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Transport model at basin scales: a theoretical framework

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In this contribution, we address a theoretical framework for continuous geomorphic models of the hydrologic response, specifically aimed at coupling hydrologic processes with the catchment-scale generation and transport of solutes. The approach orders theoretical results appeared in disparate fields into a coherent framework where the mobilization of solutes from soil is assumed to be controlled by the residence time of the carrier hydrologic flow. Following a well-mixed approximation appropriate in cases (like basin-scale transport phenomena) when the characteristic size of the injection area is larger than that of heterogeneous features, the spatial gradients of the solute concentration within the hillslopes (where the solute generation occurs) are here neglected. As a result we define general mass-response functions of catchments, which extend to transport of reactive solutes geomorphologic theories of the hydrologic response. The framework proposed provides an operational tool for describing large-scale transport phenomena driven by spatially distributed hydrologic fields (e.g., rainfall patterns in space and time, drainage pathways, soil textures and uses, heterogeneous distributions of solutes dissolved in the soil moisture and thus prone to hydrologic leaching). A sample application to the case of the nitrate leaching through the hydrologic response in a mixed catchment located in Northern Italy is also addressed, showing the robustness and the flexibility of the approach developed.