

# ASSESSMENT OF ARD EFFECTS ON RIVER ECOSYSTEM USING BENTHIC AQUATIC MACROINVERTEBRATES (MARINDUQUE ISLAND, PHILIPPINES)<sup>1</sup>

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**Abstract.** The benthic macroinvertebrate community in the Boac River (Marinduque Island) is controlled by the dissolved copper concentration from the acid rock drainage originating from the Marcopper Mine. A four-year survey shows how the benthic community composition responds to the prevailing Cu concentration in the water. The point of first macroinvertebrate occurrence, species richness, and metal bioaccumulation data all correlate well with Cu concentration. Continuing this biomonitoring protocol may be advantageous in terms of determining water quality trends and how remediation efforts in the Boac River may be assessed.

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## Introduction

Acid rock drainage (ARD) flows out of the Marcopper Mine through the 195 tunnel which drains into the 27-km long Boac-Makulapnit River (Fig. 1). The Marcopper Mine ARD is characteristically acidic (<4) and has high dissolved Cu concentrations (~20 mg/L). In 2002, a second ARD source ensued, this time through the Bol River, entering the Boac-Makulapnit River 4 km downstream from the mine (Futures, 2004). Due to continuous dilution and interaction with bed sediments, dissolved Cu levels decrease downstream (Fig. 2). At the most downstream stations, dissolved Cu levels reach 0.01 mg/L which is comparable to levels found in uncontaminated rivers around the island. The main sources of uncontaminated water come from Upstream Makulapnit River and Upstream Boac River.

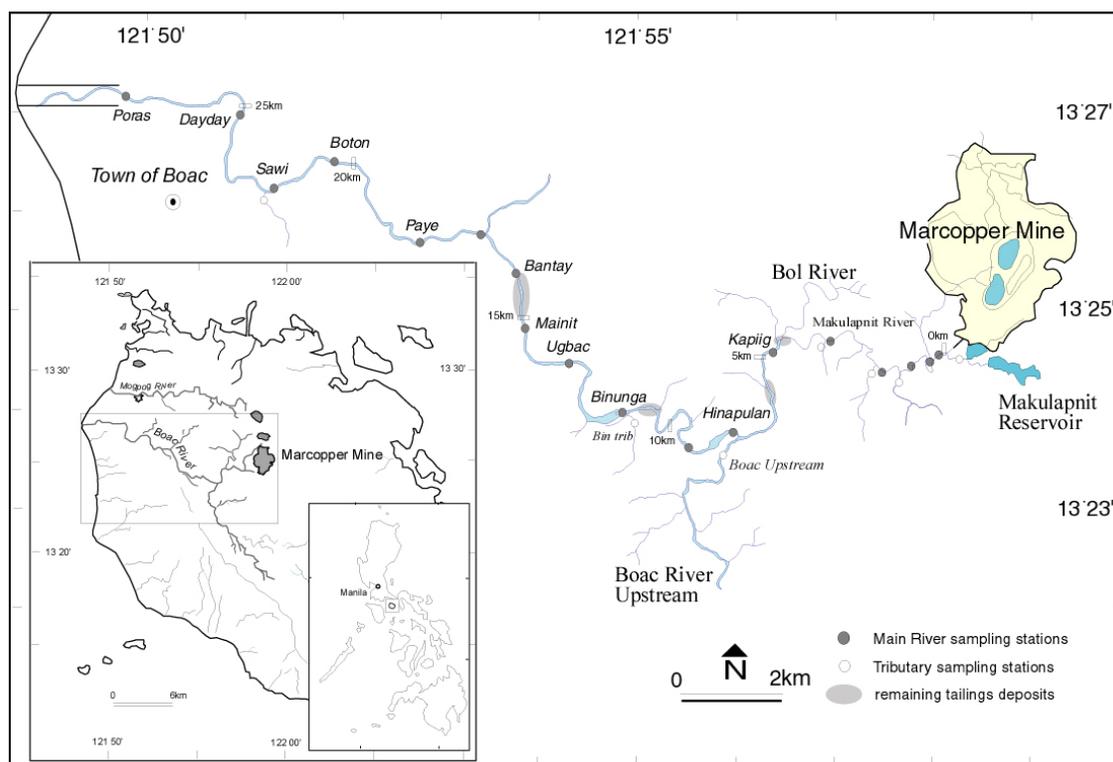


Figure 1. Location of sampling sites along the Boac-Makulapnit River.

Sampling of the Boac-Makulapnit River surface water was done on 5 occasions from 2001 to 2004. Dissolved metal concentrations were determined through either inductively coupled plasma atomic emission spectrometry (ICP-AES) or mass spectrometry (ICP-MS). The organisms sampled are benthic macroinvertebrates which are mostly the larval stages of insects. Benthic sampling was done using a 0.5mm mesh kicknet. All biologic samples were preserved in a formaldehyde-ethanol mixture prior to identification. In most cases, taxonomic identification can only be done down to the family level due to the incomplete index for identifying the larval stages of Philippine species.

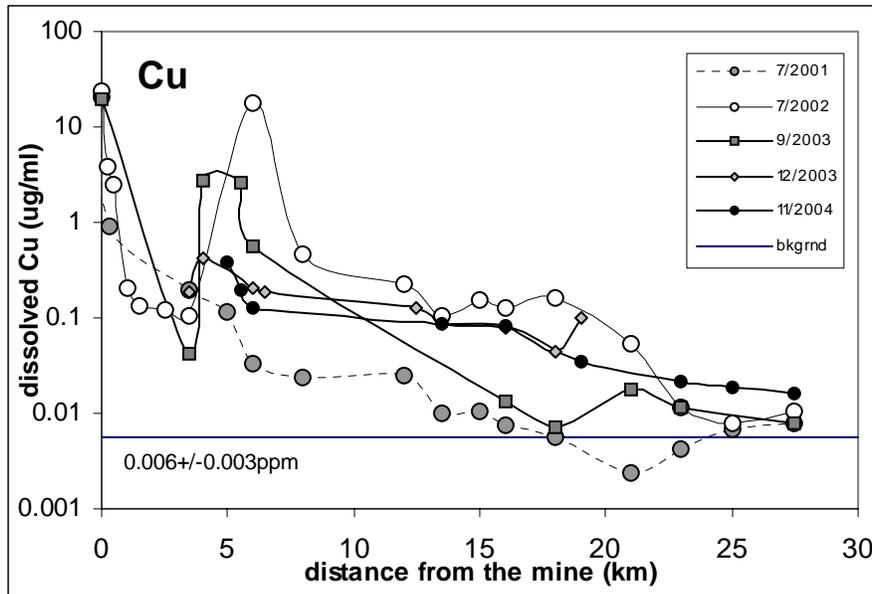


Figure 2. Dissolved Cu concentration trends in the Boac-Makulapnit River from 2001-2004.

### Results and Discussion

The geochemistry of the river water, particularly the dissolved Cu concentration, bears on the character of the benthic community observed. The first parameter used is the determination of the point of first benthic organism occurrence along the river. In 2001, organisms (belonging to the Order Trichoptera) were first observed in the town of Kapiig, 4 kilometers away from the 195 tunnel. In succeeding years when a new source of ARD commenced through the Bol River, insect occurrence has retracted to 11-14km away from the tunnel. In all occasions, the first benthic organism occurrence roughly corresponded to 0.10 mg/L dissolved Cu (David, 2003).

The second metric used to establish the relationship between water quality and the biologic community is species richness. Orders Trichoptera (caddisflies) and Ephemeroptera (mayflies) were given attention as more than 90% of the benthic communities sampled belong to species in these two Orders. In all stations along the Boac-Makulapnit River only one species of mayflies (belonging to the Family Baetidae) was observed. Upstream stations near the ARD source also typically have only 1 species of caddisflies but midstream and downstream stations show 1-2 and 2-4 caddisfly species, respectively (Fig. 3).

The impact of Cu contamination to its benthic community in the Boac-Makulapnit River becomes even more evident when compared to what is observed in uncontaminated sites. Sites such as the Upstream Makulapnit and Upstream Boac Rivers typically show 4-7 caddisfly species and 2-4 mayfly species. Furthermore, sensitive species belonging to Philopotamidae and Heptageniidae are only found in these stations.

Lastly, bioaccumulation studies also show the same trends wherein trichoptera species from upstream stations consistently show higher Cu accumulation compared to those found in the midstream and downstream stations. Copper bioaccumulation reaches to >1000  $\mu\text{g/g}$ . Samples from downstream stations show 200-300 $\mu\text{g/g}$ . In uncontaminated sites, Cu bioaccumulation in trichoptera is typically <100  $\mu\text{g/g}$  (David, 2003).

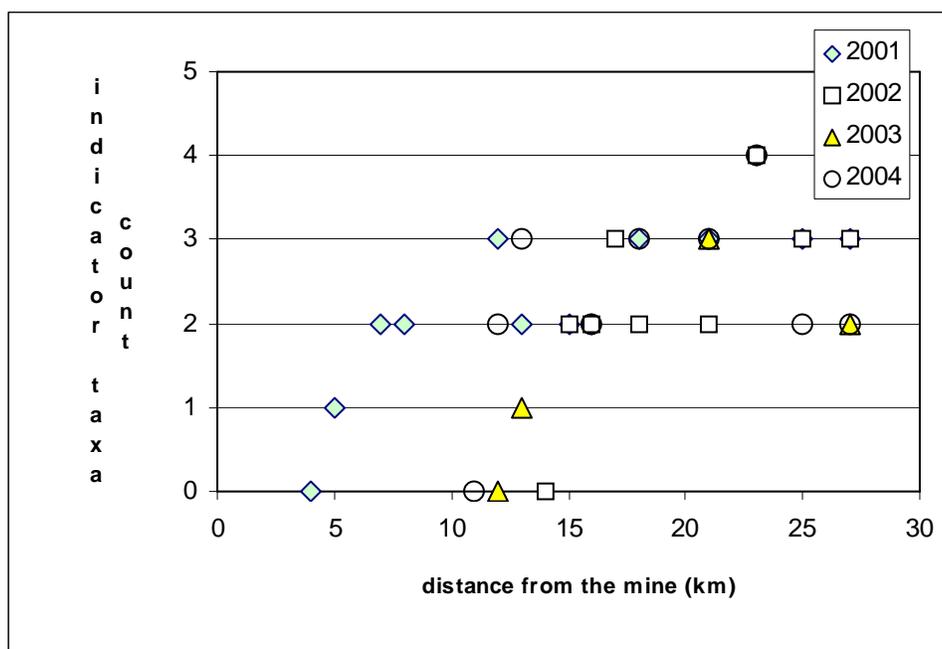


Figure 3. Indicator taxa count (Trichoptera sp.) shows an increase downstream. The point of first insect occurrence is as follows: 4km (2001), 14km (2002), 12km (2003), and 11km (2004).

### Acknowledgements

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