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The role of groundwater sapping in the initiation and development of a river drainage system (postglacial area in NW Poland, the Parsęta basin)

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The ways of initiating a valley and river channel are closely related to the nature of water circulation in the slope system. A crucial morphogenetic factor in this development is groundwater. Seepage erosion is a process of combined mechanical and chemical action leading to the loosening, tearing off and carrying away of material from the zone of groundwater exfiltration. As a result of seepage erosion, around a groundwater outflow there develops a spring-head alcove, which often becomes the beginning of a river valley. Spring erosion has a significant share in the development of valley forms and river network in the areas covered by the last glaciation on the Polish Plain.
Based on the conducted crenological mapping and geomorphological studies of the valley heads and river channel heads initiated by groundwater outflows in the postglacial area in NW Poland (the Parsęta basin), the presence of morphological features characteristic of the erosive impact of groundwater outflows was found. In the analysed spring-head alcoves, the occurrence of geomorphological processes was recognised, such as seepage erosion, mass movement, wash, geochemical and biogenic processes, as well as human impact. Most of the processes as mentioned above are or can be generated with the participation of groundwater flows, and their intensity is regulated by external factors, such as the size of precipitation, snow cover and icing, biosphere impact, as well as increasing human interference in the spring areas. The dominating share of outflowing groundwater in the development of spring-head alcoves means that in moderate climate their development is determined by secular processes of spring erosion and fluvial transport, with episodic mass movements.
In the investigated area of the Parsęta basin, river channels originating in spring-head alcoves have a small surface area of the topographic basin. These mostly short first-order watercourses connect with the main streams, which results in a large number of watercourses flowing directly into the watercourses higher by several orders. Groups of small valleys initiated by groundwater outflows are either morphologically conditioned or involve the occurrence of groundwater discharge lines located at the contact of geomorphological units with diversified geological structure. Lower-rank network systems are sub-consistent to the main directions of the valleys conditioned by the structure and postglacial topography
The analysed spring-head alcoves in the postglacial area have a twofold contribution to the development of the river system. This development can take place in two directions:
1. from the watershed towards the higher order valley (downward growth),
2. from the higher-order valley towards the watershed (upward growth).
The share of spring erosion in the formation of river valleys is a current research problem because the terrain recognition of the relief-forming effects of groundwater outflows and their interaction with other morphogenetic processes is insufficient. The indicated directions of the valley and river network evolution with the participation of spring erosion require confirmation by conducting further experimental and model studies.