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THEMATIC MAPPING OF SNOW COVERED AREAS FROM THE ANALYSIS OF REMOTELY SENSED IMAGES FOR APPLICATION TO HYDROLOGICAL MODELLING

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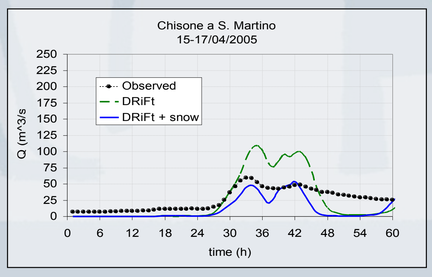
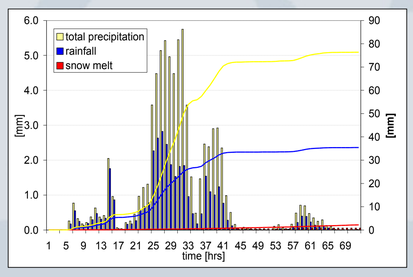
Snow plays an important roles in mountain regions hydrology, such as Alpine and Apennines regions, not only for water supply recharge but for flooding too. The availability of remotely sensed images and them analysis can provide information as snow cover, fundamental for calibration and validation of snow models. This work proposes a method to automatically map the snow cover from multispectral images. Given a classification problem, effectiveness of a Decision Tree Classifier (DTC) has been verified. The DTC approach decomposes the problem in a suitable tree-structured set of binary classification sub-problems, for which simple (threshold-based) decision rules were defined. A drawback of the method is the presence of internal threshold parameters to be empirically set by the user or by means of a wide set of training samples. During the calibration of the tree structure, DTC was combined with an unsupervised technique to automatically select optimal values for thresholds. A Bayesian approach was adopted to express the problem of threshold selection as the minimization of a functional related to the probability of classification error. In addition, an evaluation of the results was carried out by comparing results with higher resolution supervised classification maps.

DESCRIPTION

SNOW MODELLING

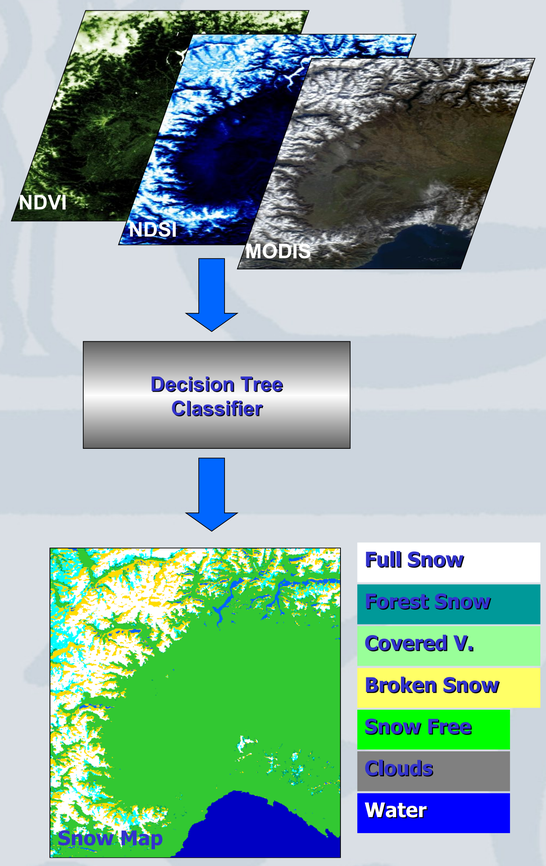
Snow Models provide precipitation maps, considering the snow phenomena, to the semi-distributed hydrological model. The meltwater production is directly proportional to the changing areal extent of the seasonal snow cover. To model snow, it's necessary to:





evaluate distribution of snow depth, follow the temperature variation over the altimetry, define a mean value for the "zero isothermal line" on the base of the temperature in the previous days, the interpolation of the nivometric information (before the event). The Snow Model provides the precipitation maps, considering the snow phenomena, to the semi-distributed hydrological model and allows to better estimate the runoff. The figures on the left reports some of the obtained results on Alpine Catchment.

SNOW COVER MAPPING



METHODOLOGY

Original Data Set: MOD02HKM - Level 1B product: calibrated and geolocated radiances at-aperture for MODIS spectral bands 1 through 7 at 500m resolution.

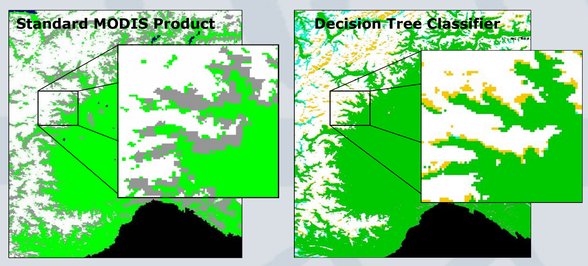
Input Data: Georeferenced *MODIS* data, *Snow Information* by Normalized Difference Snow Index (NDSI), *Vegetation Information* by Normalized Difference Vegetation Index (NDVI)

Decision Tree Classifier: is a hierarchical classifier that *recursively partitions* the data set in smaller subdivision on the basis of *decision rules*. The algorithm is based on statistical or empiric decision rules that check the input data set with a fall approach. The set of input data is an information stack that describe each single point of the space with a vector of features (X): X = [x1, … xf]; i=1,… f

Snow Map: the classification algorithm exploit the NDSI combined with the NDVI to distinguish the different snow cover properties. Final result is a thematic map representing the snow features distribution over the investigated land.

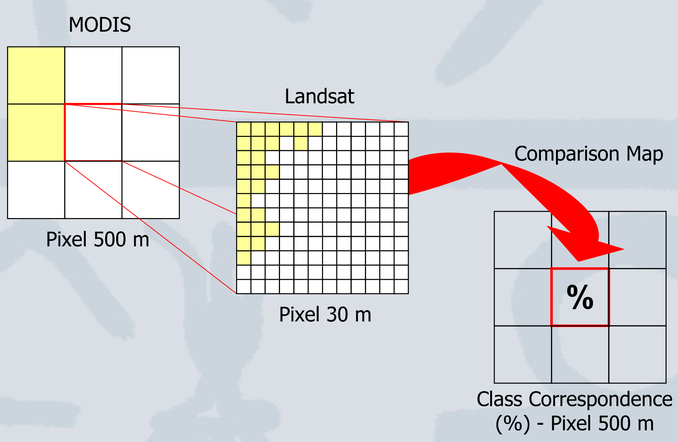
RESULTS & REMARKS

The main problem in the image processing is the validation of the proposed methodologies. When the investigated feature of the observed surface is snow, often the available ground information is a set of point data. The mismatch of spatial data with point data is increased by the lack of a well distributed information over the investigated territory.



	Snow Map		Standard Product	
	0-20cm	20+ cm	0-20cm	20+ cm
Full Snow	8%	64%	14%	62%
Snow / Vegetation	13%	16%	-	-
Snow / Bare soil	41%	9%	-	-
Clouds	2%	4%	34%	23%
Snow Free	34%	7%	52%	15%

Comparison of the standard snow maps and the relative snow maps by DTC-OT



The wide availability of remotely satellite images allows to compare data at different spatial and spectral resolution. Then a way to evaluate the characteristics of the surface is by assuming higher resolution data as the truth.

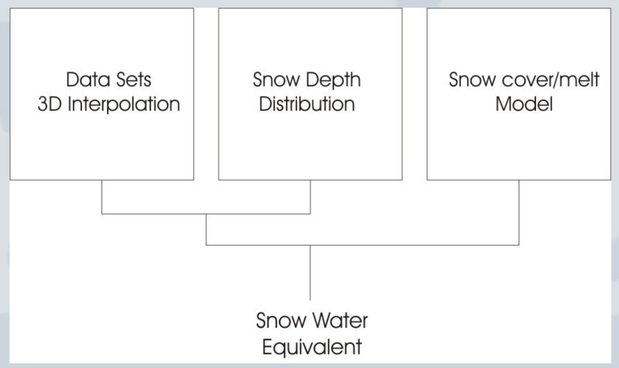


Chart of the data assimilation framework for Snow Water Equivalent estimation

By combining the satellite data with surface measurements of snow depth and water equivalent and meteorological variables, we will model the spatial distribution of SWE and the rate of melt and thereby generate weekly and seasonal estimates of snowmelt runoff. A more accurate specification of snow cover will lead to more accurate stream flow forecasts and to a more accurate evaluation of the water budget within mountain catchments.

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