Geophysical Research Abstracts
Vol. 14, EGU2012-10685, 2012
EGU General Assembly 2012

Density-salinity-suspended sediment experimental curves for Guadalquivir River estuary conditions

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Estuarine water in Mediterranean watersheds contains high suspended sediment concentrations due to both the fine textured nature of the materials reaching the final stretch of the fluvial network, and the agricultural predominance of soil uses upstream. Saline conditions induce flocculation processes which alter the original behavior of the soil particles in water. The final high density mixture of water-salts-sediments has physicochemical characteristics very different from the saline water alone. However, this is not often included when modeling the dynamics of estuaries, adopting the density, viscosity, etc., values corresponding to the present level of salinity found at each point. The nature of the local sediments influences the density values finally found.

The Guadalquivir River estuary (southwestern Spain) extends along the 105 km between the Alcalá del Río dam, upstream, and its mouth in Sanlúcar de Barrameda. It is an Atlantic mesotidal estuary (Díez-Minguito *et al.*, 2010) with a mainly longitudinal salinity gradient. The sediments in the estuary are very fine-textured due to the great length of the river and, mainly, the extreme trapping efficiency of the dense reservoir network upstream along the 57400 km^2 of the contributing area. With an average value of 0.5 – 4.5 g L^{-1} for the suspended sediment range along the estuary, extreme values up to 160 g L^{-1} can be found associated with persistent turbidity events forced by different combinations of conditions.

This work shows the density variation with changing bivariate conditions of salinity-suspended sediments, following the combined range found along the estuary. Laboratory measurements were made at 19°C for synthetic seawater with 35 g L^{-1}salinity and the decreasing range found upstream by dilution until a final value of 0.2 g L^{-1}, for which an increasing suspended sediment concentration (SSC) was induced by adding sediments locally extracted from the estuary. The final density of these sets of mixtures with SSC values from 0 to 4.5 g L^{-1} was determined. The results from the blank set of samples (0 SSC) followed the seawater state equation by UNESCO (1985) with a correlation coefficient of 0.9986.

The results show the expected increasing trend for density with SSC for every salinity level, with a linear relationship and density values from 1023.5 to 1025.5 g L^{-1}for SSC between 0 and 4.5 g L^{-1} (35 g L^{-1}salinity), from 1009.5 g L^{-1}to 1012.5 g L^{-1} (17.5 g/l salinity), and from 997 g L^{-1}to 1000 g L^{-1} (0.3 g L^{-1}salinity). Characteristic curves were obtained by using the density for 0 SSC at each salinity level as a reference value for each stretch along the estuary, with a resulting linear coefficient of around 0.6 for the low and medium range salinity values; however, this coefficient decreased to 0.4 for the high salinity samples. Additional work including temperature variation in the environmental range found for the Guadalquivir River estuary water is being carried out.

These local curves will used in the hydrodynamic model of the estuary, and are applicable for other estuaries along the Andalusian coast with similar sediment patterns.