Preface

In the present time, our natural environment is frequently associated with a number of destructive hazards such as flood, earthquake, storm surge, drought, landslide, volcanic eruption, etc., worldwide. All these environmental problems may bring about a tremendous change in the geomorphic system over the land surface and may also divide a system into a number of subsystems. It is the task of Physical Geographers to study natural hazards and their destructive impacts over the earth's surface in a scientific way. Here, we studied in detail geologic, geomorphic, and hydrologic processes responsible for landslides in a representative mountain watershed, Shivkhola of Darjiling Himalaya, where landslides are very much active and have destroyed communication lines, settlements, and tea estates. A quantitative understanding of all the triggering landslide inducing parameters can provide a clear vision of the changes and evolution of landforms. The aim of this book is to provide an integrated knowledge and understanding of the application of semi-quantitative approaches in evaluating various landslide triggering factors and assessment of landslide susceptibility as well as landslide risk, which can help planners and policymakers to check the magnitude of landsliding in mountain terrains.

The concerned area, Shivkhola, is badly affected by slope instability jeopardizing the economy and social systems; taking a toll of lives, lands, and properties; promoting road blockage and hampering flow of tourists; destroying pipelines of water; and causing subsidence of road and rail cut benches. The effects are conveyed over a long distance, both upslope and downslope, by disruption of transport and hydrological systems and thus invites instability into both physical and social systems. Most landslides of this trouble-torn district of Darjiling are concentrated in this area where most of the torrential jhoras (Hill Streams) at their upper catchments develop a potential sinking zone, and the Hill Cart Road and Narrow gauge Rail when traversing through these zones invite catastrophic slides. The present work tries to identify the zones of potential slides by investigating into the systematic interaction among the number of prominent physical and human triggering factors.

The geotechnical attributes, viz., major principal stress, minor principal stress, normal stress, shear stress, angle of internal friction, angle of rupture, cohesion,

shear strength, and safety factor of the Shivkhola watershed have been determined using the Tri-axial Compression Test from the geotechnical laboratory, Geological Survey of India (Kolkata). There is every possibility for the generation of geomorphic thresholds for initiation of slides due to hydrologic factors. Thus debris slide occurs and the slope on scar face is reduced to that of repose angle to attain temporary stability through internal feed back in a process of homeostatic adjustment. Remote Sensing and GIS-based Landslide Susceptibility Zone Map reveals that Paglajhora, Shiviter, Gayabaria, and Tindharia are more susceptible in terms of slope instability. The prepared Landslide Hazard Risk Map also states that Tindharia, Gayabari, Shiviter, and Paglajhora are prone to landslide risk because of prevalence of risk elements such as road network and settlements. As most landslides occur along Hill Cart Road (NH-55), and a huge amount is spent on Post Slide Management, an attempt toward pre-slide management of the susceptible areas has to be introduced with immediate effects with less efforts and investment. A sector-wise job assignment has to be made for regular supervision of the slope stability and a serious drive for pre-slide management of potential slope failure zones should be introduced; these should be considered as emergency as in post-slide condition. In such a highly instable region the protection of slope and soil is a great challenge through rational use of these resources for harnessing greater utility over a long time.

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