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ACRONYMS

CEO	Centre for Earth Observation
DEM	Digital Elevation Model
EC	European commission
EO	Earth observation
FP5	Framework programme 5
HydAlp	Hydrology of Alpine and High latitude Basins
IST	Information Society Technologies
KSAT	Kongsberg Satellite Services
LfW	Bavarian Water Management Agency
LREC	Lapland Regional Environment Centre
NVE	Norwegian Water Resource and Energy Directorate
R&D	Research and development
ROF	Runoff forecast
SA	Snow Albedo
SAR	Synthetic Aperture Radar
SCA	Snow Covered Area
SM	Soil Moisture
SMHI	Swedish Meteorological and Hydrological Institute
SST	Snow Surface Temperature
SW	Snow Wetness
SWE	Snow Water Equivalent
SYKE	Finnish Environment Institute
TIWAG	Tiroler Wasserkraftwerke
URD	User requirement document
WP	Work package
WWW	World Wide Web

APPLICABLE AND REFENCE DOCUMENTS

[R-1] EuroClim – Deliverable 1 – User requirements report, Draft Delivery, Contract noIST-2000-28766

[R-2] HydAlp - Hydrology of Alpine and High Latitude Basins, Final Report.

[R-3] Requirements for Supplementary Climate Observing Network from National Plan for Cryospheric Monitoring – A Canadian Contribution to the Global Climate Observing System, Appendix 4.

[R-4] Snow-Tools – User requirements for a satellite snow data service WP 710, Contract no: ENV4-CT96-0304

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1 INTRODUCTION

The EnviSnow project is a research project supported by the EC under the FP5 and contributing to the implementation of the Key Action Research and Technological Development Activities of a Generic Nature within the Energy, Environment and Sustainable Development, contract n°: EVG1-2001-00052. The overall goal is to develop and validate new and improved multi-sensor algorithms for retrieving snow and soil parameters from Earth Observation (EO) data. Improved EO-based snow and soil information will be used in global climate study and hydrology, in particular for runoff and flood prediction. The project duration is from 2002-2005.

Assessment of the user requirements is an important first step in the EnviSnow project. Collecting and analysing the various user requirements for an operational snow information system throughout Europe will be conducted for the other work packages of this project.

This report (D1-WP7) covers the first user requirement collection, i.e. task 1 of WP 7. A final user requirement document (D2-WP7) will be written after the evaluation of the demonstrations in WP 6. The work of this task was carried out during the first half of 2002.

The objective of this report is to gather relevant user requirements for guidance to the other WPs of the EnviSnow project. In particular, it is important to achieve information on which products the project should focus on and also input to what is needed for the development of these products. The report is public and will be distributed to DG for Research of the EC.

Kongsberg Satellite Services (KSAT) is responsible for WP 7 and is also responsible for the work in this task. However, all other partners have contributed to the work in order to ensure that the experience and knowledge of the entire consortium are included when establishing the user requirements.

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2 METHODOLOGY

The methodology for collection of user requirements is based on the experience of Kongsberg Satellite Services and the other project partners. There has already been performed user requirement collection in other hydrology projects both in Norway and in Austria, and the results from these projects have been the starting point for the project [R-1, R-2, R-3, R-4].

The tasks to be carried out are illustrated in figure 1. The figure also gives an overview of the contributions from the partners of the consortium.

The project focuses on three geographical market segments, Norway/Sweden, Finland and Austria/Italy. The partners of the project are all within these three areas. These market segments have different topographic characteristics; mountains in South Norway, boreal forest in Finland and boreal forest in the Alpine region in central Europe. The approach of colleting user requirements in these three market segments was the same.

A draft methodology and a work plan based on the model described in figure 1 were presented to the project consortium at a user requirements session at the kick-off meeting. This draft was based on both the collection of user requirements through interviews with selected end users and analysis of this information. Discussions at this meeting revealed that several other studies within hydrology had already addressed similar user requirements. Therefore the need for an extensive information collection process was reduced.

Hence, the methodology was changed to focus extensively on studies of existing user requirements documentation. Consequently, the number of planned interviews was reduced.

The users have not been asked to consider the cost-benefit issues. This will be covered in the second part of the user requirements assessment towards the end of the project as well as in the market evaluation.

The main reason for excluding cost benefit assessments is that we consider this to be immature to this phase of the project. The cost related to the EO data (in particular SAR), is expected to change over the project period, and also today's pricing model have to be modified for this type of services.

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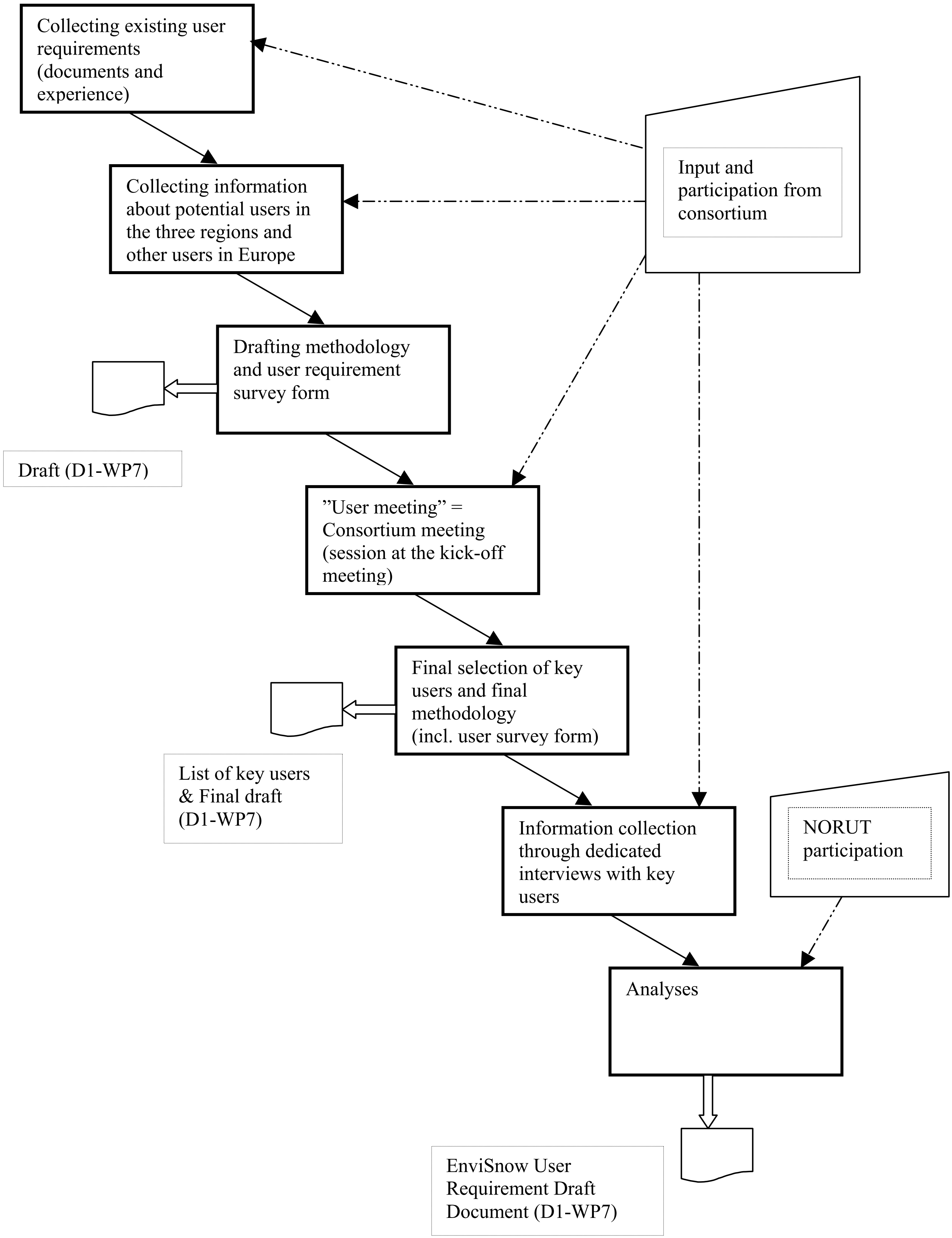

Figure 1. Methodology

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Collecting existing user requirements
Over the past few years there have been other projects within hydrology where user requirements have been established and assessed, eg. SnowTools, EuroClim and HydAlp [R-1, R-2, R-3]. There have been arranged dedicated user meetings on the subject and the results of these previous projects were collected in the EnviSnow project consortium. These were used as the draft set of user requirements. These studies cover the three geographical market segments of this project as well as other market segments ie. Great Britain and Canada.

The reports from these projects have been analysed. These reports have also been used for selecting candidates for information collection. The strategy has been to contact users in market segments or user groups where the existing knowledge on user requirements were poor or non-existing.

Collecting information about potential users in the regions
The consortium has members from all three geographical market segments. Their knowledge about the market and potential users has been used to identify relevant user groups and users.

Draft methodology
Kongsberg Satellite Services has prepared a draft methodology and a user requirement survey form used at the interviews. These were presented to the consortium at the project kick-off meeting =user (consortium) meeting, and revised thereafter.

User (consortium) meeting
During the kick-off meeting there were a dedicated session on user requirement collection. The objective was to gather relevant knowledge and experience and to agree upon the methodology for the user survey.

Final selection of key users
The selection of key users to be contacted for personal interviews was done after the user (consortium) meeting. Since the number of existing user surveys turned out to be higher than anticipated, the number of interviews was reduced and more effort was dedicated to analysis of the existing documentation of user requirements.

Information collection
Information was collected through personal interviews at dedicated meetings and a few were preformed by telephone. Most interviews were done by KSAT, and the EnviSnow Project Manager (NORUT) participated in some of them. The end users within the consortium filled in the survey by themselves. In Finland SYKE was responsible for all of the interviews.

Analysis
The final analysis of the new information collected through the interviews were done by the KSAT project team with additional support from the EnviSnow project manager and the project team at NORUT.

The conclusions were made on the basis of both information from the existing user surveys and the new information from the interviews in this project.

The resulting documentation (this document) information was put together to provide guidelines to the project on what user requirements to focus on. An updated document (D2-WP7) based on the project results and finding will be provided at project end.

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3 EXISTING DOCUMENTATION OF USER REQUIREMENTS

Over the past few years there have been several studies on cryospheric user requirements. The results of existing user requirement studies known to the consortium, have been analysed and used as a draft set of user requirements. A summary of relevant results is given below.

3.1 EuroClim – European Climate Change Monitoring and prediction System

EuroClim is a project within the EC IST program. Its aim is to develop an advanced climate monitoring prediction system for Europe. The user requirement study in this project was by interviewing 25 professionals (mainly scientist working in the field of global warming and climate change research) and 25 public users (non-scientist users). The survey was carried out in January 2001 [R-1].

In this survey the need for different cryospheric variables for climate monitoring and prediction has been examined. Values for required spatial resolution, temporal resolution (how often data is needed) and accuracy have been obtained.

The most commonly required cryospheric parameter was found to be snow cover and snow temperature, rated by 92% and 68% of professional users respectively as very important or essential. Frequently specified requirements for snow on land variables are presented in the Table 1 below.

	Albedo	Snow Coverage Area	Snow Temperature	Snow Wetness
Spatial resolution	1 km- 10 km	1 km	1 km	1 km
Temporal resolution.	7 day	daily - 5 day	daily	7 day
Precision	1 - 5%	10%	1°C	10%

Table 1 Most important snow on-land variables from the EuroClim user requirement survey [R1].

3.2 SnowTools

Snow-Tools (research and development of remote sensing methods with main focus on snow hydrology) was a research project within the European Environment and Climate research and technological development program. The main objective was to extract snow cover extent and snow properties from multitemporal and multisensor earth observation data, and to use these as input to modified hydrological models for improved snow melt runoff prediction.

The user requirement survey performed in Snow-Tools was carried out among 10 potential users of remotely sensed snow data in February 1997.

The Snow-Tools survey showed that Snow Water Equivalent (SWE) is the most important variable for water resource planning and management. The information on available amount of water within a catchment is the basis for production planning in Norway and Finland within a time scale of weeks to months, and in Great Britain for a time scale of days. The amount of snow on a regional level affects the expected energy prices. This information is therefore important in the whole commercial energy market.

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For flood forecasting and short term runoff simulation, snow covered area (SCA) is more important. Meteorologist focus on albedo and snow cover data, and temporal resolution and delivery time is more important than in water resource management. For avalanche use, most snow variables except water equivalent are important, several of them in depth profiles. Hourly delivery of snow parameters with spatial resolution of 50 meters is required.

Application	**Product**	**Spatial unit**	**Classification**	**Accuracy**	**Update freq.**	**Delivery time**
Water Resource Management	SWE	Elevation zones within catchment		10% uncertainty in each elevation interval. 200 –500 metres (small catchm.) 1 km for large baisins	Weekly (spring) Monthly (winter).	1-2 days
Flood Forecasting	SCA	Elevation zones within catchment	5-8 steps	10% uncertainty in each elevation interval. 200 –500 metres (small catchm.) 1 km for large baisins		Hours – 1 day
Meteorological modelling	Albedo	Tens of kilometers	5% steps	low *)	High *)	High
	SCA	Tens of kilometers	5-10 classes	low	High	High
Avalanche	SCA	50 m			daily	
	Others (not SWE)	50 m			hourly	< 1 hour

Table 2 Summary of results from SnowTools user requirement survey.
*) Not possible to obtain quantitative measurements.

3.3 HydAlp

HydAlp (Hydrology of Alpine and High Latitude Basins) was a shared cost action project of the Centre for Earth Observation (CEO) Programme within the Environment and Climate Programme of the 4th Framework Programme of the European Commission. The main project tasks included the improvement of methods for satellite data analysis, the modification of hydrological models for Earth Observation input, and the demonstration of the application in a pre-operational environment. The project was carried out 1997-1999.

The requirements for hydrological modelling and forecasting were defined with the help of potential customers. HydAlp established a Customer Focus group as a tool to interact with customers. Four areas of customer interest in operational use of hydrological modelling were identified.

- Hydropower production
- Insurance and flood prediction
- Environmental monitoring
- Sport and leisure

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Hydropower production and flood forecasting were the most important application areas for operational EO based snow information.

For the hydropower industry, interests are in the final information outputs, not in the remotely sensed imagery. The ideal primary needs were:

- Short term runoff forecasting (1-5 days); next day delay
- Flood forecasting: short term, same updating frequency but separate from runoff forecasts.
- Snow water equivalent (total catchment resource): Once a week to once a month with 1 – 2 weeks delay and ground resolution of 100 – 200 metres.
- Total melt water storage: Once a week to once a month; long term trend predictions.
- Snow location: temporal change of snow extent and melting condition.

The insurance industry is reactive to flooding events. EO data, hydrological snowmelt and runoff models, could also be used along with improved DEMs, and land cover maps, to enable the targeting of flood protection in high-risk areas.

Within the environmental group snow information is of interest for flood prediction improvement. Areas of interests are:

- Snowpack extent and location.
- Type/composition (water equivalent and depth).
- Prediction of quantity in reserve.
- Flood forecasts.

For the sports and tourists group remote sensing imagery to measure snow extent is not directly useful.

The Swedish Meteorological and Hydrological Institute (SMHI) representing the Water Management Industry, have also provided an evaluation of the HYDALP products for a basin in northern Sweden. For Swedish hydropower companies with large reservoirs, forecasts over longer periods are often of more interest.

In discussions with Swedish Energy brokers the key appears to be a question of trusting the runoff forecast. If it can be trusted, reservoirs can be operated with smaller margins, saving extra water to be used later when prices are higher. Because of the size of Swedish reservoirs, a few metres of height saved gives a substantial storage capacity and thus huge estimated profits.

The HYDALP project concluded that EO-based models may be favoured under the following conditions:

- In large basins where the tooling up of the EO-based model is simpler and where the snowpack is usually difficult to estimate or infer from other information sources
- In remote regions where the availability of in-situ meteorological observations is inadequate.

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3.4 Canadian National Plan for Cryospheric Monitoring

Within Canada, the Meteorological Service of Canada, provincial water resources agencies and hydroelectric companies conduct “snow course” observations in support of water resource operation and planning, e.g. flood and drought forecasting, soil moisture recharge, water supply, and reservoir management. The data are also used by climate research community and for validation of physical models.

As part of the work on a National Plan for Cryospheric Monitoring, the Canadians have done a study on the value and applications of data for snow cover and snow depth [R-3]. The interviewed made frequent to occasional use of observations of snow on the ground, many citing them as very important data.

Interviewees identified snow on the ground data and networks of point measurement stations as important for the following operational applications:

- Engineering applications such as National Building Code design snow loads
- Estimation of spring runoff
- Flow and flood forecasting
- Hydro operations
- Recreational and tourism applications – skiing, snowmobiling
- Snow removal
- Forecasting applications
- Pavement forecasting
- Initialisation of the Fire Weather Index (in spring)

Snow on the ground observations were stated to be very important for climate and Numerical Weather Prediction modelling and frequently used for these purposes. A modelling requirement was identified for water equivalent observations with “season-beginning” snow water equivalent being used in testing land surface models and validating parameterisation schemes. It was also pointed out that observations of snow have long time series and that this is very important in the context of studies of climatic variability and change, particularly as the database spans a period of warming in the Arctic.

In-situ observations of these variables were also regularly used to evaluate or assess satellite data retrievals and to understand the performance of algorithms. It was suggested that remote sensing could optimise networks for snow on the ground but could not eliminate the need for in situ observations.

3.5 Meteorological requirements

Meteorological Global Data Processing System Centres requires snow depth observations with horizontal resolution of 100 km, temporal resolution of 1 day and accuracy (RMS error) of 10%. They also require water equivalent on the same spatial and temporal scale with an accuracy of 5mm.

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3.6 Summary

The results from the user requirement assessment provided from the previously referred work [R-1, R-2, R-3, R-4] can be summarised as:

- Water resource management and flood forecasting are the most important application areas for operational EO-based snow-information.

- SWE is the most important parameter for water resource planning and management.

- The hydropower industry is interested in short term runoff and flood forecasting with a temporal resolution of 1-5 days with one day delay. SWE should be (total catchment resource) updated once a week – once a month with 1-2 weeks delay and a ground resolution of 200 metres. Total melt water storage – long term trend prediction, snow location and melting conditions.

- SCA is important for flood forecasting and short term runoff simulation. Prediction of quantity in reserve and type/composition (SWE + depth) is also of interest.

- Snow cover and temperature are the most commonly requested snow-on land variable among scientists working in the field of global warming and climate change. These parameters are required daily, with a spatial resolution of 1 km.

- Meteorologist focuses on Albedo and snow cover. Albedo is used for calculating the energy between the ground and atmosphere. Temporal resolution and delivery time are the most important.

- Temporal update expressed by the Nordic hydrology users, generally range from once or twice a week to monthly, emphasising the spring flood as the most critical period. In UK where short snowmelt events may occur, daily data is required. A Norwegian remote sensing snow product should be delivered weekly during melt seasons, while monthly data is sufficient throughout the winter.

- Satellite observation of snow is most valuable in mountain areas. Here the spatial variation and uncertainty is larger than at lower altitude.

- EO-based hydrological models may be favoured in large basins where tooling up of the EO-based model is simpler and where the snowpack is difficult to estimate or infer from other sources and in remote regions where the availability of in-situ meteorological observations is inadequate.

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4 COLLECTION OF ADDITIONAL USER REQUIREMENTS

4.1 Consortium user requirement assessment

At the consortium meeting there was a dedicated session dealing with the user requirements. The list of possible snow products was discussed and it was agreed that this list of products should be the basis for the user requirement study and hence for the development of the user survey form (ref. Appendix A). The complete list of snow products to be investigated in this project is:

- Snow cover area (SCA)
- Snow water equivalent (SWE)
- Snow albedo (SA)
- Snow surface temperature (SST)
- Soil moisture

The major conclusion from this meeting was that the project should focus on the two products that users likely are most interested in:

- Snow Covered Area (SCA)
- Snow Water Equivalent (SWE)

Furthermore, it was agreed that efforts should be made in order to make a product available on WWW as soon as possible, i.e. during the melting season of 2003.

The consortium agreed not to make another extensive user requirements survey, but to use the existing documentation on user requirements and to just add interviews in user groups and/or market segments that are poorly covered.

4.2 Market model

Based on studies of the existing documentation of user requirements and the discussions in the kick-off meeting a model of the market was developed, see figure 2. The model has been used to identify user categories and the products that should be provided to these users:

User category I represents users that receive raw satellite data for processing of level 0 and level 1 products. Such users are typical data providers, e.g. Kongsberg Satellite Services.

User category II represents users that use the level 0 or level 1 data products to produce level 2 snow products, e.g. Kongsberg Satellite Services, SYKE.

User category III represents end users of the level II snow products and/or users that use level 2 products as input to produce level 3 snow products, e.g. NVE, SYKE.

User category IV represents end users of level 3 snow products, e.g. Verbund.

The model has also been used for the selection of additional users as well as to prepare the user requirement survey form (ref. Appendix A).

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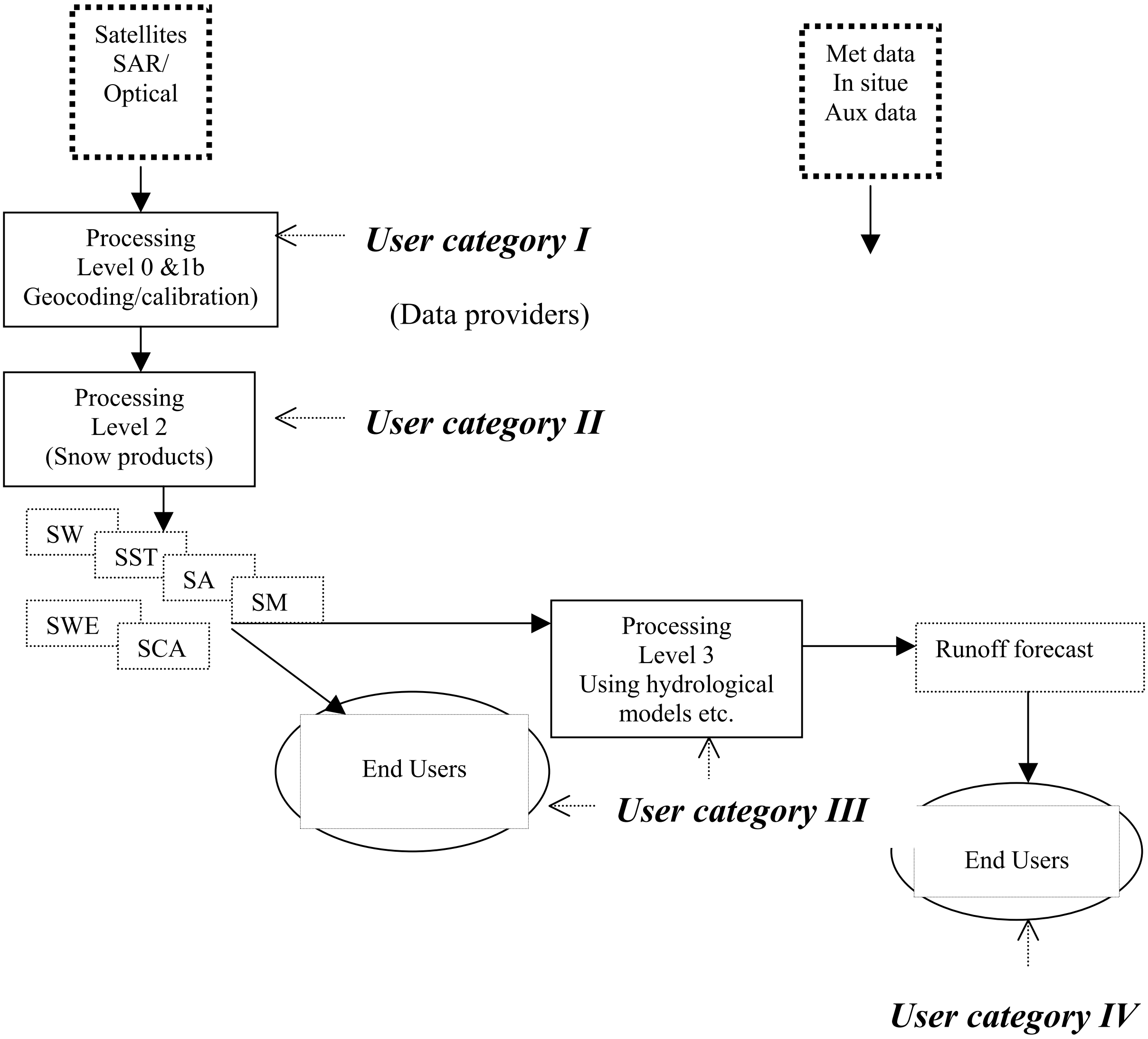

Figure 2. Market model, EnviSnow project

Definition of processing level:
Level 0: Reformatted, time-ordered satellite data (no overlap), in computer-compatible format
Level 1b: Geolocated engineering calibrated products
Level 2: Geolocated geophysical products
Level 3: Products processed including other sources of information

Definition of snow products:
SCA: Snow Covered Area
SWE: Snow Water Equivalent
SA: Snow Albedo
SW: Snow Wetness
SST: Snow Surface Temperature
SM: Soil Moisture

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4.3 Selection of key users for interview

The existing documentation of user requirements is based on interviews and user meetings with selected end users with an interest in water management and other hydrological services.

Within this documentation there are user groups and/or geographical market segments where almost no requirements assessments studies have been performed. These are:

- Italy (none)
- Austria (only one hydropower production company)
- Germany (none)
- Switzerland (only one within avalanche warning)
- France (none)
- Finland (only one within water resource management)
- Sweden (only one within water resource management)
- Energy brokers (none)
- Consultants (only in the UK)

The project agreed to focus on users in mountainous regions and in the northern part of Europe where snowmelt is an important factor for runoff. KSAT, as an Earth observation service provider, is also focused on the potential for developing an operational EO-based snow product service. We therefore concentrated on user groups expected to be the most important users of operational EO-based snow information. Earlier studies have concluded that water resource management and flood forecasting are the most important application areas for operational EO-based snow information, and we decided to focus on national and regional authorities on water management and hydropower production companies. Meteorological offices where also contacted as they provide hydrological forecasts for these user groups. We also decided to contact energy brokers, since they might have a commercial interest in snow information and improved runoff prediction since the availability of hydropower energy effects the electricity prices.

Based on these facts and discussion within the consortium a selection of users to contact was made, and priority was given to customers in:

- Alpine area in Italy/Austria/Germany/France
- Finland
- Sweden
- Norway

Users from water management organisations, Hydropower companies, Meteorological organisations and energy brokers represented all user categories described in the market model in figure 2.

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5 USER REQUIREMENTS SURVEY

The users contacted in this user requirement survey are categorised into four groups:

- Water and energy management authorities
- Hydropower production companies
- Meteorological organisations
- Energy brokers

This chapter gives a summary of the snow information requirements found for each user group. The temporal and spatial resolution required for each snow parameter is also given. The completed set of questionnaires is found in appendix B.

5.1 Water and energy management authorities

These organisations are national or regional authorities with water monitoring and management responsibilities according to national or international legislation. Their customers are national ministries, hydropower companies, regional civil defence, other national and regional environmental authorities and the public. The information they provide is usually available free of charge for their users.

The following 6 organisations where interviewed:

- **Hydrographic service organisation in Austria (The organisation wants to be anonymous)**
  The organisation is organised under the Central Hydrographic Office at the federal ministery of agriculture forestry environment and water management. The organisation is one of 9 provincial authorities in Austria. Keywords of tasks are water cycle, water balance and quantitative investigations. They also provide high water information and warnings. They do actual measurements of runoff.

- **A.R.P.A.V. (Hydrological Services)- Italy**
  ARPAV works to protect, control and recover the environment, and to promote and protect collective health, making integrated and co-ordinated use of resources with the aim of reaching maximum efficiency in marking out and removing all factors that put man and his environment at risk. The ARPAV is composed of Central Management, seven provincial Departments and three Technical Regional centres. The Avalanche Centre of Arabba is one of the regional centres which work on snow avalanches, ecosystem protection and mountain hydrology fields.

The Hydrological Service of South Tyrol - Italy
Observation, registration and derivation of the hydrological cycle of South Tyrol – Alto Adige. The office is also an operational unit providing all kinds of hydrological warnings and hydrological risk planning tools. They also provide operational avalanche warnings and local weather service. Observation of glacier mass balances and variations is also part of their work.

- **Bavarian Water Management Agency (LfW) - Germany**
  Bavarian Water Management Agency is the supreme technical-scientific authorities for water management in Bavaria and is subordinate to the Bavarian State Ministry for Regional

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Development and Environmental affairs. They are responsible for the fundamental technical and scientific issues related to water management for Bavaria. The department interviewed is responsible for Surface water, Quantitative determination, Catchment hydrology and flood information and warning services.

- **The Lapland Regional Environment Centre (LREC) – Finland**
  The Lapland Regional Environment Centre is part of the Finnish environmental administration. They are the regional authority for flood warnings and the distributor for water level and discharge information. Major tasks are:
  - Environmental protection
  - Environment research and monitoring (hydrological and water quality monitoring, environmental effects research, fish and fish stock research and monitoring, sampling and the field measurements)
  - Land-use and conservation
  - Environmental technology (safety of dams, flood control)

- **Finnish Environment Institute (SYKE) - Finland**
  The Finnish Environment Institute (SYKE) is the national environmental research and development centre of the environmental administration. Research and development in the SYKE deals with changes in the environment, cause and effect relationships, means of resolving environmental problems and effects of policy measures. SYKE is the national environmental information centre, and provides expert services and takes care of certain national and international statutory tasks.

- **Norwegian Water Resources and Energy Directorate (NVE) - Norway**
  NVE is a directorate under the Ministry of Petroleum and Energy. NVE's mandate is to ensure integrated and environmentally friendly management of the country's watercourses, to promote efficient power market and cost-effective energy systems, and to work to achieve a more efficient use of energy. NVE has a central role in flood prevention work and the work to prevent accidents in watercourses, and has the overall responsibility for maintaining national power supplies.

Vattenregleringsføretaken

Vattenregleringsføretaken is a union of several local hydropower companies in Sweden. The water regulation enterprise manages water regulation in six of the longest rivers in Sweden, equal to an area of 1/3 of Sweden. Vattenregleringsföretagen" stands for about 50 % of the Swedish hydropower production.

5.1.1 Snow information requirements

For all these organisations snow information is important to improve the run-off prediction where flood forecasting is the most important application. Snow information is also important for avalanche forecast and for monitoring of water level and discharge. For organisations responsible for energy resource management snow information is used for monitoring of energy potential.

Today these organisations get snow information based on point measurements from meteorological offices or others having ground observing stations i.e. avalanches services. Some of the organisations also operate their own measuring stations for collection of snow depth, SCA and SWE. Today,

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SYKE's hydrological model produces soil moisture information, but there also exist automated measuring points where this information is obtained.

The experience on the use of EO-data varies. SYKE and NVE produce SCA maps from NOAA/AVHRR data, and use the information to correct the snow cover simulated from their models. LfW have experience from research projects using optical data.

None of the interviewed organisations were satisfied with their existing solution for gathering of snow information. Main problems were limitation of single point observations from ground stations. Measuring along snow courses is also very time and cost consuming. Organisations with EO-experience also mentioned weather dependency as a limiting factor with current optical satellites. i.e. better temporal coverage was required. They also wanted improved performance in forest areas.

The interviewees were asked to assess within the range of 0-10 the importance of the snow products (0= not important, 10= very important). The results are presented in table 3.

	SCA	SWE	SA	SST	Runoff forecast	Soil Moisture
Hydrographic Service -Austira	4	3	0	0	10	0
Hydrological office of South Tyrol	10	7	3	7	10	5
ARPAV – Hydrological Service	5	10	0	0	10	0
Bavarian Water management	7-8	7-8	7-8[1]	4	10	0[2]
The Lapland Regional Env. Centre	7	10	0	0	10	7
SYKE	9	10	0	5	10	
NVE	10	10	3	3	10	1
Vattenregleringsføretaken	7	9	1	1	10	5
Mean value	**7.5**	**8.2**	**1.7**	**2.5**	**9.2**	**2.2**

1) Same importance as SWE because they need it to calculate readiness to melt
2) No experience, could be interested in weekly measurements

Table 3 Relative importance of snow parameters

The runoff forecast is overall the most important product and if snow information could be assimilated into hydrological models it hopefully would improve the performance of these models and a better runoff forecast could be produced. The table shows that the snow parameters of highest priority are SWE and SCA. These products are assessed as base products to be used as input to hydrological models. SST is also useful for the hydrological models as it indicates when the snow starts to melt, and it is an important parameter for avalanche warning in the Alpine region.

Soil moisture is also important for runoff prediction, since soil act as water storage for melted snow. It is important to know how much the soil moisture (inner storage) affects the discharge at the end of the melting season. Soil moisture is important if assimilated into the models and improve the functioning of the models.

SWE and SCA are also assessed as useful stand-alone products. In areas where snow melts is an important factor for runoff, SWE is considered as the most important parameter. SCA is used for visual validation of snow extent, and it is applied as auxiliary information to validate runoff forecasts.

In Alpine areas snow melting does not contribute considerable to flooding during melt season. In these areas the amount of rain is more important. Since precipitation above the snow line does not contribute to flooding information on SCA combined with elevation data is the most important snow product.

Other issues derived during the interview:

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- Time series of data is very important.

Standardisation of information is important.

5.1.2 Temporal and Spatial Requirements.

The interviewees were asked to indicate spatial and temporal requirements for each product of interest. The result is presented in table 4below.

	Product	Seasons	Temp. resolution	Time Constraints	Spatial resolution	Geometric accuracy	Thematic accuracy
Hydrogr. service Austria	SCA, SWE	May - October	Daily (high risk), Weekly (non-risk)	6-12 hours. In the morning.	1 km	Sub-pixel	Steps of 10, 10% accuracy
Hydrological Service of South Tyrol	SCA	Nov-May	every 75 day	~1 day	200 m		10%, but varies for different
		May- Oct	every 12 day	~1 month ?	200 m		
	Runoff Forecast	May - Nov	every 10 day	~5 hours	200 m		
		Nov-May	every 30 day	~1 day	500 m		
	SST	Nov-May	every 10 day	~3 hours	50 m		10%
ARPAV	SCA,SWE	December –July	every 20 day	2 days	50 m	50 m	
Bavarian Water Management	SCA, SWE, SA	December -June	Daily, 2-3 times a week is ok	Hours. Round the clock in flood situations	1 km – 50m	Pixel	10%
Lapland Regional Environment Centre	Soil Moisture	January-June	Daily	24 hours		Half the resolution	< 10%
		June -December	Weekly			Half the resolution	< 10%
	Runoff Forecast	January-December	Daily	3-4 hours		Half the resolution	< 10%
	SWE	October - June	Daily	3-4 hours		Half the resolution	< 10%
Finnish Environment Institute	SCA	November-June	Daily	12 hours		1 km	5-10%
	Soil Moisture	April - October	daily	12 hours		1 km	10%
NVE	SCA	April-July	every 3 day	3 hours	250 m	250m	10 %
		September-March	every 7 day	6 hours	250 m	250m	10 %
Vattenreglerings -føretagen	SCA	March -June	every 2 day				
	SWE	March - June	daily	hours			
	Runoff	March - June	every 5 day	1 week			

Table 4. Spatial and temporal product requirements

In the Alpine region two of the three interviewed organisations requested information on SCA and SWE in the periode from May to October. One weekly (daily in high risk situations) and the other every 12 day. Two organisations were interested in snow information in the winter and spring time (November/December to May/July). One required SCA and SWE every 20 day and the other every 75 day.

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In the northern part of Europe all of the five interviewed organisations wanted SCA and SWE products during the winter and/or spring period (from October, March or April to June/July). SWE was requested daily from two of the five north European organisations. Temporal resolution requirement for SCA varies from daily to every 7 day in this period. Information should be accessible within 3-4 hours (maximum 12 hours) after data acquisition.

For both regions the spatial resolution requirements of SCA and SWE varies from 1 km down to 50 m, with 200 m as the most frequent requirement. The spatial accuracy requirement varies from a pixel down to half a pixel. The acceptable classification error rate shall be within 10 %.

The interviewees were also asked to assess the relative importance of different product requirements within a range from 0 – 10 (0 = not important, 10 most important). The results are presented in table 5 below.

Organisation	Product	Temporal resolution	Spatial resolution	Thematic accuracy	Geometric accuracy
Hydrogr. service Austria	SCA, SWE	4-5			
Hydrological Service of South Tyrol	SCA	7	10	6	6
	Runoff forecast	10	7	5	5
ARPAV	SCA, SWE	8	8	10	8
Bavarian Water	SCA, SWE, SA	5	5	8	8
Lapland Regional Environment Centre	Soil Moisture	7	9	10	7
	Runoff	10	9	10	7
	SWE	10	9	10	7
Finnish Environment	SCA	10	10	10	10
Norw.egian Water Resources Energy Directorate	SCA	10	8	8	8
Vattenregleringsforetagen	Runoff, SCA, SWE	10	10	4	8

Table 5 Relative importance of different product requirements

Table 5 shows that temporal and spatial resolution is generally assessed as the most important product requirement for SCA and SWE. The thematic accuracy (classification accuracy) is the second most important requirement.

5.2 Hydropower industry

Three hydropower companies were interviewed.

- **ENEL-Italy**
  ENEL is an Electric energy production company which produces electricity from thermoelectric and hydroelectric sources. The company manages about 100 basins in the northern and central part of Italy. The Hydroelectric Business Unit of Vittorio Veneto is in charge of the water resources of the Piave River, located in the north-eastern part of Italy. The hydroelectric system of the Piave River consists of more than 10 reservoirs but only three of them are relevant for the operational management of water on a time scale greater than the daily time step.
- **Verbund-Austria** – Not received yet

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- **TIWAG- Tiroler Wasserkraftwerke Austria** –. TIWAG owns several hydro-electricity power stations in Austria, and has a total capacity of 1512.3 MW (in 1999) and provides about 50 % of the power generation in the Tirol. They were not interested in remote sensing data at the moment because EO-data does not have the necessary resolution for use in runoff and flood prediction in the small catchment areas in the Alpine regions.
- **Kemijoki-Finland**
  Hydropower company with production of 4 GWh (producing about 34% of the country's total hydropower production. 20 hydropower stations)

Statkraft- Norway
Statkraft is a wholly state-owned power company and is the largest producer of hydroelectric power in Norway. The company operated after commercial principles and has over the last few years experienced rapid growth with the purchase of minority and majority stakes in regional power companies. They have a power production of 42 TWh, which is about 1/3 of the country's total hydropower production. Energy trading is also an important business area, and they have trading offices in both in Sweden and Central Europe.

5.2.1 Snow information requirements

The results show that for the hydropower industry snow information is important for two main purposes, production management and energy trading. Information on available amount of water within a catchment, runoff forecasts, and melting conditions is important for production planning. For energy trading the same information is important as the electricity price varies with the availability of hydropower energy. Thus the amount of snow in a region affects the expected energy prices.

At present ENEL acquire snow information from point measurements of water content and snow height. They have their own measuring stations, but they also buy data from ARPAV. They are not satisfied with the time nor the spatial resolution of the current snow information available. They have an ongoing snow cover research project based on AVHRR to find out whether satellite data could be used to improve the quality and accuracy of the water volume estimation in the catchment. They would also like to reduce the time delay between the actual point measurements and the availability of the information.

Kemijoki uses the runoff forecast and water level produced from SYKE's hydrological models. They also have a dedicated flight to collect field data before the flooding time. They would appreciate more accurate information, but they are confident with SYKE's operational system itself.

Statkraft have been using snow information derived from satellite data for several years, and they produce snow cover maps based on NOAA/AVHRR (snow cover, snow cover per elevation and snow cover development) on an operational basis as often as possible in the melting season.

The interviewees were asked to assess within the range of 0-10 the importance of the snow products described in the introduction (0= not important, 10= very important). The results are presented in table 6.

	SCA	**SWE**	**SA**	**SST**	**Runoff forecast**	**Soil Moisture**
ENEL	8	8			6-8	2-6[1]
Kemijoki	8[2]	8	0	0	10	0
Statkraft	7	10			10	

Table 6 Relative importance of snow product assessed by hydropower companies.

1) For runoff forecast

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Run-off information is described as a base product and the most important for production planning. SWE is the most important snow product as it gives information on available amount of water within a catchment. SCA is also important for visual inspection of the catchment and can help them to validate the runoff forecasts as remarkable errors can easily be seen.

5.2.2 Temporal and Spatial Requirements.

The hydropower companies were asked to indicate spatial and temporal requirements for each product of interest. The result is presented in table 7.

	Product	Seasons	Temp. resolution	Time Constraints	Spatial resolution	Geometric accuracy	Thematic accuracy
ENEL	SCA, SWE	January – mid March	Monthly	1-2 days	0.5-1km		
		Mid March – mid May	Weekly	1-2 days	0.5-1km		
Kemijoki	Runoff	January-December	daily	12 hours		10 m	5% m^3/s
	SCA	February-June	daily	12 hours		10 km	< 10%
	SWE	February-June	every 14 days	24 hours	[2]	100 km	< 10%
Statkraft	SCA, SWE	April - August	Weekly	2 days	200-300 m	pixel	10% (SWE) 1 km (SCA)
		September-October	daily	daily			

Table 7 Temporal and spatial requirements from Hydropower companies

ENEL requires SCA and SWE monthly from January to mid March and weekly from mid March to mid May. Information must be available within 1-2 days after data acquisition. Kemijoki would like to have daily delivery of SCA and SWE every 14 days from February to June. Spatial resolution varies from 200 m to 1 km and the acceptable classification error rate shall be within 10 %.

Statkraft requires daily coverage from September to October. In this season updated snow information is important as wet snow in the mountain areas may melt within a few days. Updated runoff forecast is necessary to avoid flooding, as the basins are full at this time of the year. In the spring the snow melt is slower and weekly coverage of snow area is enough to monitor the melt outflow of the following days.

The interviewee was asked to assess the relative importance of different product requirements within a range from 0 – 10 (0 = not important, 10 most important). The results are presented in table 8.

Organisation	Product	Temporal resolution	Spatial resolution	Thematic accuracy	Geometric accuracy
Enel	SCA/SWE	8	7		
Kemijoki	Runoff	10	5	10	5
	SCA	10	5	10	5
	SWE	5	5	10	5
Statkraft	SCA, SWE	10	6	4	8

Table 8 Relative importans of product requriements assessed by the Hydropower industy

Table 8 shows that temporal resolution and thematic accuracy are assessed as the most important requirements.

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5.3 Meteorological offices

Two meteorological organisations were interviewed.

- **Storm Weather Centre-Norway**
  Storm is a privately owned and funded company. Their business philosophy is to provide tailor weather forecasting services to the private sector. By introducing new ideas and new solutions, they seek to provide meteorological information to both commercial customers and the broad public, informatively packaged according to each customer's specifications. Their customers are media, hydropower industries and offshore companies.

- **Swedish Meteorological and Hydrological Institute (SMHI).**
  SMHI is the national institute for meteorology, hydrology and oceanography. It is responsible for the observation networks as well as for forecasts to the public. The institute also provides consultant services, both within and outside Sweden

Accuracy improvement of runoff forecast is an important application for EO-based snow information for meteorological organisation.

At present they use ground observations, which is not considered to be good enough. Particularly in the mountainous regions in Northern Scandinavia, there are problems in assessing the actual snow cover only from ground observations. The area is sparsely populated and there are few meteorological stations. At the same time, the area is very important for hydropower production. Better information on the snow pack should improve runoff forecasts and thus enable a more efficient use of hydropower reservoirs.

SMHI have experience with snow cover based on EO-data, but do not use it operationally today. They work on method development and hope to be able to use the snow cover product from the EUMETSAT Satellite Application Facility (SAF) on Land when it becomes operational. SMHI is the developer of the Land SAF Snow Cover product.

5.3.1 Snow information requirements

The interviewees were asked to assess within the range of 0-10 the importance of the snow products described in the introduction (0= not important, 10= very important). The results are presented in table 9.

	SCA	SWE	SA	SST	Runoff forecast	Soil Moisture
Storm	10	10			10	5
SMHI	8	10	0	0		

Table 9 Relative importance of snow products assessed by STORM weather centre.

Storm provides product and services for the hydropower industry. They would like to use snow images, SWE and runoff together with weather forecasts. They assess SCA, SWE and runoff forecast as equally important. They are also interested in soil moisture, but this product is assessed less important.

As reservoirs in Sweden are large, forecasts are often made several months ahead. These forecasts are based on the amount of water stored in the snow pack in March and April, which is why observations of SWE is of particular interest (at that time SCA is always 100%).

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5.3.2 Temporal and Spatial requirements

The temporal and spatial requirement for each product of interest is presented in table 10.

	Product	**Seasons**	**Temp. resolutio**	**Time Constrain**	**Spatial resolution**	**Geometric accuracy**	**Thematic accuracy (error)**
Storm	SCA, SWE	September -June	1 day	12 hours	1 km	best	best
SMHI	SCA, SWE	May-July	2 days	12 hours	1km –5 km	200m – 500m	SCA:less than 5% SWE : 5-10%
		Nov - April	7 days	1 day			

Table 10 Temporal and spatial resolution.

To improve the accuracy of their flood forecasts they want accurate observations of Snow Water Equivalent with a complete spatial coverage, particularly in the mountain regions. High temporal resolution during the melt season, less frequent during winter. The error in the estimation of SWE should be less than 5% for a catchment area of 500 km2 (i.e. it must be considerably better than present models).

The interviewee was asked to assess the relative importance of different product requirements within a range from 0 – 10 (0 = not important, 10 most important). **Feil! Fant ikke referansekilden.**Table 11 shows the results.

Organisation	**Product**	**Temporal resolution**	**Spatial resolution**	**Thematic accuracy**	**Geometric accuracy**
Storm	SCA/SWE	10	10		
SMHI	SCA, SWE	6	6	9	9

Table 11 Relative importance of product requirement assessed by Meteorological organisations

Table 11 shows that temporal and spatial resolution are assessed as the most important requirements.

5.4 Energy broker

Oslo Energi is an energy trading company in Norway. Oslo Energi is interested in runoff forecast and a prediction of total amount of snow water reserve. This type of information would be used to predict the development of prices and decide where and when to buy hydroelectric power. The area of interest is Norway and Sweden. Information should be available "regularly" and should be presented as a regional map. Information should be presented relative to a "normal year". At the moment they are not interested in running their own hydrological models. Today they by snow-cover maps from Norwegian meteorological institute, and they prefer to buy information from analysing companies. These companies have not been covered in this user requirement survey.

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5.5 Summary of product requirements

For water and energy management authorities snow information is important to improve the accuracy of their runoff models. Flood forecasting and management of energy potential are the most important applications. For hydropower industries snow information is important for production planning and energy trading. EO-based snow parameters are most important if they could be assimilated into hydrological models and improve the runoff forecast.

In areas where snow melt is an important factor for runoff, SWE is considered as the most important parameter for runoff forecasts as it gives information on available water within a catchment. In the Alpine area SCA combined with elevation data is the most requested snow parameter.

At the moment SCA is a supplementary product used for visual validation of snow extent at a regional scale or for catchments. SCA is important as auxiliary information to validate runoff forecasts.

To fulfil the requirements from the northern part of Europe accurate information on SWE and SCA within their region of interest should be provided daily during melt seasons, and less frequent, i.e. weekly, during winter. Information should be available within 3-4 hours in the melt season. The estimation error should be less then 10% and the spatial resolution should be around 200 m.

Temporal resolution is hence identified as the most important requirement, and spatial resolution is the second most important requirement.

In addition, the following products are also identified as interesting, but for a more limited number of users:

1. Snow Surface Temperature (SST), is important for runoff forecasts as it indicated when the snow starts to melt. It is also important for avalanche warning

2. Snow Albedo (SA), is requested mainly by the meteorological users

3. Soil Moisture (SM), is requested as supplementary information by the water resource and energy management group

The runoff forecast and the water reserve products are level 3 products, while SCA, SWE, SST, SA and SM are level 2 products (ref. figure 2, Market model).

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6 CONCLUSIONS AND RECOMMENDATIONS

The objective of the EnviSnow is to develop and validate new and improved multisensor algorithms for retrieving snow and soil parameters from EO data improved for use in global climate study and hydrology, in particular run off and flood prediction.
An important first step in the project has been to ***establish the user requirements*** for snow information parameters, as documented in this report.

The current survey documents the needs for improved snow information. In particular the ***users request regularly available accurate information on SWE and SCA***. The main application is improved runoff forecast by assimilation of snow products into hydrological models. SST is also important for the hydrological models as it indicates when the snow starts to melt.

The conclusions of this user survey coincide with the conclusions of previous user surveys. Both the rating of the relevance of the suggested snow products as well as the spatial, temporal and thematic requirements are similar to the findings of the other studies.

Currently, the use of EO based snow information is rather limited, even though there has been several R&D project focusing on operational EO-based snow product development.

SWE and SCA are also identified as useful stand-alone products, with SWE as the most important one. At present, SCA is used for visual validation of snow extent, and as auxiliary information to validate runoff forecasts. SCA and SWE parameters derived from traditional methods such as ground station measurement do not give enough information because of the large spatial and temporal variability of the snowpack. EO-data offer the advantage of spatial distributed observations. At present, SCA from medium resolution optical satellites is available operationally. However, the temporal resolution in northern parts of Europe is limited due to cloudcover. Methods for deriving SCA from SAR exist but no operational services exist.

An operational EO-based service meeting the temporal and thematic requirements is considered by the users to improve the organisations existing service and help in decision-making.

Ongoing R&D activities are focusing on improving the capability of providing SCA products from EO-data. In order to develop the familiarity with EO-based products among the users an operational delivery of SCA utilising current state of the art technology combining optical and SAR data should be established now. Assimilation of the product into hydrological models is important, and should be emphasised. SWE is the most important parameter, but at present it can not be derived from EO-data with the sufficient accuracy and availability. Taking into consideration the identified need for this product, reliable methods for operational delivery of SWE based on EO-data should be developed.

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6.1 Recommendations for the R&D in the EnviSnow project

The user requirements established in this survey are compared to the existing products and services in order to identify technology gaps. Based on this evaluation EnviSnow will focus on following R&D activities:

1. The operational production of the level 2 snow products SCA based on integrated use of SAR and optical satellite data. The proposed EnviSnow target for spatial resolution of SCA product is 200 meter and for temporal resolution 3 times a week. Thematic error rate should be less than 10%.

   This would, however require that the EnviSnow project give priority to the following tasks:

   Development of methods for operational derivation of SCA from a combination of SAR and optical satellite data

   Operational production and delivery of level 2 snow products (WP 6) as pilot demonstrations from Kongsberg Satellite Services to the other partners of the consortium

2. Algorithm development for SWE production.

3. Assimilation of these products into the hydrological models to produce the level 3 products, runoff forecast.

The plan is to have some demonstrations of products available at the WWW for the melting season of 2003, so efforts should be made to establish a pre-operation production of SCA for this season.

6.2 Other recommendations for the EnviSnow project

This user survey has given valuable new information and confirmed existing knowledge on the user requirements. However, the number of users contacted was limited and does not cover all relevant European regions. It it's recommend to update the survey and the URD with input from a few additional end users. These are either users identified during the work of this project, users contacted in previous surveys or recommendations from the partners in the consortium. The list of additional users includes:

- Additional users from the energy brokers user group
- Hydrological analysing service companies

The user survey showed that ***there is interest in how EO data may contribute*** to cost effective collection of information about snow conditions. But there is ***not enough knowledge about the existing and future possibilities*** so there is an ***educational challenge*** to increase the EO knowledge among the potential users.

Also, there are several initiatives taken around Europe to explore the possibilities of using EO data within hydrology. Thus, efforts should be taken to avoid duplication of already performed work and rather join forces to achieve progress. We therefore recommend that the **user panel** of the project are extended with some of the users contacted during this survey, and that the panel meets regularly during the lifetime of the project to ensure the information flow to and from the project.

In order to disseminate information about the progress and the results of the project we recommend to submit a short newsletter about the progress twice a year (as part of regular project progress reporting) to all the users contacted during the survey as well publication on the project WWW.

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APPENDIX A QUESTIONNAIRE FORM

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Introduction

EnviSnow (Development of Generic Earth Observation Based Snow Parameter Retrieval Algorithms) is a remote sensing project financed by the European Commission, within the Energy, Environment and Sustainable Development program. The overall goal of the project is to develop and validate new and improved multisensor algorithms for retrieving snow and soil parameters from EO data improved for use in global climate study and hydrology, in particular run off and flood prediction.

The project is carried out through a cooperation between the following partners:

- NORUT Information Technology Ltd, Norway
- Norwegian Computing Center, Norway.
- Helsinki University of Technology, Finland.
- Institut für Meteorologie und Geophysik, Universität Innsbruck, Austria.
- The Institute of Research on Electromagnetic Waves, Italy.
- Kongsberg Satellite Services, Norway.
- Norwegian Water Resources and Energy Directorate, Norway.
- Verbund, Austria.
- ARPAV Italy.
- The Finnish Environment Institute, FEI, Finland.

The snow information products developed in this project shall be validated and brought into operational use. To be able to fulfil this goal user requirements for operational snow information will be used as input to algorithm development and prototype system development (production and distribution requirements). User requirements will also be used as an input to the market assessment to be done at the end of the project.

Kongsberg Satellite Services is responsible for collecting end-user requirements. Since the user requirements vary within Europe according to the geographical area and user's field of interest, these requirements will be derived based on interview with end users. The purpose of the enclosed questionnaire is to collect information on users needs and interest for the snow products described below.

Relevant products

The products will be available as georeferenced images in a given projection (UTM). The temporal and spatial coverage, resolution and accuracy varies depending on sensor used and type of product.

The relevant products are:

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- **Snow cover area (SCA)**: Snow covered area in percentage per pixel. Available from optical and SAR data, or a combination (optimal). MODIS, AVHRR, Radarsat and ASAR most relevant sensors. Historic data available for Norway/Scandinavia for about 20 years into the past based on AVHRR.

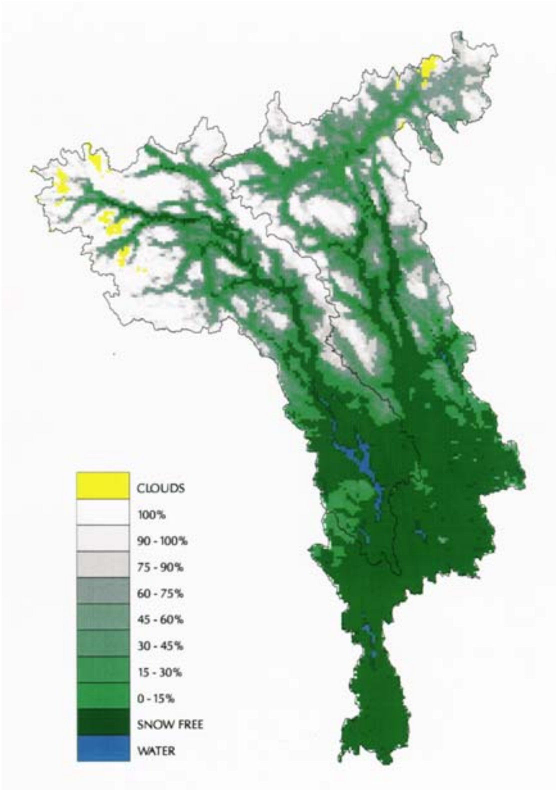

Figure 1. *A snow cover map generated by NVE's snow cover mapping system. The map covers the catchment area of the river Glomma in south Norway. (Courtesy NVE)*

- **Snow water equivalent (SWE):** A product which gives the snow water equivalent in mm. Current available from passive microwave imaging sensors such as SSMI.
- **Snow albedo (SA)**: Integrated spectral albedo in percentage. Directly measurable with optical sensors, except for some spectral windows with low atmospheric transmission. Could be derived from historic optical image data sets. Most relevant sensors are AVHRR and MODIS.
- **Snow wetness (SW)**: A categorical variable of two values: *dry snow* and *melting snow*. Available from a combination of optical and SAR data, where optical data determines the snow covered area and SAR which of the snow covered areas are wet. MODIS, AVHRR, Radarsat and ASAR most relevant sensors.
- **Snow surface temperature (SST)**: Continuous variable derived from optical sensors with thermal bands. A historic data set could be established from AVHRR data. Most relevant sensors are AVHRR and MODIS.

The questionnaire

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The questionnaire is divided into two main parts. The first contains questions about your company. The second part is to collect information about each of the snow products of interest to your company. Please fill in one form for each product of interest.

The questions are supposed to be answered through a face to face interview, where the interviewer fills in the form. However, it is strongly recommended that interviewee prepares for the interview by studying the enclosed forms prior to the interview.

Enclosed:
Questionnaire

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EnviSnow
Development of Generic Earth Observation Based Snow Parameter Retrieval Algorithms

User Requirements Questionnaire

Company name: ………………………………………………………………
Address: ………………………………………………………………
Country: ………………………………………………………………
Turnover: ………………………………………………………………
Number of employees: ………………………………………………………………

Interviewee: ………………………………………………………………
Position: ………………………………………………………………

Interviewer: ………………………………………………………………
Date: ………………………………………………………………

To be filled in by KSAT:
User type: ☐ I ☐ II ☐ III ☐ IV

Market segment: ……………………………………………………………………………………

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General information

1)Type of company:
☐ Private company ☐ National authority ☐ Regional authority
☐ Scientific ☐ Consulting

2) Short company description:

……….

……….

……….

……….

……….

……….

……….

3) Who are your customers?

……….

……….

……….

4) Do you have experience with satellite based product or services?
………..

5) What is the relative importance of the different snow variables described in the questionnaire introduction?

Please assess within a range from 0 to 10 the importance of the snow products described in the attached Snow information product description (0 = not important at all, 10 = very important)

SCA	SWE	SA	SST	Runoff forecast	Soil Moisture

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Snow Product Information Form

(Please fill in one form for each product of interest)

Select product:

SCA	SWE	SA	SST	Runoff forecast	Soil Moisture

I Present use of information

1) What is your geographical market segment (area of major interest) for this information?

……………………………………………………………………………………………………….

……………………………………………………………………………………………………….

……………………………………………………………………………………………………….

a) What is the nature of your area of major interest with respect to this information?
☐ Local areas ☐ Regional areas ☐ National ☐ Multi National

b) Area type:
☐ Alpine ☐ Forest ☐ Mountainous ☐ Agricultural

3) Why is this information important for your activity?

………………………………………………………………………………………………………..

………………………………………………………………………………………………………..

………………………………………………………………………………………………………..

………………………………………………………………………………………………………..

4) Do you use this information on an operational basis?
☐ Yes ☐ No Comments: ………………………………………………………..

5) Do you use this information for further processing or visualisation?
☐ Yes ☐ No

If yes, please answer the following questions:
a) Give a short description of the process (or visualisation):
…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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b) Which software is used for processing (or visualization)
☐ ERDAS ☐ ENVI ☐ IDL ☐ Golden Software Surfer
☐ ESRI ArcView 3.x ☐ ESRI ArcInfo 8 ☐ ESRI ArcView/Info8.1 ☐ Geomatica PCI
☐ MathLab ☐ In-house developed software
☐ Other (Please specify)…………………………………………………………………………..

c) Which operating system is used for processing?
☐ Windows ☐ Unix
☐ Other (Please specify)………………………………………..

d) Is the process dependent on manual input during processing or can it be done fully automatically?

☐ Fully automatically ☐ Manually ☐ Semi-automatically (just verify OK/re-run)

e) Describe your final product

…………………………………………………………………………………………………….

…………………………………………………………………………………………………….

…………………………………………………………………………………………………….

II) Present Information Collection

1). How do you presently cover your needs with respect to the type of information this product provide?

……..

……..

……..

2). What information sources do you use today?

……..

……..

3). How important is this information for your business?
☐ Base product ☐ Supplementary product

4). Does the present solution fully meet your requirements?

☐ Yes ☐ No
Comments: ………………………………………………………………………………………

……..

……..

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5). What is your annual expenditure on this type of information today?
☐ less than 10.000 € ☐ 25.000 € ☐ 50.000 € ☐ 100.000 € ☐ 200.000€
☐ > 200.000 €

III Temporal and Spatial requirements

	I	II	III
1. Please indicate seasons (described by month numbers) when you require information?			
2. How often do you require this type of information? Answer in every x day for each season?			
3. What are your time constraints for data delivery (time from acquisition to delivery)? Answer in terms of hours, days or weeks for each season			
4. What are your spatial resolution requirements? Answer in meters for each season			
5. What are your geometric accuracy requirements? Answer in meters for each season			

6) What are your thematic accuracy requirements?
☐ (%, mm, degrees)

Comments:
……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

V Delivery

1. Would you like to order single products or have a subscription?
☐ Single products ☐ Subscription

2. Do you want the required information to be delivered or made available on a web site?
☐ Delivered ☐ Available on a web site

3. Delivery format?
……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

VI Relative Importance of Requirements

What is the relative importance of different requirements?
Please assess within a range from 0 to 10 the importance of your requirements (0 = not important at all, 10 = most important)

Temporal	Spatial	Thematic	Geometric

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VII Wishful thinking

1) Describe your idea of a snow based product or service that would be “perfect” for your business. Describe it independent of cost and what is realistic today.
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2) How would this product/service improve your business?
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