

## **Estimation of mercury wet deposition in the tributary sub-basins of the Negro river (Amazon-Brazil) using RS/GIS tools**

W.F. Jardim and G. Silvério da Silva

*Chemistry Institute, State University of Campinas, UNICAMP, Brazil*

### I. Abstract

Recent studies have shown high concentrations of Hg in fish, soil, lakes and rivers of the Negro river basin. These concentrations were surprisingly high when considering the scarcity of anthropogenic point sources in the region (Fadini and Jardim, 2001). In order to investigate the role of wet deposition in the mercury biogeochemistry cycle in this basin, Hg deposition was estimated for 18 tributary sub-basins of the Negro river, covering an area of nearly 700,000 km<sup>2</sup>. Mercury wet deposition estimate was done by combining analytical data obtained from total Hg measurements in bulk precipitation (8 measurements between 1997 and 2002), Remote Sensing (RS) and GIS (Geographic Information System) tools, with the help of orbital images from the JERS-1 SAR project (Global Rain Forest Mapping Project, South America- Amazon Basin), Amazon rainfall map (Sombroek, 2001) and SPRING (Geographic information of processing system) from INPE (Brazilian National Institute of Space Research). For each sub-basin, Hg wet deposition flux (ton km<sup>-2</sup> yr<sup>-1</sup>) and the annual amount of Hg (ton yr<sup>-1</sup>) deposited on the area were estimated. The result allowed a clear picture of each sub-basins, by looking for a relation between the wet deposition, the drainage characteristics of each sub-basin and the Hg concentration in the water column.

## II Water sampling and mercury determination

Samples were collected in previously washed Polyethylene Terephthalate (PET) bottles, and frozen until analyzed in the Environmental Chemistry Laboratory-LQA-UNICAMP, following the procedure recommended by Fadini and Jardim (2000). Mercury determination was carried out by CVAFS (cold vapor atomic fluorescence spectrometry), where the mercury is detected in its elemental form  $Hg^{\circ}$ . An argon gas flux transports the  $Hg^{\circ}$  to be amalgamated in a gold sand column, what is then desorbed by heating, and detected using a Brooks Rand<sup>®</sup> equipment. Total mercury was obtained by adding 10 mL  $L^{-1}$  of a 0.2 mol  $L^{-1}$  BrCl solution in an 100 ml of river and rain water sample, following by the reduction with  $SnCl_2$  (Fadini and Jardim, 2000).

## III RS/GIS application.

RS/GIS tools were carried out by using the SPRING (Geographic information of processing system), created by INPE (Brazilian National Institute of Space Research), according to the following steps:

- 1) estimates of each sub-basin area were carried out by IBGE Map (Legal Amazon, 1995) and satellite images from JERS-1 SAR project (Global Rain Forest Mapping Project, South America- Amazon Basin);
- 2) estimates of mercury wet deposition in Negro River Basin-AM were carried out by the average value of  $Hg_{total}$  concentration (Table 1) combined with the average values of annual rainfall, according to each region of Amazon Rainfall Map (Sombroek, 2001). The result was the wet deposition to each annual rainfall region (Table 2).
- 3) mercury wet deposition for each rainfall region and sub-basin area were estimated, resulting in the annual mercury amount deposited for each sub-basin. This value was then divided by the area of each sub-basin to obtain mercury annual wet deposition (Figure 1).

Table 1: Concentration of total mercury present in the bulk precipitation over the Negro River Basin-AM, Brazil (average value 9.8 ng L<sup>-1</sup>).

Date	Hg <sub>total</sub> (ng L <sup>-1</sup> )	Location	Reference
Feb/1997	9.2	S 0°25' W 64°30'	Fadini and Jardim, 2001
Feb/1997	11.2	S 0°25' W 64°30'	Fadini and Jardim, 2001
Feb/1997	8.5	S 0°25' W 64°30'	Fadini and Jardim, 2001
Feb/1997	9.6	S 0°25' W 64°30'	Fadini and Jardim, 2001
Jun/1997	10.0	S 1°57' W 61°47'	Fadini and Jardim, 2001
Jul/2001	13.8	S 0°25' W 64°30'	This work
Jul/2001	9,8	S 1°00' W :63°00'	This work
Feb/2002	6.1	S 1°00' W :63°00'	This work

Table 2: Mercury wet deposition obtained by rainfall region in the Negro River Basin-AM, Brazil

Ranges of Annual Rainfall used (Rainfall Map)*	Annual rainfall (average value )	Hg <sub>total</sub> (average value, ng L <sup>-1</sup> )	Mercury wet deposition by rainfall region (µg m <sup>-2</sup> year <sup>-1</sup> )
1400-1600 mm	1500 mm	9.8	14.7
1600-1800 mm	1700 mm	9.8	16.7
1800- 2000 mm	1900 mm	9.8	18.6
2000- 2200 mm	2100 mm	9.8	20.6
2000- 2400 mm	2300 mm	9.8	21.6
2400- 2800 mm	2600 mm	9.8	24.5
2800- 3200 mm	3000 mm	9.8	29.4
3200- 3600 mm	3400 mm	9.8	33.3
3200- 4000 mm	3600 mm	9.8	35.3
4000- 6400 mm	5200 mm	9.8	51.0

\* Sombroek, 2001

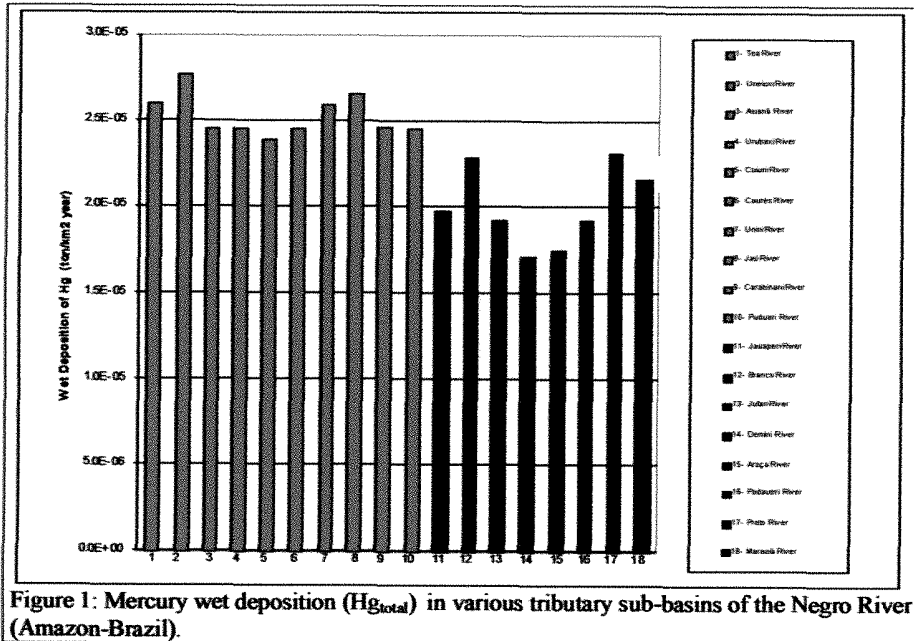


Figure 1: Mercury wet deposition ( $Hg_{total}$ ) in various tributary sub-basins of the Negro River (Amazon-Brazil).

#### IV. Conclusions:

Mercury wet deposition in 18 tributary sub-basins of the Negro River from left margin (black column) varied between  $2.7 \times 10^{-5}$  to  $1.7 \times 10^{-5}$  ton  $km^{-2}$   $yr^{-1}$ . Estimates of mercury wet deposition in each sub-basin can be a very powerful tool in helping to elucidate the metal cycle in the region. These results are important to establish a relationship between mercury concentration in the water column and sub-basin characteristics, including a better understanding of how each watershed will trap and release the deposited metal.

#### V. References:

- Fadini P.S. and Jardim W.F.(2001), *Sci. Total Environ.* 275:71-82  
 Fadini P.S. and Jardim W.F.(2000), *Analyst.* 125:549-551  
 Sombroek W. (2001), *Ambio* 30: (7) 388-396