Geographers draw up full inventory of barely researched icing fields

April 28 2021

Aufeis formation in the area of a flat valley section below a springshed at 4,400 meters Credit: © Marcus Nüsser / Heidelberg University

Seasonally occurring fields of aufeis (icing) constitute an important resource for the water supply of the local population in the Upper Indus

Basin. However, little research has been done on them so far. Geographers at the South Asia Institute of Heidelberg University have now examined the spreading of aufeis and, for the first time, created a full inventory of these aufeis fields. The more than 3,700 accumulations of laminated ice are important for these high mountain areas between South and Central Asia, particularly with respect to hydrology and climatology.

In the semi-arid Himalaya regions of India and Pakistan, meltwater from snow and glaciers plays an essential role for irrigation in local agriculture and hydropower generation. In this context, aufeis has been given little attention. It appears as thin sheet-like layers of ice that form through successive freezing of water and can be several meters thick. This phenomenon occurs on a seasonal basis below springsheds, along rivulets or streams under conditions of frequent freeze-thaw cycles. "In individual cases, this process is deliberately fostered through the construction of stone walls. These artificial reservoirs are used in some valleys of Upper Indus tributaries as water harvesting measures to bridge the seasonal water shortage in spring. However, the amount of ice, size and number of natural aufeis fields have been unknown so far," underlines Prof. Dr. Marcus Nüsser from the South Asia Institute of Heidelberg University.

The Heidelberg geographers have now compiled an inventory of these fields for the whole Upper Indus Basin and, in this context, also analyzed the role of topographical parameters such as altitude and slope. The basis were several field campaigns spent in the region along with the evaluation of almost 8,300 Landsat satellite images taken between 2010 and 2020. With this imagery, the scientists were able to record the characteristic seasonal formation of aufeis and map the annually recurring bodies of ice. They detected over 3,700 aufeis fields, covering a total area of approximately 300 square kilometers. The majority of the aufeis fields lie in the Trans-Himalaya of Ladakh and on the Tibetan

Plateau. In contrast, they hardly occur at all in the western part of the Upper Indus region, Marcus Nüsser explains.

The study is part of a project funded by the German Research Foundation about the significance of aufeis and ice reservoirs for the population and agriculture in the Indian region of Ladakh. The participating scientists are studying the effectiveness of the different types of ice reservoirs and whether they function efficiently on a seasonal basis. "Climate change alters both the melt rate and the annual timing of runoff, which causes increasing uncertainties for irrigated agriculture," emphasizes Prof. Nüsser. "Our findings may contribute to identifying suitable locations for ice reservoirs that can improve seasonal water availability for local farming. In addition, we are going to investigate the extent to which bodies of aufeis can serve as appropriate indicators of climate change."

The current research findings were published in the journal *Science of the Total Environment*.

More information: Dagmar Brombierstäudl et al, Distribution and relevance of aufeis (icing) in the Upper Indus Basin, *Science of The Total Environment* (2021). DOI: 10.1016/j.scitotenv.2021.146604

Provided by Heidelberg University