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Evaluating the Spatial Performance of WaTEM/SEDEM Using Multi-Source Datasets Across Scales

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Soil erosion by water poses a critical threat to global soil resources, with increasingly severe impacts under changing climate conditions. To implement specific soil conservation measures, it is essential to accurately identify areas of erosion and deposition within a landscape. However, soil erosion models are often calibrated solely against sediment yield at catchment outlets. This approach creates uncertainty regarding the model's ability to represent internal redistribution processes and amplifies the equifinality problem, as outlet data aggregates complex spatial dynamics into a single value. In our study, we evaluate the performance of the spatially distributed soil erosion and sediment delivery model WaTEM/SEDEM by utilising data at varying spatiotemporal resolutions. Our goal is to validate the model's ability to simulate internal soil redistribution, rather than just total sediment yield at the outlet. We focused on a mesoscale catchment in Southern Germany (405 km²) and utilised high-resolution orthophotos (2011–2012), expert-validated erosion and deposition classification, as well as sediment delivery data. Our evaluation follows a three-step approach: (1) We compared model simulations against visually detected erosion classes at the field scale for single events; (2) We analysed depositional patterns in grasslands, located downslope of erosion-affected arable fields, against mapped deposition polygons for the same events; and (3) We followed the traditional approach, assessing model performance at the catchment scale by comparing simulated results with observed sediment loads at the outlet. This methodology enables a detailed assessment of how effectively WaTEM/SEDEM captures field-scale erosion as well as landscape-scale sediment connectivity and sediment routing. Our findings highlight specific sources of model uncertainty and demonstrate the importance of spatially distributed multi-step validation. These insights are crucial for improving sediment redistribution models and supporting sustainable land management practices in complex agricultural landscapes.