How significant is the pollution of the Amazon by trace elements?

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Measurements of trace metals in rivers are of substantial interest for researchers examining basic scientific questions related to geochemical weathering and transport and to scientists involved in pollution control evaluation. Trace metals in natural waters include essential elements such as cobalt, copper, zinc, manganese, iron, molybdenum, nickel, which may also be toxic at higher concentrations, and non-essential elements, which are toxic, such as cadmium, mercury and lead. The release of potentially large quantities of these toxic metals, particularly in the river systems of industrialized countries, but also in tropical rivers, is an acute problem of great environmental concern. With few exceptions (e.g. the Hg in the Amazonian region) emission inventories of antropogenic sources are still rare for developed countries and almost non-existent for developing countries. We tent here to present a first quantitative estimate of anthropogenic and natural fluxes of trace metals in the Amazon basin. We have limited our inventory to the principal industrial sources known in the Amazon Basin.

Concerning use-related sources, Mn ore mining activities taking place as open pits (for instance in the Serra do Navio, Amapa State), represent a potentially source of associated ferrous metals (such as Ni, Cr, Cu, As...). Wind dispersal of material from unstable spoil heaps can result in local or regional atmospheric contamination. Currently, the manufacture and disposal of trace metals-containing products (e.g. battery production in the industrial district of Manaus) are also a source of metals.

Concerning the inadvertent discharges, a source of metallic contamination in the studied region comes from the residual oil combustion using for electric utilities and fluvial and terrestrial transportation. Using the selected emission factors (Nriagu and Pacyna, 1988; Nriagu, 1989), the electric-power production installed in the Amazonian states and the fuel consumption using for transportation (Ministério de Minas e Energia, 1995), the emissions of trace elements from fossil fuel burning have been estimated. Another important sources of metals in the Amazonian atmosphere, is due to forest burning. Based on the past 10 years-deforestation rates , this inventory suggests that forest fires will be the far more major source of Cr, Cu, Mn, Ni, Pb, V, As, and Zn, released annually to the atmosphere from anthropogenic sources. Fuel burning source account for less than 1 % of the trace element emissions, except for V (10%).

In order to compare the magnitude of anthropogenic transport of trace metals to the Amazonian atmosphere and the riverine fluxes from the Amazon system to the Atlantic Ocean, we computed the amount of trace elements as particulate and dissolved forms transported at Óbidos, using the systematic relationships obtained between dissolved trace elements and discharge. A comparison of these values with those termed as the anthropogenic sources suggests that industrial emissions of trace metals exceed the total flux from Amazon River by factors of 10-30 for Mn and Cu, 1-15 for V, 0-50 for As, and 30-90 for Ni. Antropogenic discharges, essentially due to forest fires, are apparently exercising a profound influence on the global scale-fluxes of these trace metals. Thus, it seems, even in the Amazon basin, that manking has become the key agent in the global biogeochemical cycles of trace elements.

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