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Drainage and Slope Relationships of the Punjab Haryana Alluvial Plains, North West Himalayas

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Drainage networks have the potential to record evidence of tectonically driven landform evolution through time. Drainages and their patterns of an area evolve with the growth of topography and structures and change according to the variation of the regional slope. In the vicinity of the tectonically active Himalayan Frontal Thrust, a link between the growing topography and the drainage could be observed. The outermost Siwalik hills – the youngest topography of the Himalaya – resulted in the development of several modern-day streams, which are tributaries of the antecedent streams. The present study investigates one such area in the NW Himalaya, where the Sutlej and the Ghaggar rivers are the antecedent streams and several young streams originating in the Outermost Siwalik Hills form their tributaries in the Punjab Haryana Plains of north India. These drainage patterns are analyzed using statistical and vector analysis to characterize their link with the regional slope. The drainage vectors are based on the network element, which is defined by the straight line joining the two bounding junctions and the direction is measured with respect to the north towards downstream. Around 600 drainage vectors including paleochannels, modeled flow vectors generated from the 30m Digital Elevation Model (ASTER), and the present day drainages digitized from satellite imagery and topographic maps are investigated. More than 9000 slope vectors were accounted for slope analysis. Drainages flowing from the Outermost Siwalik Hills into the plains can be divided into two domains of west flowing and south-west/south flowing drainages separated by an interfluve domain where there is nil or minimum flow. However, the overall regional slope in the study area indicates a downslope direction towards south west. This interesting phenomenon of slope deviatory drainages, as well as the slope parallel drainages, has been further investigated based on the concept of Stream Orientation structures (Jarvis, 1976). The comparison of the slopes against the stream channel orientation patterns is distributed in a pattern indicating that a stream orientation structure (forcing) is present. The results show that the present-day drainage networks and their directivity vary from the paleo-drainage networks or modeled flow patterns. Such similarities or deviation in the directivity of the drainages in comparison to the regional slopes can be answered in its drainage evolution model. It is concluded that the slope deviatory drainages are controlled by their competence as well as several young lineaments in the adjacent plains which are in turn governed by the interplay of climate and tectonics.