# QUANTIFICATION OF EROSION RATES AND EVOLUTION OF GEOMORPHOLOGY IN THE HIGHLANDS OF SRI LANKA

A PROJECT REPORT PRESENTED BY
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To the Board of Study in Earth Sciences of the
**POSTGRADUATE INSTITUTE OF SCIENCE**

*In partial fulfilment of the requirements*
*for the award of the degree of*

**MASTER OF PHILOSOPHY**

of the

**UNIVERSITY OF PERADENIYA**
**SRI LANKA**
**2010**

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## ABSTRACT

Erosion is a natural and geomorphological process, which is mainly driven by climate and tectonic forces. However, due to the human activities, the rate of erosion has dramatically increased over the natural level especially in agricultural-based tropical countries. Several negative impacts are associated with the erosion. Thus, scientists have been paying more attention to control the elevated erosion through conservation practices. Therefore, identification of erosion hot spots and determination of efficiency of soil conservation measures is vital. Quantification of long-term erosion rate is also an important requirement to compare the short-term erosion rates considering long-term rate as natural benchmark level and useful for quantitatively measurements of geomorphological process. In this research, short-term erosion rate is estimated in plot scale using a novel technique. Further, short-term erosion rates in catchment scale were quantified while introducing an easy, low-cost but reliable river load gauging method. In addition, long-term erosion rates were quantified in the same area based on cosmogenic $^{10}Be$ nuclide concentrations in river sediments. The entire study was carried out at 8 tributaries of two large river basins (viz Walawe and Kalu river basins) in the tropical highlands of Sri Lanka. Previously measured long-term erosion rates of Upper Mahaweli Catchment were also used to discuss the long-term geomorphlogical processes in the Central Highland of Sri Lanka.

To quantify short-term erosion rate on plot scale, soil samples were collected randomly from top and sub-surface. The samples were subject to dry sieve analysis. Then the fine fraction loss was calculated by enumerating the retained percentages of fine fraction in the top soil samples and the sub-soil samples. Finally, the net soil loss was calculated based on area weighted soil loss and deposition rates. To quantify the short-term erosion rates in

catchment scale, surface water samples were collected by trained villagers on daily basis throughout a complete hydrological year from the 8 tributaries to estimate the suspended loads. Additionally, depth-integrated water samples were collected on monthly basis. Then a site-specific calibration graph was established between surface and depth-integrated suspended sediment concentrations. In addition, suspended sediment rating curves were constructed. Moreover, chemical erosion rates were measured in these tributaries using dissolved concentrations. To quantify the long-term erosion rates, sediment samples were collected from bed of the rivers of seventeen selected tributaries in the Walawe and Kalu river basins. Concentration of $^{10}Be$ cosmogenic nuclides was measured in quartz grains of the bed load sediment using AMS facility at the ETH. Zurich.

At plot scale, net sediment generation rate in the plot was calculated as 3304 t $km^{-2}$ $y^{-1}$. Short-term erosion rates estimated in catchment scale using river load gauging range from 180 to 240 t $km^{-2}$ $y^{-1}$ and from 390 to1250 t $km^{-2}$ $y^{-1}$ in Walawe and Kalu ganga river basins, respectively. Long-term erosion rates in these two basins are in a range of 44-190 t $km^{-2}$ $y^{-1}$ and 114-130 t $km^{-2}$ $y^{-1}$ for Walawe and Kalu ganga river basins, respectively. The resulted erosion rates in the two basins were analyzed and interpreted with geomorphological parameters and landslide distribution, which were derived using GIS.

This research presents a new method to measure soil erosion and deposition rates on plot scale. Gem mining is prominent in the Kalu ganga basin, which yields sediments at a rate higher than 3-10 times over the natural rates of sediment generation in the source regions. However, the short-term sediment yields and the long-term sediment generation rates in the Walawe ganga are nearly equal, implying that human interferences in the basin is negligible. It was identified that chemical erosion rate in the catchments are mainly controlled by extent of fresh rocks exposed to the environment via landslides. Tectonically passive tropical Central Highlands of Sri Lanka offer a range of cosmogenic nuclide derived erosion rates for diverse geomorphological settings. The existing geomorphology of the country has being developed through escarpment retreat process. The analyses of geomorphological parameters and cosmogenic nuclide derived erosion rates reveled that possible process of retreat is driven at the tip of the escarpment by rock falls and creek incision while base of the escarpment is prominently worn down by mass movements