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Near Real-Time Mapping to Estimate Snow Cover Fraction Area

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Abstract:

The 13th Sustainable Development Goal (SDG) "Climate Action" intends to have an impact on the reduction of greenhouse gases by 2030, as they contribute to warming the atmosphere. According to the Intergovernmental Panel on Climate Change (IPCC), warming beyond 1.5 degrees could have irreversible and irreparable consequences. The increase of temperature has been reducing the number of snow events, resulting in less snow cover, earlier melting periods reflected on poor recorded volumes of snow. Once it melts and incorporates into the water cycle, activities with environmental and agricultural importance are affected.

A specific approach to describing the water content in alpine areas in an automated protocol has been described by Stevanato et al. (2019) and Schattan et al. (2020). They proposed using a Cosmic Ray Neutron Sensor (CRNS) calibrated by historical data to provide real-time measurements of snow and soil moisture properties. Moreover, research on complex data integration developed by Premier et al. (2021) proposes hierarchy-based techniques from remote sensing and in situ measurements integration. The goal is to overcome temporal gaps present in situ data from sparsely acquired time series with high and low-resolution snow cover maps. Aside regarding visualization research Franke (2023), points out that data visualization is one of the core components in the current state of the internet communication, and thus it should consider incorporating the emerging technological advancements to enhance human understanding on the surrounding changes.

Here we present a visualization approach for near real-time (NRT) mapping of snow cover fraction (SCF), achieved by incorporating data from sensor stations using the Internet of things (IoT) philosophy and aerial imagery. By improving data assimilation and spatial visualization, we aim at supporting domain experts to enhance the comprehensibility of snow dynamics in complex terrains and enable comprehensive Geo-data visualization for non-experts. Furthermore, it will contribute to the 13th SDG's data governance through FAIR data principles (Findable, Accessible, Interoperable, Reusable) and optimizing the Data Life Cycle (DLC) for geoinformation available to society.

This work is based on data integration and assimilation following next data pipeline (Fig. 1)

1) Geo-data management: in situ CRNS and weather station snow data, transmitted every 15 and 10 minutes to a centralized ftp repository; UAV-based data, and remote sensing data (Planet Scope) retrieved via API, all stored to Eurac premises. Some of the analyzed parameters were acquired on site (dedicated field campaigns) for calibration of the historical snow dataset and validation. Subsequently, the datasets which meet the quality requirements are prepared and stored on a database to facilitate constant retrieval and integration. Finally, aside from the collaboration with domain experts (final user at this research point) an interactive analytical dashboard is being developed for enhancing the analysis of SCF state in the area. The data organization follows IoT and FAIR principles.

2) Analytical process: It consists in different scripts prepared in Python and R to estimate snow cover fraction, harmonized across both spatial and temporal dimensions.

3) Geo-visualization: An interactive dashboard developed in Power BI, which integrates the acquired sources into a thematic mapping-based visualization platform. It can simultaneously present different temporal and spatial scales and visualize the latest observations from the IoT sensors alongside free-cloud historical remote sensing

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datasets.
This will offer a new way to present research, uncovering hidden insights enhancing the analytical and communicational processes of domain experts through geospatial and interactive visualizations.

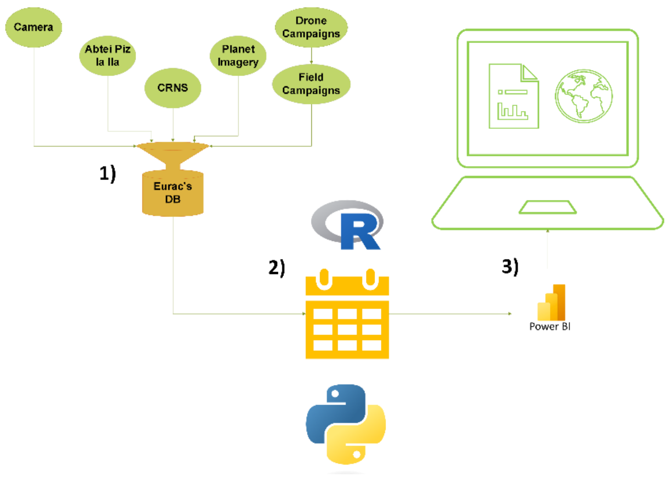

Figure 1. Visualization tool design pipeline.

The research outcome aims to contribute to the ongoing visual analytics and spatial visualization research for innovative research presentations, such as dashboards as they have not been deeply investigated. Additionally, it will enhance domain expertise by incorporating cartographic knowledge, making the analysis and visualization of research data more intuitive. This, in turn, will open a new cartographic research agenda tailored to the specific needs of the scientific community. The presented approach can be duplicated and extended to the different COSMOS CRNS stations to predict snow coverage in the entire Alps region.

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References

Franke G. (2023, March 7) *The evolution and future of interactive data visualization* | CLEVER°FRANKE | Medium. Retrieved June 20, 2024, from https://medium.com/clever-franke/the-evolution-and-future-of-interactive-data-visualization-26aa30ae7ef2

Premier, V., Marin, C., Steger, S., Notarnicola, C., & Bruzzone, L. (2021). *A Novel Approach Based on a Hierarchical Multiresolution Analysis of Optical Time Series to Reconstruct the Daily High-Resolution Snow Cover Area*. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 14, 9223–9240. https://doi.org/10.1109/JSTARS.2021.3103585

Schattan, P., Schwaizer, G., Schöber, J., & Achleitner, S. (2020). *The complementary value of cosmic-ray neutron sensing and snow-covered area products for snow hydrological modelling*. Remote Sensing of Environment, 239. https://doi.org/10.1016/j.rse.2019.111603

Stevanato, L., Baroni, G., Cohen, Y., Lino, F. C., Gatto, S., Lunardon, M., Marinello, F., Moretto, S., & Morselli, L. (2019). *A novel cosmic-ray neutron sensor for soil moisture estimation over large areas. Agriculture (Switzerland)*, 9(9). https://doi.org/10.3390/agriculture9090202

Thaler, E. A., Crumley, R. L., & Bennett, K. E. (2023). *Estimating snow cover from high-resolution satellite imagery by thresholding blue wavelengths*. Remote Sensing of Environment, 285. https://doi.org/10.1016/j.rse.2022.113403