IMPACT OF HUMAN ACTIVITIES ON PRESENT-DAY MEDITERRANEAN RIVERS

John D. Milliman
School of Marine Science, College of William and Mary, Gloucester Pt, VA 23062, USA - milliman@vims.edu

Abstract
Human activities on rivers discharging into the Mediterranean Sea have affected annual as well as seasonal discharge, annual sediment loads, and the quantity and character of dissolved constituents. As population pressures increase, these trends undoubtedly will accelerate. Present and future environmental changes and their impacts require a more concerted monitoring effort as well as an efficient dissemination of data and observations.
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Rivers discharging into the Mediterranean and Black seas have long been influenced by human interference to the landscape and to the rivers themselves through such activities as mining, deforestation, agriculture and urbanization. As a result, erosion in Mediterranean watersheds tends to be higher than in other global watersheds (Fig. 1A), and historically sediment delivery to the coastal zone has been elevated.

Over the past century, however, dams and irrigation have reduced discharge from many rivers, including the southern, northeastern and northwestern Mediterranean [1] , far more than what one might predict from reduced precipitation (Fig. 1B). In fact, other than French and many Italian rivers, in fact, fluvial discharge to much of the Mediterranean has declined by >50%. The present-day Nile, for example, discharges only a fraction of its pre-Aswan levels, and during this same period Ebro discharge has declined by ∼50%.

Dams also have affected the seasonality of river discharge, not only in those rivers in which annual discharge has decreased but also those rivers in which annual discharge appears to have changed little. It is not surprising, for instance, that the winter and spring peaks in Ebro discharge have muted (Fig. 2A), but the decreased seasonality in the Dniepr, which discharges into the NW Black Sea, is more surprising since between 1952 and 1984 its annual discharge remained relatively unchanged (Fig. 2B). This presumably reflects water removal for hydroelectric power in the winter and for irrigation in the summer.

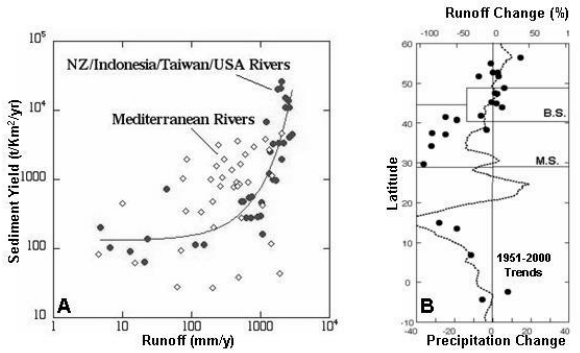

Fig. 1. (A) sediment yield versus runoff for Mediterranean rivers, 1000-5000 km^2 in basin area), compared with similar-sized mountainous rivers in New Zealand, Indonesia, Taiwan and the U.S.A. For any given runoff, Mediterranean rivers generally have 2-10x greater sediment yields, primarily the result of long-term poor land use. Data from Milliman and Farnsworth (in preparation). (B) trends in precipitation and runoff (vs. latitude) of selected African and European rivers, 1951-2000. Note the relatively close correlation between the two parameters in sub-Sahara and northern Europe (including the Black Sea: B.S.), but the mostly negative correlation for rivers discharging into Mediterranean (M.S.), reflecting the impact of dams and irrigation.

Changing landuse patterns, particularly land conservation, have meant that many northern Mediterranean watersheds are less farmed and more forested than they were 50-100 years ago. Combined with the trapping of fluvial sediments in reservoirs, sediment delivery to the coastal Mediterranean has declined, often dramatically - even in those rivers whose discharge has remained unchanged (Fig. 2C and 2D). Exacerbating the problem of understanding and managing Mediterranean rivers, the impact of industrial activities, use of artificial fertilizer, as well as the "ageing" of waters in reservoirs have changed the quantity and character of dissolved solids [2].

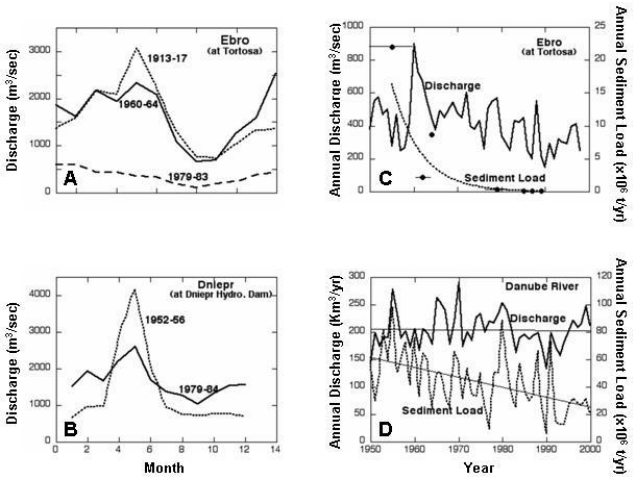

Fig. 2. (A) changing seasonality of Ebro at Tortosa before and after major dam construction. Note the decreased annual discharge as well as season variation. (B) Dniepr annual discharge at the river Hydro Dam changed little between 1952 and 1994, but seasonal patterns did change, presumably in response to wintertime use of hydroelectric power and summertime irrigation. (C) and (D) upstream damming of the Danube has led to >50% decline in sediment load despite no change in discharge.

Whether or not such anthropogenic changes are as significant as generally believed (e.g. [3]), the discussion has been considerably compromised by the limited database for many rivers, their estuaries, and surrounding coastal areas. What are the recent changes in discharge, solid and dissolved loads for the rivers draining into the Mediterranean and Black seas? How have these changes affected coastal accretion or erosion, the ecosystem of coastal waters, etc? What has been the effect on coastal fisheries? The answers to some, perhaps many, of these questions may be contained within local and regional databases, but until they are more readily available to the scientific community, a comprehensive regional understanding may remain limited.

References

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