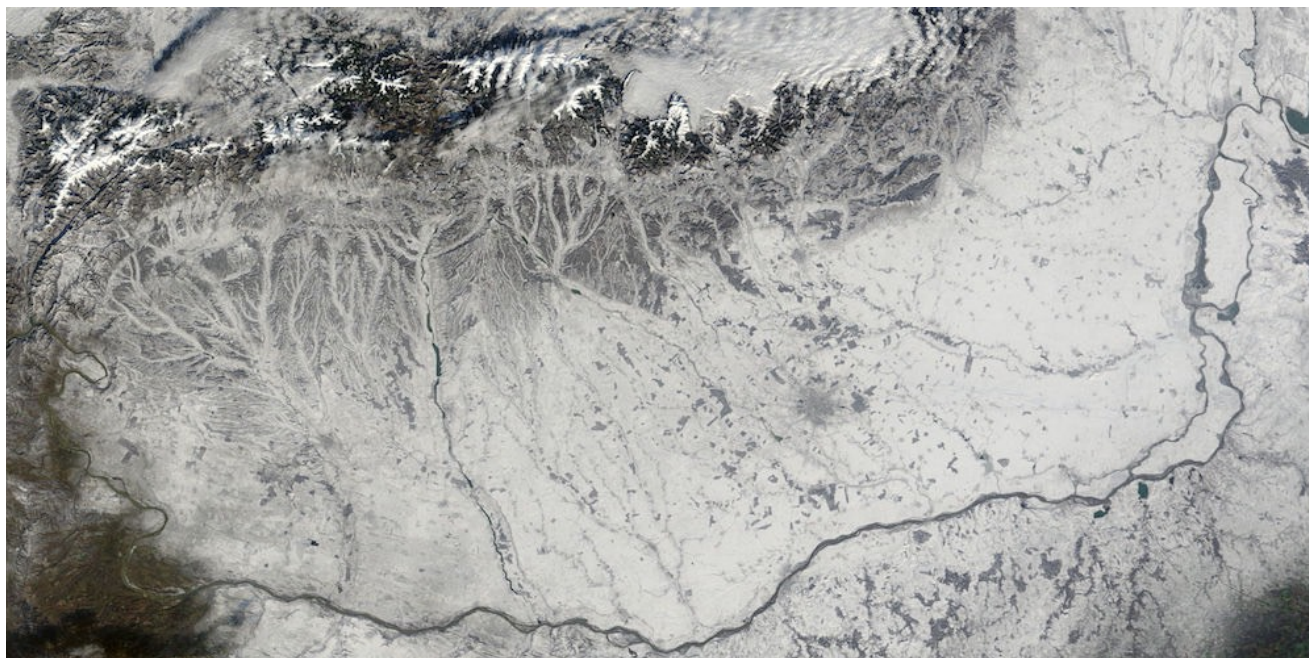


# SNOWBALL

## Newsletter



Dear readers,

The Snowball team presents the second newsletter dedicated to disseminating the results achieved in the project. The Snowball (Remote sensing, model and in-situ data fusion for snowpack parameters and related hazards in a climate change perspective) is a scientific research project won by the National Meteorological Administration in partnership with the Norwegian Computing Center, Technical University of Civil Engineering of Bucharest, National Institute of Hydrology and Water Management and the West University of Timisoara. The project is funded under the EEA Financial Mechanism 2009 – 2014. The main goal of the project is to develop a new service to provide to national authorities and to general public, consistent information, in quasi real time to monitor the spatiotemporal characteristics of snow cover and the associated hazards (floods caused by the sudden melting snow and avalanches), in the context of present and future climate conditions, based on in-situ and provided by satellites data.

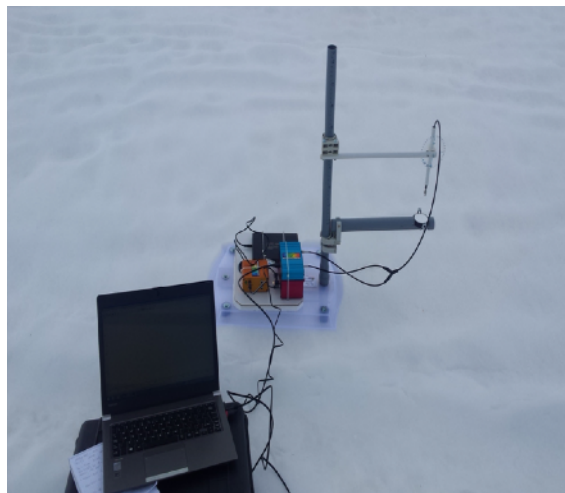
## In-situ snow parameters measurement

During January 2016, air temperature probes have been deployed at the Sinaia test zones on an altitude gradient slope every 100 meters, from Sinaia 2000 – Sinaia 1500 and Sinaia 2000 – Valea Dorului.

In February, the same type of sensors have been deployed in Valea Argesului, between Salvamont 2000 and Capra Chalet . The air temperature probes are doing hourly measurements which are stored in the device memory. Data have been uploaded at the end of the winter season after the probes were collected in May, and have been used to help identify the snow melt episodes, thus essentially contributing to the validation of optical and microwave satellite derived snow products.

Deployment of the snow stations at the test zones and Joseni and Targu Secuiesc cal/val sites has been completed in February.

During January – April 2016, Meteo Romania conducted several field campaigns in the test zone Sinaia 2000 – Valea Dorului, collecting in situ snow data collocated with optical and microwave satellite overpasses. Snow surface temperature, snow moisture, snow temperature and density, snow spectra and other parameters are used to validate satellite derived snow moisture products.

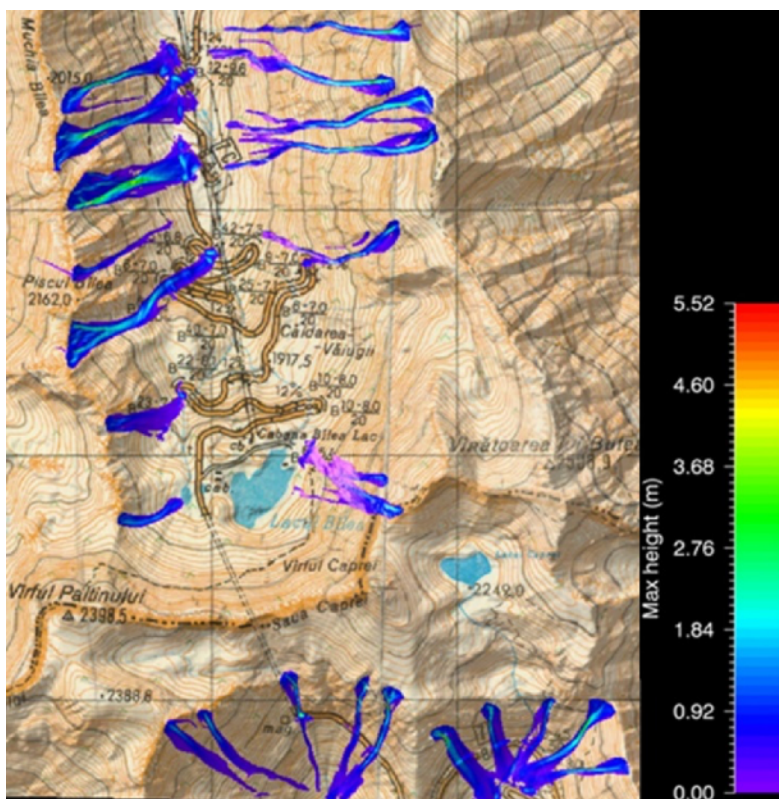




## Avalanche simulation and hazard assessment

Avalanche hazard assessment was based on a topographic-statistic model combined with simulation results to identify areas with favorable conditions for snow avalanche release areas and separate levels of potential danger based on snow pressure thresholds derived from the simulation of avalanche extent, volume and pressure.

The hazard being expressed as the probability of occurrence of a given process, in the case of snow avalanche assessment, the release areas and runout distances for several magnitude classes have been determined. A combination of topographic factors to identify the potential release areas and simulation of avalanche pressure and volume based on past events with maximum extent has been applied for central part of Făgăraș Mts.



The simulations were tested using RAMMS software in the area surrounding the Transfăgărășan highway, this being the most affected by snow avalanches events, that caused damages, as are mentioned in the records.

The input parameters for the simulation were the parameters derived from digital elevation model, forested or non-forested areas, the avalanche return period and their magnitude and the release fracture heights. The friction parameters were calculated using the automatic procedure implemented in this model. The procedure classifies terrain parameters, altitude, slope gradient, and plan curvature, in types like flat terrain / open slope, channelled / gully and forested or non-forested areas.

Related to the input of global parameters, return period of 10 and 30 years and type of the avalanches small and medium size events were used in simulations. Beside the information related to avalanche release areas, an important aspect for the avalanche hazard assessment is the frequency and the impact pressure in the runout areas. Values between 0.5 and 2 meters were used in the tests for the release fracture heights.

Based on the above mentioned inputs and pressure values intervals as defined in the Swiss guidelines, we separated the hazard areas into 3 levels of danger. The hazard areas generated for the central part of Făgăraș Mts., in valleys along the highway, show that for major events, several parts of the highway, including forested areas for the southern slopes are in the high level of danger.

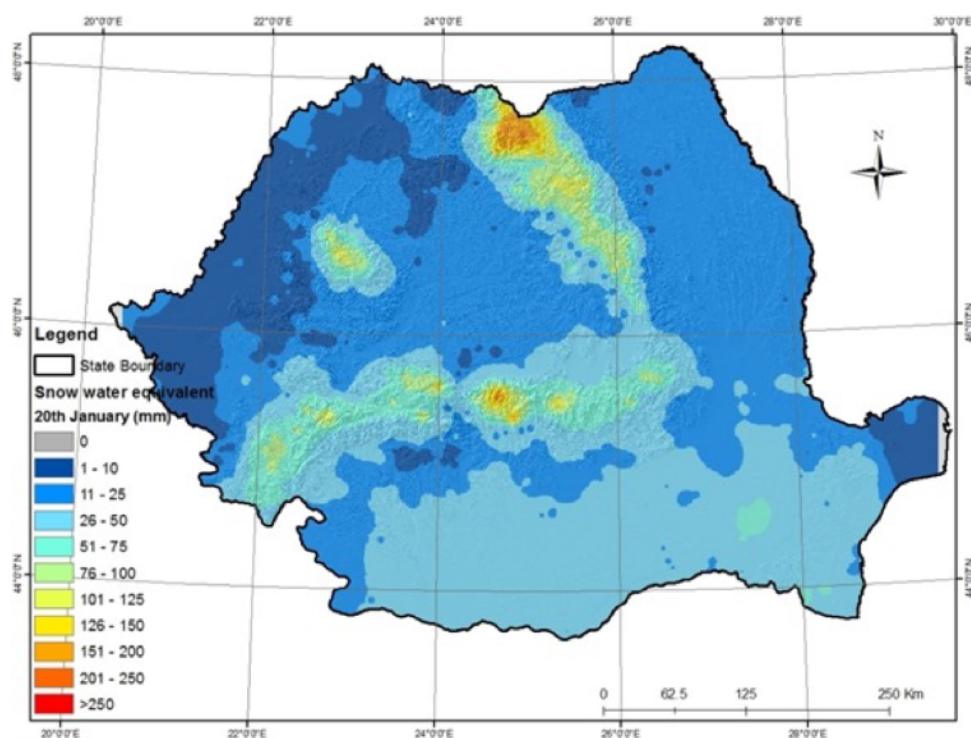
### Data fusion methodology for snow water equivalent estimation

The main parameters of the snow layer (snow layer depth, water equivalent) have a particularly high spatial and temporal variability, which generate a very high degree of uncertainty in estimating these parameters at river basin level using only observations from the national monitoring networks, especially in the mountain region.

In order to reduce the errors associated with the estimation of the snow water equivalent, we designed and implemented within SNOWBALL Project a specific data fusion type approach.

Within the data fusion process, the different type of data and information are analysed and compared, using a series of automatic cross-validation algorithms, and then the snow water equivalent is estimated in a gridded format, at spatial resolution of 1 km, by multiple successive steps of interpolations and adjustments, depending on the degree of uncertainty associated with different type of input data.

The entire processing workflow take into account also the topographical and land use / land cover controlling factors for the snowpack evolution, especially during snowmelt period, mainly based on results from the previous research done within the National Institute of Hydrology and Water Management, using the data from the national representative river basins network.

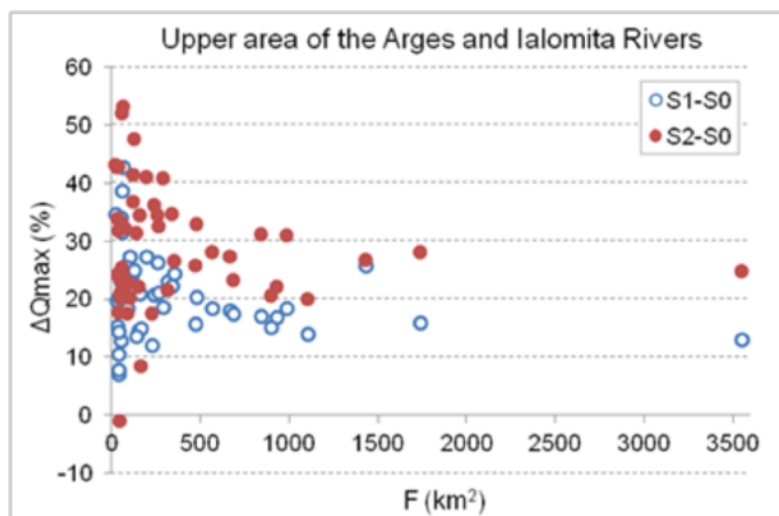


## Snow-related impact of climate change in Romanian Carpathians

The hydrologic modelling applied to the sub-basins corresponding to the rivers Argeş and Ialomița, located mainly in mountain areas, supports the previous findings from the analysis of EURO-CORDEX results and add more local details about the maximum discharge and flood statistics.

The results of the hydrologic model (CONSUL) indicate that multiannual averages of maximum discharges during the interval from November to April 2021-2050 show increases compared with present climate (1981-2010) under stabilization (RCP 2.6) and worst (RCP 8.5) climate scenarios. For sub-basins with larger areas, the increases are systematically larger under the worst scenario compared to those under the stabilization one showing how the climate change signal overcomes the noise in relation to the specific spatial scales of river basins. In this context, noise is the natural climate variability.

Relative deviations (%) of the maximum discharges during November to April, multiannual averages, for S1 (RCP 2.6) and S2 (RCP 8.5) scenarios compared to S0 (historical conditions) scenario, at hydrometric stations from upper area of the Argeş and Ialomița Rivers. S1 and S2 scenario cover the period 2021-2050. S0 scenario covers the period 1981-2010.



## Evaluation of snowmelt water infiltration in unsaturated zone for aquifers recharge

In the analysis of the unsaturated zone, one of the most challenging problems is to use inverse theory in the search for an optimal parameterization of the porous media, because direct measurements of hydraulic properties of soils are tedious and time consuming. Inverse procedures require optimization of an objective function. The method Levenberg-Marquardt provided by HYDRUS-1D code has become a standard in nonlinear least-squares fitting parameters among soil scientists and hydrologists. The Levenberg-Marquardt nonlinear minimization method was found efficient for the study area in Padina (Romania). When the optimization problem deal with a larger number of parameters for multiple soil horizons are involved a global optimization algorithm is required. As example, the ACO (Ant Colony Optimization) algorithm based on the behaviour of a colony of ant. ACO uses the fact that ants are capable of finding the shortest path from a food source to their nest by depositing a trail of pheromone. The trail attracts other ants. We can extend the idea to the modeling of the transport of pollutants through unsaturated zone.

Based on statistical analysis of daily snow depth, precipitation and temperature, for Romania significant trends were identified: the increase in the number of days with positive temperature together with the slight decrease in winter precipitation, the diminution of the snowfall days, decreasing trends in the number of days with snow coverage and in the mean snow depth. Snowmelt increases linearly with temperature so diminution of snow cover area will reduce water availability for irrigation and agriculture. Due to the early snowmelt, the reduced contribution of snowmelt from lower elevation is counteracted by increased spring runoff from higher elevation. An analysis of variability of mean SWE in Padina area under the IPCC-AR5 new climate change scenarios RCP 8.5 and RCP 2.6 was developed.

