Effects of catchment features and mining disturbances on river alluvial aquifers of New Caledonia

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Résumé

The idea that rivers are strongly influenced by their catchment's features was already central to Hynes's eloquent plea (1975) that 'In every respect, the valley rules the stream'. Since then, Hynes' intuition has become a guiding tenet in freshwater ecology, especially when it comes to understand how catchment disturbances may in turn affect the functioning of rivers. In the present study, we examine the effects of catchment features and mining activity on river alluvial aquifers of New Caledonia. Ultramafic catchments, which form over peridotite rocks, differ markedly from non-ultramafic catchments in that they have nutrient-poor and metal-rich soils sustaining low-productivity vegetation. Mining extraction of nickel occurs only on ultramafic catchments. We made three predictions. First, ultramafic and non-ultramatic alluvial sediments would exhibit low and high respiratory activity, respectively. Second, invertebrate communities of ultramafic and non-ultramatic alluvial sediments would respectively be dominated by slow- and fast-growing taxa, respectively. Third, mining activity would further decrease the respiratory activity of ultramafic alluvial sediments and further increase the proportion of slow-growing taxa within their communities.We tested these predictions using a field experiment dataset and a biodiversity inventory dataset. In the field experiment, we sampled water, sediment and invertebrate communities at 15 sites equally distributed among three treatments corresponding to non-ultramafic, non-mining ultramafic, and mining ultramafic catchments. We measured surrogates of respiratory activity including dissolved oxygen, sediment oxygen consumption, enzymatic activities and C and N concentrations in particulate and sedimentary organic matter, and we sampled invertebrate communities. In the inventory, we sampled water and invertebrates at 228 sites distributed all over New Caledonia and measured dissolved oxygen, pH and specific conductance of alluvial groundwater. For each site, we quantified the areal proportion of ultramafic rocks

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and mining areas.For the two data sets, we found clear evidence that the particular organic matter content, quality of sedimentary organic matter, and respiratory activity of sediment decreased with increasing areal proportion of ultramafic rocks in a catchment (prediction 1). We found support for prediction 2 that the proportion of slow-growing taxa in invertebrate communities increased with increasing areal proportion of ultramafic rocks. Prediction 3, that mining activity accentuated the natural imprint of ultramafic catchments on respiratory activity and community composition, was either rejected by the two datasets or partially accepted by only one of the two datasets.

Mots-Clés: Alluvial aquifers, New, Caledonia, Catchment, Disturbance, Ecosystem functioning, Biodiversity