A REASSESSMENT OF THE MEDITERRANEAN RIVER RUNOFF

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Abstract

An estimation based on field measurements of water flow from 69 rivers has shown that the Mediterranean drainage basin (some 4,135,000 km^2) has the ability to provide 570 km^3 (0.23 myr^{-1}) of freshwater. During the second part of the 19th century the construction of thousands of small and big dams has reduced this natural freshwater flow almost to the half. This reduced value corresponds to 0.11 myr^{-1}, which is comparable to the Black Sea net outflow .

Keywords: Mediterranean, rivers, freshwater, water-balance

Introduction

The Mediterranean drainage basin covers an area of about 4,135,000 km^2, incorporating more than 160 rivers, with catchment areas larger than 200 km^2. Overall, there are only a few rivers with drainage basins larger than 50x10^3 km^2: the Ebro (Spain); the Rhone (France), the Po (Italy), the Moulouya (Algeria), and the largest river Nile (Egypt).

The freshwater inflow controls the overall water balance of the basin being one of concentration, whereby evaporation excess precipitation and runoff by some [1] 0.6 myr^{-1}. A recent river runoff estimation [2] gives a value of 0.2 myr^{-1}; this denotes the importance of the river inputs, as they account for one third of the water deficit. Thus, any changes in the river runoff would affect substantially the freshwater budget, which is linked strongly with the overall functioning (thermohaline circulation, dense water formation) of the Mediterranean Basin system [3]

In the present investigation, based on field measurements, the overall river inputs is quantified and the significance of the smaller rivers is revealed. The effects of the dam construction on the magnitude of the natural freshwater flux are examined and the freshwater contribution into the Mediterranean water budget is re-assessed.

Data and Methods

In order the overall water load to be calculate, the Mediterranean rivers and their catchment have been divided into 5 geographical regions (PR), considering their geographical locations and climatological conditions (Fig. 1). Subsequently, the water yields (m^{3}km^{-2}) for each of the 5 PR was estimated. This estimation is based upon the calculation of the weighted average of the corresponding water yields from field-measurements of the water fluxes of 69 rivers discharging along the Mediterranean coastline. Subsequently, the mean (weighted) value for each PR was calculated, using the known water yields and the weighted area of the watersheds corresponding to the measured water fluxes (Table 1).

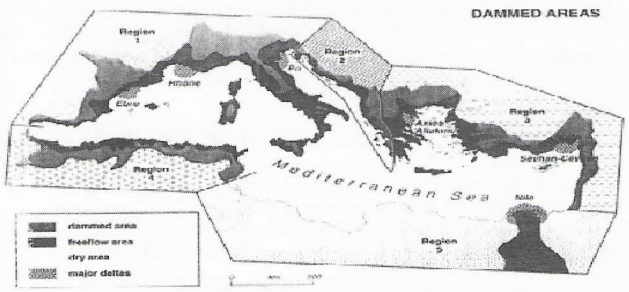

Figure 1: Physiographic regions (1-5) and corresponding dammed areas. Key: (1): the area covered by the field measurements (in parenthesis the percentage relatively to the total area is given; (2): the number of rivers associated with field measurements (in parenthesis the total number of rivers is given); (3): in parenthesis the percentage relatively to the total freshwater load is given.

Results and Discussion

The Physiographic region PR^{-1} supplies annually the largest amount of fresh water (254 km^3), whilst the lowest fluxes are associated with PR^{-4} (12 km^3). The overall (potential) annual freshwater load estimated to be some 570 km^3 (0.23 myr^{-1}). But within the second half of the 19th century the construction of almost 3000 dams [4] has reduced the (natural) drainage basin area of the Mediterranean by 78%. Furthermore, an analogous reduction has been caused in the overall water supply within each physiographic region, in response to dam construction. Thus, the overall estimation of the freshwater load retained behind the dams accounts accordingly some 297 km^{3}yr^{-1} which corresponds to 52% of the total water volume i.e only 273 km^{3}yr^{-1} reach the ocean.

Table 1. Estimation of the annual freshwater yields and loads before and after damming

	Water yield (10^3 m^3/km^2)	Area[1] (10^3 km^2)	Rivers[2]	Water load (km^3)	Dammed Area (10^3 km^2)	Water load after damming (km^3)
PR-1	517.50	299.1 (75%)	30 (83)	254	~225	137(54%)3
PR-2	1050.00	48.4 (81%)	11 (19)	63	~31	31(49%)
PR-3	440.00	71.8 (21%)	11 (36)	150	~125	94.5(63%)
PR-4	55.25	150.6 (71%)	16 (21)	12	~145	3.6(30%)
PR-5	30.00	3035 (99%)	1 (5)	91	~2800	7.3(8%)
Total			**69(164)**	**570**	**3326**	**273 (48%)**

If we add to this figure the net Black Sea outflow, which according to a recent estimate [5] is around 260 km^{3}yr^{-1}, the resulting sum corresponds to an annual total runoff of 0.21 m. It has also been estimated [6] that the divergence of the vertically integrated horizontal water vapour fluxes to be around 0.66 myr^{-1}. A subtraction of 0.52 myr^{-1}, the estimated net inflow from Gibraltar strait [1], yields an implied effective runoff (Med. Rivers + Black Sea) around 0.14 myr^{-1} a value slightly less than the one estimated in this work.

Finally we would like to stress that the fresh water contribution of the major river systems (drainage basins >104 km^2) is shown to be smaller than what was assumed in earlier studies, as it represents only the 37% of the total influx. For exapmle the R. Nile before dumping contributed only the 16% of the total annual freshwater input.

References

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