Dr.-Ing. Arnab Muhuri was a Humboldt Fellow at the Institute of Geography at Heidelberg University from 2019 to 2021. Under the guidance of Lucas Menzel, Professor of Hydrology and Climatology, he successfully worked on various interdisciplinary research projects dealing with issues of remote sensing of the cryosphere and natural disasters. In addition, the Humboldt Foundation granted him a European research stay at the Centre d'Etudes Spatiales de la Biosphère (CESBIO) and the Centre National d'Etudes Spatiales (CNES) in Toulouse, France. Here he worked with Dr. Simon Gascoin, an expert in remote sensing of the cryosphere. In 2022, he joined the Earth Observation and Modelling (EOM) at the Institute of Geography, University of Kiel, where he is working towards his Habilitation. In the following, Arnab Muhuri presents his two key publications from his time as a Humboldt Fellow at the University of Heidelberg.

A massive rock and ice avalanche caused the 2021 disaster at Chamoli, Indian Himalaya
https://www.science.org/doi/full/10.1126/science.abh4455

This publication about the 2021 Chamoli disaster in the Indian Himalaya is significant for several reasons:

Unveiling the Cause of the Disaster:
The research revealed that the disaster was triggered by a massive rock and ice avalanche, which caused a deadly flash flood in the Chamoli district of Uttarakhand, India. Initially, there was uncertainty about whether the disaster was caused by a glacial lake outburst or a landslide. This study clarified that the event was due to a rock and ice avalanche, a critical distinction for future risk assessments in glaciated mountain regions.

Global Attention and Importance:
The scale of the disaster, which led to the loss of over 200 lives and significant damage to infrastructure, including hydropower plants, drew international attention. The publication's findings on the vulnerability of mountain communities and infrastructure to such natural hazards resonated globally, especially with increasing concerns around the impact of climate change on glacier and permafrost regions.

The study also highlights the potential dangers of rising temperatures and their role in destabilizing glaciers and mountain slopes.

Media Coverage and Public Awareness:
International media outlets covered the disaster and its analysis extensively, emphasizing the role of climate change in triggering such catastrophic events. The global media attention brought a spotlight on the fragility of Himalayan ecosystems, the need for sustainable development in such areas, and the broader issue of global warming's impact on mountainous regions. Global media houses like The New York Times and BBC reported on our investigation, making it a topic of global environmental concern.
https://www.bbc.com/news/av/science-environment-57453988
https://www.bbc.com/news/science-environment-57446224
https://www.nytimes.com/2021/02/08/climate/climate-change-flash-flood-india.html

Scientific Relevance:
The disaster and its analysis were critical for the scientific community studying glacial dynamics, permafrost degradation, and landslide-triggered avalanches. It highlighted the importance of monitoring high-altitude regions for sudden mass movements, contributing to disaster risk management efforts worldwide.

In summary, the study not only provided a crucial understanding of the specific disaster but also raised awareness about the broader risks posed by climate-induced changes in mountainous regions, with significant global media coverage helping to bring attention to these urgent environmental issues.

Performance Assessment of Optical Satellite-Based Operational Snow Cover Monitoring Algorithms in Forested Landscapes
https://ieeexplore.ieee.org/abstract/document/9456092

This publication holds significant importance in the field of remote sensing of snow cover in forested areas for some of the following reasons:

Highlighting the Challenge of Snow Monitoring in Forested Areas:
Forested landscapes pose a unique challenge for snow cover monitoring because the tree canopy often obscures snow on the ground, making it difficult for traditional optical satellite sensors to accurately detect snow. The publication addresses this challenge by evaluating and improving algorithms specifically designed for snow cover detection in these difficult environments. Accurate snow cover monitoring is

essential for hydrological modeling, flood prediction, and climate change studies. Snow cover in forests has a direct impact on water resource management, especially in regions where snowmelt is a primary source of freshwater.

Contribution to Algorithm Development and Validation:
The research assesses the performance of different operational algorithms used for snow cover monitoring in forested regions. This includes algorithms from well-established satellite systems like MODIS (Moderate Resolution Imaging Spectroradiometer) and Sentinel-2. These assessments are crucial for identifying the limitations of existing algorithms and for improving the accuracy of remote sensing data in these complex landscapes. By providing a comparison of multiple algorithms and validating them against ground truth data, this study enhances the understanding of the scientific community towards the detection of snow in forested regions.

Impact on Remote Sensing Techniques:
This work contributes to the global research effort in remote sensing by exploring how different optical satellite sensors can be applied in challenging terrains. It highlights the need for sensor fusion techniques (ex. combining optical, radar, thermal, and lidar data) to improve snow cover detection. This is particularly important as snow cover monitoring plays a critical role in assessing climate change impacts on forested regions and ensuring accurate predictions of water availability in snow-dominated river basins.

Relevance to Operational Monitoring:
The publication is valuable for improving operational snow monitoring systems that are used by governmental and environmental agencies for disaster management, water resource planning, and agricultural forecasting. Enhancing snow detection in forests directly improves these operations, helping to inform decision-making processes related to forestry management and flood risk mitigation. By focusing on a specific scenario (remote sensing of snow cover under canopy obscured landscape) where many regions around the world struggle (such as Northern Europe, Canada, and Siberia), the research has a global relevance. It also aligns with the goals of global organizations like the European Space Agency (ESA) and National Aeronautics and Space Administration (NASA), which invest in improving snow cover monitoring through programs like Copernicus (Sentinel) and Landsat.

In summary, this publication contributes significantly to the advancement of remote sensing methodologies for monitoring snow cover in forested areas, a challenging yet essential task for understanding climate dynamics, managing water resources, and improving operational snow cover monitoring systems. The research adds value to both algorithm development and real-world applications, pushing the boundaries of accurate snow detection in canopy obscured landscapes.

More information about Arnab Muhuri's current position at CAU, Kiel:

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