

# **HYPORHEIC FLOWS IN MOUNTAIN STREAMS: HIERARCHY, HYDRAULICS AND NITROGEN CYCLE**

**Daniele Tonina**

## **Abstract**

The hyporheic zone is a saturated band of sediment that surrounds river flow and forms a linkage between the river and the aquifer. It is a rich ecotone where benthic, hyporheic, and groundwater species temporarily or permanently reside. The interaction between the stream and its surrounding saturated streambed sediment has a profound impact on fluvial ecosystems. Bed forms cause near bed pressure gradients that induce a complex flow pattern within the streambed sediment. This process, known as hyporheic exchange, is important for delivering nutrients, oxygen and other solutes to the sediment, and for washing away waste products to support this ecotone. Here, we first present a simple mathematical framework for examining the mechanics of hyporheic exchange. Then, we apply this approach to describe the systematic variations of hyporheic exchange with channel types and associated fluvial processes that occur in mountain basins. Successively, we describe a novel three-dimensional analytical model for predicting hyporheic flow in gravel bed rivers with pool-riffle bed form. Finally, we apply the model to predict the role of hyporheic flow in the emissions of nitrous oxide, an important greenhouse gas from riverine systems.