Atmospheric input of contaminant to a small Mediterranean basin

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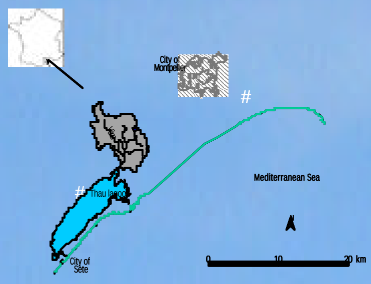
The atmosphere disseminates and deposes at the ground numerous substances which have a notable geological, geochemical and ecological impact. In the Mediterranean area, anthropogenic and natural sources are both contributing to the atmospheric deposit. Mediterranean coastal waters are receiving pollutants from various inputs: atmospheric, sea, riverine. Observations of rainfall chemical concentration over the Mediterranean area have emphasized the importance of atmospheric deposition. Nevertheless, little is known on the magnitude and trends of atmospheric deposition to small coastal Mediterranean basins. The aim of this study is to estimate atmospheric deposition of major elements and nutrients into a small Mediterranean basin.

Study site

The study site is the Vène basin (67 km^2) located in the French Mediterranean coast, north east to the Thau lagoon. The basin is divided in two main zones: i) the central part of the basin, a flat marly plain dedicated to agricultural activities; ii) on both sides, limestone massifs, highly karstified, are covered by natural garrigue used for sheep and poultry. Human activities (about 9200 inhabitants) are concentrated in the middle basin part. The Vène feeds the Thau lagoon devoted to recreational activities and shellfish farming.

Two highly traffic roads cross the basin on its south, the south France highway and a secondary road. The major cities around are the city of Montpellier and Sète. The area is free from major industrial activities, the closest one being around Marseille, more than 100 km to the east.

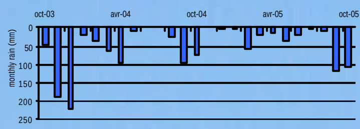


The Vene basin and its surrounding

Two rain samplers were installed at the Plagnol site located midrange of the river basin : a refrigerated automatic wet-only precipitation collector with a nearby bulk sampler. Bulk precipitation was collected by a conventional tipping buckets rain gauge. Wet and bulk samples were collected on rain event basis. Conjointly to sampling, rainfall amounts were continuously measured by the tipping buckets gauge.

The wet-only and bulk collectors

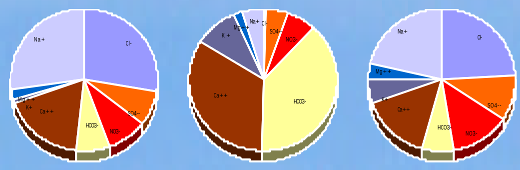
Rainwater chemistry was monitored during a two years period (Nov. 2003 – Oct. 2005). 13 wet-only and 23 bulk samples were analysed for major elements and nutrients. They account for 35% (wet only) and 78% (bulk) of the two years total rain amount. Broadly a half of the actual rain events were sampled. Annual rainfall varied markedly between 2003-04 and 2004-05. The first year annual rainfall, 836 mm is more than twice the second year observation, 397 mm .



Monthly rainfall at the sampling site

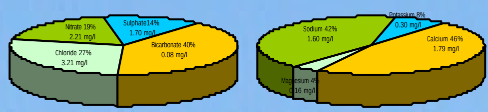
Rainwater content

• At the event time scale ion repartition is highly relevant to the the rain origin : marine, saharan or anthropic.



Wet samples ions composition (meq l^{-1})

• The volume weighted mean concentrations of anion can be ordered in a descending order as follows: $HCO_3^- > Cl^- > NO_3^- > SO_4^{--}$. For cation, mean concentrations are ordered $Ca^{2+} > Na^+ > K^+ > Mg^{2+}$. Similar dominance were observed in other studies carried out in the Mediterranean basin (e.g. Avila and Alarcon, 1999, Samara et al. 1992, Al-Momami et al., 2000 …)



Contribution of cations/anions to total cation/anion mass

• Considering nutrients, absolute levels of concentrations vary from 0.5 to 3.6 mg-N l^{-1} for TN and from 3 to 49 g-P l^{-1} for TP.

Wet and dry deposition rate

Wet, bulk and dry deposition rates were estimated during two continuous sampling periods.

• wet deposition rate

$D_w = C\,h\,/d_e$ — The product of rain constituant concentration(C)and rain depth (h) divided by the exposition duration (d_e)

• bulk deposition rate

$D_w = C_b\,h\,/d_e$ — The product of bulk sample concentration (C_b) and rain depth (h) divided by the exposition duration (d_e)

• dry deposition rate

$D_d = (D_b - D_w)\ d_e/ (d_e\text{-}d)$ — Bulk minus wet deposition divided by the no rain duration (d-d_e) where d is the duration of rain event

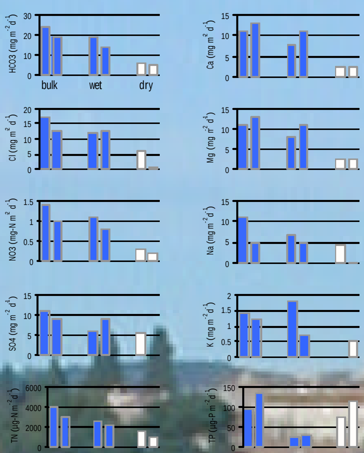
Continuous exposition periods were :

#1, from 24th of February 2004 to 3rd May 2004 (from end of winter to beginning of spring) ; 62 days

#2, from 13th September 2004 to 13 December 2004 (during autumn) ; 53 days.

• Except total phosphorus, the wet deposition is larger than the dry deposition for the all elements.

• There are no significant differences of deposition rates between period #1 and #2.

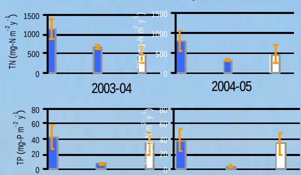


Bulk, wet and dry deposition rate estimation from data of period #1 and period #2

Nutrient atmospheric deposition vs river loads

Yearly bulk, wet and dry depositions of nutrients were extrapolated from the observation periods.

• At the annual scale, wet and dry contribution to TN deposition are comparable but for TP the dry deposition is four to six times the wet deposition.



Bulk, wet and dry annual deposition

• TN bulk atmospheric depositions are in the same range that river loads. River loads estimations are in the range 1190-2740 for 2003-04 and 140-3100 mg-N m^{-2} y^{-1} for 2004-05.

• TP river loads were approximately ten times larger than atmospheric deposition (2003-04 : 90-570 mg-P m^{-2} y^{-1}; 2004-05 : 20-1390 mg-P m^{-2} y^{-1})

These first results are giving indicative values of the atmospheric input to a small basin in the Mediterranean coastal area. Further analysis should be conducted on the dataset in order to i) evaluate the spatial and temporal variation in rainwater for contaminants. ii) to identify the possible origins and the main factors affecting the concentrations of the measured species at the rain event time scale and iii) take into account trace element content.

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