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# Snow depth time series retrieval by time-lapse photography: Finnish and Italian case studies

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| | METHODS | SPATIAL RESOLUTION | TEMPORAL RESOLUTION | SPATIAL COVERAGE | SD ACCURACY (m) | MAIN APPLICATIONS |
|---|---|---|---|---|---|---|
| **Airborne** | Photogrammetry (Airborne) | DEM Spacing Grids: 5 m | Due to the high costs: 1 Year | Hydrological Basin Scale (100-500 $Km^2$) | $< 0.01$ | Hydrological- Hydropower Purpose (Amount of Snow in the Hydrological Basin) |
| | Photogrammetry (Drone) | DEM Spacing Grids:< $10 \cdot 10^{-2} m$ | Depending on the Design Survey and Purposes: Monthly | Area of Few $Km^2$ (< 10 $Km^2$ ) | <0.1 | Avalanche Volume estimation, Snow Depth on Accumulation Basin of Mountain Glaciers. |
| | LIDAR | DEM Spacing Grids: 1 m | Due to the high costs: 1 Year | Hydrological Basin Scale (100-500 $Km^2$) | $< 0.01$ | Avalanche estimation, Snow Depth on Accumulation Area of Mountain Glaciers. |
| **Spaceborne** | Passive Microwave (e.g. AMSR-E) | 25 m – 50 Km | (Surveyed Period Different for Each Satellite) Weekly- Daily | Regional or Continental Scale | > 0.2 | Regional or Continental Scale Applications: Monitoring Snow depth in the European Alps or Northern Hemisphere, Estimate the Freshwater Resources, Climatological Purposes, Water Storage Anomalies. |
| | Active Microwave | 25 m – 50 Km | (Surveyed Period Different for Each Satellite) Weekly- Daily | Regional or Continental Scale | > 0.2 | |
| **GroundBased** | LIDAR | DEM Spacing Grid: 1 m | 1 Survey when requested | Few $Km^2$(< 10 $Km^2$ ) | < 0.01 | Avalanche estimate, Snow Depth on Accumulation Area of Mountain Glaciers. |
| | Time Lapse Photography | Depending on the snow stakes number | 1 Hour | Limited Area: Max 1 $Km^2$ | $(0.01 \div 0.05)$ | Real-time snow depth monitoring, especially for Avalanche forecast. Validate Manual Measurements |
| | Manual (Rulers) | Spot Measurements | Generally Daily | In-Situ or Snow Field | $(0.01 \div 0.05)$ | Validate Automatic Weather Sensor Estimations, avalanche risk monitoring |
| | Automatic Weather Station | Spot Measurements | 1 minute | In-Situ | $0.001$ | Real-time snow depth monitoring, avalanche risk monitoring, support of water resource and flood management |

**Table S1. Snow depth measurements method overview.**

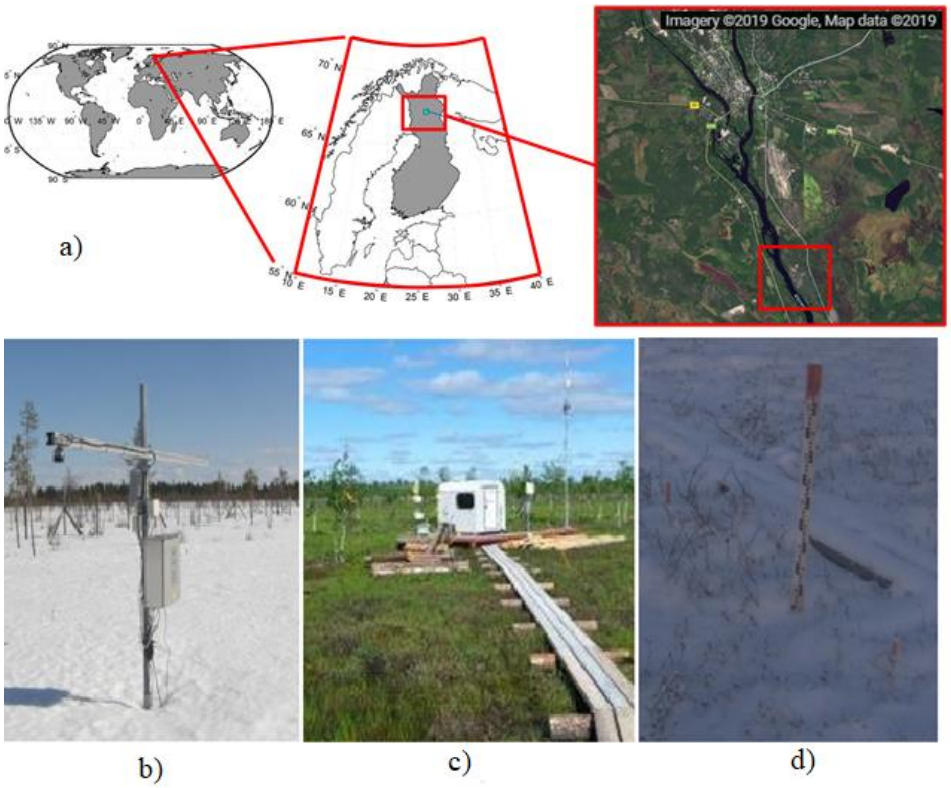


**Figure S1. a) Arctic Space Center location - Sodankylä - Tähtelä - Finland (67.367 °N, 26.629 °E). Peatland Site (Sodankylä): Ultrasonic Snow Depth Sensor (b), Automatic weather station and camera (c), Snow Stake image from camera (d).**

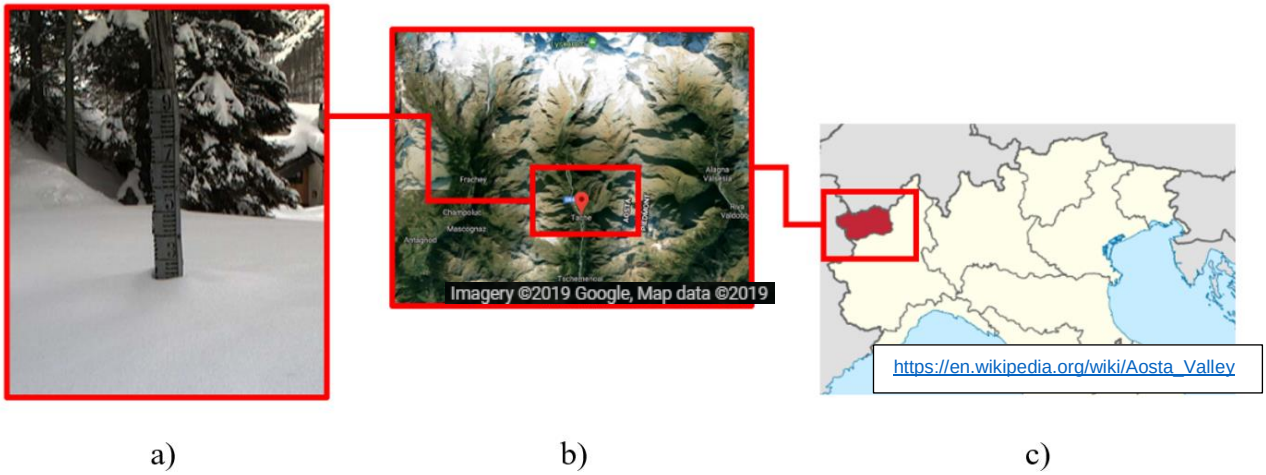


**Figure S2. Gressoney La Trinitè Dejola (Historical Observatory): a) snow stake image from the camera, b) Territorial Framework of Gressoney, c) Valle D'Aosta Autonomous Region.**


**Figure S3. Careser dam case study: a) Trentino's region - Italian Alps, b) Location and Google Map view, c) snow stake camera's view.**

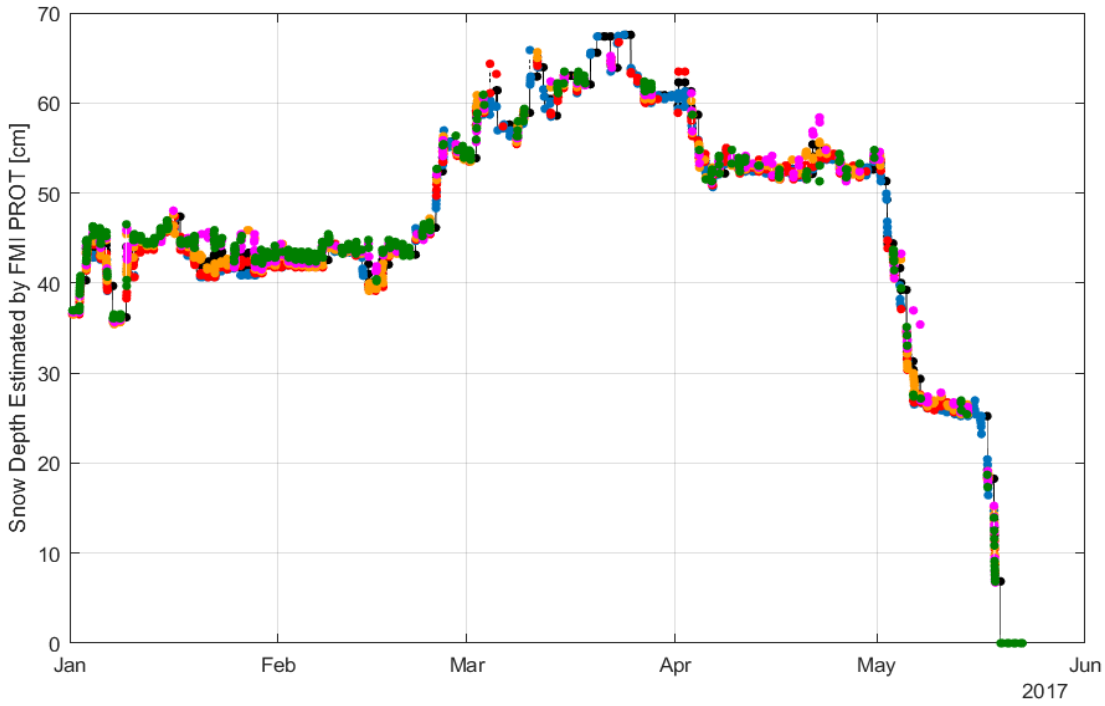


**Figure S4. Sodankylä Peatland: Snow Depth Estimations by FMIPROT with 5 different values of sigma parameter from 1 to 5. In black dots we reported the mean value of these.**