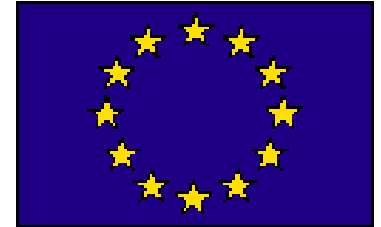




istituto per il rilevamento  
elettromagnetico  
dell'ambiente



# Assimilation of EO data for evaluating runoff in Alpine watersheds: the case of *AWARE* project

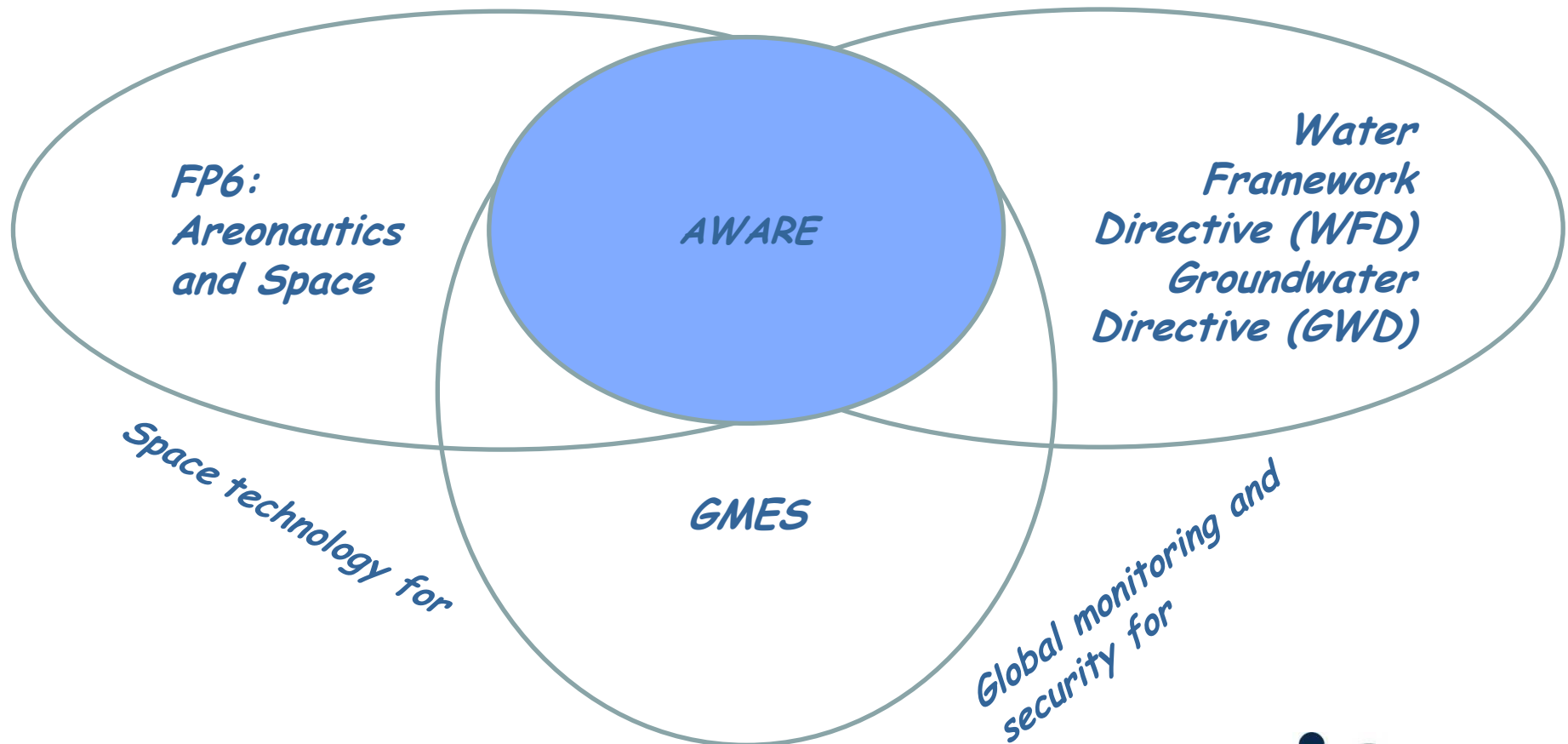
*Branka Cuca*

Politecnico di Milano  
Department BEST  
Representative Office in Brussels  
c/o Casa della Lombardia  
Lombardy Region Delegation

## AWARE context

### AWARE

*A tool for monitoring and forecasting  
Available WATER REsource  
in mountain environment*



Coordinator: IREA-CNR via Bassini, 15 20133 Milano  
tel. 0039 02 23699275 email: rampini.a@irea.cnr.it

## AWARE objectives

- Development of **innovative tools for monitoring and predicting water availability** in those drainage basins where **snowmelt** is a major component of the annual water balance
- Experiment **mathematical models** to represent snow-pack dynamics and snowmelt runoff, **integrating Earth Observation data** and in-situ hydrological and meteorological measurements
- Implementation of a **geo-service** for tailoring data and models to different environments

**Remote  
Sensing**

**Hydrological  
Modelling**

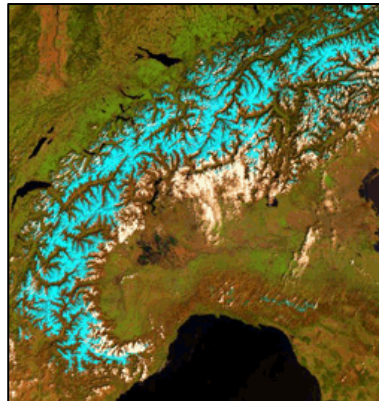
**Information  
Technology**

## WHY AWARE



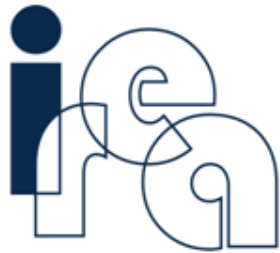
- To increase awareness in favour of **high mountain regions**

- To concretely apply **space technologies for water resource management**



- To provide a friendly tool for guiding **users** in the integrated use of **remote sensing data**

## AWARE PARTNERS



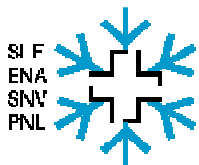
Consiglio Nazionale delle  
Ricerche  
Istituto per il Rilevamento  
Elettromagnetico  
dell' Ambiente – Milano - Italy



University of Technology - Institute for  
Hydraulics, Hydrology and Water  
Resources Management of Vienna -  
Austria



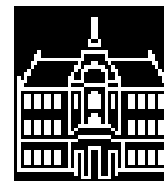
University "Jaume I" -  
Departament of Computer  
Languages and Systems,  
Castellon de la Plana - Spain



Swiss Federal Institute for Snow and  
Avalanche Research of Davos -  
Switzerland



Politecnico di Milano  
DIAR – Milano- Italy



University of Ljubljana -  
Faculty of Civil and Geodetic  
Engineering - Slovenia



Institut Cartogràfic  
de Catalunya -  
Spain

# AWARE Users



**Est-Sesia Consortium**



**Regione Lombardia**

General Direction Territory  
and Town Planning



Regione Valle d'Aosta



Regione Emilia Romagna

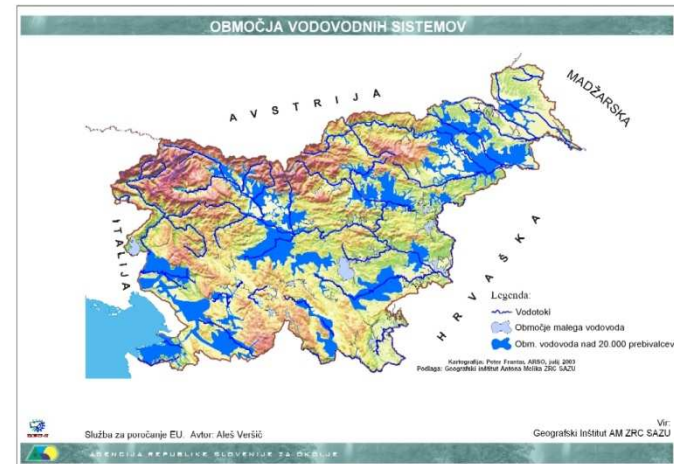


**SAVSKE  
ELEKTRARNE  
LJUBLJANA d.o.o.**

**SEL – Savske  
Elektrarne Ljubljana**



**Environmental Agency  
of the Republic of Slovenia**





# AWARE Partner/User

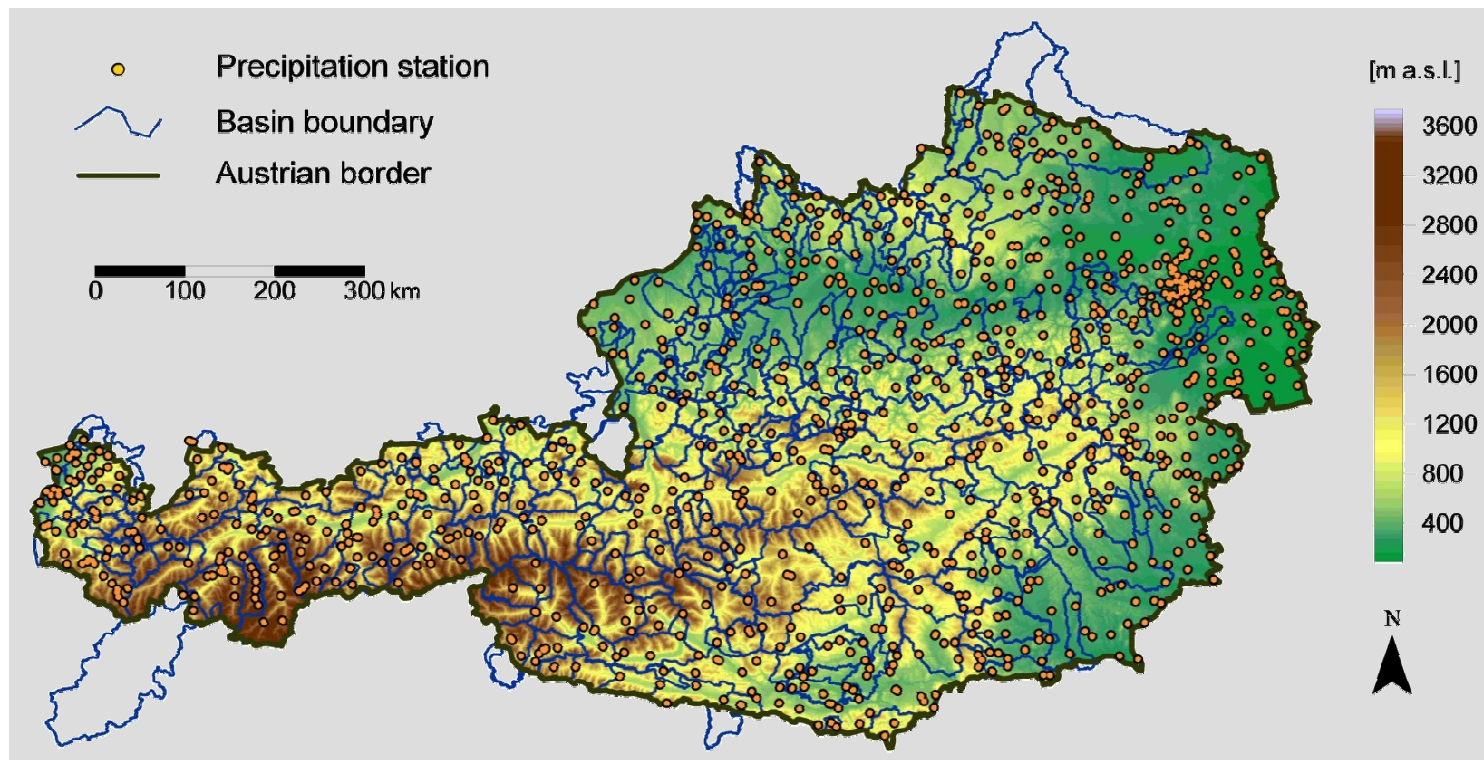


The Institute for Hydraulic and Water Resources Engineering of the TUW is the leading Austrian institution in the area of regional hydrology among other expert areas.

The Institute provides advice to governments and the industry in matters related to water resources management and planning

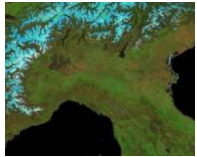
Hydrologic dataset (1976-2005):

- Precipitation, snow depth (1091 stations)
- Air temperature (212 stations)
- Runoff (148 basins, 10 km<sup>2</sup> - 10 000 km<sup>2</sup>)

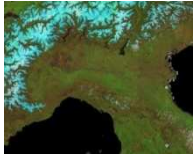


# Assimilation of EO data in Hydrological models

## MODIS (EOS-TERRA) images



23 April 2004



07 April 2004



09 May 2004



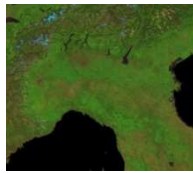
10 June 2004



26 June 2004



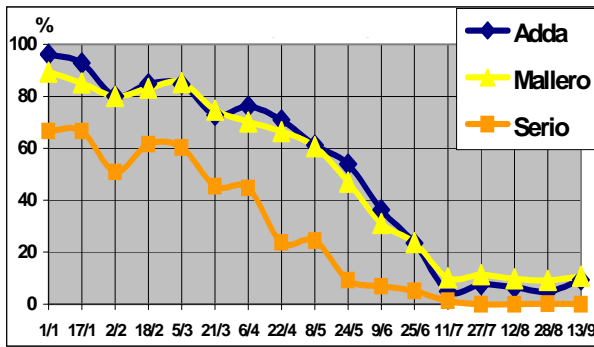
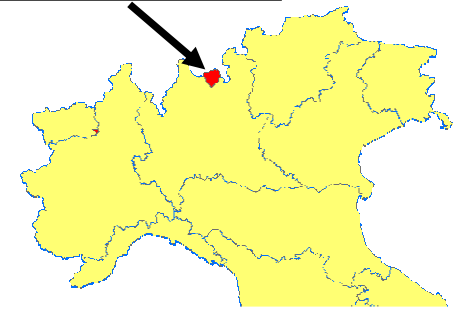
12 July 2004



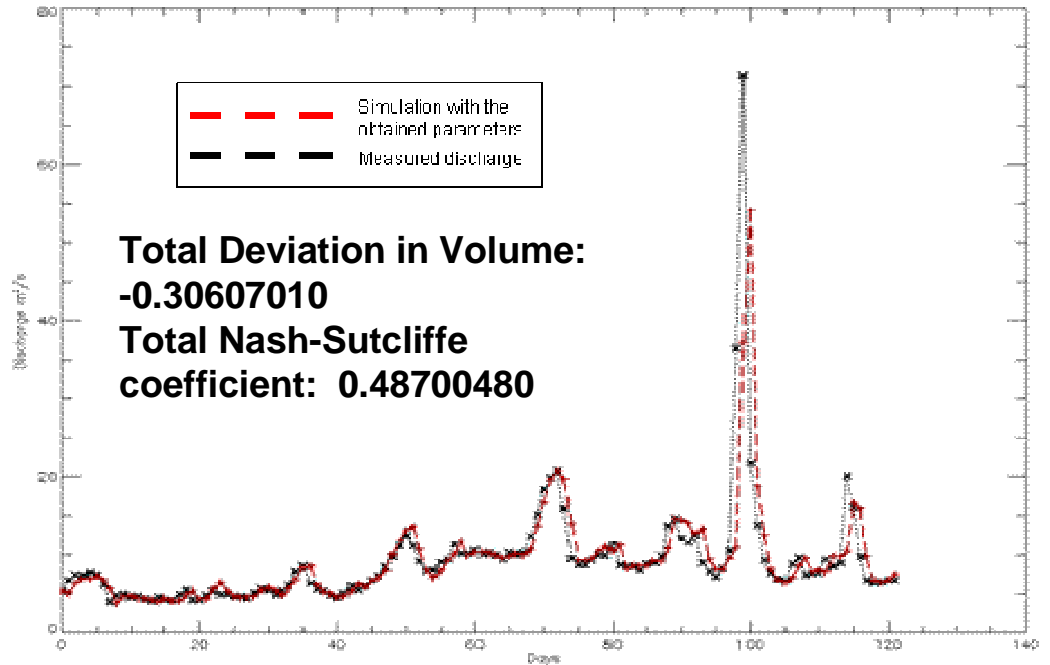
28 July 2004

## Italian example

Mallero basin



Trend of percentage of snow cover in Lombardy Region



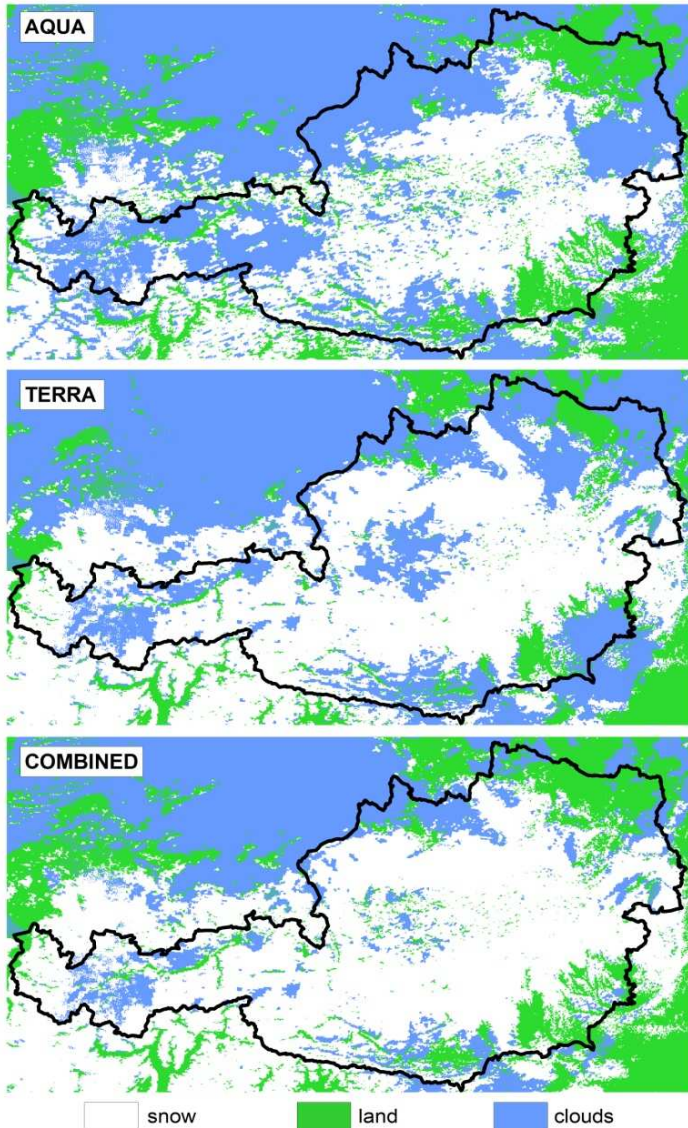
2004 (April 1<sup>st</sup>-July 31<sup>st</sup>)

- Spatial Resolution: 250/500/1000 m to nadir
- Temporal Resolution : 12 hours
- Radiometric Resolution: 32 bit/pixel
- Spectral Resolution: 36 bands

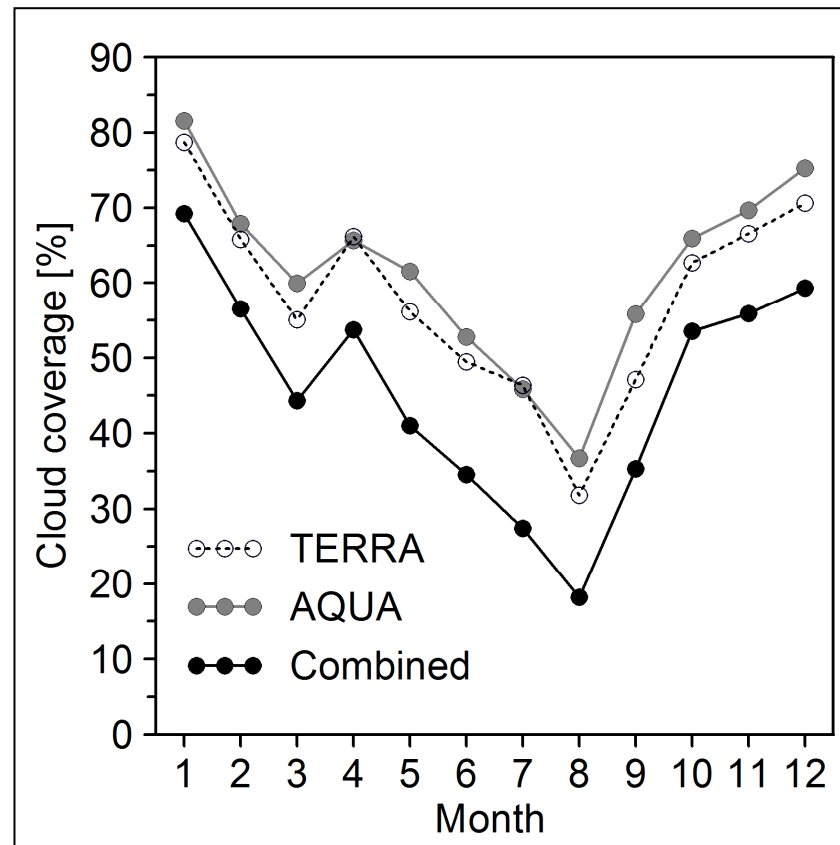


# Assimilation of EO data in Hydrological models

## The Austrian case



EO dataset (2002-2005):  
MODIS combined snow cover product

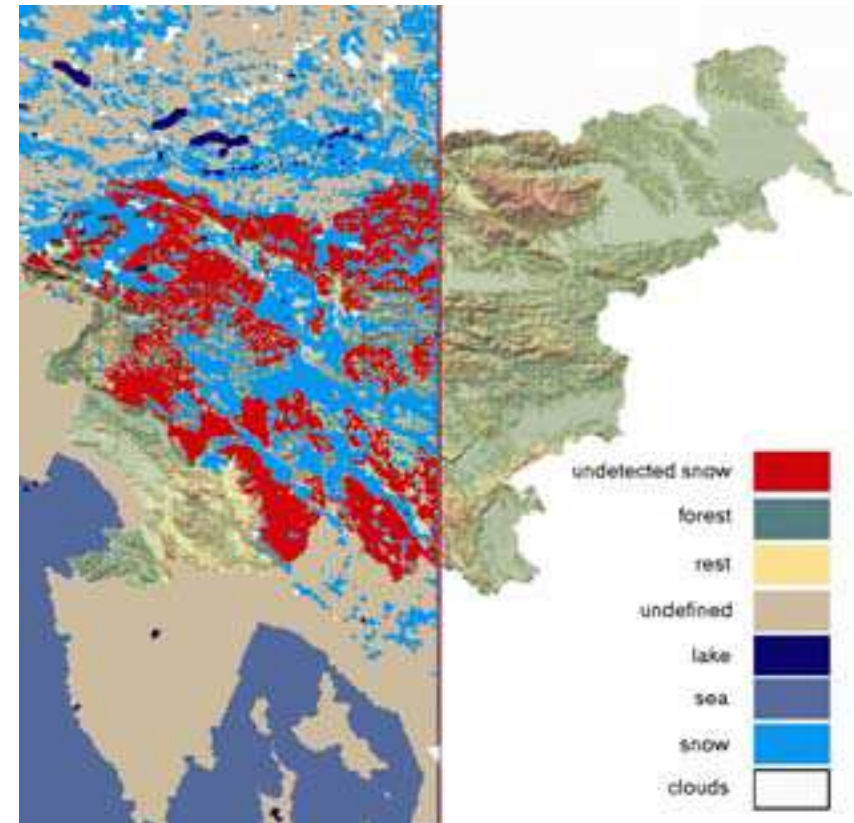


# The groundwater impact on runoff formation

## The Slovenian case

Sava River contributes approximately **25% of the Danube's total discharge** and has a drainage area of approximately 96 400 km<sup>2</sup>.

The Sava river basin is the most flood-threatened region in Slovenia.

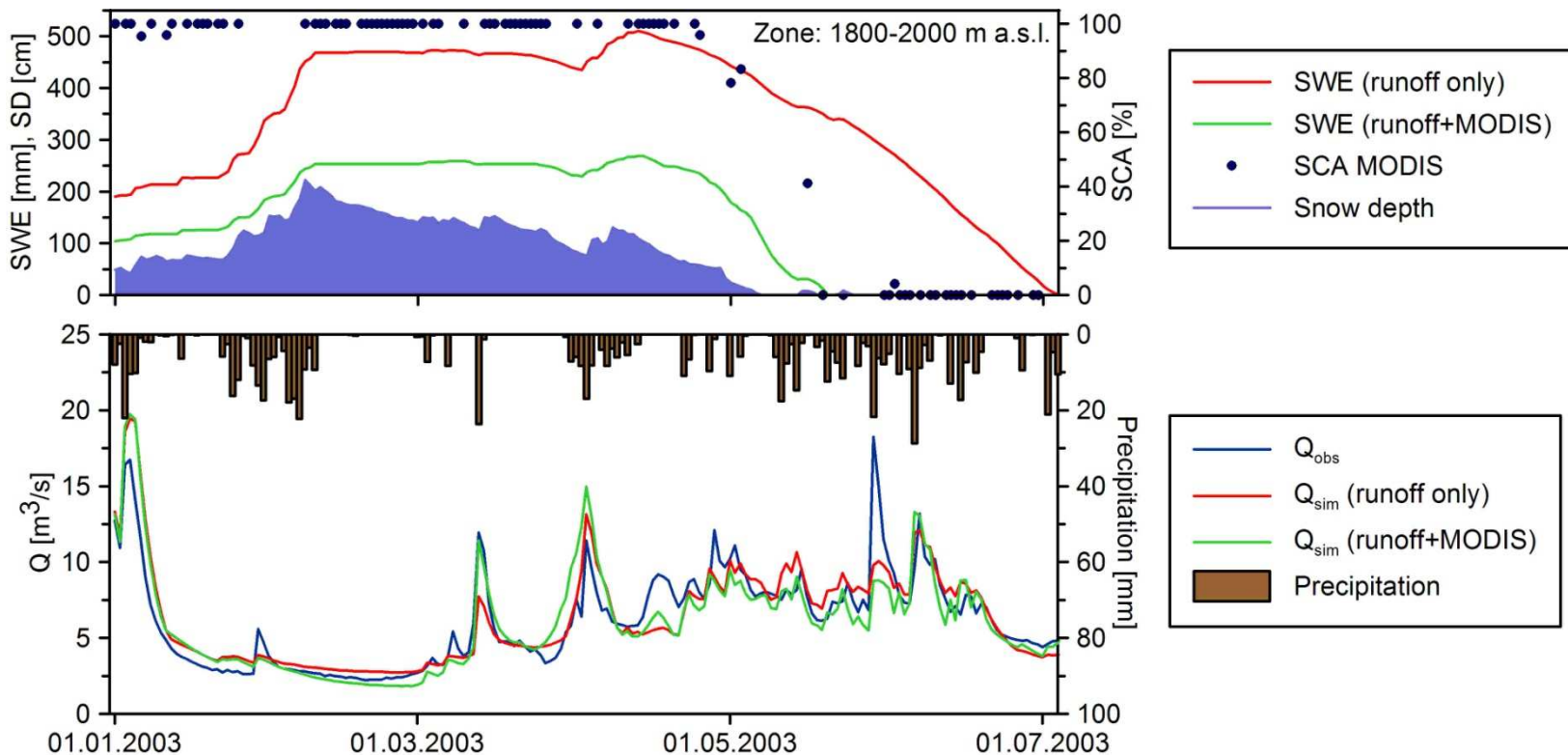


Vectorized areas under snow, 24 February 2003, Republic of Slovenia.

Area of Ljubljansko Polje aquifer.  
In RED: Groundwater level measurement stations at wells Kleče and Hrastje

# Assimilation of EO data in Hydrological models

## TUW-HBV conceptual semi-distributed hydrologic model



- EO snow cover data assimilation improves the snow model performance and slightly runoff model performance in the verification period
- Data availability is the major factor that controls the added value of data assimilation (improvements mainly in catchments with limited direct observations)



<http://www.aware-eu.info/>

# THE AWARE GEOSERVICE

The **Aware geo-service** is a geo-application accessible by a standard web interface, allowing to access remote information and processes

The screenshot displays the AWARE Geoportal interface in Mozilla Firefox. The browser address bar shows the URL <http://geoportal.dsi.uji.es/aware/dataCollectionSRM2.do>. The page title is "SRM Model Calibration > Data Collection And Consistency (step 1)" and the subtitle is "Availability and consistency of EO data (step 1.3)". The user is logged in as "carles".

The interface is divided into several sections:

- Basin Information**: A section for providing details about the study area.
- Manual Service Catalogue**: A section for manual data selection.
- Automatic Service Catalogue**: A section for automated data selection based on search criteria.

The **Automatic Service Catalogue** section includes a search form with the following criteria:

- Keyword: AWARE
- Bounding Box: 9.7142,46 -16.79 10.0013,46,381
- Time period: from 01-abr-2003 to 31-jul-2003

The search results are displayed in a table with columns for Identifier, Projection, and Date. The table contains several entries, including snow cover area products and MODIS data.

The **Google Maps Viewer** section shows a satellite map of a mountainous region with a blue outline indicating the basin boundary. Numerous red markers with numbers (e.g., 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100) are overlaid on the map, representing specific data points or stations. The map includes a scale bar (0 to 2 miles / 0 to 5 kilometers) and a legend.

Find and handle the satellite data needed for model use

<http://www.aware-eu.info/>

# THE AWARE GEOSERVICE

The **Aware geo-service** is a geo-application accessible by a standard web interface, allowing to access remote information and processes

The screenshot displays the AWARE Geoportal interface in a Mozilla Firefox browser window. The page title is "SRM Model Calibration > Data Collection and Consistency - Mozilla Firefox". The browser address bar shows the URL "http://geoportal.dlsi.uji.es/aware/dataCollectionSRM2.do". The page content includes the AWARE logo with the tagline "imaging water from snow" and the breadcrumb "SRM Model Calibration > Data Collection And Consistency (step 1) > Availability and consistency of EO data (step 1.3)". A user login "User: monica [Log out]" is visible in the top right.

The main content area is divided into two sections:

- Basin Information**: A section with a "Manual Service Catalogue" and an "Automatic Service Catalogue" containing 8 records. The records are listed in a table with columns for Identifier, Projection, and Date.
- Google Maps Viewer**: A satellite map showing a catchment area outlined in blue. The map includes a scale bar (0 to 2 miles / 0 to 5 kilometers) and a small inset map of the region.

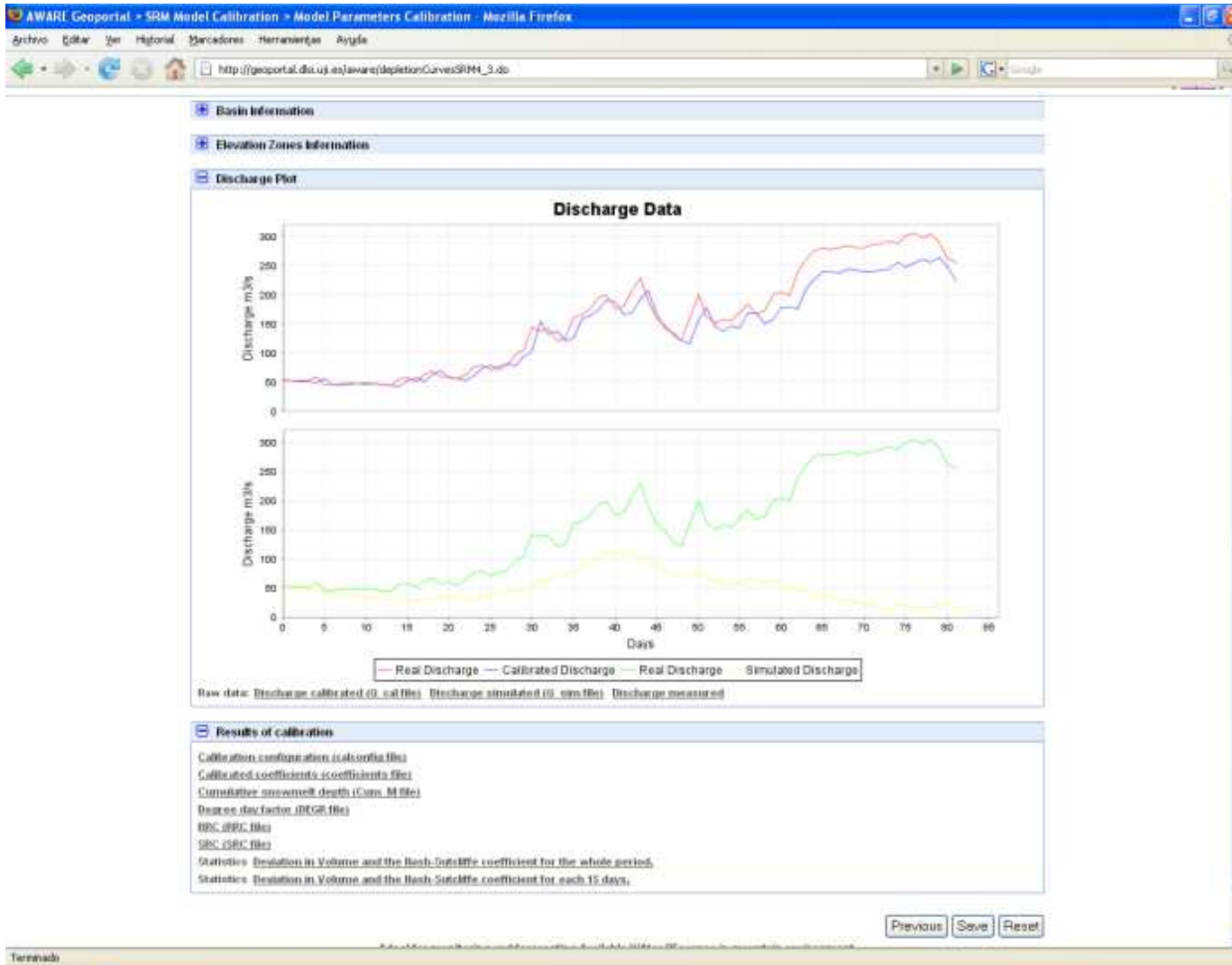
Identifier	Projection	Date
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<i>AWARE project Snow Cover Area products rel. 3 as obtained by satellite data (sensor MODIS, Products: MOD02 and MOD35) over the Alps in GEOTIFF format</i>		
<input type="checkbox"/> <a href="#">AWARE_SCA3_2003-04-13_33N_TIFF</a>	EPSG:32633 - WGS84 / UTM zone 33N	13-apr-2003
<i>AWARE project Snow Cover Area products rel. 3 as obtained by satellite data (sensor MODIS, Products: MOD02 and MOD35) over the Alps in GEOTIFF format</i>		
<input checked="" type="checkbox"/> <a href="#">AWARE_SCA3_2003-05-03_32N_TIFF</a>	EPSG:32632 - WGS84 / UTM zone 32N	3-mag-2003
<i>AWARE project Snow Cover Area products rel. 3 as obtained by satellite data (sensor MODIS, Products: MOD02 and MOD35) over the Alps in GEOTIFF format</i>		
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<i>AWARE project Snow Cover Area products rel. 3 as obtained by satellite data (sensor MODIS, Products: MOD02 and MOD35) over the Alps in GEOTIFF format</i>		
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<i>AWARE project Snow Cover Area products rel. 3 as obtained by satellite data (sensor MODIS, Products: MOD02 and MOD35) over the Alps in GEOTIFF format</i>		

**Integrate** remote and local data on the catchments of their interest

<http://www.aware-eu.info/>

## THE AWARE GEOSERVICE

The **Aware geo-service** is a geo-application accessible by a standard web interface, allowing to access remote information and processes



Run models on the catchments of their interest to obtain **discharge forecast**



# GEOSERVICES: TERRITORIAL DATA FOR INFORMED DECISION MAKING

## Example:

**Integration of the Atlas of historical cadastral and topographic maps with space and other source data for water courses identification and analysis in an SDI framework**

- Experiments done by Polimi-BEST and CNR-IREA within a framework of Italian project **Atl@nte** (2009-2011)
- Project funded by CARIPLO Foundation, Milano (Italy)
- Partners:
  - Politecnico di Milano, Dept. B.E.S.T. (Lead Partner)
  - National Archive of Milano (ASMi)
  - Cadastral Administration (Agenzia del Territorio – AdT)
  - Centro Studi PIM
  - Regional Administration of Lombardy
  - Municipality of Gorgonzola (Lombardy)
  - CILEA inter-university consortium
- Currently available @ URL: [www.atlantestoricolombardia.it](http://www.atlantestoricolombardia.it)

# GEOSERVICES: TERRITORIAL DATA FOR INFORMED DECISION MAKING

STUDY CASE: ADDA RIVER | Landsat TM image (1999) provided by CNR-IREA WMS

**Possibility to integrate with ANY OGC compliant WMS like other CORINE layers, Regional database (IT2000, thematic vector files etc.)**

**Adda river: Landsat TM image at 1:100.000 provided by CNR-IREA WMS superimposed to EEA WMS (Water bodies).  
Macro transformation of the river bed visible!**

# GEOSERVICES: TERRITORIAL DATA FOR INFORMED DECISION MAKING

STUDY CASE: ADDA RIVER | Landsat TM image (1999) provided by CNR-IREA WMS



**A detail of the Censuary Section of Trezzo and Concesa. The ancient archaeological area of Trezzo, with roman and Lombard settlements along the river Adda and its riparian area, asks for further investigation, analysis and classification of higher resolution thermal images.**

## Conclusions

- AWARE constituted an **effective test-bench** to integrate remote sensing images with traditional data and models
- AWARE will provided **tools** to easily and friendly bring users to the use of remote sensing images
- AWARE will allow the user to **forecast snow water** without diffusing private data
- AWARE represents the answer to the effort promoted by **GMES** of **bringing data and information providers together with users** (<http://www.gmes.info>)
- The Aware geo-service is **compliant with INSPIRE** initiative aiming to trigger the creation of a European spatial information infrastructure that delivers to the users integrated spatial information services (<http://inspire.jrc.it/>)
- Geo-service that are compliant with INSPIRE ensure **data interoperability** accross Europe → **infomed decision making** at national, regional and trans-regional level

**Thank you for your attention!**

**For more info contact AWARE project coordinator**

**Ana Rampini**

**[rampini.a@irea.cnr.it](mailto:rampini.a@irea.cnr.it)**