



Tree-ring based reconstruction of past lahar activity at Popocatépetl volcano, Mexico

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Lahars are rapid, saturated flows of water and rock fragments that occur on volcanoes and that can be triggered either by volcanic activity or by intense precipitation falling on unconsolidated volcanic deposits. As their occurrence is unpredictable, as the flow contains sometimes considerably large rock fragments and as the flow is able to travel long distances even on gentle gradients, lahars represent one of the most destructive natural disasters in terms of loss of human lives and property damage. In order to realistically assess hazards, knowledge on the occurrence and timing of past lahar activity is of crucial importance. However, archival data on past events is usually scarce or completely missing. Tree-ring records have repeatedly proved to be a reliable data source for the reconstruction of past geomorphic events. However, tree rings have hardly ever been applied for the identification of past lahars. Therefore, it was the aim of this study (i) to identify and describe disturbances in tree growth induced by well-documented lahar events and on this basis (ii) to recognize older, unknown lahar events with tree-ring analyses. Based on these goals, we collected 140 tree-ring series from 62 trees (*Abies religiosa*, *Pinus hartwegii*, *Pinus ayacahuite*) standing inside or adjacent to the lahar channel in the Huiloac gorge at Popocatépetl volcano, central Mexico. Most commonly, the known lahar events of 1997 and 2001 resulted in abrupt changes in tree-ring width as well as injuries. The same growth disturbances could be identified in the tree-ring series, indicating that five previously unknown lahar events would have occurred during the 20th century. Popocatépetl is one of the best surveyed volcanoes in the world and past eruptions are precisely noted in archives. As most of these unknown events occurred during periods with no volcanic activity, we believe that they were rainfall-induced rather than related to volcanic activity. This study revealed the potential of tree-ring investigation in the reconstruction of past lahar activity. This method can therefore be transferred to other locations where data on past events are missing.