.,* GOMEZ-PINA *et al.,* 2004).

ANFUSO and GRACIA (2005) made smart use of the surf similarity index for the morphodynamic classification of the studied beaches. This parameter, introduced by Iribarren and Nogales (IRIBARREN and NOGALES, 1949), and thus called the Iribarren number, relates the beach slope to the square root of wave steepness. It was introduced as $\xi_o = \tan\alpha/\sqrt{H_0/L_0}$ for deep water or $\xi = \tan\alpha/\sqrt{H/L}$ at a depth where wave transformation due to shoaling before breaking begins.

As the values found by ANFUSO and GRACIA (2005) are close to the limit between plunging and spilling breakers, bottom friction over a reef flat, which is the case of some of the beaches studied by the authors, should be taken into account. HORIKAWA and KUO (1966) demonstrated that, because of the friction over a horizontal rocky bottom, the ratio between the local wave height and the mean water depth decreases from 0.8 to become almost constant, at about 0.5, in the inner zone. Wave decay expressions can be consulted, for example, in FREDSOE and DEIGAARD (1992). On the other hand, it is

DOI: 10.2112/06-0637.1 received 23 January 2006; accepted in revision 13 November 2006.

our opinion that semi-empirical relationships, such as the one developed by KOMAR and GAUHAN (1973) and used by BENEDET *et al.* (2004), are not recommended at this littoral zone due to the nonhomogeneous character of the coast.

As far as the profiles are concerned, ANFUSO and GRACIA (2005) have collected a very useful series of data at the berm and the foreshore. Nevertheless, their conclusions, taking into account the lack of submerged data, would be more supported by using any mathematical method for interpretation of the data. The use of empirical orthogonal functions (EOF), for instance, would have provided an objective way to identify each and every one of the different tendencies of the beach profiles in the short, medium, and long term.

When ANFUSO and GRACIA (2005) claimed that the beach changing rate in this region is usually slow, it should be pointed out that this assumption is true only for accretion periods. EOF analysis, used in Victoria Beach, a nearby beach with similar sediment and coastline orientation, shows that during the winter, the beach does not experience a remarkable regression except during storm events, when the volume of sand removed may reach 68 m^3/m in just some hours (MUNOZ-PEREZ and MEDINA, 2005). Moreover, the accretion period is just about 3 or 4 mo, from May to August, with an approximate rate of 1 $m^3/(m \cdot d)$. This methodology also permits us to filter out changes, not small at all (*e.g.,* 0.60 m elevations at the foreshore), related to fortnightly tidal variations, which could lead to erroneous interpretations when analysing just the wave energy income (MUNOZ-PEREZ and MEDINA, 2000).

Ultimately, we agree with ANFUSO and GRACIA (2005) about their opinion that most sediment of the beaches between Chipiona and Rota should be considered as relict deposits. And so, the sand dunes that fringe the littoral zone are not just a resilient barrier for the destructive forces of waves, but the only natural reserve for long-term erosion (GOMEZ-PINA *et al.,* 2002). That is the reason why the SPANISH SHORE ACT (1988) imposed a protection easement over a zone of 100 m landward from the limit of the seashore. In this area, any activity that involves the occupation or destruction of sand deposits (buildings for residential purposes, construction of high-traffic roads, advertising, aerial electric cables, *etc.*) is forbidden. Regrettably, before the act was approved, a great part of the Spanish coastline had already been occupied by hotels, apartments, and other infrastructures, and these huge investments have to be protected.

The utility of articles like the one by ANFUSO and GRACIA (2005) should be highlighted, and this may be a step forward in the effort to solve the difficulties involved with setting up an integrated management due to the complexity of existing boundaries of the different authorities involved in coastal zone management in Spain. If politicians, decision makers, and urban developers of other not-so-developed countries (from the touristic point of view) were aware of the importance of retreating urbanisation from the coastline and leaving unoccupied the surface needed by the sea for its natural variability or for future landward advances, that would be an invaluable environmental gift for future generations.

LITERATURE CITED

ANFUSO, G. and GRACIA, F.J., 2005. Morphodynamic characteristics and short-term evolution of a coastal sector in SW Spain: implications for coastal erosion management. *Journal of Coastal Research,* 21(6), 1139–1153.

ANFUSO, G.; BENAVENTE, J., and GRACIA, F.J., 2001. Morphodynamic response of nourished beaches in SW Spain. *Journal of Coastal Conservation,* 7, 71–80.

BENEDET, L.; FINKL, C.W., and KLEIN, A.H.F., 2004. Morphodynamic classification of beaches on the Atlantic coast of Florida: geographical variability of beach types, beach safety and coastal hazards. *Journal of Coastal Research,* Special Issue No. 39, pp.

FREDSOE, J. and DEIGAARD, R., 1992. *Mechanics of Coastal Sediment Transport. Advanced Series on Ocean Engineering,* Volume 3. World Scientific, 369 p.

GOMEZ-PINA, G., 1999. Beach nourishment: fundamental, the Spanish experience. *In: Proceedings of the Short Course on Coastal and Port Engineering, 5th International Conference on Coastal and Port Engineering in Developing Countries (COPEDEC),* (Cape Town), pp. 6.1–6.48.

GOMEZ-PINA, G.; MUNOZ-PEREZ, J.J.; RAMIREZ, J.L., and LEY, C., 2002. Sand dune management problems and techniques, Spain. *Journal of Coastal Research,* Special Issue No. 36, pp. 325–332.

GOMEZ-PINA, G.; MUNOZ-PEREZ, J.J.; FAGES, L.; RAMIREZ, J.L.; ENRIQUEZ, J., and DE SOBRINO, J., 2004. A critical review of urban beach nourishment projects in Cadiz City after 12 years. *In; Proceedings of the 29th International Conference on Coastal Engineering* (Lisbon, Portugal, ASCE), pp. 3454–3466.

HORIKAWA, K. and KUO, C.T., 1966. A study on wave transformation inside surf zone. *In: Proceedings of the 10th Coastal Engineering Conference* (Tokyo), pp. 217–233.

IRIBARREN, R. and NOGALES, C., 1949. Protection des Ports. *XXVII International Navigation Congress, Section 2,* pp. 31–80.

KOMAR, P.D. and GAUHAN, M.K., 1973. Airy wave theory and breaker height prediction. *In: Proceedings of the 13th International Conference on Coastal Engineering* (ASCE), pp. 405–418.

MUNOZ-PEREZ, J.J. and ENRIQUEZ, J., 1998. Dinamica litoral de una unidad fisiográfica completa: Chipiona-Rota. *Revista de Obras Publicas,* 3375, 35–44.

MUNOZ-PEREZ, J.J. and MEDINA, R., 2000. Profile changes due to a fortnightly tidal cycle. *In: Proceedings of the 27th International Conference on Coastal Engineering* (Sidney, ASCE), pp. 3063–3075.

MUNOZ-PEREZ, J.J. and MEDINA, R., 2006. Short term variability of reef protected beach profiles: an analysis by using EOF. *In: Proceedings of the 5th International Conference on Coastal Dynamics* (Barcelona), pp. 1–11.

MUNOZ-PEREZ, J.J.; LOPEZ, B.; GUTIERREZ-MAS, J.M.; MORENO, L., and CUENA, G.J., 2001. Cost of beach maintenance in the Gulf of Cadiz (SW, Spain). *Coastal Engineering,* 42, 143–153.