Congreso de Métodos Numéricos en Ingeniería – METNUM 2013
Bilbao, Spain, 25-28 June 2013

Thematic session proposal

Modelling coastal processes in nearshore zones

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SHORT DESCRIPTION

Knowledge of the flow characteristics associated with surface waves, tides and currents, and their dependency on the bathymetry and coastal geometry, is of considerable importance when designing structures commonly found in the fluvial and coastal environment, like bridges, groins and breakwaters. Such knowledge also helps to predict the modifications thereby introduced into sea disturbance and into the transport and deposition of sediments. Energy for these nearshore processes comes from the wind blowing over the sea surface, gravitational forces of the Moon and the Sun and by possible impulsive disturbances at the atmospheric and land boundaries. Although the nearshore zone is usually considered from the storm-influenced landward limit seawards to shoaling-inducing depths, coastal landslides, estuarine circulation and river plumes cans significantly affect the nearshore circulation.

At the end of the 1970s linear models were used to simulate the refraction effect produced by the depth variation along the direction of the crest wave propagation and the diffraction effect produced by the gradient of the amplitude along the wave crest. However, as they are based on the linear theory, those models should not be utilized for shallow water conditions.

A number of factors have made it possible to employ increasingly complex mathematical models. Not only has our theoretical knowledge of the phenomena involved greatly improved, but numerical methods have been used more efficiently. The great strides made in computer technology, especially since the 1980s, improving information processing and enabling vast amounts of data to be stored, have meant that more mathematical models, of greater complexity, can be used, with fewer restrictions.

Then, the Saint-Venant equations were frequently used in practical applications of tidal circulation in estuaries and enclosed seas. However, as has been widely demonstrated, in shallow water conditions and for wind-generated waves, models based on a non-dispersive theory, of which the Saint-Venant model is an example, are limited and are not usually able to compute satisfactory results over long periods of analysis.

It is generally accepted that for practical applications the combined gravity wave effects in shallow water conditions must be taken into account. In addition, the refraction and diffraction processes, the swelling, reflection and breaking waves, plus the wave-wave and wave-current interactions, and the phenomena resulting from important sudden time-bed-level changes, all have to be considered, too.

Therefore, only wave models of order σ^2 or greater, of the Boussinesq or Serre types, are able to reproduce effects other than the dispersive effects, including the non-linearities resulting from wave-wave and wave-current interactions, and the waves resulting from sudden time-bed-level changes that cause "*tsunamis*"; submerged landslides in reservoirs or landslides on reservoir banks are examples such changes.

To describe the strongly nonlinear dynamics of waves propagating from deep waters, through intermediate waters, and final stages of shoaling and surf zones, fully nonlinear models are required. The ability of recent Boussinesq-type models and Serre equations (or Green and Naghdi) to reproduce these nonlinear processes in the different propagation conditions is well known. However, these models are restricted to shallow water conditions and addition of other terms of dispersive origin has been considered recently.

Offshore to nearshore wind-wave generation propagation and transformation is already operationally obtained by means of third generation spectral wave models (e.g. SWAN).

On what concerns ocean and nearshore circulation, operational models are usually based on the hydrostatic assumption (e.g. POM, ROMS and COHERENS) although assuming both baroclinic and barotropic modes. Nevertheless the nearshore circulation near river mouths, especially where a strong plume is to be expected, models are highly convective and non-hydrostatic models shall be used (e.g. SELFE). Most of such models are still in a research stage.

A complete description of the nearshore processes would involve successive nested runs of all the above referred models with very different time scales.

As part of this thematic session, will be particularly appreciated, though not exclusively, communications dealing with the following themes:

- ◊ Fully nonlinear models to describe the strongly nonlinear dynamics of waves propagating from deep waters, through intermediate waters, and final stages of shoaling and surf zones.
- ◊ Wave-wave and wave–current interactions over bottom with appreciable variations in both space and time.

◊ Numerical wave models to deal with cohesive and non-cohesive sediment-transport and bed-level changes in estuaries and nearshore regions.

◊ Numerical methods to discretize dispersive wave models, examples of which are the Boussinesq-type and Serre equations, namely: finite element type methods, finite difference discretization, and finite volume schemes.

◊ Wave-structure interaction numerical modelling. Numerical models and applications.

◊ Wave interaction with floating bodies. Numerical models and applications.

◊ Practical applications of nonlinear numerical models.

◊ Non-hydrostatic circulation models.

◊ Nearshore circulation modelling.

◊ Estuarine circulation modelling.

◊ River plume modelling.

◊ Dispersive effects in tsunami waves.

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