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Semi-arid runoff and soil erosion processes and models

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Runoff in semi-arid areas is generated largely by Hortonian infiltration excess mechanisms, with the possibility of saturation excess only seasonally or in exceptional wet periods. Conditions for local runoff generation can be estimated from a runoff threshold or storage-based infiltration equation, and identified with Hydrologically Similar Surfaces (HYSS) defined primarily by land use/cover and soil properties, although uncultivated areas commonly show wide variations in infiltration capacity associated with vegetation patterns. Overland flow discharge accumulates during bursts of intense rainfall that generate local overland flow runoff, and along pathways where the infiltration capacity is continuously exceeded. After intense bursts, water re-infiltrates, limiting the distance over which flow accumulates, with generally longer distances in larger storms. In a given storm, discharge initially increases linearly, and then more slowly until a plateau is reached. Over the frequency distribution of storms however, average discharge does increase downslope, but more and more slowly over longer distances.

Sediment transport, which behaves roughly as discharge squared, reflects this slow increase, influencing the point at which unstable channel incision can occur through the predominance of wash incision over splash deposition. Where infiltration is low, as in badlands, channels can form close to the divide, within the zone of linearly increasing discharge. Where infiltration is high on coarse-textured soils, channel formation is limited by the slow increase in overland discharge, accentuating contrasts in drainage density, and channels can generally form only in the most extreme events. These processes can be incorporated into models at a range of scales, both to map average erosion rates at regional scales, and to compare with hillslope profiles and drainage textures.