13 Quantitative Geomorphology in Neotectonics Interpretation

S. Sinha-Roy, Birla Institute of Scientific Research, Jaipur,
E-mail ssinharoyQ@yahoo.com

Geomorphology is concerned primarily with generating knowledge about the terrestrial surface of the earth. The current debate concerning the status of geomorphology as a science in terms of theory and methodology reflects a conflict between research rooted in geology and physical geography and an emerging approach dealing directly with scientific principles of physics, chemistry and mathematics. This debate started with the concept of "Geographic Cycles" by Davis (1840) and the subsequent challenge of the concept by Penk (1845) and Gilbert (1918) as the dominant overarching concept of landform development. Over the years, the paradigm of dynamic equilibrium advanced by Hack (1960) and process-based geomorphology became very influential. Although some geomorphologists claim that the recent conceptual changes have been essentially incremental, it seems that there has been a revolution in geomorphologic science over three decades that brought in new postulates or axioms, and also new theories centered on the study of contemporary processes, a topic neglected by the Davisian school. The abandonment of the Davisian model of landscape evolution and denudation chronology in favour of process-based approach has imparted a change in the mode of scientific explanations sought through geomorphologic studies.

It is now reasonable to characterize geomorphology as a robust scientific discipline embracing the principles of basic sciences and numerical modelling. There is growing conflict between researchers focusing on development of individual landscape as a form and those seeking general principles governing landscape dynamics. The concept of process-response system in geomorphologic research was heralded by the introduction of quantification of geomorphic parameters and by the adoption of statistical analysis techniques. The new quantitative geomorphology is concerned with the elucidation of the relevant geomorphologic processes that shape the earth's surface and with the rates at which these processes operate. This has led to a new concept, namely, Earth-Surface Science, that is gradually replacing geomorphology as an interdisciplinary science. As a result, in recent years an explosion of research has taken place in geomorphology involving non-linear dynamics with complex inter-relations between and within geomorphic system or Earth-Surface system. The adoption of a systems approach has provided an overall structure within which geomorphologic models can be formulated. In dynamic geomorphologic systems Newtonian mechanics and thermodynamics promoted the idea of entropy maximization, equilibrium and open systems.

One of the important applications of quantitative geomorphology has been in the understanding of Neogene crustal deformation or neotectonics giving rise to the methods of tectonic geomorphology dealing with the relationships between tectonics and landform development at different spatial and temporal scales. Morphometric parameters (geomorphic indices) used in tectonic geomorphologic interpretations include hypsometric variables, characteristics of river morphometry including gradients, nature of river valley networks and valley profiles, morphology of land slopes and mountain fronts, formation of tectonic basins etc. The interpretation of these characteristics is based on the fact that vertical and horizontal tectonic movements cause elevation changes and landform dislocations, thereby changing hypsometric parameters and drainage systems, and alter the ground slope and stream gradients thereby changing drainage morphometry.

Based on geomorphic indices, DEM and remote sensing data it is now possible to delineate neotectonic structures and work out the kinematics of neotectonic deformation, including the reactivation pattern of older structures.

The importance and application of quantitative geomorphology in understanding the characteristics of neotectonic reactivation of older dislocation zones is highlighted from an example in the Precambrian terrain in Rajasthan.

The Sahyadri (Western Ghats) constitutes tectonic escarpments that have protracted evolution history related to the development of the passive western continental margin of India. The feature of plateau uplift and scarp retreat at different spatial and temporal scales, including the eastward tilt of the peninsula are problematic and debated, and hence, offer scope to apply quantitative geomorphologic methods to resolve them. This would call for integrated multidisciplinary study progammes that can be initiated by the National Centre for Earth Science Studies, Trivandrum.