SUSPENDED SEDIMENT AND ASSOCIATED RADIONUCLIDES TRANSPORT : 2001-2008 FLOOD MONITORING AT THE LOWER RHÔNE RIVER

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Abstract

Total Suspended Solid loads (TSS) and associated natural and artificial radionuclides were monitored over the 2001-2008 period at the lower course of the Rhône River thanks to the SORA monitoring station located at Arles. The high frequency monitoring established affords to quantify TSS annual fluxes and TSS fluxes generated by flood events. Besides, the survey allowed registering two uncommonly high loaded events in 2008 partly due to dam management. 9.1 106 tons were thus exported in 2008 whose almost 70% during the two atypical events of may and December. Globally, artificial and natural radionuclide activities display a decreasing trend with rising liquid flow rates making possible to access to geochemical or anthropogenic background values.

Keywords: Radionuclides, Monitoring, Rhone Delta

As described for many land to sea systems, the Rhône River inputs affect primary production significantly in the north-western Mediterranean area and plays a leading role on the marine ecosystem functioning in the whole Gulf of Lion [1]. The Rhône River also transfers to the Sea various Potentially Contaminating Trace Elements (PCTE) including heavy metals, poly-aromatic hydrocarbon and artificial radionuclides that are largely associated to solid compounds, i.e. particles. Radionuclides inputs from the Rhône River whatever from natural or artificial origin may generate radiotoxicity for man and its environment even though generally awfully low due to the extremely low level of contamination. The inputs of particle reactive radionuclides from the Rhône may be also of a particular interest to determine residence time of sedimentary mass from the coastal to the open sea. In this frame depending on the distance to the source term, i.e. the Rhône mouth, and the velocity of mass transfers, short to long-lived radionuclides may represent useful tools for quantifying sedimentary mass dynamics at various spatial scales. In this frame, Total suspended sediment (TSS) and associated natural and artificial radionuclides were monitored over the 2001-2008 period at the lower course of the Rhône River. Over this period of time high frequency samplings was gradually established for floods > 3000 $m^3.s^{-1}$ as these events were shown to export the main part of the solid load towards the marine environment [2-5]. Our results underline several key points:

a- TSS loads follow a power function relationship with the liquid discharge that does not significantly differ from the relations established for previous period of time. The correlation is highly significant mainly due to the huge number of data Nevertheless, TTS concentrations may range over two to three orders of magnitude for a same liquid flow rate in some cases.

b- From 2001 to 2008 TSS annual fluxes ranged from 0.98 10^6 tons in 2005 to 9.1 10^6 tons in 2008, with a mean value of 4.7 10^6 tons.

c- Dam management during flood episodes and consecutive excess water and sediment deliveries may conduct to 'semi anthropogenic floods' characterised by moderated liquid discharges but abnormally high TSS concentrations. In 2008, 56% of the solid annual flux was transferred during such an event. The high frequency TSS survey at the lower course of the Rhône made possible to register for a first time such scare unusually heavy loaded floods that may largely supply solid fluxes to the sea.

d- The particulate concentrations of the various studied radionuclides show generallly a decreasing trend with rising liquid discharges towards more or less constant values reflecting the geochemical or anthropogenic background levels.

e- ^{238}Pu and $^{239+240}Pu$ isotopes display a different trend as increasing particulate activities have been registered during rising waters due to the remobilisation of labelled sedimentary storages downstream of the Marcoule spent fuel reprocessing plant. Around 30% to 50 % of $^{239+240}Pu$ and 80% to 90% of ^{238}Pu transferred by the River downstream during flood events originate from sediment remobilisation, the residual coming from the soil erosion of the watershed.

f- $^{238}Pu/^{239+240}Pu$ activity ratio signatures during Rhône River floods may present an important variability (1) over a single flood event since hysteresis loops were observed and (2) between two different events depending on flood types and probably on the flood chronicles.

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