

# Conceptual model of mercury transfer to the food chain

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The conceptual model is an indispensable tool, it summarises the understanding of the system and allows to consider management solutions.

In French Guiana, a "generic" conceptual model for the functioning of the mercury cycle has been developed. It shows the importance and the necessity to adapt the model to the local hydrogeological and exploitation context.

The conceptual diagram (see figure below) makes it possible to visualize, on the one hand, the sources of pollution, on the other hand the mechanisms of mercury transfer in the environments and the location of the methylation zones to specify the exposures.

Potential sources of inorganic mercury directly related to soils and sediments are both natural (litter, sediments and colloids) and anthropogenic (mercury of historical and current anthropogenic origin and release of natural mercury).

Potential zones of methylation have been represented: i) tailing ponds are the first stage of methylation in connection with gold extraction, ii) sediments in creeks (with methylation phenomena, resuspension, etc.), iii) deposit zones such as flats, and iv) other areas flooded during the rainy season and finally v) the jumping zone.

This approach is at this stage purely qualitative because it is difficult to quantify all these processes, probably seasonal, because of the small number of analyzes of the various species of mercury available to date. It should be noted the influence of anoxic zones (flood plains, marshes, etc.) in the methylation both for the gold-peeled and non-peeled zones.

The regime of rivers is directly related to rainfall and is characterized by two distinct phases: a period of high water, usually between January and July, and a period of low water, between August and December (Richard, 1996). The rainy season or high water period is characterized by significant inputs of organic matter from erosion and runoff processes in the thick rainforest equatorial rainforest (Horeau 1996, Richard 1996). During this period, many areas are submerged on the edge of rivers (flood zones) and are a favorable site for the nutritional needs of aquatic species, but also for their reproduction. Guimarães et al. (2000) and Roulet et al. (2000) have shown that floodplains, particularly important in the Brazilian Amazon, constitute a preferred mercury methylation site.

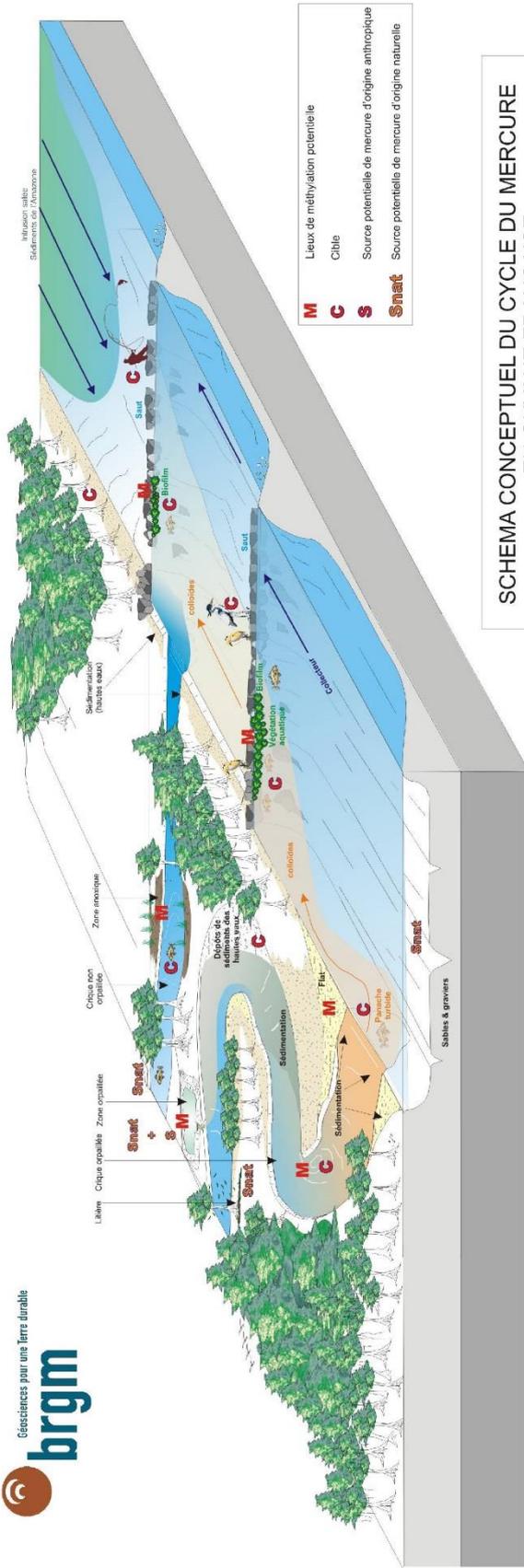
The jumps on rivers are one of the few places where a large aquatic vegetation develops. The strong oxygenation of these turbulent zones favors the installation of a particular family of plants adapted to these conditions of strong currents: kumaru salad (family Podostemaceae). These very original plants are indispensable to a diversified fauna both as a source of food, as a refuge and a nursery, especially for invertebrate larvae and young fish.

In some cases, jumps may be a preferential medium for sedimentation of particles.

In the creeks, where gold exploitation takes place, the accumulation of the sediments can be very important at the bottom and on the wall of the creeks. In some cases the initial course of the creek is so obstructed that during the rainy season an alternative route is set up which also joins the collector downstream. In non-exploited creeks, sedimentation is low to none because of their vegetative cover, the current-driven hunting effect and the turbulence related to jumps and rock bars except for terraces and areas where the vegetation is able to trap sediments. The majority of sedimentation observed in rivers is sandy with little or no fine particles (washed sands!). In rivers, the transport of mercury is mainly through colloids that have the ability to contaminate plants and biofilms present in particular on rocks.

The importance of bio-films, especially on substrates such as rocks, is now established by different authors and in particular in Dominique's thesis (2006). *H. aimara* reflects the evolution of MMHg biomagnification through its position at the top of food webs; *C. cyprinoides* reflects the preponderant role of biofilms in the downstream zone as a compartment at the base of benthic food chains capable of storing mercury, methylating Hg (II) and transferring it to predatory organisms.

Some species of fish will move more or less in their environment. The exposure of the organisms is dependent on their mobility and according to the seasons. Some species of fish will move more or less in their environment. During low water, some fish such as herbivorous serrasalmidae are attracted to aquatic plants growing in jumps or on exposed rocks (podostemaceae or herbs at Kumaru). In the high water season, fish enter the creeks to come and breed there. The Aymaras seem to go there at once to reproduce, but especially to follow the forage fish. The juveniles of aimaras find there a zone of magnification because of the presence of numerous aquatic invertebrates. Juveniles and adults of herbivorous serrasalmidae (Siba kumalu, agouéti and mabe) and omnivores also feed in the flooded areas that adjoin the creeks during high water. They feed on fruits, flowers and fallen leaves of trees.



SCHEMA CONCEPTUEL DU CYCLE DU MERCURE  
 EN GUYANE FRANCAISE

Conceptual model of the mercury cycle in French Guiana

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