Shared Cost Action Projects in Area 3.3 (CEO) of the Specific Programme for Climate and Environment

HYDALP
Hydrology of Alpine and High Latitude Basins

Project Reference: ENV4-CT96-0364

Minutes of the 4th Technical Meeting and Workshop held at SMHI, 8-9 February 1999

Author: Thomas Nagler, Graham Glendinning
Date: 26th February 1999
Institute: Institut für Meteorologie und Geophysik, Universität Innsbruck

This document was produced under the terms and conditions of Contract ENV4-CT96-0364 for the European Union, DGXII.

Distribution list

- Helmut Rott (IMGI) 1 copy
- Graham Glendinning (IMGI) 1 copy
- Shaun Quegan (SCEOS) 1 copy
- Ron Caves (SCEOS) 1 copy
- David Miller (MLURI) 1 copy
- Hannes Kleindienst (UBE) 1 copy
- Stefan Voigt (UBE) 1 copy
- Barbro Johansson (SMHI) 1 copy
- Thomas Nagler (IMGI) 1 copy
- Otto Pirker (VERB) 1 copy
- Rob Ferguson (SCEOS) 1 copy
- Owen Turpin (SCEOS) 1 copy
- Gary Wright (MLURI) 1 copy
- Roger Dunham (MLURI) 1 copy
- Michael Baumgartner (UBE) 1 copy
- Luc Lepan (EC-DGXII) 1 copy
- Spare (IMGI) 2 copies

A full set of viewgraphs of the 4th Technical Meeting are distributed to:

H. Rott IMGI
S. Quegan, SCEOS
G. Wright MLURI,
B. Johansson SMHI
M. Baumgartner UBE
L. Lepan (EC, DGXII)

AGENDA

Chair: Helmut Rott

Day 1: Monday, February 8, 1999, 9:00 h - ca. 17:00 h

1. Welcome
2. Approval of agenda

3A) Status of Action Items of 3rd Technical Meeting *(added at item 2)*

3B) Summary of work performed during project month 16 to 24
300-Quegan, 330-Voigt, 340-Caves, 400-Ferguson, 500-Rott,
510-Kleindienst, 520-Johansson, 600-Miller, 610-Caves

4. Intercomparison of SCA from different sensors (Quegan, Caves, Voigt, Nagler)
5. Results of runoff simulations with HBV and SRM
(BASSW: Johansson, BASUK: Turpin, BASCH: Kleindienst,
BASAT: Glendinning,)
6. Status of RS data for real time forecast period:
(ERS: Nagler/Caves, AVHRR: Caves/Voigt)
7. Availability of real time hydro-met data
(BASAT: Glendinning, BASSW: Johansson, BASCH: Kleindienst)

Day 2: Tuesday, February 9, 1999, 8:30 h - ca. 12:00 h.

8. Activities of upcoming tasks (each 15 min + discussion):
530-Wright, 620-Miller
9. Management issues, critical points, risk assessment (Rott)
10. Review of overall project status (Rott et al.)
11. Deliverables for project months 24 to 33, Final Report (Rott)
12. Publications / Conference presentations (Rott)
13. Communication / Responsibilities (Rott)
14. Next meeting
15. AOB

List of Participants:

Helmut Rott (IMGI)
Thomas Nagler (IMGI)
Graham Glendinning (IMGI)
Hannes Kleindienst (UBE)
Stefan Voigt (UBE)
Shaun Quegan (SCEOS)
Ron Caves (SCEOS)
Rob Ferguson (SCEOS)
Owen Turpin (SCEOS)
Barbro Johansson (SMHI)
David Miller (MLURI)
Roger Dunham (MLURI)
Sten Bergström (SMHI) (only 8 February)

1. Welcome

The meeting was opened at 9:00 am by the chairman, H. Rott. Prof. Sten Bergström, the director of the research department at SMHI, welcomed those present and wished everyone a successful meeting. He presented a short summary of the research activities at SMHI.

2. Approval of Agenda

The Agenda was distributed. H. Rott proposed to include an item point "*3a) Status of Action Items of 3rd Technical Meeting"*. Furthermore it was decided to present remote sensing related items (item 3B/WP300, item 4 and item 6) first and then items related with hydrological modelling (item 3/WP440/WP500, item 5, item 7). All agreed.

H. Rott informed about the reorganisation at CEO/Ispra and Brussels. The technical supervision of shared cost action projects has been shifted from Ispra to Brussels. For HydAlp the technical co-ordinator is Luc Lepan, EC DGXII. Due to the reorganisation the accounting for HydAlp has been delayed. According to the latest information from DGXII all accounts for HydAlp have been accepted, but it will take some more time for the money to be transferred.

H Rott shortly presented the overall HydAlp objectives and the HydAlp/CEO success criteria.

3A. Status of Action Items of the 3rd Technical Meeting

H. Rott summarised the status of the action items of the 3rd technical meeting:

ID	***Action Item***	***Status***
1	Updated versions of EO Analysis Tools	✓
2	Tests of modified hydrological models	✓
3	Real time data links for EO, agreements	✓
4	Tests of real time data links for EO and hydromet data	✓
5	Definition of basins and periods for forecasts	✓
6	Plans for runoff simulations (periods etc.)	✓
7	Intercomparison of EO snow cover products	***ongoing***
8	Areal interpolation of precipitation	***ongoing***
9	Flowline for WWW demonstrator	✓
10	Conversion routines HydAlp Format - SRM /- HBV	✓
11	Guidelines on cost-effectiveness	***draft***
12	Info sheet for EO methods	✓

3B: Summary of the work performed during project month 16-24

WP300: S. Quegan

S. Quegan summarised the objectives and the status of WP300. Only WP340 - EO Data Analysis is still active, which has the objective of analysing EO data to measure parameters for input to hydrological models. All other work packages are complete.

An overview of actual status of SAR, MROI and HROI flowlines was given. The SAR flowline is well defined. Within the project two software implementations are available (at IMGI and SCEOS), which are functionally identical but differ in data housekeeping operations. Implemented improvements to the SAR flowline were presented later by T Nagler (WP 341) and R.Caves (WP343).

The MROI flowline is also well defined and implemented in ERDAS/IDL (UBE) and PCI (SCEOS, IMGI). At UBE the MROI flowline has been modified for the use of RESURS data. The main problem with RESURS is the snow / cloud discrimination. Known shortcomings of MROI processing are sub-pixel analysis and the variation of classification thresholds. The MROI flowline was also discussed later in the presentations of R. Caves (WP343) and S. Voigt (WP342).

The HROI flowline is not required for near real time forecasting, hence it has not been developed for automatic processing. HROI based snow maps are, however, important for comparison of snowmaps from SAR and MROI sensors. Main problems are the calibration of Landsat-5 TM scenes (the right choice of gains and offset), and the detection of snow in cast-shadow areas. In BASAT and BASSW the classification scheme based on Rott & Markl (1989) is used. The HROI data analysis is also covered by the presentations of T. Nagler (WP341) and O. Turpin (WP344).

WP 341, T Nagler: A draft version of DI341 has been delivered and reviewed. The SWSM software package was extended to process both ERS and Radarsat SAR data. Speckle filtering is now applied on power values. Post-processing steps include corrections for dry snow areas and agricultural areas. To improve the representativity of the refererence image T. Nagler recommended averaging several images acquired during dry snow or snow free conditions. This has also improves speckle reduction. In BASAT three images (18 Nov 96, 27 Jan 97, 1 Feb 99) are used as reference images for ERS-2. The work carried out with SAR and HROI data of 1996 (6 scenes), 1997 (27 scenes), 1998 (30 scenes) for BASAT was summarised, and examples of the change of the snow extent in 1997, 1998 derived from these data (SCA-elevation curves) were shown.

WP342, S. Voigt: A draft report has been delivered. The presentation included (a) adaptation of MROI flowline, (b) derivation of time series of snow maps, (c) analysis of MROI data to derive basin characteristics. The UBE MROI module was extended for automatic processing of AVHRR data (using IDL and ERDAS) and for processing RESURS 01/3 and RESURS O1/4. RESURS O1/3 data will not be available for near real time processing. A post classification procedure for SCA estimation in cloudy areas was developed. The procedure is described in RI342. Time series of snow cover maps have been generated for 1992 (15 snow maps from 18 AVHRR scenes), 1996 (30 snow maps from 25 AVHRR + 5 RESURS scenes), 1997 (4 snow maps from 4 AVHRR scenes), 1998 (1 IRS-

1C/WiFS scene), 1999 (by now 7 AVHRR scenes). A land cover map for BASCH-I (Rhein-Felsberg) and BASCH-II (Engadin) was generated from RESURS data using supervised classification. Regarding MROI data processing, the following outstanding problems were identified and possible solutions were given:

- AVHRR data for real-time forecasting:
  (i) repairs to UBE receiving station,
  (ii) use data from Dundee receiving station

- RESURS data in near real time.
  If RESURS data are not available in near real time, use IRS-1C/D WiFS data

- IRS-1CD/WiFS data do not enable automatic snow/ cloud classification:
  (i) use only cloud free data
  (ii) use cloud mask from AVHRR data

S. Voigt will check whether RESURS O1/4 and IRS-1C/WiFS data will be available for near real time processing (**Action Item 1**).

WP343, WP344, R Caves / O Turpin: Draft reports of DI343 and DI344 have yet to be delivered. R Caves gave an overview on the SAR flowline at SCEOS. This package differs from the IMGI SWSM package in reading of data over the local network, setting up directories and temporary workspace. But both software packages have the same functionality.

A threshold of -3 dB is used for BASAT and BASSW, while -2 dB is used for BASUK: In the following discussion it was mentioned that this may rely on the fact that for BASAT and BASSW winter images (dry snow conditions, frozen soil) are used as reference images, while for BASUK a summer image acquired during a dry period was used.

R Caves presented methods used for (i) wet snow inference in areas of missing coverage, (ii) dry snow inference at higher elevations. He also presented estimations of the processing time and operator intervention for the SAR flowline.

There was a short discussion on how to correct areas of other changes, for example agricultural areas (none in BASSW), frozen lakes, dry snow areas etc. B. Johansson mentioned that snow on lakes is not included in HBV. It was then decided to exclude lakes and agricultural areas (at low elevations once they are snow free) by using masks from land classification and/or by using the DEM. For dry snow correction the wet snow line method will be used for those areas where no historic snow maps are available. This method has the disadvantage that areas which are snow free most of the year (like mountain ridges) are not taken into account. When historic snow maps are available they should be used for correction of dry snow areas.

The *AVHRR flowline* is based on the UBE flow line, but was re-coded in PCI. In principle both flowlines are very similar, although the SCEOS AVHRR software is tuned for processing data from the Dundee receiving station. R Caves stated that 32 bit data from Dundee should be preferred against 16 bit data which have a 30% cut-off of albedo values. Regarding the cloud coverage, B. Johansson mentioned that at SMHI AVHRR scenes of several NOAA passes of one day are merged to reduce the loss of information due to

clouds.

At the end of his presentation R Caves summarised the available SAR and HROI data for BASUK and BASSW (SAR+AVHRR: 1992, 1996, 1998).

The status of the analysis of HROI data was given by O Turpin. HROI snow maps are generated using the method from Rott & Markl (1989), including a threshold for TM band 3. HROI snow maps are the basis for the comparison with snow maps from other sensors. The main problems identified by O. Turpin are the calibration of Landsat-5 TM data, and the classification of snow in shadow. An overview on the status of processing HROI images of BASUK and BASSW was given.

After the presentations of WP341 to WP344 several items for processing EO data were discussed. The outcome of this discussion was:

(i) The SAR snow line is well defined. One flowline has been selected including the following post processing steps:

- *dry snow correction*: Two methods are available. The first proposed by IMGI uses snow maps from previous years, which has the advantage that areas which are snow free most of the year (such as mountain ridges) are not included as dry snow. The second proposed by SCEOS is the wet snow line method, which does not require data from previous years. It was agreed that both methods are useful: (i) in areas where historic snow maps are available the historic snow map method should be used. (ii) for basins without historic snow maps the wet snow line method is required.

- Missing coverage: a method for estimating the SCA in areas of missing coverage dependent on azimuth and elevation was presented by R. Caves. A similar method is used at IMGI (SCA in areas of missing coverage is estimated dependent on elevation only). The method is described in RI341.

- Lakes, agricultural areas (after retreat of the snow line to higher elevations): are excluded by using masks from HROI data and/or by using the DEM.

(ii) MROI flowline: SCEOS software is tuned to Dundee AVHRR data. The following differences and general problems were highlighted:

- Calibration: included in UBE MROI software; SCEOS software does not include calibration, therefore calibrated input files as provided by the Dundee receiving station are required.

- Geocoding: at UBE and SCEOS different geocoding methods are used. UBE: manual, SCEOS: semi-automatic, ANRTP software provided by A. Marcal. H. Rott mentioned that for accurate geocoding the topography (DEM) has to be taken into account, which is not the case for both geocoding software packages. A recommendation is needed for the final report on which geocoding approach to adopt.

- To investigate the expected availability of cloudfree AVHRR images, statistics

of the number of cloudfree AVHRR images is required. H. Rott noted that information on this has been published (**Action Item 2**).

- Sub-pixel classification will be tackled using spectral unmixing (UBE) or using high resolution data from the same date (SCEOS or IMGI). This second method has a problem of accuracy of geolocation.

- Cloud-masking: For sensors with better spatial resolution as AVHRR but without a channel in the short wave infrared region (necessary for cloud detection), a cloud mask derived from AVHRR data acquired at about the same time can be used. It was decided to discuss this further in the workshop.

WP 400 - R. Ferguson:

A short presentation was given on this work package. Virtually all of the tasks are complete and were reported at the last technical meeting. The last two reports were completed in month 17. The key outcomes were a chosen procedure for temporal interpolation of snow covered area (linear depletion with accumulated melt depth) and a procedure for setting degree-day factors in areas with mixed snow and glacier ice. The external report, RM4, on Runoff Modelling has been delivered. It contains a summary of the work carried out in WP400.

Since RM4, further improvements have been made on basin calibration in all basins, the HBV updating has been tested in BASSW and BASAT, and the sensitivity of HBV to land cover has been tested for BASSW. Work has also been carried out on the hydrological implications of biases in EO SCA estimates.

R. Ferguson highlighted the two remaining areas of interest in WP 400 as being SCA interpolation and sub-pixel snow mapping.

4. Intercomparison of SCA from different sensors

The intercomparison of SCA from different sensors (Action Item of 3rd Technical Meeting) was done for BASSW at SCEOS and for BASAT at IMGI. To date SAR/HROI and MROI (AVHRR)/HROI and SAR/AVHRR comparisons have been made in both basins. In BASAT, SAR/AVHRR comparisons have also been made. Large differences were found between AVHRR and the other sensors. Smaller differences were found between SAR and HROI in BASAT, though still substantial in BASSW.

In his introduction, ***S. Quegan*** asked several key questions:

- How sensitive are the models to differences in SCA?
- How do the models perform with SCA estimates derived from a single as compared to a mixture of EO sensors?
- What is the most accurate EO sensor/method?
- What causes the differences in SCA?
- Where are the differences located?
- Are differences between EO sensors systematic?

- Can correction factors be devised and are they temporally stable?
- Are similar trends observed in different basins?

R. Ferguson reported on the results of the intercomparison in BASSW, and ***T Nagler*** presented the results for BASAT. In both basins SCA from HROI, AVHRR and SAR have been compared. The BASAT AVHRR snow maps were provided by UBE. For BASCH no comparison of the SCA from different sensors has yet been carried out.

R. Ferguson and T. Nagler used various methods for the intercomparison, which are listed below.

Method	***BASAT***	***BASSW***
Regression analysis of SCA from 2 different sensors		✓
Total SCA from various sensors	✓	✓
Confusion Matrix	✓	
Area-Elevation Curves of SCA	✓	
Visual Intercomparison of snow maps	✓	
Time Series of SCA		✓

Generally the results of the SCA intercomparison in BASSW and BASAT agree well. Systematic differences in the SCA from different sensors have been found by the analysis for both basins. For BASAT, during the melting season AVHRR highly overestimates the SCA, especially on South facing slopes. SAR tends to slightly underestimate the SCA in comparison with Landsat TM derived snow maps, especially in areas of broken snow coverage. HROI (Landsat TM, SPOT HRV) provide snow maps which are probably very close to the real snow coverage, but a trend of overestimation of snow coverage for patchy snow is observed, especially on south-facing slopes. After a short discussion it was agreed that some guidelines for the intercomparison would be send out by S. Quegan (**Action Item 3**).

A further point of discussion was how to proceed if SCA from various sensors are used for runoff modelling. After a short discussion it was decided to include this topic into the agenda for the workshop on Tuesday, afternoon.

5. Results of Runoff Simulations with HBV and SRM

H. Rott summarised the objectives of WP500 and the work package breakdown. The work package co-ordinators and managers presented the work done since the 3rd technical meeting.

WP510 H Kleindienst:

In addition to the work done by the WP managers H Kleindienst mentioned the items: (i) improvements and further development of Java-SRM, (ii) Precipitation interpolation, (iii) selection of new basin for Near Real Time forecast (BASCH-2, the Inn-Martina basin, Engadin).

The report on precipitation interpolation (Action Item of the 3rd Techn. Meeting) is still pending. It was stated that this item is of high importance. After a short discussion it was agreed that the report should describe each method used within HydAlp. It provides also input to RM5. B. Johansson mentioned that a SMHI report on precipitation interpolation is being prepared. The report will be available before the delivery of the HydAlp final report.

The Engadin basin (~1500 km^2) is a potential candidate for carrying out the NRT forecast in Switzerland, because runoff and meteorological data are available online. One problem is that for a part of the basin the DEM which is required for the EO analysis is missing. H. Rott mentioned that this area may be covered by the DEM available at IMGI, which will be checked by IMGI (**Action Item 6**). H. Rott stated that there is also a runoff station available near the Swiss/Austrian border, the availability of these data will also be checked (**Action Item 5**).

WP 511 BASAT: G. Glendinning

The results of simulations in the Austrian basin were presented for both SRM and HBV. Both models were run for the Persal and Schlegeis basins in the Zillertal of the Austrian Alps. Both models were run from 1996 to 1998 (HBV calibrated for 1985-96). The precipitation interpolation is calculated using an inverse-squared weighting with distance.

A large number of satellite snow cover maps was used, enabling a study of the temporal coverage necessary for SRM. The study showed that in 1997 and 1998, in the Persal basin, 4 well-chosen images were sufficient to adequately describe the snow depletion (two of which should be during the main melt season). This should prove important for the benefit-cost analysis.

The HBV model was run with the winter snow pack being updated just before the main spring melt using RS data from 1997 and 1998. The remote sensing analysis proved very useful in showing that the build up of the winter snow pack was incorrectly modelled, pointing towards the need to recalibrate the model. It was decided that BJ and GG should meet afterwards to arrange an automatic calibration of the basin using the routines available at SMHI.

WP 512 BASCH: H. Kleindienst

The results of the SRM simulations in the Rhein-Felsberg basin were presented. The basin was split into three climatic regimes for calculation of precipitation. Two new parameter estimation techniques were described for the SRM model, with other parameters being left fixed.

The SCA accumulated melt depth method was used, though a fixed value of total snowmelt depth was used as a fixed point for extrapolating past the last available image. These values of total snowmelt depth are found from historical data from a *similar snow year*. This differs from the method in use at BASAT, where the gradient of snow depletion with

accumulated melt depth between the previous two images is used.

The snow and rain runoff coefficients can also now be inferred by the model, selecting from a range of values. Over a period of 10-30 days, the maximum and minimum values for the inverse of the temperatures are taken, and are then associated with a maximum and minimum runoff coefficient (user supplied). Each day's runoff coefficient is then interpolated according to its inverse temperature. This is carried out for each zone. The advantage of this method is in the reduced need for input of rather uncertain parameters. The method essentially relates the evaporative water losses to temperature.

WP 513 BASUK & BASSW: O. Turpin

The results of HBV simulations in BASUK and BASSW were presented. Good fits were shown for both basins. BASUK was re-calibrated with eight sub-basins using Thiessen polygons for precipitation interpolation. No comparison was made between calculated SCA and EO SCA. BASSW was modelled with and without EO data from 1992, 1996 and 1998. Different parameterisations of the build-up of the snowpack in winter were used to try to follow the remotely sensed SCA information within the model.

A sensitivity analysis of land-cover classification was carried out in BASSW. The results showed that errors in land cover classifications had a minimal effect on snowmelt runoff simulations: the R^2 value changed by less than 1%.

B. Johansson reported on the results of the HBV with input from AVHRR data. Runoff simulations have been carried out for the years 1992, 1996, 1998. It was shown that the use of snow maps from remote sensing can improve the simulation quality. Because SAR and AVHRR give different SCA estimates, and more AVHRR scenes are available, only the snow maps from AVHRR have been used so far.

Only the snow maps from AVHRR images have been used as yet. Because not enough scenes have yet been made available by SCEOS, SAR data have not yet been tested. S. Bergström mentioned that the size of hydrological units used in HBV is in the same order as the geometrical resolution of AVHRR. For SAR with a much higher resolution the results may be different.

WP520: B. Johansson

It was mentioned that Java SRM has been extended to perform real time forecasts.

B. Johansson presented results of the impact of EO snowmaps on calculating runoff using HBV. She mentioned that in BASSW long term forecasts (1 to 6 months) and short range forecasts (1 to 10 days) are of interest for the customers in Sweden. Within HydAlp short term forecasts are planned.

6 & 7: Status of RS data for Real time forecast period, Availability of real time hydro-met data

BASAT T. Nagler: In a meeting in December with the customer partner Verbund, represented by O. Pirker, the basins for the near real time forecast were decided. The basins

are the Tuxbach/Persal basin, and the basins of the 3 reservoirs Schlegeis, Zillergründl, and Stillupp. Then the structure of data flow for Near Real Time forecasts was explained. The snow maps will mainly be based on ERS data, with Radarsat images being ordered if required. AVHRR image acquisition is not planned for this basin. The test for NRT delivery of ERS data was successfully carried out with one ascending and descending ERS-2 scenes on 1 February 1999. Weather forecast data from ECMWF and Alandin (Grid data) are automatically sent to IMGI by the Austrian Weather Service (ZAMG) in Innsbruck (ftp protocol). Meteorological data and runoff data measured at several stations are collected daily by Verbund/TKW and sent to IMGI; this data link is planned to become operational by the beginning of March 1999. The NRT forecast period is planned for mid of April 1999 to mid of June 1999. It was proposed by T. Nagler that all ERS SAR scenes for NRT period should be ordered by one acquisition request, which will be done by SCEOS. IMGI will provide the required tracks/frame/orbit information for the BASAT scenes (**Action Item 11**).

BASSW: Ron Caves described shortly the data flow structure and processing time for ERS and AVHRR images. EO analysis will be carried out at SCEOS. The Earth observation products will be send to SMHI, where the hydrological forecast will be made. The NRT forecast period is planned for late May 1999 to mid-July 1999, as required.

BASCH: H. Kleindienst described the data flow structure for the NRT forecast period in BASCH. Meteorological forecasts are provided by the SMA. Snow mapping will rely mainly on AVHRR data. There is a faint possibility that the receiving station at Bern will be operational in time for the runoff forecasts. Otherwise AVHRR data from Dundee, RESURS and IRS1-C/D WiFS data from Neustrelitz or SSC will be used. Within the next few weeks it will be decided whether RESURS or IRS will be used to augment AVHRR data. The data link for receiving stream flow data is not defined, but this will be done by the end of February. By this time a final decision on the basin for which the NRT forecast will be carried out will have been made (**Action Item 4**). H Kleindienst stated that the NRT forecast period for BASCH will start in mid March 1999.

8. Activities of upcoming tasks

WP530: D. Miller

D. Miller summarised the work planned for WP530. A customer workshop to be held in Aberdeen is planned for August 1999. The key customer is the hydro-power industry. It was decided to invite hydropower companies from several European countries, i.e. the "in-house" partner Verbund, Austria, (O Pirker), Kraftwerk AG Engadina, Switzerland, Vattenfall, Sweden, etc. Furthermore, the SCFG is a potential customer of HydAlp products, as D. Miller explained. R. Dunham explained that British hydro-power companies may also be interested in the HydAlp results in basins other than BASUK, where no NRT forecast is being carried out.

To estimate the cost-benefit, information from Hydropower companies is required. This may be a problem because they would not like to publish commercially valuable information. To overcome the confidentiality problem one possibility would be to ask the companies how much they would pay for a HydAlp product.

It was agreed that D. Miller should send out a list of requirements for cost-benefit analysis to the HydAlp partners by 10 March 99, who will contact local customers (e.g.: SMHI: Vattenfall, UBE: Engadina, MLURI: British and/or Scottish hydro-power companies). The completed list will be sent back to MLURI by 15th June 1999. (**Action Items 7 & 8**)

WP600: D. Miller

D. Miller summarised the objectives and the breakdown of this WP. HydAlp WWW pages are installed at MLURI, UBE, and IMGI. The official HydAlp WWW pages are those at MLURI. H. Rott will contact CEO to determine the role of the CEO/EWSE (**Action Item 9**).

WP610: R. Caves

This WP started in project month 22. By now preparatory work has been done. The project co-ordinator mentioned that the objectives of this WP were discussed and revised at the Kickoff Meeting. It was then discussed which information is to be displayed and how the information would be presented on the WWW. According to the minutes of the Kick-Off meeting it is not required to put any EO data analysis software or hydrological models on the WWW. Descriptions of the methods, flowlines and hydrological models, including examples, should be provided on the WWW site. The information should be presented in condensed form to make it useful for a wide range of readers and customers.

WP620: R. Dunham

The aims of this WP were clarified and several options of WWW implementation were discussed:

- pre-cooked demonstrations (snapshots), some interactivity, full models, or a combination
- access to basic research and publications
- selection of browser and standard for WWW implementation
- screen resolution.

Regarding publications it was proposed to provide a list of all HydAlp publications including full papers and/or abstracts. It was noted that for papers published in international journals, there may be a conflict with the copyright. Further, some concern was expressed about the quality and currency of some internal reports with regard to their external publication.

Five different options were proposed for the demonstrators:

- Professional SRM / HBV version
- Light Version of SRM /HBV
- Tutorial version of SRM

- SRM-like javascript version

- Pre-cooked examples with metadata

B. Johansson mentioned that a version of HBV-Light has been developed at Uppsala University, but she was unsure as to the availability. After a short discussion about the distribution of Java-SRM within HydAlp, H. Rott stated that both hydrological models (SRM and HBV) should be treated in the same way, with no preferences. It was then agreed that links to the WWW-Page of both models should be given. For demonstration, pre-calculated examples will be provided on the WWW. The official WWW-site is at MLURI. All partners will provide input to the demonstrators, preferably in HTML format. In the discussion it was proposed that the final HydAlp Home Page could also be send out on CD-ROM, which is readable using Internet browsers.

9. Management issues, critical points, risk assessment

The risks not to meet the main objectives were identified by the project co-ordinator:

- Provide the basis for *operational use of EO data for modelling and forecasting runoff* in alpine and high latitude basins
  Technical basis: main objectives achieved
  Application assessment: will rely on the outcome of the last project phase

- Algorithms and software for analysis of EO data as input for hydrological models: project objectives fully achieved

- Modify and test hydrological models to enable input of remotely sensed information: main objectives achieved

- Test the data chain and models for runoff forecasts in a pre-operational environment preperations for real-time forecasts finished, forecasting activities coming up.
  Possible risks:- Low impact of EO, ERS failure

- Assess the cost-effectiveness of remote sensing for runoff modelling and forecasting:
  Risks: - Products are not well suited to customer needs
  - Customer not able to assess profits

The main activities of the last project phase:

- Make demonstration packages and information available through CEO EWSE: preparations on schedule.

10. Review of overall project status

H. Rott summarised the achievements in the project months 16 to 24. The project is well developed according to the technical annex to the project contract:

The main achievements during months 16-24 are:

- Further improvements of EO data analysis tools for snow cover monitoring:
  SAR-tool additions: speckle filter, Radarsat input
  MROI semi-automatic algorithm, improved handling

- Intercomparison of snow cover products from different sensors
  (SAR-HROI, HROI-MROI, SAR-MROI)

- Runoff simulations and model tuning using EO input:
  SRM extensively tested in BASAT and BASCH
  HBV tested in BASSW, BASAT

- Preparation and testing of data transfer and processing chains

11. Deliverables for project months 24 to 33, Final Report

Contract Deliverables:

ID	Title	Type	Dist	Month	Status
RPR: 1-10	3- Monthly Progress Report 1 to 10	R	I	3 - 33	**ongoing**
RM1	Interim Report on Customer Requirements, MS 1	R	U	8	✓
RM2	Interim Report on Project Data Base; MS2	R	U	9	✓
RM3	Interim Report on Remote Sensing Methods for Hydrology; MS3 and MS 4	R	U	12	✓
RM4	Interim Report on Runoff Modelling Using Remote Sensing; MS 5	R	U	17	✓
RM5	Interim Report on Runoff Simulation, MS6	R	U	24	in pre-paration
RM6	Interim Report on Runoff Forecasting, MS7	R	U	31	
RM7	Interim Report on Customer Assessment of Services and Cost-Effectiveness, MS8	R	U	31	
RF	Final Report	R	U	32	

Technical Deliverables

W1	Runoff model and documentation	W	U	28	
W2	Hydrological demonstration package	W	U	32	

Regarding the delivery of W1 and W2 H. Rott will contact EC-DGXII (**Action Item 9**)

Status on Internal Reports for Project Month 24 (February 1999)

Report	Title	Resp.	Institute	Note
	February 1999			
DI341	Data Analysis for BASAT	Nagler	IMGI	Draft
DI342	Data Analysis for BASCH	Voigt	UBE	Draft
DI343	Data Analysis for BASSW	Turpin	SCEOS	
DI344	Data Analysis for BASUK	Caves	SCEOS	
RI511	Runoff Simulations for BASAT	Glendinning	IMGI	19Feb99
RI512	Runoff Simulations for BASCH	Kleindienst	UBE	19Feb99
RI513	Runoff Simulations for BASUK,BASSW	Turpin	SCEOS	
RM5	Interim Report 5 on Runoff Simulation	Turpin	SCEOS	
RPR8	3-Monthly Progress Report	WP-Coord	IMGI	

	May 1999			
RPR9	3-Monthly Progress report	WP-Coord	IMGI & al	

	June 1999			
WI611	WWW Documentation of Hydro Models	Caves	SCEOS	
WI612	WWW Documentation of EO analysis tools	Nagler	IMGI	
W1	WWW Runoff model documentation	Caves	SCEOS	

	August 1999			
RI131	Customer Activities	Dunham	MLURI	
RI521	Runoff Forecasts BASSW	Johansson	SMHI	
RI522	Runoff Forecasts BASAT and summary	Glendinning	IMGI	
RI523	Runoff Forecasts BASCH	Kleindienst	UBE	
RI532	Assessment for hydropower management	Pirker	VERB	
RPR10	3-Monthly Progress report	WP-Coord	IMGI & al	

	September 1999			
RM6	Interim Report on Runoff Forecasting	Glendinning	IMGI	
RM7	Interim Report on Customer Assessment and Cost Effectiveness	Wright	MLURI	

	October 1999			

WI621	WWW Data sets for basins	Nagler	IMGI	
WI622	WWW Demonstration	Dunham	MLURI	
W2	Hydrological Demonstration Package	Dunham	MLURI	
RF	Final Report	Rott	IMGI	

Contents and Schedule of the Final Report

H. Rott gave an overview about the table of contents of the final report. The report has been broken up in 11 chapters. Each chapter is assigned to one partner and has to be delivered at the given deadline. The draft chapters will be reviewed by the Review Committee, which is formed by

H. Rott,
S. Quegan,
D. Miller,
M. Baumgartner,
B. Johansson.

The time for reviewing is limited to **2 weeks**. The corrections and comments are implemented by the author of the chapter and the final version is delivered to IMGI as Word file without any special layout. The final layout will be done by IMGI. S. Quegan mentioned that the EC may have specified guidelines for preparing the final report (**Action Item 12**). For further distribution it was mentioned that the Final Report may also be distributed on CD-ROM.

No	***Chapter***	***Partner***	***Delivery***
1	Introduction (objectives, organisation)	IMGI	15Jul99
2	Customer requirement	MLURI	15Jul99
3	Basin descriptions and database	UBE	15Jul99
4	Remote sensing methods	SCEOS	15Jul99
5	Remote sensing data analysis	SCEOS	15Aug99
6	Hydrological methods, model modifications	IMGI	15Aug99
7	Runoff simulations	SCEOS	15Aug99
8	Runoff forecasting	IMGI	15Aug99
9	Customer Assessment and cost-effectiveness	MLURI	30Sep99
10	EWSE: Demonstration, Exploitation	MLURI	30Sep99
11	Summary, final compilation, delivery	IMGI	15Oct99

12. Publications / Conference presentations

H. Rott and S. Quegan will contact ESA to publish a paper on real time runoff forecasting using ERS in Earth Observation Quarterly (EOQ) or ESA Bulletin (**Action Item 13**).

Furthermore the partners are asked to send a list of recent papers and conference presentations to IMGI for updating the publication list (**Action Item 14**).

13. Communication / Responsibilities

Nothing of note.

14. Next Meeting

Customer Workshop: organised by MLURI will be held in late August 1999, in Aberdeen. The objectives of this workshop are cost-benefit analysis and promotion of the project results. Participants are HydAlp project partners and customers. It was agreed that the following customers are invited: Verbund (VERB, project partner), SCFG (invited by MLURI), Vattenfall (invited by SMHI), Engadina hydro power company (invited by UBE). Furthermore CEO will be invited by H. Rott (IMGI).

Final Presentation: is planned for late October 1999. The place of the meeting is unsure and will be clarified by H. Rott. It will be probably be held in Brussels or at JRC / Ispra. The list of invitees has to be sent to EC. H. Rott stated that customers should be invited.

15. AOB

No other business.

B. Johannson and S. Bergström were thanked for organising the meeting and for the enjoyable social arrangements.

The meeting was declared closed.

Action Items - 4th Technical Meeting

Documents related to these action items should be delivered to the project co-ordinator, who will be responsible for distribution.

1.	UBE	Check for Near Real Time delivery of WiFS and RESURS	28Feb99
2.	IMGI SCEOS UBE	Statistics of cloudfree AVHRR images (from literature) responsible by SCEOS (R. Caves)	15Mar99
3.	SCEOS	Notes on SCA Intercomparison: what to do, which issues?	28Feb99
4.	UBE	Decide on basin and period for NRT forecast (Engadin, BASCH) responsible: H. Kleindienst	28Feb99
5.	IMGI	Check for online availability of runoff gauge of Inn near Swiss border.	20Feb99
6.	IMGI	Check for DEM covering Engadin at IMGI	20Feb99
7.	MLURI	Send out list of requirements for cost benefit analysis to all partners. responsible D. Miller	10Mar99
8.	ALL	List of requirements for cost-benefit analysis (see Item7) back from HydAlp partners to MLURI	15Jun99
9.	IMGI	Role definition of CEO Enabling Services (EWSE) responsible H. Rott (result: no standard format for documentation) Contact P. Churchill (CEO), L. Lepan (DGXII) for setting up WWW site regarding WU1/2; responsible H. Rott (result: just a link at CEO)	28Feb99
10	SCEOS / SMHI	Select snow cover product for real-time forecasts in BASSW (AVHRR, SAR or both)	15 Mar99
11	SCEOS	Ordering ERS acquisitions for NRT period for BASSW, BASAT; responsible R. Caves	20Feb99
12	SCEOS IMGI	EC guidelines for final report; Specifications for final report responsible: S. Quegan, H. Rott	15Apr99
13	SCEOS IMGI	contact ESA to publish a paper on real time runoff forecasting using ERS in Earth Observation Quarterly (EOQ) or ESA Bulletin: S. Quegan, H. Rott (confirmed by J. Lichtenegger ESRIN)	15Feb99
14	ALL	Send a list of recent papers and conference presentations to IMGI for updating the publication list	15Mar99

Deadlines of Deliverables for Month 24 to 33

Shifted to	*WP*	*Title*	*Resp. Person*	*Institute*
		Deliverables for June 98 (Month 16)		
Aug 98	RI240	Preparation and conductance of field work	Nagler	IMGI
		Deliverables for July 98 (Month 17)		
	RSI442	Model optimisation for alpine basins	Glendinning	IMGI
	RM4	Interim Report on Runoff Modelling using remote sensing	Glendinning	IMGI
		Deliverables for August 98 (Month 18)		
	RPR6	3-Monthly Progress Report	WP-Coord	IMGI
		Deliverables for October 98 (Month 21)		
	RPR7	3-Monthly Progress Report	WP-Coord	IMGI
		Deliverables for February 99 (Month 24)		
	RI231	Search and acquisition of NOAA data	Ottersberg	UBE
15Jan99	DI341	Data Analysis for BASAT	Nagler	IMGI
15Jan99	DI342	Data Analysis for BASCH	Voigt	UBE
15Jan99	DI343	Data Analysis for BASSW	Turpin	SCEOS
15Jan99	DI344	Data Analysis for BASUK	Miller	MLURI
15Jan99	RI511	Runoff Simulations for BASAT	Glendinning	IMGI
15Jan99	RI512	Runoff Simulations for BASCH	Kleindienst	UBE
15Jan99	RI513	Runoff Simulations for BASUK, BASSW	Turpin	SCEOS
	RM5	Interim Report 5 on Runoff Simulation	Turpin	SCEOS
	RPR8	3-Monthly Progress Report	WP-Coord	IMGI

HYDALP Workshop, Norrköping, SMHI, 9th February 1999

13:30 h - ca. 16:00 h.

MINUTES

AGENDA:

1) Methods for intercomparsion of snow maps from different sensors
2) MROI: classification scheme: snow - cloud discrimination
3) Forecast Performance criteria
4) HBV in BASAT: B. Johansson & G. Glendinning

Participants:
S. Quegan, R. Ferguson, B. Johansson, H. Kleindienst, G. Glendinning, O. Turpin, R. Dunham, D. Miller, S. Voigt, R. Caves, T. Nagler.

The meeting was opened at 13:30.

1) Methods for intercomparsion of snow maps from different sensors

This item was discussed by all participants. According to the first intercomparison results it is apparent that a systematic differences in SCA from different sensors exist. Up to now the intercomparison showed that in general AVHRR significantly overestimates SCA, SAR underestimates SCA to a lesser extent, while HROI data are probably closest to reality. Further analysis will be carried out in the next few weeks. It was further mentioned that the hydrological models can be calibrated to either of the sensors, but the use of different sensors at the same time will cause problems. According to the regression analysis between SCA of different sensors it seems that the SCA from one sensor can be transformed to the SCA from another sensor. After a short discussion it was agreed that in the case of several sensors HROI should be used as reference, because it is closest to reality. This has to be checked with insitu data or airborne images.

Furthermore S. Quegan will send out a note on methods for intercomparison, which is an action item of the 4th Technical Meeting.

2) MROI: classification scheme: snow - cloud discrimination

This item was discussed by remote sensing people, S. Quegan, R. Caves, S Voigt, D. Miller, T. Nagler. The MROI flow line was shortly discussed. S. Voigt noted that after geocoding the data were corrected for terrain illumination (cosine-correction).

One discussion point was the reason for the significant overestimation of SCA on south facing slopes. This is probably due to mislocation of pixels, because the topography was not

taken into account in the geocoding process. For sensors without a channel in the short wave infrared region (about 1.5 microns) such as RESURS O1/3 and IRS-1C/D WiFS, clouds can barely be detected. A cloud mask from AVHRR data acquired at about the same time or visual cloud masking are required.

3) Forecast Performance Criteria

H. Kleindienst, R. Dunham, O. Turpin, R. Ferguson and G. Glendinning discussed the performance criteria to be used during the forecast periods to rationalise the results for inter-basin comparison purposes.

A nomenclature was devised for the forecast parameters and the statistical tools for measuring the quality of the forecasts were defined. These are described below.

Runoff forecasts will take place with the measured runoff data from the previous day and meteorological forecasts for the present day and beyond. The numbering of days for forecasts is taken from today as day 0, with forecast 1. This is shown below:

Day Number	0 (today)	1	2	3	4
Forecast no.	1	2	3	4	5
Forecast Runoff	$\hat{Q}_1$	$\hat{Q}_2$	$\hat{Q}_3$	$\hat{Q}_4$	$\hat{Q}_5$
error = $\hat{Q}$-Q	e_1	e_2	e_3	e_4	e_5
$rel.err = \frac{e}{Q}$	$\frac{e_1}{Q_1}$	$\frac{e_2}{Q_2}$	$\frac{e_3}{Q_3}$	$\frac{e_4}{Q_4}$	$\frac{e_5}{Q_5}$

A 5-day Nash-Sutcliffe R^2 can be calculated:

$$R^2 = 1 - \frac{\sum e^2}{\sum (\hat{Q} - \overline{Q})^2}$$

and a standard error of estimate (or RMS error) as a fraction of the mean flow over the 5 days:

$$RMS = \frac{\sqrt{\overline{e^2}}}{\overline{Q}}$$

The accumulated relative volume error over the 5 day forecast is calculated as:

$$D_v = \frac{V_s - V}{V} = \frac{\sum \hat{Q} - \sum Q}{\sum Q} = \frac{\sum_1^5 e}{\sum_1^5 Q},$$

where V is the measured runoff volume, V_s is the simulated runoff volume, and Q_s is the simulated daily runoff.

Other measures of goodness will be the number of days with predictions within 10% of the measured values, and number of days within 20%. These are calculated at the end of the melt season.

Comparisons of the forecast predictions will be compared against the steady-state forecast as a worst case predictor. Scatterplots may also be made of relative error (e/Q) vs precipitation over the season, to see if there is a systematic error for larger precipitation events etc.

4) HBV in BASAT: B. Johansson & G. Glenddinning

BJ and GG met on Wedenesday morning to discuss re-calibrating HBV for BASAT.

The meeting was closed at 1600.