

Additional Material

Snow depth estimation 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
A i r b o r n e	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 · 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.
S p a c e b o r n e	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	
G r o u n d B a s e d	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 ÷ 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 ÷ 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.

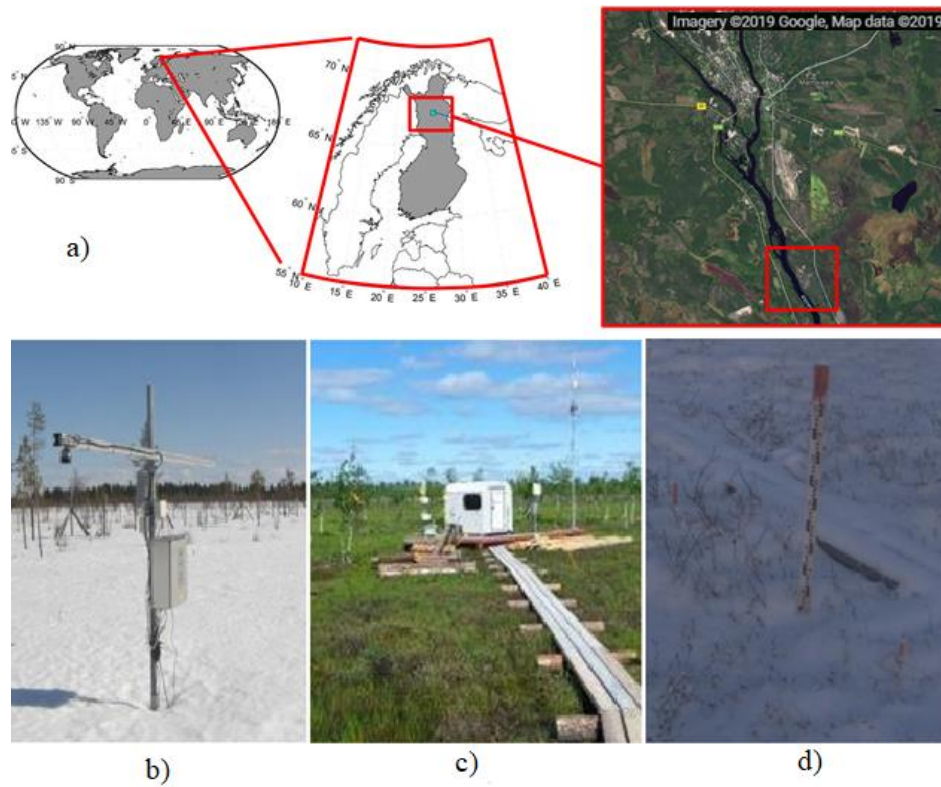


Figure S1. a) Arctic Space Center location - Sodankylä - Tähtelä - Finland (67.367 °N, 26.629 °E). Peatland Site (Sodankylä): Ultrasonic Snow Depth Sensor (b), Automatic weather station and camera (c), Snow Stake image from camera (d).

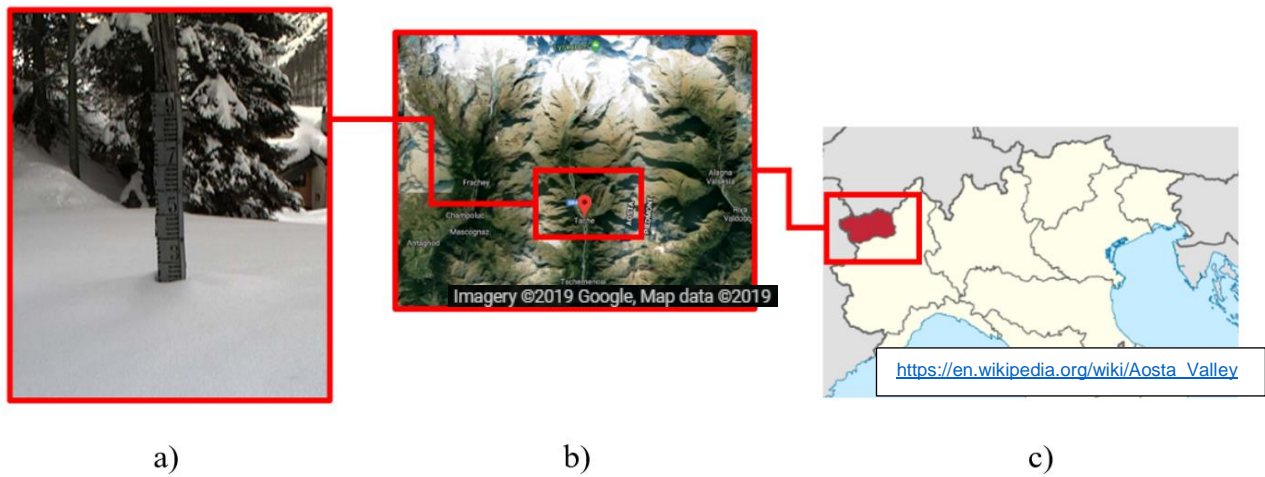


Figure S2. Gressoney La Trinitè Dejola (Historical Observatory): a) snow stake image from the camera, b) Territorial Framework of Gressoney, c) Valle D'Aosta Autonomous Region.

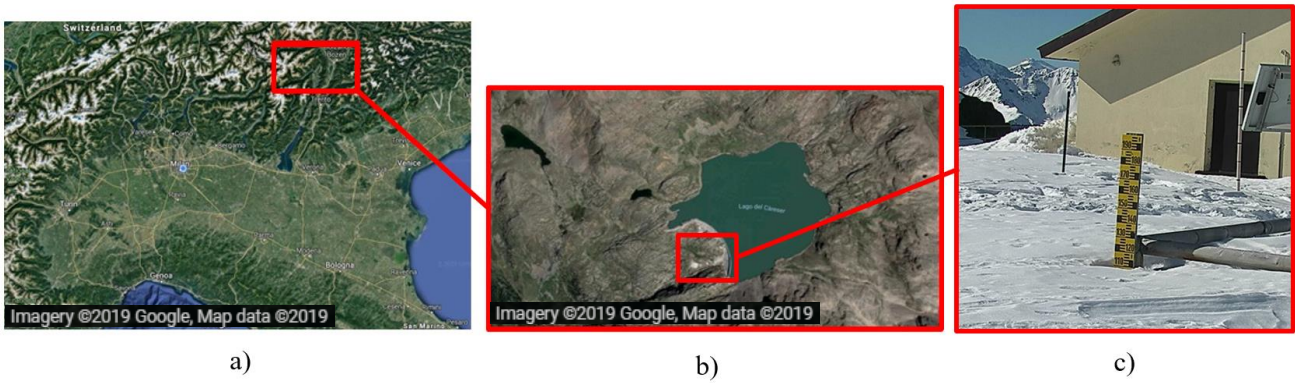


Figure S3. Careser dam case study: a) Trentino's region - Italian Alps, b) Location and Google Map view, c) snow stake camera's view.

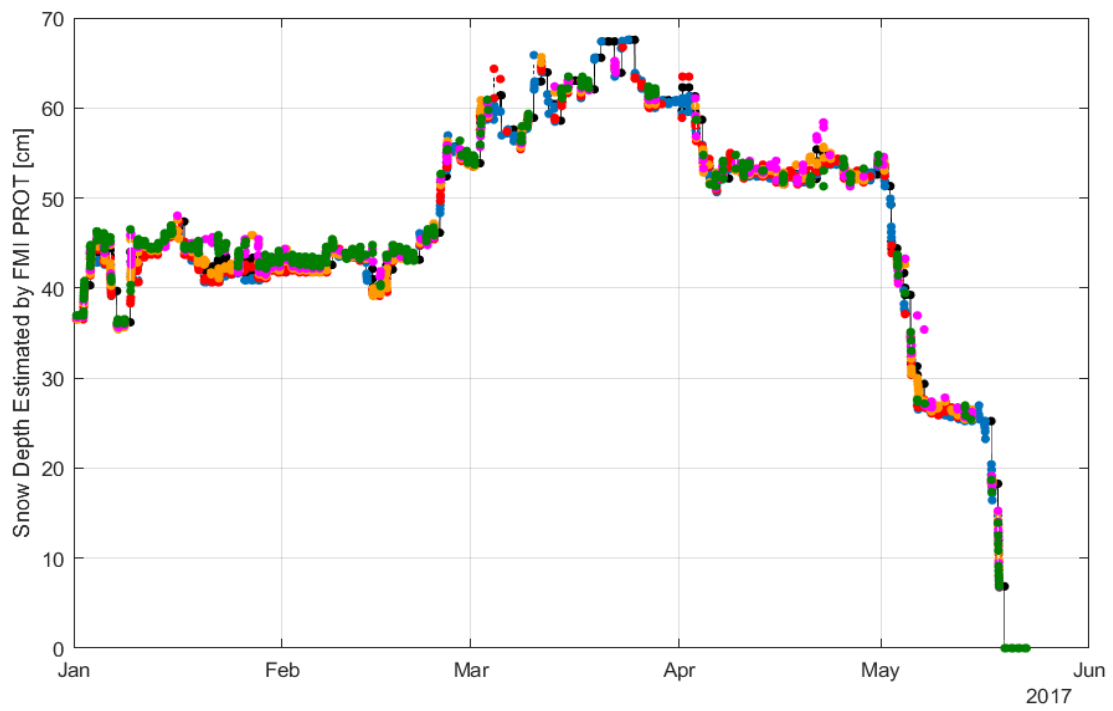


Figure S4. Sodankylä Peatland: Snow Depth Estimations by FMIPROT with 5 different values of sigma parameter from 1 to 5. In black dots we reported the mean value of these.