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# Hazards from dynamically changing glacial and periglacial environments: an overview of detection, modeling and assessment techniques

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Natural hazards from glacial and periglacial environments frequently affect populated high mountain regions. Hundreds or even thousands of lives can be lost in catastrophes related to glaciers. Densely populated mountain regions such as the Alps are particularly affected but also more remote areas such as the Andes or the Himalayas are vulnerable to high-magnitude events. Ongoing atmospheric warming driving increased rates of dynamic change in glacial and periglacial environments and growing human activities in mountain areas are two important components which govern the risk posed by such hazards. Glacial lake outbursts in connection with strongly retreating glaciers, debris flows from steep slopes of unconsolidated sediment, ice avalanches from glaciers with changing geometry, or increasing rock fall in relation with degrading permafrost are prominent examples of hazards that may have impacts beyond historical precedence. Methods are therefore needed that can readily and regularly assess the rapid changes in high-mountain regions and estimate the effects on downstream areas. This contribution presents a set of methods based on satellite remote sensing to detect and model the aforementioned mass movements. The models that use a simple flow-routing algorithm indicate the potentially affected areas and provide a qualitative probability for each cell to be affected. Integration of remote sensing data and model results in a GIS furthermore permits an integrative perspective, in order to recognize important links among the relevant processes and detect process and hazard interactions. These methods are also apt to anticipate future effects concerning glacial hazards.