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Influence of reservoirs and land use on the river contribution: case study of the Guadalquivir stuary.

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In Mediterranean regions, the non-coincidence in time of demand and availability of water throughout the year, together with the interannual variability of the climate, makes it necessary to store water in the short and long term. Dams, along with changes in land use, have important effects on watershed dynamics concerning runoff circulation and, as well as the dynamics of sediments, nutrients and other substances associated with them. Existing studies analyzed the influence of both factors in riverine systems; however, very few studies do it in estuaries, complex dynamic systems with fluvial, coastal, weather and human processes interacting continuously at different spatial and temporal scales. The estuary of the Guadalquivir River, in Southwestern Spain, is an example of highly modified estuaries because of the human action upstream, with antecedents up to the Greek and Roman societies. Besides, the unique character of the Guadalquivir estuary relies on its double condition: located in a typical Mediterranean climate context and thus with strong intra and inter-annual variations in precipitation, but also with a strong Atlantic influence, where the occurrence of precipitation is linked primarily to the arrival of storms from the ocean.

This work shows the modification of the Guadalquivir estuary and the river basins upstream during the second half of the 20th century, and its impact on the fluvial inputs along time, from maps of land use and cover, orthophotos taken in 1956 and 2004 flights, water flow data analysis, rainfall and water quality series collected at different stations along the whole basin area, as well as information about the dams built in the watershed.

Since 1930, the freshwater input to the estuary is subject to intense regulation by the whole network of dams along the catchment, which ends in the Alcalá del Río dam at the head of the estuary. This dam blocks the propagation of the tidal wave upstream and influences the inner tidal dynamics. The contribution of seawater occurs mainly associated with tidal dynamics, essentially semidiurnal, ranging in amplitude cycles and neap tides. In this context, the predominance of fluvial conditions is reduced only to flood events, and this facts greatly influences the status of water quality in the estuary and the associated flows. The annual regime of discharge from the Alcalá del Río dam has been drastically decreased since the 70s, up to a 70% of the antecedent regime, not only due to the construction of dams in the upstream catchment area, whose storage capacity doubled during these decades, but also by the gradual and intense development of large irrigated agricultural areas upstream (which increased their area by 150% in that period). As a result, the average daily flow for the last 3 decades is 63 m3s-1 , versus the 183 m3s-1 averaged during the decades 30-60; moreover, 50% of the days its current average value is much smaller (25 m3s-1), although in flood situations water flow can increase several orders of magnitude. Upstream water uses influence the water quality of the estuary, due to both pollutant inputs, and the capacity of dilution and mixing that the current flow regime exhibits, much smaller than the value corresponding to the natural regime of the Guadalquivir River. Examples of this are frequent salinity increases in the lower and middle estuary (up to 30 PSU), and the persistence of extreme suspended solids concentrations after extreme floods (2000-10000 mg l-1 during several months); the latter is accentuated by the agricultural soils management, with high soil loss rates, especially in cropping systems such as olive orchards and herbaceous crops.