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The evolution of supraglacial lakes, Ngozumpa Glacier, Khumbu Himal, Nepal

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Glacial lake outbursts can severely impact upon both the fragile mountain ecosystems and the often limited local economy. Within the Himalayas, the associated death toll is currently in the hundreds, with costs in the millions of dollars due to, loss of hydroelectric power stations, infrastructure and agricultural land. In recent years a series of supra glacial lakes have formed in the terminus region of the Ngozumpa Glacier, Khumbu Himal. A number of these lakes have begun to coalesce, contributing to a significant moraine dammed lake perched high above one of the most frequented parts of the Himalaya. Analysis of multi-temporal satellite imagery shows that the surface area of these lakes is rapidly increasing. The surrounding topography provides the potential for the formation of a lake around 10 km long and over 1 km wide. A key factor in assessing the stability of such lakes is an accurate estimate of the volume of water contained behind the moraine dam. While satellite data analysis has had some success in estimating the surface area of some of larger lakes and ponds, accurate measurement is difficult due to the highly variable topography and existence of steep ice cliffs. At present however, there is also no accurate estimation technique for lake depth, rendering volume estimates subject to large margins of error. Differential GPS surveys were carried out to map the perimeter of all the major lakes in the terminal region, giving accurate surface areas. This included the length and height of any adjacent ice cliffs. Sonar depth measurements were carried out in a grid over the frozen lake surfaces, interpolation of this data provides a continuous model of lake bathymetry. Initial analysis suggests that the lake volumes are significant with surface areas of at least 6 km2 and lake depths of over 20 metres. This data has been used in conjunction with measurements carried out in 1999, providing an estimate of recent growth rate. Hypotheses of the predominant processes involved in lake expansion can also be inferred from this analysis as well as a prediction of future evolution.