Summary

This thesis presents a detailed analysis of hydrological, morphological, and sediment transport dynamics within the proglacial area of the Rutor Glacier, Italy, aimed at understanding seasonal discharge variability, sediment transport patterns, and the physical functioning of proglacial deltas and a braided reach in a rapidly changing glacial environment. The study employs continuous hydrometric monitoring, targeted hydrological modeling, sediment transport measurements, and morphological analysis to capture distinct hydrological and sedimentary responses to climate-driven glacier retreat.

The initial focus is on hydrometric monitoring, utilizing four gauging stations to provide continuous water depth data for analyzing discharge patterns. Methods such as water depth sensing, Acoustic Doppler Velocimeters, and salt dilution enable the development of stage-discharge relationships for discharge time series reconstruction. Results reveal distinct diurnal and seasonal discharge cycles driven by glacier melt, with occasional disruptions from rainfall events. This hydrometric data serves as a foundation for estimating glacier ablation and provides a valuable proxy for glacier mass balance in regions where direct measurements are challenging.

The TOPMELT hydrological model, enhanced and integrated with the Unit Hydrograph (UH) approach, has been specifically adapted for the Rutor Glacier to simulate runoff dynamics during the ablation season. This refined modeling framework bridges distributed meltwater generation and runoff routing, enabling more precise discharge estimations and daily runoff pattern predictions. The integration not only captures the complex interactions of temperature, radiation, and precipitation on runoff but also addresses limitations of standalone models, offering a robust tool for understanding hydrological behavior in glacier-fed systems under evolving climatic conditions.

The research also examines five proglacial deltas and a braided reach using digital elevation models (DEMs) and high-resolution orthophotos to assess physical functionality. The assessment employs the Normalized Bed Relief Index (*BRI**), further normalized by slope and active width to account for their significant influence. This refined *BRI** methodology evaluates whether the systems are supply-limited or transport-limited, providing insights into sediment dynamics and clarifying the interplay between sediment supply and transport capacity in response to glacier retreat and changing hydrological conditions.

Finally, it also focuses on sediment transport, examining bedload and suspended sediment dynamics through seismic and turbidity-based methods. A network of geophones monitors real-time bedload movement, while turbidity sensor, calibrated against local sediment samples, estimate suspended sediment concentration (SSC) at Lake Seracchi. These measurements reveal pronounced temporal variability in sediment fluxes, correlating with peak melt events and discharge highs, offering a clearer picture of sediment transport in glacier-fed streams.

Overall, this thesis provides a comprehensive assessment of the hydrological, sedimentary, and morphological processes within the Rutor proglacial area, delivering critical data to support future research and management efforts in high-mountain alpine proglacial regions.