Are POPs a threat to the aquatic alpine ecosystems?

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Abstract

Many international and national projects like IPCC (Intergovernmental Panel on Climate Change), AMAP (Artic Monitoring Program), ACIA (Artic Climatic Impact Assessment) and RICLIC WARM (Regional Impact of Climatic Change in Lombardy Water: Resources and Modelling) highlight the relevance of contaminant effects in higher latitude/altitude systems.

To investigate fate and effect of persistent organic pollutants (POPs) accumulated in Alpine glaciers for the cold condenser effect and released trough ice melting, the glacial-fed stream Frodolfo (Italian Alps) was sampled during summer 2006, when ice and snow melting produces a significant increase of stream water flow. The sampling was conducted monthly, from May to October, in four sites up to 2 km from the glacier lobe. In the same geographic area, a non-glacial stream was sampled in order to evaluate possible differences in POP concentrations as a function of water origin.

Water, sediment and biological (macro-invertebrates) samples were collected in both environments. In the sampling station closest to the glacier, POP concentrations were investigated as a function of the daily temperature cycle.

All abiotic and biotic samples, added with a suitable recovery standard and internal standard, were analyzed in GC-MS in Single Ion Monitoring mode. The investigated molecules were 37 PCBs, DDTs (isomers and metabolites), HCHs (α-, γ-, β- isomers) and HCB. Prior to chemical analyses, macro-invertebrates were taxonomically identified and grouped according to their trophic role.

Major objectives of the study are:

- determining the contamination fingerprint in streams of different origin (glacial fed and non glacial fed) and subject to different exposure patterns in Italian Alps;
- evaluating the possible presence of a seasonal pattern in POP contamination, in order to assess the intensity of the pollutants stress for aquatic ecosystem in a seasonal cycle;
- analysing the relationship between distance from the glacier and POP contamination;
- determining a relationship between daily temperature cycle and concentration of POPs in melting water;
- assessing the potential transfer in the trophic chain and the level of risk for Alpine freshwater ecosystems exposed to POPs.

The results for pesticides like DDT, HCH and HCB, in water and sediment, were in the range of literature data for pristine areas (Villa et al., 2006, Blais et al., 2001a, 2001b; Lafrenière et. al, 2006). Concentration of selected PCBs were higher than the literature data on comparable systems, but in the same order of magnitude of data reported by Villa et al. (2001) for recent ice of Stelvio glacier, located in the same area of Frodolfo. In

both cases the fingerprint was those of the technical Aroclor mixture, supporting the hypothesis of a local recent contamination.

POP contamination in glacial-fed stream during summer 2006 seems to be subject to two different inputs and sources of pollutants; in early summer (May-June) contamination seems more affected by snow melting and reflects the present atmospheric condition; in late summer (July - October) the contamination seems mainly due to glacial ice melting and the fingerprint reflects old and long range transport.

In detail, at the beginning of the melting season (May), the preferential elution of HCHs (dominated by lindane) was observed in the first snowmeltwater fractions. In this period, PCBs and HCB are retained in the snowpack. This behaviour is reported also by Semkin (1996) for a small creek in the Amituk Lake region on Cornwallis Island (Canadian High Arctic). This dynamic has been supported by modelling prediction (Wania et al., 1999) and explained mainly by snow characteristics and the air-ice and air-water partition coefficients of the chemical, which controls the timing of chemical release in the meltwater.

In the middle-late summer (late July to September) contamination is dominated by HCH (mainly the alfa isomer) and p,p'-DDE.

Less evident are patterns during the daily cycle. POP concentrations show some variability, however, a regular daily trend is not apparent, since the concentrations are not significantly correlated with water temperature. Moreover, the distance from the glacier seems not to influence the POP content in the water; this is probably due to the relative short distance between the glacier and the sampling sites.

In the macro-invertebrate community, evidences of bioaccumulation are measured. In non-predator macro-invertebrates major patterns are bioconcentration processes, driven by physical chemical properties of the molecules and environmental concentrations. On the contrary, data on predators macro-invertebrates seem to suggest that a slight effect of biomagnification can occur, although the trophic chain analyzed is very short.

As pointed out by Wania (1999), the dynamics of contaminant release may be of crucial ecotoxicological importance, because they determine the occurrence, timing and magnitude of a potential pulse exposure in aquatic systems during early spring, a period when biological activity is starting and the life stages of some organisms may be particularly vulnerable to contaminants.

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