CU AND PB INPUTS FROM A SMALL RIVER TO THE MEDITERRANEAN SEA

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Abstract
The particulate and dissolved Cu and Pb inputs to the Mediterranean Sea from a small, anthropized Mediterranean coastal river located in the South of France were quantified along a whole hydrological year. More than 90% of the annual metal inputs were due to short, intense floods, occuring after a long dry period. Extrapolation to the whole Mediterranean basin indicates that the Cu and Pb inputs from such small rivers are of the same order of magnitude than the inputs from large rivers, and they should not be neglected in their pollution contribution to the sea.
Keywords : Coastal Waters, Metals.

Most studies concerning continental inputs to the sea focused on large rivers. However, small coastal rivers, can have a high ecological impact because they rapidly bring to the sea the contamination produced in the coastal area, especially when it is located in dense human population area. Among the studies of small coastal rivers, only a few deal with the Mediterranean area, despite its fast anthropization and its climate specificities: long dry periods corresponding to low water levels (base-flow) are interrupted by short, severe floods.

We chose to study the Eygoutier river, whose watershed is representative of modern anthropization, mixing urban, semi-urban, small industrial and agricultural areas. The base-flow of the river is typically around 10 m^3h^{-1}, while the river flow rapidly (commonly within 15 minutes) increases up to 40,000 m^3h^{-1} during floods. After the end of a rainfall, the river returns to its base-flow level within less than 24 h. We characterized the base-flow along one hydrological year and we studied into details 5 representative flood events occurring within one year. We quantified the fluxes of suspended particulate matter (SPM, fraction >0.22μm), dissolved organic carbon (DOC), particulate organic carbon (POC), as well as dissolved and particulate Cu and Pb and nutritive ions brought to the sea. The base flow was studied by a bimestrial sampling and the floods by the mean of an automatic sampler providing 25 samples per flood, the sampling interval being smaller at the beginning of the flood because of higher concentrations. The water flow was measured every 30 minutes all along the year 2004. The base-flow fluxes were calculated by multiplying the mean concentration values by the mean base flow. Flood fluxes were calculated considering that any flow higher than 200 $m^3.h^{-1}$corresponded to a flood event. Consequently, 1432 hours of flood (16% of theyear) were registered during the year 2004 with a mean flow around 5100 m^3.h-1. The Table 1 presents the fluxes calculated over the whole year.

Tab. 1. Species annual fluxes at the outcome of the river.

	Base flow	Flood	Total
Flow (m^3.yr)	0.39 10^6	7.34 10^6	7.73 10^6
MES ($t.yr^{-1}$)	5.1	2638.4	2643.5
DOC ($t.yr^{-1}$)	4.7	125.7	130.4
POC ($t.yr^{-1}$)	1.2	384.7	386.0
Dissolved Pb ($kg.yr^{-1}$)	0.1	8.2	8.3
Dissolved Cu ($kg.yr^{-1}$)	1.9	26.0	27.9
Particulate Pb ($kg.yr^{-1}$)	1.2	452.4	453.6
Particulate Cu ($kg.yr^{-1}$)	1.4	466.3	467.7

The total Pb concentration transferred to the sea was estimated around 462 $kg.year^{-1}$ (98% in the particulate phase) and the total Cu concentration around 496 $kg.year^{-1}$ (94% in the particulate phase). More than 99% of the total Pb and Cu were transferred during floods, exceeding the values acceptable for a good quality water. This indicates that brief periods of high metal concentrations occurred at the outcome of the river, and could have a negative impact on biological life in the sea. Considering the whole Mediterranean basin, the annual input of riverine water is 620 $km^3.year^{-1}$, with 81% brought by the northern half of the basin [1]. Six large rivers (Nile, Rhône, Pô, Drin, Ebro and Neretva) contribute for 43.4% of the annual input, and the 56.6% remaining are due to small rivers. Extrapolating our small river data to the corresponding water volume, small rivers input to the Mediterranean Sea would be around 25 and 420 $t.year^{-1}$for dissolved and particulate Cu, respectively, and around 7 and 408 $t.year^{-1}$for dissolved and particulate Pb, respectively. This extrapolation is somehow excessive, but gives an order of magnitude of what would be small rivers input by a fully anthropized Mediterranean coastal area. For comparison, realizing a similar extrapolation to larger river inputs to the Mediterranean scale using the Rhône annual transfers values [2], 517 $t.year^{-1}$ of total Cu and 26 $t.year^{-1}$ of total Pb were obtained. Such values do not go beyond rough estimate, but, being of the same order of magnitude than the input from small rivers, indicate that the latter cannot be neglected in contaminant balance at the Mediterranean scale.

References

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