

Part I: report of the completed year

3. Activity report

3.1 Information related to the research plan

SwissEx has so far achieved its aims: developing leading edge hardware and software to augment the long-term, sparse, wide-area measurement networks with dense, high frequency measurements of short duration, which indicate the small scale processes occurring and can be related to the large scale, long term measurements. All of the milestones deliverables have either been fulfilled or state a timeplan below for their fulfillment before the end of year 4.

WP1 milestone 1: Integration of data

New data sources are being integrated as fast as the resources can manage. These sources are wide-ranging and in many cases have long acquisition histories. As the planned GSN and wiki developments are carried out over the next year, the system will gain improved capabilities for indicating when and where specific data types are available. SwissEx will approach BAFU and Meteoswiss in year 4 regarding the integration of data from their national networks, increasing the impact of SwissEx on the individual projects.

WP1 milestone 2: Baseline SwissEx data infrastructure completion

Although the baseline infrastructure was completed in years 1 and 2, we are still adding to this baseline infrastructure in addition to developing more advanced tools; adding fundamental changes to the infrastructure which change the way that we are able to work, whilst also maintaining and expanding the existing baseline infrastructure.

Having established data management infrastructures for SwissEx during 2008 - 2010, we have continued to maintain these systems, making improvements to both GSN and the metadata repository to keep them running as the data volumes and usage levels increase. In addition to the maintenance work, EPFL-LSIR has developed various important system components that enrich the utility of the main SwissEx data infrastructure.

Data repositories:

In addition to the operational instances of GSN, we have created other instances used as data repositories for: internal usage (LSIR repository), simulation (La Fouly repository), or to be used in associated projects (Planetdata repository). The data in the LSIR repository replicates data from various sources at SLF and includes metadata search. La Fouly repository contains data from a catchment used by the SwissEx and Hydrosys projects in La Fouly region. The Planetdata repository mirrors Wannengrat public data from SLF.

Data access:

In order to synchronize data between different GSN instances, the remote wrapper is commonly used. This wrapper is not very efficient as it involves many communications between peers and suffers from poor performance when communicating on high-latency channels, as is the case with remote databases. A more efficient wrapper (the JDBC wrapper), which connects directly to remote databases, was developed for this reason.

Postgres is now fully supported in GSN as the underlying database (as requested by the COGEAR project). GSN internal data types and queries are automatically translated through the dedicated storage manager layer. The support of Postgres facilitated the integration of the PostGIS spatial extension as described in the following section.

Spatial extension to GSN:

GSN has been extended to handle geographical data and provide spatial information in addition to streaming data. We initially added GML formatted output to GSN in order to comply with GIS standards. In addition to this basic support, other extensions have now been added:

- Spatial queries: we added support for Java topology suite (JTS) and PostGIS as spatial query engines. A GiST index (Generalized Search Tree) is built for all the sensors and can be used

for spatial queries. This extension allows queries to be performed (e.g. average temperature) on sensors enclosed within a given geographical area (defined with Well-known text markup).

- Support for gridded data: a gridded wrapper was developed to read ESRI raster datasets (for example digital elevation models) from the file system and then transform them into binary objects on the database system. These can be later queried using a new web method “/griddata”. This method returns grids (following ESRI ASCII format) for a given time range or a stream of values for a single cell within a grid (as a time series). In addition to the ability to download grids or cell values, grids can be rendered as an image within GSN and shown in the web interface. Data arrays are transformed into raster images following a predefined color map. This has been implemented as a virtual sensor.

During close collaboration with SwissEx partners, innovative data acquisition and data management systems were jointly optimized to RECORD's specific needs. Most of RECORD's non-streaming data is currently regularly fed into the wiki, such as sensor data from piezometers, soil data and surface water levels. In year 4, this data will be reshuffled to fit into the system used by other SwissEx partners, however some components of the data entry system used by RECORD will be introduced for widespread use. The data upload system developed for RECORD was taken up by SLF and extended such that it may be integrated with the main SwissEx metadata system. This integration was tested with published Mountland data for uploading large volumes of non-standard 'metadata' which in this case was static data relevant to the location.

The final step in making a system for distributed data storage is the provision of a centralized query interface for distributed data together with its metadata. This presents a barrier, as the single point of entry can become a bottleneck for large data volumes. SLF have implemented a joint data-metadata query system which distributes the queries and returns the results directly to the users from the distributed storage nodes; bypassing the bottleneck. Although the interface is available for use (and fully integrated into the metadata system), there are still many developments to be made, such as automated configuration of metadata by GSN (to ensure that the wiki has information on all of the sensors available) and wider use of the metadata in the queries.

WP1 milestone 3: Advanced infrastructure development completion

LSIR has developed several advanced system components to assist in processing sensor data:

Dynamic uncertainty handling for sensor data:

We have developed a novel approach to capture time-varying probabilistic databases from (imprecise) sensor data, which offer a generic solution for creating probabilistic databases from arbitrary time series. The approach consists of two key components. First, the dynamic density metrics that infer time-dependent probability distributions for time series, based on various mathematical models. Our main metric, called the GARCH metric, can robustly capture such evolving probability distributions regardless of the presence of erroneous values in a given time series. For efficient processing, we introduce the sigma-cache that reuses the information derived from probability values generated at previous times. SLF currently have a student working on automated detection of data anomalies based on probability distributions, hence the two institutions will work together on the problem in year 4.

Sensor data compression:

We have taken a set of different approaches which can significantly improve the performance of compression for sensor data. This includes multi-model compression [Papaioannou et al. 2011] (which dynamically adapts to the properties of the data stream and approximates each data segment with the most suitable model) as well as model coding [Arion et al. 2011] (which compresses even the values for parameters used in the approximation models). These outperform standard compression techniques as they exploit application-specific knowledge on the error tolerance.

Sensor data management in the cloud:

As part of a 3rd party funding project, and in anticipation of SwissEx phase II, we have been developing TimeCloud [Rolewicz et al. 2011], a storage-and-computing platform for managing large-scale time series in the cloud. TimeCloud is built upon scalable, fault-tolerant distributed systems as Hadoop and HBase, and facilitates complex data analysis over massive time series by taking novel approaches. We have also developed various optimization techniques which play key roles in cloud-based sensor data management [Bonvin et al. 2011].

Latency optimization for scientific data processing:

We have implemented and tested an adaptive software architecture [Popescu et al. 2010] that can effortlessly switch between MapReduce and parallel DBMS in order to efficiently process queries regardless of their response times, leading to lower latency for scientific data processing. Switching between the two architectures is performed in a transparent manner based on an intuitive cost model, which computes the expected execution time in the presence of failures. The experimental results show that the adaptive architecture achieves lower query execution time for various scenarios. This system is particularly suited for scientific data processing, whose wide variety of queries imply that some queries will be best executed in a MapReduce model while others benefit from a parallel DBMS.

Semantic sensor data and metadata querying:

In order to effectively deal with the problem of searching specific data over a wide variety of sensor data streams, we have developed an advanced search functionality that is built upon the semantic web technologies. Our search system is based on an ontology-based approach that uses metadata for adding contextual information to the sensor observations, such as which sensor recorded what, where, when, and in which conditions. It is also used to help users filtering sensor data in their queries. To this end, we use declarative mappings that relate the underlying sensor schemas with the ontology terms, effectively creating virtual semantic streams that can be queried in terms of a high level sensor network ontology, using an extended version of the SPARQL query language that considers window constructs. Once completed, this work will be used to significantly extend the basic capabilities of the SLF implemented wiki search tool. An additional input to this work has been carried out between EAWAG and the University of Twente. Here, a student has been developing a specific query language to query over different databases combining data and meta data. Basic capabilities have already been proven using RECORD data.

Positional sensor data processing:

We have also conducted intensive research on analyzing GPS sensor data. In particular, our focus on developing techniques for comprehensive semantic annotation framework [Yan 2010] [Yan, Spremic et al. 2010] [Yan, Parent et al. 2010], which allows enriching trajectories with any kind of semantic data provided by multiple 3rd party sources. The framework and its algorithms have been designed to work on trajectories with varying data quality and different structures, with the objective of covering abstraction requirements of a wide range of applications. In addition, we have developed novel indexing and query processing mechanisms for predicting future locations of moving objects [Jeung et al. 2010]. This work will be used in future to provide improved analysis tools for the GPS measurements developed in COGEAR.

WP2 milestone 1: Comparison of SensorMap vs. IKG GIS interface

Although SensorMap initially provided superior data integration over Geovite, it also had inferior capabilities in displaying spatial information. Sensormap is unfortunately no longer being developed, but the features of Geovite are always improving. GeoVITE provides a very simple interface for downloading spatial information, which (according to the plans for year 4) will be developed to also include sensor time-series data. 'Open' access within ETH domain to be available soon. IKG (previously IKA) are also actively working on both creating and displaying spatial data from queries of the SwissEx infrastructure.

WP3 milestone 1: SensorScope 2nd Generation Network

This work was completed in years 1 and 2. Second generation SensorScope stations continue to provide valuable measurements to CCES projects. Currently, Moutland is the primary beneficiary of these stations.

WP3 milestone 2: Setup of Calibration and Measurement Team

A team for calibration and measurement is now in place. The consequences of the integration of Decagon's soil and groundwater sensors with both SensorScope and Campbell loggers has been investigated in detail and cross validated with other standard soil sensors such as Trimble TDR. Guidelines for calibration have been developed by EAWAG together with WSL and ETHZ and will be available on the SwissEx wiki soon. Cross-calibration with other soil moisture sensors like Trimble TDR has also been performed. At the RECORD test sites, water quality sensors, total-dissolved gas

pressure probes and on-site mass spectrometers were developed, calibrated and tested. Instrument design has been further improved and field deployments for measurement campaigns were conducted.

WP3 milestone 3: Long distance communication links

The PermaSense and APUNCH team continued on the collaborative operation of joint networking infrastructure in Zermatt, which has led to an improvement in the LAWR data transfer and remote control of the hardware state. In addition to the leased line from Zermatt to Trockener Steg and Klein Matterhorn and the distribution network to the PermaSense field site on the Hörnliridge set up in the previous years an additional link to Randa, Dirruhorn and Grabengufer has been set up in collaboration with the CCES COGEAR and nano-tera.ch X-Sense projects. A monitoring and alerting infrastructure at ETH Zurich helps to maintain this system. This infrastructure is now actively servicing these projects with internet connectivity. Negotiations are under way to extend the internet access contract with the Zermatter Bergbahnen AG beyond the 2011 timeframe. Parties involved in these negotiations include SWITCH, Matterhorn Gotthard Bahnen and the High Alpine Research Station Jungfrauoch-Gornergrat. It is planned that a common infrastructure be made available and maintained for research usage from 2012 onwards.

In Davos, the weather independent infrastructure has been extended to Wannengrat for the acquisition of 20Hz sonic data. The radar has now been removed and the connection is being converted to allow GSN open access to the data.

WP3 milestone 4: Permasense 2nd Generation Network

The PermaSense project has been successfully developing a second generation wireless sensor networking system targeted for environmental monitoring in extreme environments. The system is made up of simple, battery powered sensor nodes, a more powerful base station including webcam and weather station as well as a solar power supply. The base station can be connected to the internet using a number of different options (GPRS, WLAN, satellite links). The sensors currently used for monitoring permafrost on two sites in the Swiss Alps are thermocouples (temperature), crack meters, pressure sensors and a set of resistivity measurements. The system is ideally suited for long term monitoring in hazardous and remote areas and is built for reliability, including disconnected operation in case of a subsystem failure. In case of a failure of part of the network, the base station or the data server, all sensor data is retained on backup memory contained in every node. The key technology herein is developed in partnership with the NCCR MICS PermaSense project. In the last year the system components were further refined and now form an easy to use, quick to deploy and reliable means for wireless environmental monitoring. All PermaSense data is currently fed in to GSN database servers making it compatible with the Swiss Experiment infrastructure.

Based on the preliminary discussion with the RECORD project in the first year a set of PermaSense wireless sensors and base station were set up on the RECORD field site at the river Thur. The system consists of a number of wireless sensor nodes with custom built multiplexing boards and 4 Decagon soil moisture sensors that are each submerged in wells provided by RECORD. Together with a Base Station, Webcam and Wireless LAN link the measurement data is fed into a GSN database server at ETH Zurich: <http://data.permasense.ch>. To date, about 12 million data samples of soil moisture data have been collected. Negotiations to extend this capability to other field sites/experiments are ongoing with EAWAG.

The material used on the RECORD field site as well as the development overhead for customization of the sensor multiplexers has been made available pro bono by the NCCR MICS project PermaSense.

In collaboration with the APUNCH project, ETHZ TIK also designed and installed a second generation X-Band weather radar system on Klein Matterhorn.

PermaSense has installed and maintains operation of two L2 GPS reference receivers in the Matter valley in collaboration with the COGEAR project. One receiver is hosted on the PermaSense Hoernliridge field site, the other is hosted in Randa on the Grossgufer field site of COGEAR. Apart from individual research the data from these units is fed to Swisstopo. Further consulting work as well as joint field work has also been undertaken with the COGEAR participants.

A high-resolution camera (Nikon D300 SLR) has been developed for usage in remote locations for very high fidelity imaging. Initial image analysis/processing work has been done with EPFL/LCAV (S.

Susstrunk). A second generation camera has been implemented for glaciology research and is currently deployed on the Rhone glacier. This is a collaboration with Martin Funk/Andreas Bauder, VAW, ETH Zurich.

The PermaSense corestation platform is additionally used for deployment work in the nano-tera.ch 3rd party funding project, OpenSense. Support, hard- and software has been made available to this project.

WP3 milestone 5: Hydromon self organising wireless network

The network is up and running. The companies involved in the project (VonRoll and AGE) are maintaining the sensors and continuously updating them. The communication network is maintained by AGE, which reports no significant glitches or major problems.

WP3 milestone 6: SensorScope 3rd Generation Network

We are working on distributed algorithms which maximizes network lifetime by allowing different nodes to act as a base-station (sending data to distant servers). In particular, we implemented a distributed scheduling algorithm that dynamically chooses an optimal base-station schedule, drastically reducing energy consumption. These algorithms are currently being tested at EPFL-campus outdoor test-bed. We plan to submit a paper early 2012. Electronic design is also continuously evolving to improve the robustness, flexibility, and portability of the sensing stations. During next year we will extend the station functionalities with embedded image capabilities.

Image transmission through sensor networks

The camera prototype we developed last year included a GSM-GPRS module to directly transmit the captured image to a remote server. Since the GSM-GPRS module consumes a significantly higher amount of energy in transmission mode than a short range radio (such as the radio used in the Sensorscope stations), this prototype required a dedicated power system (2W solar panel and a 12v battery). The goal of this task is to minimize the energy consumption required to transmit the captured image from the camera to the remote server. As the radio transmitter is definitively the largest energy consumer, image compression algorithms play a fundamental role in reducing the transmitted data and the hence the energy required for the camera module. To deliver images under the severe energy constraints of wireless sensor networks (e.g., nodes operating on batteries and a solar panel), multi-terminal source coding has an important role as it can cut the rate to the theoretical lower limit.

We showed that the broadcast nature of wireless communication in sensor networks provides a free gossip mechanism which can be used to simplify encoding/decoding and reduce transmission power. Using this broadcast advantage, we designed a new practical distributed image coding scheme which imitates the ping-pong game between multiple cameras and has a successive approximation structure. It also offers a potential energy saving over conventional distributed coding. This ping-pong distributed coding idea provides the theoretical foundation for a new class of distributed image coding method in wireless scenarios. This work has already resulted in a paper publication [Chen et. al. 2010], and we are currently working on the journal version [Chen et al. In prep.]².

In the case of multiple cameras focusing on a common object, we proposed an interleaved sampling strategy to minimize camera unit consumption by distributing sampling tasks among cameras. To overcome the uncertainties in the sensor network, we proposed a robust adaptive synchronization scheme to build optimal sampling configuration by exploiting the broadcast nature of wireless communication. We verified the fast convergence and robustness of the algorithm through simulation. Under the interleaved sampling configuration, we have explored three video coding methods to compress correlated video streams from independent cameras, namely, distributed/independent/joint coding schemes. The energy profiling on a two-camera system showed that independent and joint coding perform substantially better. The comparison between two-camera and single-camera system shows 30%-50% per-camera consumption reduction. On top of these, we showed that MIMO technology can potentially be utilized to push the communication consumption even lower. This work has resulted in a publication [Chen, Barrenetxea et al. 2012]².

Event detection from still Images

LCAV are currently developing an automatic control system for environmental monitoring based on autonomous low-power cameras. A low-resolution camera is connected to a wireless module that transmits the images to a remote server, making them available for processing and visualization.

Camera and wireless module are powered by four AA batteries and a small solar panel that provides energy autonomy without requiring an external power supply. On the server, dedicated software processes the images, and based on a gradient detection algorithm, performs the event detection.

The algorithm it is based on Histogram of Oriented Gradients (HOG) which were originally introduced by Dalal and Triggs [Dalal et al. 2005]¹ for the detection of pedestrians in static images. HOGs are descriptors of the distribution of intensity gradients, the latter being a feature relevant for object detection in an image. The algorithm divides the image into small connected cells, and for each cell it computes the histogram of gradient directions for the pixels within the cell. The combination of these histograms then represents the descriptor of the cell. The descriptors are then fed into the Support Vector Machine (SMV) classifier [Press et al. 2007]¹, which is a recognition system based on supervised learning. Once trained on images containing a particular object, the SVM classifier can make decisions regarding the presence of an object. The SVM classifier then outputs the number of detected objects (events).

We have also studied the problem of retrieving weather information from still images. If we want to provide a weather report in the conventional way from the images/videos, we need to label the images/videos with different weather condition semantics, which require a lot of labor force if we do this manually. We have developed an algorithm that given a still image, can automatically label the image with different weather conditions, e.g., sunny, cloudy, and overcast. The system includes three main stages: sky region extraction, image feature extraction/gathering, and multipass active learning/recognition. We have proposed an algorithm for sky region extraction, which is based on the dynamic nature of the cloud and layout of the images. A “Bag of histogram” algorithm is used for feature extraction, and multiple kernel learning is implemented to achieve an optimal linear combination of different features so as to reduce the complexity in the training and classification stages and improve the recognition performance. To further increase the recognition performance and reduce the complexity, we have adopted the multipass active learning for selecting the training set. We have shown by experimental results that this system achieves a high confidence. This work has also resulted in a publication [Chen et al. Submitted]².

Routing Algorithms for long range communications

While deploying wireless sensor networks with a single base station is a common practice, it can be risky to ignore the effects of potential failures of that single point. The solution that immediately comes to mind is to deploy multiple of them, thus adding some redundancy. This however cannot always be considered viable, as base stations are often assigned tasks (such as sending data to distant servers) that consume a substantial amount of energy, and installing large batteries at multiple places may not be feasible. We studied this problem and presented an elegant solution in which multiple base stations are deployed but only a subset of them acts as such at any given moment. When a base station is not active, it acts as a simple node, gathering and routing data. We described the resulting “hopping base station problem”, which consists of efficiently choosing the next base station while maximizing the network lifetime. We also showed that, using energy scavenging, sufficient energy can be retrieved across the whole network to sustain the operation of the active base stations while using only small-sized batteries. We proposed a distributed scheduling algorithm, proved that it is optimal, and showed practical results obtained from our real-world testbed at EPFL campus [Zhang et al. Submitted]².

WP3 milestone 7: SensorScope extreme environment test deployment on Wannengrat

Extreme environment testing at Wannengrat is ongoing. Two experiments were carried out last winter, one consisting of 5 stations in inaccessible locations for the duration of the winter and one short term campaign to look at snow-patch melt processes. This winter, the 5 stations will again be used for the duration of the winter in addition to several other small scale winter experiments elsewhere. Snow height sensors will be added to some of these stations. These stations, although still in an extreme environment, are now mostly deployed for research purposes, having fulfilled their requirements for SensorScope testing.

¹ External references

- N. Dalal and B. Triggs. IEEE Conference on Computer Vision and Pattern Recognition (CVPR), vol. II, pages 886-893, June 2005.
- W.H. Press, S.A. Teukolsky, W.T. Vetterling, B.P. Flannery (2007). "Section 16.5.Support Vector Machines". Numerical Recipes: The Art of Scientific Computing (3rd ed.). New York: Cambridge University Press.

WP3 milestone 8: Completion of RADAR, LIDAR and Disdrometer and development of DTS

After the installation and instrumentation of all monitoring wells, loggers and field sites were maintained and data were downloaded at regular periods. For the detailed investigation of infiltration rates in the river bed a high-resolution vertical temperature profiler was developed based on distributed temperature sensing (DTS). The main activity and innovation of the third year was data evaluation in an array of vertical profilers. Groundwater exfiltration areas in the side channels were further investigated during different hydrological situations by lateral DTS measurements combined with other temperature methods and tracer tests. In addition, an active DTS was installed which can be heated whilst deployed in a gravel bar of the Niederneunforn site. This is a new collaboration with the group of Wolfgang Kinzelbach (ETHZ).

The X-Band RADAR of ETHZ-HWRM was repaired and installed again in February 2011 and now a set of about 100 precipitation events is available for analysis. The data correction procedure was further refined and the calibration procedure was improved.

Lidar testing was completed in year 1 and the EPFL-LTE radar deployment was concluded in June 2011.

WP3 Milestone 8: SensorScope deployment

Winter deployments in Davos (continuation of TRAMM work and SwissEx):

SensorScope stations were deployed for several projects during Winter 2010/11: 5 SensorScope stations were used for the acquisition of data related to avalanche release at Wannengrat, 3 stations were used for the acquisition of data related to evaporation of snow over snow patches at Wannengrat (REF). One station was used for the acquisition of data related to gliding snow avalanches in St Antönien, and 3 stations for data related to wet snow (TRAMM project) in collaboration with under-snow radar research from SLF and LMU. One additional station was used for a snow drift experiment at Weissfluhjoch and one for an infra-red surface temperature calibration experiment.

An additional 4 SensorScope meteostations with soil moisture profiles were set up for the 3rd party funding project, IRKIS. These stations will remain in place for two years.

Full-scale measurements at the RECORD-sites started in 2008 and were continued through 2011. Intensive tests of the SensorScope stations have been successful, resulting in a continuous record of data.

Summer/winter deployments in Valais (Mountland):

In spring 2011, the majority of the SwissEx sensorscope pool (11 stations) was loaned to Mountland Pfynwald for the instrumentation of their field site. These stations will remain on loan for a year. In addition to standard meteorological and soil moisture parameters, the stations were instrumented with Midori dendrometers (supplied by Mountland). The 2 stations used for the dendrometers were purchased by SwissEx additionally and will remain in place for as long as required by Mountland.

Burkina Faso deployment (SwissEx/Info4Dourou):

The deployment of Sensorscope stations in the commune of Madjoari, Burkina Faso continued between September 2010 and 2011. The largest success in this deployment has been the completion of an 18-month intensive field campaign. In addition to other equipment, 19 Sensorscope stations were deployed, made up of a variety of sensors. Of particular interest are the two stations which take soil moisture data up to 2 meters in depth and the 3 stations surrounding the tree. Starting in November 2010, the measurement campaign was reduced, but the Sensorscope stations remained and are functioning. In October 2011, we will travel to Burkina Faso to upgrade to a more robust Sensorscope module.



Figure 1: 2011 SensorScope station in Burkina Faso

Evaporation was calculated from the Sensorscope data, using Monin-Obukov similarity theory and comparison to the eddy correlation stations. The calculation of evaporation across the watershed will allow for the water balance at both point and watershed scale to account for the spatio-temporal variations in landcover and their effect on the hydrological processes.

In addition, the data from the Sensorscope stations are being used to improve watershed modeling. To model the rainfall runoff processed, we developed a hydrological model with three reservoirs according to the three types of land use, soil types and runoff peaks. The main components of the model are: rainfall, soil moisture, evaporation, groundwater and discharge. The model is still in development and the first results are promising.

La Fouly wind experiment (SwissEx)

We conducted a summer field study in the Swiss Alps to understand the evening transition period over alpine terrain. Under clear skies and weak synoptic conditions, a shallow layer of slope flow typically forms. During the day, winds travel up the slopes and at night, they travel down toward to the bottom of the valley. Little is known about how the transition between these two wind regimes takes place over very steep slopes, mostly because they are extremely challenging to monitor. In summer 2010, we deployed a suite of meteorological stations on a steep slope (20 to 45 degrees) to capture the complex interplay between the surface and the atmosphere during this period (Fig. 1).

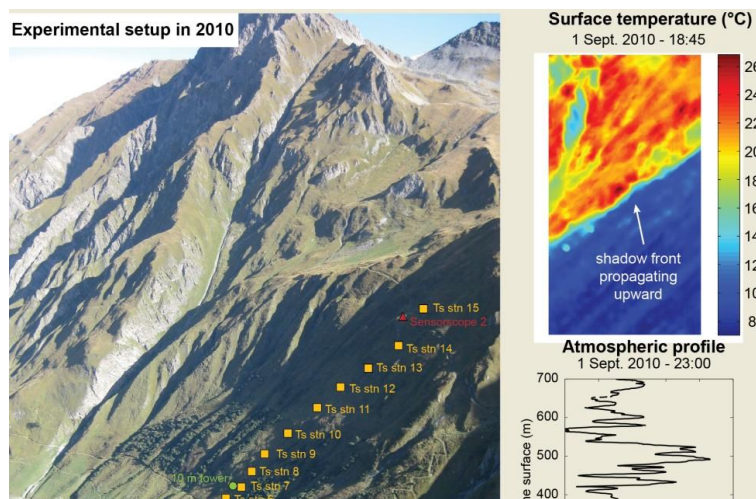


Figure 2: Example of La Fouly wind experiment results

The observations we made revealed a fascinating sequence of events taking place around the end of the day. Every evening on 'convective' days, the geometric configuration of the experimental site leads to the formation of a 'shadow front' propagating from the bottom to the top of the slope. The impact on the surface temperatures is dramatic and in some cases drops of 10°C in less than 10 min can be observed (Fig. 2). This rapid diminution of the surface temperature reduces the temperature contrasts at

the valley scale and eventually suppresses the daytime wind circulation. This is followed by a quiescent period with very low turbulence levels and extremely small wind speeds (< 0.5 m/s). The surface cools by emitting longwave radiation. In doing so, it cools down a shallow layer of air above the surface, up to the point where this layer of cold air starts to 'sink' down the slope (Fig. 1). Downslope flow then persists throughout the night.

A further SensorScope deployment took place in La Fouly. This is described in WP4, milestone 2.

WP3 Milestone 8: LIDAR field campaign and development

The LIDAR field campaign took place in year 1. No more developments have taken place under Swiss Experiment.

WP4 milestone 1: Integration of CCES projects into the SwissEx infrastructure

The PermaSense team has worked closely with EPFL/SLF on the definition of a suitable data handling architecture and a number of technical issues with respect to GSN and data management have been jointly handled. Due to the late availability of suitable prototype solutions for data mapping and raw value conversion based on EPFL/SLF's wiki infrastructure the PermaSense project had to implement a custom, configuration file and GSN based solution.

This GSN infrastructure allows Permasense to manage multi-site, multi-station, multi-revision data with meta-data integrated from simple ASCII text files. It supports metadata change management, i.e. cut-and-pasting of the data to reflect the data measured at a position as opposed to on a specific piece of hardware, which is of importance when changes happen in field-site specific hard- and software. A backlog architecture prevents data loss on sensors and corestations on the field-site level. This infrastructure will form the performance baseline for a more collaborative, robust solution to be implemented by LSIR.

A novel plotting frontend (SensorViz) has been developed by TIK with a view to integrating it into the GSN software and hence providing user interface improvements. It allows plotting, panning and zooming through timeseries data in a quick and easy manner. A backend cache service is running next to a GSN instance.

This solution is currently successfully used in the operational PermaSense data handling system for 4 field sites and has collected over 170 M data packets.

RECORD project now have data streaming to GSN (e.g. DTS, Sensorscope and Permasense sensors) and more than 850 Wiki pages providing views and access to the data by location, time, observer and type. Work is continuing on joint queries of data and metadata derived from multiple sources (manual sampling, manual sensing, automatic sensing, and streaming sensor data).

SwissEx partners have put significant effort into integrating data from Mountland Davos and Vaud. SLF employed an ex-Mountland employee for 3 months in year 3 for the sole purpose of integrating Mountland data, and significant progress was made during this period in integrating data from both Davos and Vaud. She remains involved in the SwissEx integration and will assist in providing domain specific tools. Integration of data from Valais is planned for the 4th year. Mountland in particular have a mix of both manually sampled and streaming data, so a common interface was required. The data upload system developed for the RECORD project was extended and integrated into the metadata system. This now provides a method for integrating non-standard static metadata, though it has been decided that any data which changes over < 50-100 years should be stored in GSN. Other 'data' may be deemed to be location specific metadata and should be stored in the wiki.

APUNCH data from SensorScope and permanent meteo stations have continued to be integrated over the past year. The meteorological data collected and post-processed by HWRM within the APUNCH project are available on the GSN platform. In addition to the data obtained by the automatic weather stations, radar images of daily cumulative rainfall are also available.

EPFL-LSIR and ETH-SED have been collaborating on particularly bridging the end points of the systems between COGEAR and SwissEx infrastructures to allow the integration of the COGEAR databases with GSN. COGEAR have followed world standards, such as SensorML, GML, and etc., so integrating their data will be a useful exercise for future datasets. SLF has been concentrating on using existing GSN software to integrate the less-complex COGEAR data into GSN.

WP4 milestone 2: Precipitation measurement campaign in alpine terrain

After the three first field campaigns that took place from 2008 on, the 2011 campaign is composed of 16 third generation and 10 fourth generation (see Figure 3) SensorScope stations that collect meteorological and soil data, which is available in real time through the Climaps website. Discharge measurements using the salt dilution method have been carried out on a weekly basis from late April until late-October since 2008. The stage-discharge relation has been established combining the discharge measurement along with continuous monitoring of the water level with pressure and ultrasound sensors. During the 2011 field campaign, the discharge of two sub-basins has been monitored in order to evaluate the contribution of each sub-basin. Moreover, water from different rivers of the basin has been sampled automatically, along with water samples from precipitation, in order to proceed to a two-component hydrograph separation with stable isotopes analysis. Finally, an intensive field survey was set up in August 2011 to monitor the channel heads of the river network, in order to compare them with the river network extraction calculated automatically with a Digital Elevation Model. In this framework, we began a collaboration with Prof. Paolo Tarolli from Padova University in order to proceed to a geomorphological study of the La Fouly catchment.



Figure 3: Sensorscope station installation close to the Lacs Fenêtres

WP4 milestone 3: Vispa catchment measurement campaign

Due to the inclusion of only one deliverable in this milestone, this campaign has not taken place as a coordinated inter-institutional campaign. Data is however available in the SwissEx infrastructure from COGEAR, APUNCH, Permasense and Mountland for the extent of the CCES funding period.

In the third year of the APUNCH project the 13 SensorScope stations were again installed along hill slopes above Zermatt in order to further investigate precipitation gradients with altitude. In order to overcome the connectivity problem among the slave stations along the hillslope transects, all stations were equipped with a GPRS module. The 6 reference stations remained at the same locations as in the previous years. The collected data are available on the HWRM GSN server (see WP4 milestone 1).

WP4 milestone 4: Wiki and GSN workshops

Workshops are now being completed on a team-by-team basis, not as planned in the workplan. This makes organization easier and allows them to be tailored to the team. Presentations and data integration meetings have been held for Permasense and COGEAR, a short workshop/meeting was held for APUNCH in July, and workshops will be held for RECORD and BigLink in October. Mountland data integration is being carried out by meetings with the individual (Davos, Valais, Vaud) teams and workshops are held on a one-to-one basis.

WP4 milestone 5: Creation of a pool of SensorScope Stations for multiple use in campaigns of the participating CCES projects

The pool of Sensorscope stations was bought in Years 1 and 2. This pool has just undergone a software upgrade and repairs are underway. Two new stations were bought for the purposes of Mountland dendrometer integration in year 3. These dendrometers are now functioning extremely well.

WP5 Milestone 1: End of each education 'campaign'

This third SwissEx Environmental Education year has been dedicated to its generalisation to a national scale. To this end, pedagogical notebooks as well as a webpage have been translated into German and English (http://www.swiss-experiment.ch/index.php/SwissEx:Climatscope_fr). Deployment of SensorScope stations has also continued; Six sensing stations are currently installed (Sion, Nyon, Orsières, Bulach, Thun and Lausanne) and teachers have been providing enthusiastic, positive feedback (<http://eflum.epfl.ch/climatscope>).

Within the European Environmental Education project O3E (<http://o3e.geoazur.eu/>), two pedagogical books were written by the Swiss partners (ClimAtscope, SISMO@school and GLOBE) during 2011.

During the third year, EFLUM, in collaboration with LASIG and PH Berne developed Hydroweb (<http://lasigpc8.epfl.ch/hydroweb/>), a new EE project. This project is part of the EE program CCES@school. During year 4, we will try to integrate this tool as closely as possible with the rest of the SwissEx platform. A prototype platform has already been provided within the SwissEx wiki, which will be developed further once some bugs have been resolved. This will be the basis for an extended environmental education wiki in SwissEx phase II.

During year 3, the excellent collaboration between the SwissEx EE programs (SISMO at school, GLOBE...) have been developed and reinforced and climAtscope also participated in exhibitions such as La science ça m'intéresse or la Journée des métiers.

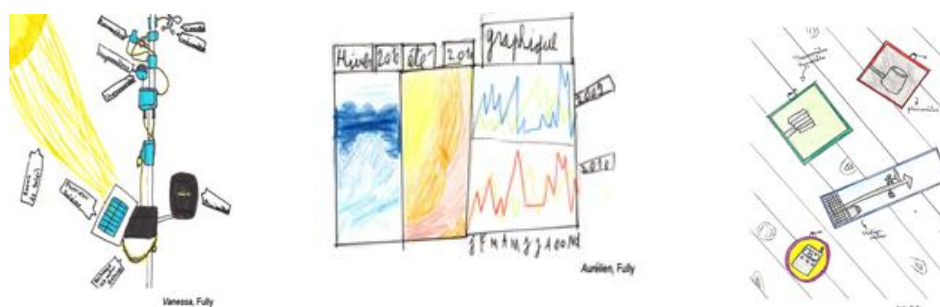


Figure 4: 2011 Drawings by 10 year old children from Fully (VS) who were involved in the programme.

Deliverables:

Deliverables WSL/SLF Lehning:

Deliverable	Collaborating institutions	Deliverable type	Due month	Milestone	WP
Infrastructure for retrieving TRAMM and BigLink streaming data	LSIR	Software, Support	3	WP4.1	4
<p>Deliverable complete</p> <p>The infrastructure for retrieving TRAMM and BigLink streaming data has been in place since the start of the project. Some streaming data was integrated from both projects. BigLink will be integrating the rest of their data into SwissEx in year 4.</p>					
Control and publishing of metadata	LSIR	Publication	6	WP1.2	1
<p>Deliverable complete</p> <p>The SwissEx metadata system is being continually improved. One of the largest changes to the system this year was the addition of experiments. This addition provides the user with the opportunity to explain the purpose for which specific sensor systems were set up and hence the reasoning behind specific nuances of the sensor system architecture. For the remote user, this means a greater understanding of another person's data. Experiments are linked to measurement locations and publications are linked to both of the above, all of which provide a greater documentation set for the data.</p> <p>The second largest change, which as yet remains incomplete, was the integration of manually sampled data into the metadata system. The system built by the University of Twente in collaboration with RECORD was replicated and integrated with the metadata system. Specific (published) datasets from Stillberg were integrated to prove the system which can be found HERE. The system remains however too insecure for the integration of unpublished data. A solution to this has been located, but requires an update of the wiki system. Currently, the latest update removes support for the SPARQL queries required for communication between the wiki and GSN. LSIR have been communicating with the Semantic Mediawiki developers in order to resolve this issue such that the SwissEx wiki can be upgraded. Once this is complete, it should be a relatively simple process to move RECORD data into the mainstream system.</p> <p>The second largest change was the integration of the Excel macro upload system developed by the University of Twente for RECORD project to upload manually sampled data to the wiki. During the course of this work (an example of which can be found here: http://www.swiss-experiment.ch/index.php/Stillberg:Sample_Melissa.martin_2107.01.1985.tree_height), it was determined that this method of data storage is a. too insecure and b. not in line with the SwissEx data infrastructure. This work was not however wasted, as the upload system and documentation remain in-place for the upload of measurement position based metadata, such as the plot information at the bottom of the following page: http://www.swiss-experiment.ch/index.php/Record:R007</p> <p>In order to merge functionality and centralise the SwissEx functionality, such that it appears to be a single system to the end user, we have replicated GSN functionality inside the wiki. Previous attempts to do this have placed a large processing burden on the central system. The advantage of this new centralised interface is that data is returned directly from the distributed GSN instance, directly to the user, hence avoiding processing problems. The centralised location in the wiki means that metadata can be returned with the data, integrating the two systems fully. A user querying data via a wiki data search need not have any prior knowledge of the data's storage location.</p> <p>Deliverable:</p> <ul style="list-style-type: none"> N. Dawes, K.A. Kumar, S. Michel, K. Aberer, M. Lehning; Sensor Metadata Management and Its Application in Collaborative Environmental Research, <i>Esience</i>, pp.143-150, 2008 Fourth IEEE International Conference on eScience, December 2008 					

Sensorscope Station for Davos Schools	LCAV	Hardware	8	WP5.1	5
<p>Deliverable in progress</p> <p>Although previous attempts to bring the SwissEx outreach programme into local (Davos) schools have floundered, SwissEx will participate in a local education programme in 2012. During this programme, we will organise a subset of the ClimAtscope activities in order to raise awareness and further interest in the programme.</p>					
Data infrastructure for Mountland, Maiolica and APUNCH streaming data	LSIR	Software, Support	12 - 36	WP4.1	4
<p>Deliverable Complete</p> <p>Mountland Pfynwald have been provided with 11 SensorScope stations for the year 2011/12. In addition to standard Sensorscope meteorological parameters, LCAV integrated Midori dendrometers into the system, such that the data are transmitted on the same self organizing network as the other sensors. These data are being collected in real-time in the SLF GSN instance and are openly accessible.</p> <p>SLF worked in collaboration with Mountland Vaud to acquire all field data into the SwissEx system. All SensorScope data and all metadata are now fully integrated and all manually sampled data are formatted ready for upload to the wiki system once security issues have been resolved.</p> <p>Mountland Stillberg data are being continually integrated by the users and actively used collaboratively.</p> <p>Maiolica have repeatedly shown that they are not interested in benefitting from the SwissEx system.</p> <p>A workshop was held at ETH Zürich for the integration of APUNCH data. Further data are now being integrated and the users have expressed interest in integrating as much data as possible. We will continue to closely assist the project over the coming year.</p> <p>APUNCH streaming data integrated into the infrastructure during year 2 continue to be accessible.</p>					
Generic model interface	LSIR	Software	24	WP1.3	1
<p>Deliverable complete</p> <p>The MeteolO model plugin has now been updated to run with the improved functionality of the generic GSN webservice. This is now a tool which is openly available to any interested parties.</p>					
Paper on dense spatially and temporally distributed measurements from Wannengrat	EFLUM, LCAV	Publication	24	WP3.7	3
<p>Deliverable complete</p> <p>R. Mott, M. Schirmer, M. Bavay, T. Grünwald, M. Lehning, Understanding snow-transport processes shaping the mountain snow-cover, The Cryosphere, Volume: 4, Issue: 4, Pages: 545-559, 2 December 2010</p>					
Calibration of SensorScope meteorological instruments	LCAV, EFLUM	Web Publication	24	WP3.2	3
<p>Deliverable in progress</p> <p>This task will be carried out by a student at SLF during year 4.</p>					

Paper on characterisation of annotations on a data model	LSIR	Publication	36	WP1.3	1
Deliverable in progress SLF now working intensively on this. Publication expected by month 48					
Meteoswiss and BAFU data	LSIR	Data online	48	WP1.1	1
Deliverable in progress					
Infrastructure workshops	LSIR, EAWAG	Workshop	6, 18, 36	WP4.4	4
Deliverable complete Infrastructure workshops are now occurring on a group-by-group basis. An infrastructure workshop was already held for APUNCH, another was planned for Mountland Pfynwald, but was delayed over the summer period. A special effort will be made to carry out as many workshops as possible in year 4. There are two reasons for this effort: a. the infrastructure workshops are best held when as much of the final infrastructure as possible is complete; b. it was found that organizing a centralized infrastructure workshop for all projects did not work, hence after several attempts, they are now being organized on an institutional/project basis.					
Integration of all data into the infrastructure	All	Data online	48	WP1.1	1
Deliverable in progress A new server has now been implemented at SLF after the demand for data storage exceeded the capabilities of the old server. Data of various types are being integrated daily. There are several new types of data available within the SLF GSN instance: Pre-processed data and plots (implemented using the R system), gridded (spatial) data from laserscans and both input/output data from Alpine3D and webcam images. A new type of sensorscope wrapper now allows us to receive all SensorScope data independent of the GSN uptime. SLF are currently integrating all data recorded at Weissfluhjoch since automatic weather stations were introduced. This is a manually intensive process, due to the wide range of data formats used over the time period, but good progress is being made.					

Deliverables EPFL/EFLUM Parlange:

Deliverable	Collaborating institutions	Deliverable type	Due month	Milestone	WP
SensorScope station for climate EE programme	LCAV	Hardware	6	WP5.1	5
<p>Deliverable complete</p> <p>Six Sensorscope stations are available for climAtscope. They are currently set up in Sion, Nyon, Orsières, Bulach, Thun and Lausanne and collect data that are directly available on SwissEx webpage</p>					
LIDAR, SODAR, SensorScope field campaign	LCAV	Data and publication	12	WP3.8	3
<p>Deliverable complete</p> <p>The meteorological stations installed during the 2011 campaign cover a larger part of the catchment than in the previous years. This will allow us to test and assess the quality of our spatially distributed model, and to continue the previous work done on the spatial and temporal heterogeneity of the parameters (Simoni et al., 2011 in press). The results of the 2011 field campaign will be presented during the 2011 fall meeting of the American Geophysical Union in San Francisco.</p> <p>Results coming from La Fouly wind experiment have been published.</p> <p>The Burkina Faso deployment is ongoing. 19 second generation SensorScope stations have been installed in semi-arid West Africa small catchment. Further information can be found under this link : http://eflum.epfl.ch/research/burkina.en.php</p>					
Testing of SensorScope stations (part of calibration programme)	LCAV, WSL/SLF, EAWAG	Web publication	24	WP3.2	3
<p>Deliverable in progress</p> <p>La Fouly, Burkina and climAtscope deployments have been used to both test and calibrate new generation of SensorScope stations. Publications have been published and a web publication will follow.</p> <p>Deliverable: O. Couach, V. Luyet, P. Ristori, M.B. Parlange, G. Barrenetxea, F. Ingelrest, M. Vetterli, K. Aberer, A New Environmental Monitoring System. Example of Application in an Alpine Environment, Environmental Modelling & Software Special Issue "Sensors and Environment", 2009</p>					

Precipitation measurement campaign	LCAV, HWRM, WSL/SLF, LSIR	Publication	24	WP4.2	4
<p>Deliverable complete</p> <p>A publication based on the 2009 La Fouly deployment and especially the 12 SensorScope stations measuring, among other, precipitation has been published.</p> <p>Deliverables:</p> <p>S. Simoni, S. Padoan, D. Nadeau, M. Diebold, A. M. Porporato, M. Amilcare, G. Barrenetxea, F. Ingelrest, M. Vetterli, M.B. Parlange, Hydrologic response of an alpine watershed: Application of a meteorological wireless sensor network to understand streamflow generation, Water Resources Research, vol. 47, p. W10524, 1 May 2011</p> <p>C. Tobin, L. Nicotina, M.B. Parlange, A. Berne, A. Rinaldo, Improved interpolation of meteorological forcings and hydrologic implications for a Swiss alpine region, Journal of Hydrology, vol. 401, num. 1-2, p. 77-89, 1 April 2011</p> <p>S. Simoni, Porporato, S. Padoan, M.B. Parlange, Different sensitivity of streamflow components to spatial variability in complex topography, EGU 2010, Vienna, Austria, April 2010</p> <p>S. Simoni, A. Porporato, H.W. Huwald, S. Padoan, M.B. Parlange, Understanding the hydrological behavior of a steep watershed in the Swiss Alps through a time series analysis of river flow data, EGU General Assembly, 14 April 2009</p>					
Mobile radar field campaign	LTE, WSL/SLF	Hardware	6-48	WP3.8	3
<p>Deliverable complete</p> <p>See LTE deliverables</p>					
Disdrometer prototype deployment	LTE, ISIM	Hardware	18	WP3.8	3
<p>Deliverable complete</p> <p>See ISIM deliverables</p>					
Generalized climate EE programme in Valais	LSIR, GLOBE, LCAV, SED	Common website	48	WP5.1	5
<p>Deliverable in progress</p> <p>The third SwissEx Environmental Education year has been dedicated to its generalisation to a national scale. To this end, pedagogical notebooks as well as a webpage have been translated into German and English (http://www.swiss-experiment.ch/index.php/SwissEx:Climatscope_fr). Deployment of SensorScope stations has also continued; Six sensing stations are currently installed (Sion, Nyon, Orsières, Bulach, Thun and Lausanne) and teachers have been providing enthusiastic, positive feedback (http://eflum.epfl.ch/climatscope).</p>					

SwissEx EE programme	LSIR, GLOBE, LCAV, SED	Common website	48	WP5.1	5
<p>Deliverable in progress</p> <p>During the third year, the collaborations and coordination of SwissEx EE partners (GLOBE, SED, SLF, EPFL) have been reinforced. For more information, see: http://www.swiss-experiment.ch/index.php/SwisScope:Home. A new, common website is in progress: http://www.swiss-experiment.ch/index.php/SwissEx:Climatscope_fr</p>					
Paper on large scale interdisciplinary deployment in Valais	All institutions	Publication	48	WP1.3	1
<p>Deliverable in progress</p>					
Coordination and development of international network for Environmental Education.	SED, GLOBE, LCAV	International network	12	WP5.1	5
<p>Deliverable complete</p> <p>The SwissEx environmental education programs was involved in the European O3E program (http://o3e.geoazur.eu/). SwissEx took the lead of the meteorological part of this project and two books were written and given to our French and Italian partners.</p>					

Deliverables EPFL/LSIR Aberer:

Deliverable	Collaborating institutions	Deliverable type	Due month	Milestone	WP
GSN operation	SLF	Software, Support	1- 48	WP1.2	1
<p>Deliverable in progress</p> <p>We have successfully made GSN operational for several SwissEx partners; In 2008, data from the sensors deployed by SLF, TIK, and EAWAG were already being collected through GSN. Since spring 2009, HWRM has been using GSN for obtaining their data. Many other organizations (e.g., belonging to HYDROSYS and COGEAR projects) also use GSN. In addition, All partners plan to extend the use of GSN for more sensors that will be deployed in the following years.</p>					
Control and publishing of metadata	SLF, EAWAG	Software, Support	18	WP1.2	1
<p>Deliverable complete</p> <p>The main development of SwissEx wiki system has been completed, and the metadata store in the system is currently being used by SwissEx partners (http://www.swiss-experiment.ch/index.php/Metadata:Home). The metadata schema was created by the collaboration among EAWAG, SLF, and LSIR, through a chain of discussions with the other partners. To make the metadata store easily used, we also developed a bulk-loading system of the metadata (http://www.swiss-experiment.ch/index.php/BulkloadInstruction), and an export system (http://lsir-swissex.epfl.ch/exportMetadata/exportMetadata.html). Further developments of the metadata management system will be carried out in the 4th year, e.g., real-time joint processing of the metadata and sensor data.</p>					
Operational data exploitation software	SLF	Software	18	WP2.1	2
<p>Deliverable complete</p> <p>The integration of SensorMap with GSN was completed (http://sensormap.org) in year 1. SensorMap is now able to display not only sensor data through SwissEx GSN instances, but also associated metadata from the wiki server. This allows users to query the sensor and retrieve real time sensor information through interaction with the map. This work was demonstrated at the Microsoft all hands meeting in Redmond, March 2008.</p> <p>Several other methods of data exploitation have been tested. GSN is now able to support data processing through three methods: basic calculations in MySQL, more advanced calculations in Groovy scriptlets, or processing and or plotting using the R statistical programming language. In addition to this, R processing in the wiki was tested, but was found to significantly impact the performance of the wiki, so is not recommended.</p>					

Long term data and metadata management	All institutions	Publication	48	WP4.3	4
<p>Deliverable in progress</p> <p>In June 2009, we made a concrete plan for managing long-term sensor and metadata, targeting both SwissEx and MICS projects. This plan includes model-based sensor data compression, efficient data access, optimization in data-stream processing and storage, and data quality control using complex model-based data representation.</p> <p>For long-term metadata management, we have provided two dedicated servers for managing the metadata in the SwissEx wiki system as well as one full-time developer for this task. We will keep these resources for the metadata management until at least the end of SwissEx project.</p> <p>Deliverables:</p> <ul style="list-style-type: none"> • N. Bonvin, T.G. Papaioannou, K. Aberer, Autonomic SLA-driven Provisioning for Cloud Applications, August 2011 • I. Paparrizos, H. Jeung, K. Aberer, Visualization and Tagging of Sensor Metadata, Proceedings of the IEEE International Conference on Data Engineering (ICDE), 3 April 2011 • I. Paparrizos, H. Jeung, K. Aberer, Advanced Search, Visualization and Tagging of Sensor Metadata, Proceedings of the IEEE International Conference on Data Engineering (ICDE), March 2011 • A.D. Popescu, D. Dash, V. Kantere and A. Ailamaki, Adaptive query execution for data management in the cloud, Proceedings of the second international workshop on Cloud data management (CloudDB), October 2010 • H. Jeung, S. Sarni, I. Paparrizos, S. Sathe, K. Aberer, N. Dawes, T.G. Papaioannou, M. Lehning, Effective Metadata Management in Federated Sensor Networks, 3rd IEEE International Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing (SUTC2010); California, USA, 7 June 2010 • O.A. Jurca, S. Michel, A. Herrmann, K. Aberer, Continuous Query Evaluation over Distributed Sensor Networks, Proc. 26th IEEE International Conference on Data Engineering (ICDE 2010); Long Beach, California, USA, March 2010 • A. Wombacher, P. Schneider, Observation Centric Data Model, Proc. 21st DEXA Conference, Bilbao, Spain, 2010 • H. Jeung, M.L. Yiu, X. Zhou and C.S. Jensen, Path Prediction and Predictive Range Querying in Spatial Network Databases, The VLDB Journal, August 2010 • P. Haghani, S. Michel, K. Aberer, The gist of everything new - personalized top-k processing over web 2.0 streams, Proceedings of the 19th ACM Conference on Information and Knowledge Management (CIKM), November 2010 • P. Haghani, S. Michel, K. Aberer, Evaluating Top-k Queries over Incomplete Data Streams, Proc. 18th ACM conference on Information and Knowledge Management, November 2009 • Y. Zhou, A. Salehi, K. Aberer, Scalable Delivery of Stream Query Result, Proc. 35th International Conference on Very Large Data Bases (VLDB), July 2009 • A. Salehi, M. Riahi, S. Michel, K. Aberer, Knowing When to Slide - Efficient Scheduling for Sliding Window Processing, Proc. 10th International Conference on Mobile Data Management (MDM), May 2009 • A. Salehi, M. Riahi, S. Michel, K. Aberer, GSN, Middleware for Stream World, Proc. 10th International Conference on Mobile Data Management (MDM) (demonstration track), May 2009 • S. Michel, A. Salehi, L. Luo, N. Dawes, K. Aberer, G. Barrenetxea, M. Bavay, A. Kansal, K.A. Kumar, S. Nath, M.B. Parlange, S. Tansley, C. Van Ingen, F. Zhao, Y. Zhou, Environmental Monitoring 2.0, Proceedings of ICDE (2009), March 2009 • O.A. Jurca, S. Michel, A. Herrmann, K. Aberer, Processing Publish/Subscribe Queries over Distributed Data Streams, Proc. 3rd ACM International Conference on Distributed Event-Based Systems, 2009 • N. Dawes, K.A. Kumar, S. Michel, K. Aberer, M. Lehning, Sensor Metadata Management and Its Application in Collaborative Environmental Research, <i>escience</i>, pp.143-150, 2008 Fourth IEEE International Conference on eScience, December 2008 • O.A. Jurca, S. Michel, A. Herrmann, K. Aberer, Query Driven Operator Placement for Complex Event Detection over Data Streams, Proc. 3rd IEEE European Conference on Smart Sensing and Context, 2008 <p>+ others, see: http://www.swiss-experiment.ch/index.php/SwissEx:Publications</p>					

Deliverables ETHZ/TIK Thiele:

Deliverable	Collaborating institutions	Deliverable type	Due month	Milestone	WP
PermaSense 2 nd Generation Network	Uni Basel, Uni Zurich	Hardware, Software	12	WP3.4	3
<p>Deliverable complete</p> <p>The second generation sensor network hard- and software is now available. Sample quantities are available to project partners on stock. Larger quantities can be produced upon request. http://www.permasense.ch</p>					
Deployment and operation of high alpine field sites	Uni Basel, Uni Zurich	Deployment, Support, Operation	1-48	WP3.4	3
<p>Deliverable in progress</p> <p>The PermaSense project has now extended its field sites to a total of 4 (Matterhorn, Jungfrauoch, Thur and Dirruhorn) that are in constant long-term operation. Furthermore, two locations are currently operated as WLAN relay sites in cooperation with APUNCH/COGEAR.</p>					
Integration of PermaSense into the Swiss Experiment Data Infrastructure	SLF, LSIR, Uni Zurich	Hardware	24	WP4.1	4
<p>Deliverable complete</p> <p>Due to the late availability of a suitable data conversion and data mapping solution from the SwissEx consortium partners the PermaSense project had to devise a separate solution. This setup of two GSN servers and a number of configuration files allows for easy and quick change management, data channel mapping and raw value conversion that was mission critical for a number of users of the field campaign data generated over the last years.</p>					
Tech transfer of PermaSense technology to other Swiss Experiment projects	Uni Basel, Uni Zurich	Software, Support	24	WP3.4	3
<p>Deliverable complete</p> <p>The PermaSense project has collaborated intensely with RECORD, COGEAR and APUNCH projects with respect to sensor technology, communication infrastructure, system management and monitoring as well as joint field work.</p>					
Organization of a summer research institute in conjunction with a technical workshop on long-term remote sensing	Uni Zurich	Workshop	24	WP5	5
<p>Deliverable in progress</p> <p>This activity is planned for 2011/2012.</p>					

Deliverables EPFL/LCAV Vetterli:

Deliverable	Collaborating institutions	Deliverable type	Due month	Milestone	WP
Paper on Sensorscope 1st Generation Experiences and Results	EFLUM	Publication	4	WP3.1	3
<p>Deliverable complete</p> <p>Several papers have been published in the proceedings of major communication conferences (IPSN, EWSN, and Sensys) as well as a journal paper (ACM Transactions on Sensor Networks) describing the 1st generation Sensorscope system.</p> <p>Deliverables:</p> <ul style="list-style-type: none"> • G. Barrenetxea, F. Ingelrest, Y.M. Lu, M. Vetterli, Assessing the Challenges of Environmental Signal Processing through the SensorScope Project, Proc. 33rd IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP 2008), 2008 • G. Barrenetxea, F. Ingelrest, G. Schaefer, M. Vetterli, The Hitchhiker's Guide to Successful Wireless Sensor Network Deployments, Proc. 6th ACM Conference on Embedded Networked Sensor Systems (SenSys 2008), March 2008 • F. Ingelrest, G. Barrenetxea, M. Vetterli, SensorScope, un système clef en main de surveillance de l'environnement, 13ème Colloque Francophone sur l'Ingénierie des Protocoles (CFIP 2008), 25 March 2008 • G. Barrenetxea, F. Ingelrest, G. Schaefer, M. Vetterli, O. Couach, SensorScope - Out-of-the-Box Environmental Monitoring, Proc. 7th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN 2008), St. Louis, MO, USA, 22 April 2008 • G. Barrenetxea, F. Ingelrest, G. Schaefer, M. Vetterli, Wireless Sensor Networks for Environmental Monitoring- The SensorScope Experience, The 20th IEEE International Zurich Seminar on Communications (IZS 2008), 1 September 2008 					
SensorScope 2 nd Generation		Hardware / Software	3	WP3.1	3
<p>Deliverable complete</p> <p>Sensorscope 2nd generation has already been fully developed and has been used in multiple Swiss Experiment deployments (see second year report for more details).</p>					
Develop sensor communication protocol (sensor bus)		Software	1-6	WP3.1	3
<p>Deliverable complete</p> <p>To increase station flexibility, a new station-to-sensor protocol has been successfully integrated into the Sensorscope system. This protocol allows for plug-and-play sensors: that is, sensors can be directly connected to any station without the need for a priori configuration. This protocol also allows the developers to easily adapt new sensors to the Sensorscope system. Examples of new sensor adaptations are the snow height sensor for Wannengrat, dendrometers for Pfywald, and water level sensors for La Fouly.</p>					

New mechanical design for SensorScope (including housing, connectors, frame)		Hardware	1-6	WP3.6	3
<p>Deliverable complete. See year 2 report.</p> <p>Based on the experience gathered during the first two years, a new IP67 metallic box has been designed that allows the user to connect up to three sensors simultaneously to any Sensorscope station simultaneously.</p>					
Energy Efficient Collaborative Routing Algorithms	DISAL	Software	3-24	WP3.6	3
<p>Deliverable complete</p> <p>An efficient multi-hop communication routing protocol has already been developed and tested over the first two years (see previous reports). Designed to minimize the power consumption of sensing stations, the multi-hop protocol allows stations to be placed further away from a GPRS enabled station and communicate over a low-power radio chip.</p> <p>We have also studied the use of data correlation to reduce the amount of data sent through the network. Rather than transmitting every sample of a data stream, the goal of a compression technique for wireless sensor networks is to transmit only the most vital bits of information. This work has already resulted in a paper publication [Chen et. al. 2010].</p>					
Long-Range Communication Module		Hardware / Software	6-18	WP3.3	3
<p>Deliverable complete. See year 2 report.</p>					
Routing Algorithms for Long Range Communication	DISAL	Software	6-18	WP3.3	3
<p>Deliverable complete</p> <p>We studied the case where multiple long-range base stations are deployed but only a subset of them acts as such at any given moment. When a base station is not active, it acts as a simple node, gathering and routing data. We described the resulting “hopping base station problem”, which consists in efficiently choosing the next base station while maximizing the network lifetime. We also showed that, using a small amount of energy scavenging, sufficient energy can be retrieved across the whole network to sustain the operation of the active base stations while using only small-sized batteries. We proposed a distributed scheduling algorithm, proved that it is optimal, and showed practical results obtained from our real-world testbed on the EPFL campus [Zhang et al. Submitted].</p>					
Develop Camera System for SensorScope		Hardware / Software	6-48	WP3.6	3
<p>Deliverable in progress</p> <p>We designed and prototyped a standalone low-power GSM camera for remote image acquisition (see previous year report). We are currently working on a new camera module that combines image acquisition and event detection to further reduce energy consumption.</p>					
New Sensors in SensorScope (Disdrometer, Snow Depth)	EFLUM, EAWAG, WSL/SLF	Hardware / Software	6-48	WP3.6	3
<p>Deliverable in progress</p> <p>Several sensors have already been integrated into the Sensorscope measurement system, including snow depth sensors, water level, new anemometers (in collaboration with EPFL/DISAL), disdrometers, and universal SDI12 interfaces.</p>					

SensorScope Stations for all CCES projects	WSL/SLF	Hardware, Support	8	WP4.5	4
<p>Deliverable complete</p> <p>The manufacturing of Sensorscope stations has been transferred to an external company (Sensorscope SARL) under EPFL license. This company has already provided the stations to create the pool used in multiple campaigns of the participating projects.</p>					
SensorScope Testbed in Wannengrat	WSL/SLF	Support	8-20	WP3.7	3
<p>Deliverable in progress</p> <p>Sensorscope deployments were made on Wannengrat in 2008, 2009 and 2010. The purpose of this in 2008 and 2009 was primarily as an extreme environment system test, though it also provided valuable environmental data which lead to a publication. In 2009 and 2010, the purpose slowly shifted to being primarily a deployment to gather environmental data. A deployment will also take place in 2011.</p>					

Deliverables EAWAG Schirmer:

Deliverable	Collaborating institutions	Deliverable type	Due month	Milestone	WP
Control and publishing of non-streaming data	WSL/SLF, LSIR	Software, Publication	18	WP1.2	1
<p>Deliverable complete</p> <p>Full-scale measurements started in 2008 and were continued through 2011. Intensive tests of the SensorScope station were successful, resulting in a continuous record of data. In addition to the Sensorscope stations, in spring and summer 2011 ten piezometers were installed at the RECORD test sites using the Permasense network. SwissEx partners have continued to develop data management systems according to RECORD's needs.</p> <p>A large percentage of RECORD's non-streaming data (such as sensor data from piezometers, surface water loggers and soil data) is regularly entered into the Wiki. Since manual data correction is needed, publishing of data is subject to a delay. Additionally, manually sampled data - which is mostly analyzed in the lab - is published in the Wiki, e.g. water quality data like inorganic hydrochemistry, organic hydrochemistry, micropollutants, and ecological data. In year 4, this will be transferred to GSN to conform to the SwissEx standard.</p> <p>The number of online sensors was increased in year three by implementing, testing and adapting strategies developed together with our SwissEx partners (see www.swiss-experiment.ch, http://lsir-swissex.epfl.ch/index.php/Record:Home, http://www.permasense.ch/Tech and http://data.permasense.ch/topology.html#topology).</p> <p>Coordination with the cantons of Thurgau and Zurich regarding technical details has led to a close cooperation in sharing data and infrastructure and will be continued in the future. An additional NFP61 project (SNF funding) was fully integrated into the RECORD infrastructure.</p> <ul style="list-style-type: none"> • Instrumentation of a monitoring-well field at the restored and canalized-river site has been completed and additional equipment has been installed for a new project (RIBACLIM - NFP61 project funded by SNF) • Continuous operation of the full-scale measurement system throughout 2010 and 2011 • Further deployment of adapted sensors (in collaboration with Permasense) is in progress 					
Fusion of streaming data with sampled data	LSIR, WSL/SLF	Publication	36	WP1.3	1
<p>Deliverable in progress</p> <p>To be able to jointly query (streamed) sensor data with manually sampled data, we started a subproject to develop a specific query language which can query over different databases combining data and metadata.</p> <p>These studies are proceeding according to the workplan. This work package is not foreseen to be finished in the reporting period. We made good progress on this topic and are ahead of schedule, however, the query language has to be tested in more detail, further adapted and developed to make it applicable for users in the environmental sciences.</p>					

Development of distributed temperature sensing (DTS) applications for groundwater systems		Software, Publication	24	WP3.8	3
<p>Deliverable complete</p> <p>After the installation and instrumentation of additional monitoring wells and loggers, the field sites were maintained and data were downloaded at regular intervals. For the detailed investigation of infiltration rates in the river bed a high resolution vertical temperature profiler was developed based on distributed temperature sensing (DTS). The main activity and innovation of the third year was data evaluation in an array of vertical profilers. Groundwater exfiltration areas in the side channels were further investigated during different hydrological situations by lateral DTS measurements combined with other temperature methods and tracer tests.</p> <ul style="list-style-type: none"> • Installation of a 3-D array of vertical temperature profilers (DTS) has been completed and evaluated • Operation of the DTS and data analysis has been performed <ul style="list-style-type: none"> • velocity of 3-D river water infiltration from vertical temperature profiles of the river bed has been completed and a model is under development • identification of exfiltration areas in the side channels from lateral measurements was performed and quantification is under way • DTS operated in online mode producing continuous data streams • an active DTS was installed in collaboration with the group of Wolfgang Kinzelbach (ETHZ) 					
Setup of calibration and measurement team – development of test calibration and validation procedures (EAWAG competence: soil and groundwater sensors)	HWRM, EFLUM, WSL/SLF, LCAV	Guidelines, report	12, 24	WP3.2	3
<p>Deliverable in progress</p> <p>The calibration and measurement team is in place. The interplay of Decagon's soil and groundwater sensors with SensorScope and Campbell loggers and transmitters has been investigated in much more detail and cross validated with other standard soil sensors such as Trimble TDR. Guidelines of calibration have been developed together with WSL and ETHZ. However, the studies have been delayed according to the workplan (for details see last report of the previous period). A report on the calibration and validation of Decagon soil sensors is in preparation and will hopefully be finished by the end of the year.</p>					
Soil and groundwater sensor installation, calibration and maintenance workshops	WSL/SLF	Workshop, manual	12, 24	WP3.2, 4.4	3, 4
<p>Deliverable complete</p> <p>This task was completed as scheduled in year 2. No additional workshops are planned.</p>					

Development, calibration and test of water quality sensors, total-dissolved gas pressure probes and on-site mass spectrometers		Sensor development	18	WP3.2, 4.4	4
<p>Deliverable complete</p> <p>Water quality sensors, total-dissolved gas pressure probes and on-site mass spectrometers were developed, calibrated and tested. Instrument design has been further improved and intensive field testing has started.</p> <ul style="list-style-type: none"> • Development of a measurement procedure for field application is completed. • Field campaigns were accomplished and first evaluation results are in preparation. 					
Data infrastructure for RECORD	LSIR	Software, support	3	WP4.1	4
<p>Deliverable complete</p> <p>A data model has been developed, implemented and improved providing (i) data streaming into GSN (e.g. DTS, SensorScope and Permasense stations) and (ii) traceable linkage offering joint queries of data and metadata derived by manual sampling, manual sensing, automatic sensing, and streaming sensor data. This resulted in more than 850 Wiki pages providing views and access to the data by location, time, observer and type. Additionally, a data graph tool (software) and error detection and error handling procedures are under development in cooperation with A. Wombacher from the database group at University of Twente/NL. This is an ongoing task and not expected to be finished within the reporting period.</p>					
SensorScope station deployment and soil sensor calibration for APUNCH	HWRM, LCAV, WSL/SLF	Deployment	48	WP4.1	4
<p>Deliverable complete</p> <p>As already explained in the Year 2 report, the APUNCH project did not need support from Eawag for the deployment of the sensorscope stations at the APUNCH site. Instead, Eawag and HWRM-ETHZ have successfully compared different soil sensors in a joint test campaign in the winter of 2011.</p> <p>APUNCH project deployed for the second consecutive year 13 sensorscope stations in the region of Zermatt (see also WP4 milestone 3).</p>					
Calibrate SensorScope non-meteorological sensors	LCAV, WSL-SLF	Web publication	24	WP3.2	3
<p>Deliverable in progress</p> <p>The studies are delayed according to the workplan (for details see report of year 2). A report on the calibration and validation of Decagons soil sensors is in preparation and will hopefully be finished by the end of this year.</p>					

Deliverables ETHZ/HWRM Burlando:

Deliverable	Collaborating institutions	Deliverable type	Due month	Milestone	WP
Data infrastructure for APUNCH data	LSIR	Software, Report	48	WP4.1	4
<p>Deliverable in progress.</p> <p>The processed data collected by HWRM-APUNCH have been integrated into the SwissEx platform using a server located at HWRM.</p> <p>The following data are available:</p> <ul style="list-style-type: none"> • Daily cumulative rainfall amount from the 6 reference stations (since the first installation) • Daily cumulative rainfall amount and hourly mean values of temperature, windspeed and soil moisture from the 13 SensorScope stations (during the deployment period) • Radar images of daily cumulative rainfall (during the functional period) <p>Deliverable: data can be found at http://ifu-apunch.ethz.ch:22001/</p>					
Prototypes of sensors for embedded measurements of sediment transport	ISIM	Hardware, Publication	24	WP4.1	4
<p>Deliverable complete</p> <p>Further measurements using the RFID technique have been conducted at the two study sites (Erlenbach and Riedbach) (Hegglin, 2011, Schneider et al., 2010).</p> <p>Deliverables:</p> <p>J. Schneider, R. Hegglin, S. Meier, J.M. Turowski, M. Nitsche, D. Rickenmann (2010): Studying sediment transport in mountain rivers by mobile and stationary RFID antennas. In: River Flow 2010, Dittrich, Koll, Aberle & Geisenhainer (eds), Bundesanstalt für Wasserbau ISBN 978-3-939230-00-7, p. 1723-1730.</p> <p>Hegglin, R., 2011, Beiträge zum Prozessverständnis des fluvialen Geschiebetransport. Masterarbeit (H. Kienholz, Univ. Bern; D. Rickenmann, WSL, J.M. Turowski, WSL)</p>					
Calibration of X-Band radar	LTE	Methodology Publication	18-24, 24-30	WP4.1 WP4.2	4
<p>Deliverable in progress.</p> <p>In the third year the calibration procedure was improved and quantitative precipitation assessment is now available. Based on a visibility analysis, 44 gauges were selected for the radar calibration. The joint observation of gauges and radar during the intensive observation period will provide further insight in the validation of the calibration procedure.</p>					
Rainfall field estimation from combination of radar and raingauge observations	LTE	Methodology Publication	24-30, 30 - 36	WP4.1 WP4.2	4

<p>Deliverable in progress.</p> <p>Several techniques for rainfall field estimation were implemented in a Matlab code to display measured and interpolated rainfall maps. The user has the option to select the interpolation technique and its parameters and based on this, a precipitation map is produced. The implementation of these techniques into the SwissEx platform is under assessment, as some technical issues concerning the integration have still to be solved.</p>					
Installation of GPS station for water vapor tomography	LSIR, WSL/SLF	Hardware	18-24	WP4.1 WP4.2	4
<p>Deliverable complete.</p> <p>During a field campaign in Zermatt, 33 geodetic receivers were installed in order to obtain a high resolution water vapor field. In addition, 25 radiosondes were launched in order to validate the water vapor retrieval from the geodetic receivers. The processing of the data collected during this intensive observation period is in progress. The optimization algorithm for the design of the station network for the field campaign was further improved.</p>					
Deployment of APUNCH reference raingauges		Hardware	12	WP4.1 WP4.2	4
<p>Deliverable complete</p> <p>Data from the six reference stations installed in the Matter Valley are available from the GSN server.</p>					
Procedure for inference and scaling properties of precipitation data		Methodology Publication	18-24 24-30	WP1.1, WP4.1	1,4
<p>Deliverable in progress.</p> <p>The main achievements are:</p> <ul style="list-style-type: none"> • A quantitative analysis of the influence of instrument precision on scaling estimators was done by means of Monte Carlo procedures in order to avoid probable estimation artefacts and erroneous conclusions about scaling (Pascalis et al., 2011). • The nature of temporal scaling was explored with robust statistics (e.g. probability weighted moments) applied to our data. The results clearly show that especially for seasons affected by strong convection (mainly summer) simple scaling hypotheses are rejected and the analysis should be extended in the multifractal framework. • Exploration of the nature of deviations from scaling theory observed in our data sets. It was demonstrated that the deviations that were found in our data have several causes: the most significant cause which was quantified numerically, consists of imperfect scaling conditions such as different scaling regimes and dependencies of model parameters across scales (Pascalis et al., 2011). • One of the aims of the research is to investigate the potential connection between scaling descriptors in temporal precipitation and seasonal and/or orographic effects. The results obtained so far indicate that signatures of how different physical mechanisms may affect precipitation across time scales are not clear, even though our data sets cover a long period of time with high spatial resolution. This is especially true for orographic effects on precipitation. 					

Installation of sediment transport experimental site (Riedbach)		Test site	18	WP4.1	4
<p>Deliverable complete</p> <p>Field measurements were continued on the Erlenbach (Canton Schwyz) and Riedbach (Matter valley). In the Erlenbach more than 20 samples of bedload sediment were collected during 2010 (Rickenmann et al., 2011) and the temporal variation of the turbidity was investigated. In the Riedbach geophone measurements were continued and a submerged ultrasonic device was used to measure the deposits of finer sediment in the settling basin.</p>					
Sediment transport experiments		Methodology Publication	18, 24	WP4.1, WP4.3	4
<p>Deliverable complete</p> <p>The main achievements were:</p> <ul style="list-style-type: none"> • The development of a method to extract the variability of bedload transport rates from indirect measurements has resulted in a published paper (Turowski & Rickenmann, 2011). • The evaluation of flow resistance equations using a large field data base provided a new method for bedload transport calculation in steep and rough streams (Rickenmann & Recking, in press). • The analysis of selected bedload transport events, including a comparison of different approaches to account for high flow resistance, resulted in a new procedure for bedload transport calculation in steep and rough streams (Nitsche et al., accepted). • The analysis of start and end of bedload transport in gravel-bed streams based on geophone measurements in four streams including the Erlenbach has been completed (Turowski et al., 2011). • The analysis of two years of geophone and bedload transport measurements with a moving basket system in the Erlenbach has been completed (Rickenmann et al., submitted), and a related review of previous geophone measurements has been published (Rickenmann & Fritschi, 2010). • A comparison of different bedload transport equations with field data from the literature and including the Erlenbach data is under way (Schneider et al., 2011). <p>Deliverables:</p> <p>J.M. Turowski, A. Badoux, D. Rickenmann (2011): Start and end of bedload transport in gravel-bed streams. <i>Geophysical Research Letters</i>, 38, L04401, doi:10.1029/2010GL046558</p> <p>J.M. Turowski, D. Rickenmann (2011): Measuring the statistics of bedload transport using indirect sensors. <i>J. Hydr. Eng.</i>, 137(1): 116-121.</p> <p>M. Nitsche, D. Rickenmann, J.M. Turowski, A. Badoux, J.W. Kirchner (accepted): Performance of flow resistance and bed-load transport equations accounting for large-scale roughness in steep mountain streams. <i>Water Resources Research</i> (accepted with minor revisions).</p> <p>D. Rickenmann, B. Fritschi (2010): Bedload transport measurements using piezoelectric impact sensors and geophones. In: Gray, J.R., Laronne, J.B., and Marr, J.D.G. (eds), <i>Bedload-surrogate monitoring technologies</i>, U.S. Geological Survey Scientific Investigations Report 2010-5091, p. 407-423, available only online from http://pubs.usgs.gov/sir/2010/5091/papers/listofpapers.html.</p> <p>J. Schneider, J.M. Turowski, D. Rickenmann (2011): Comparing fractional bedload transport equations with field data. <i>Geophysical Research Abstracts</i>, Vol. 13, EGU2011-5493-1</p>					

Rainfall data disaggregation techniques		Methodology Publication	18-24, 24-30	WP4.1, WP4.2	4
<p>Deliverable in progress.</p> <p>A computer code for the multiplicative random cascade disaggregation in time was completed. Also computer code for variants of the model that take into account imperfect scaling conditions and temporal dependences in the weights of the multiplicative random cascade are implemented. The development of the space-time model and also its calibration techniques are currently in progress.</p>					

Deliverables ETHZ/IKG Hurni:

Deliverable	Collaborating institutions	Deliverable type	Due month	Milestone	WP
GIS based interface: Collection of proprietary GIS specific schemas and database domains, provided by the project partners	All partners	Schema pool	1-6	WP2.3, 4.1	1, 4
<p>Deliverable complete</p> <p>IKG has collected, organized and provided support for the generation of database schemas of existing research data as required by the Swiss Experiment partners. Schemas are available from WSL/SLF (Wannengrat sensor data), SED (seismic stations, event data) and IKG (swisstopo datasets). Due to the close collaboration with the COGEAR project, database schemas are also available from a number of COGEAR partners such as IGT (boreholes), EngGeol (cracks, soil temperature sensors at Randa), PRS (LiDAR data), LMS (boreholes) and IMAC (vibration recordings). Examples of PostgreSQL schemas collected in cooperation with the COGEAR project can be found at http://swissgear.ethz.ch/deliverables/schemapool/.</p> <p>As the majority of project partners have the task of integrating their data in the GSN (Global Sensor Network) environment, it was also decided to accept GSN generated schemas as an alternative to the creation of PostgreSQL database schemas. With the development of the GML export plugin for GSN by IKG, it is now possible to extract the schemas (and data) on demand from GSN instances. Therefore, the schemas are available automatically when GSN instances are deployed by project partners.</p> <p>Deliverable: Examples of PostgreSQL schemas collected in cooperation with the COGEAR project can be found at http://swissgear.ethz.ch/deliverables/schemapool/, though these are now automatically extracted from GSN.</p>					
GIS based interface: Unification of the schemas and database domains, planning a distributed GIS model using Web Services		Support	6-12	WP1.2 , 4.1	1, 4
<p>Deliverable complete</p> <p>The schemas collected in Task 1 were analyzed for the integration process. The result of the analysis was that the schemas were highly heterogeneous and a common schema is not practical for use by all project partners. On one hand, a common schema would be too complex to be useful for the individual domains covered by project partners and as consequence they will use only a very small subset. On the other hand, the project partners need to have the freedom for schema extensibility and schema evolution, which is hardly possible with a fixed common schema. Based on the above analysis, IKG proposed an unification at the GIS application level.</p> <p>Therefore, a distributed GIS-based model using Web Services was planned. This model is based on the COGEAR Web Service Infrastructure and allows the integration of data and metadata in a common environment. Moreover, IKG created testbeds for the project partners and combined them in an additional testbed as proof of concept for the inter-institutional interoperability (see the figures included in the first year report).</p>					

GIS based interface: Description of a Web Service Interface for sensor metadata		Report	12	WP1.2, 4.1	1, 4
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Deliverable complete

The Web Service Interface for sensor metadata (and data) is GML (Geographic Markup Language). GML is an XML-based geospatial standard that can be used to bridge the gap between GSN and spatial web services.

Deliverable:

A report is available at:

http://swissgear.ethz.ch/deliverables/reports/swissex_description_web_service_interface.pdf

GIS based interface: Implementation of a Web Service Interface for available sensor metadata of the project partners		Software	12-18	WP1.2, 4.1	1, 4
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Deliverable complete

The Web Service Interface was implemented ahead of plan due to the close interconnection with the other tasks, once it was clear that only a GML based interface can provide the unification and interoperability amongst the partners. In order to enable interoperability with GSN instances, IKG developed an export functionality for GSN allowing export of dynamic sensor metadata and data on demand as GML. The code is integrated in the GSN repository.

The implementation work performed in this task was required to support the proof-of-concept required for task 2. In collaboration with the COGEAR project, IKG tested the correct deployment of GML export in GSN by temporarily installing a GSN, it enhanced the testbeds for the metadata and data of the individual partners and combined them in a global testbed for both SwissExperiment and COGEAR projects that proved the interinstitutional interoperability (see the figures included in the second year report for additional details).

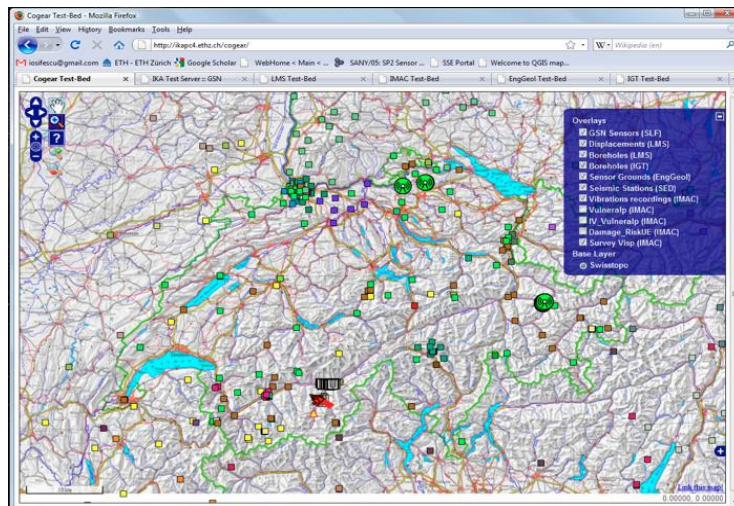


Figure 5: The Interinstitutional Testbed Platform

Deliverable:

An implemented GML interface, integrated into all instances of GSN.

GIS based interface: Alignment of the Web Service Interface with the general SwissEx Metadata Model, Adaptations of the Web Service Interface	WSL/SLF, LSIR	Software	18-20	WP4.1	4
<p>Deliverable complete</p> <p>The GML output interface is completely aligned with the Swiss Experiment Metadata Model due to the fact that is directly accessing the information defined in a deployed GSN instance from the internal structure and transforms this information into GML. Therefore, Dynamic Data Quality Information (if provided by sensor owner) will be available simultaneously with the data.</p> <p>Moreover the GIS platform has the capability to provide for each GSN layer a short description based on the available Experiment Centric Static Information and an additional "more info" link to the user metadata entered in the SwissExperiment semantic wiki. For example the GIS platform provides for the WSL/SLF GSN test layer (Wannengrat Deployment/Fieldsite) a link to http://www.swiss-experiment.ch/index.php/Wannengrat:Home. In this manner the metadata entered in the GSN instances and the SwissExperiment semantic wiki is reused and must not be entered again in the GIS Platform.</p> <p>Deliverable: Software as detailed above.</p>					
GIS based interface: GUI Web Interface prototype for metadata		Software	22	WP1.2	1
<p>Deliverable complete</p> <p>The prototype of the Web-based GUI of the GIS platform is completed (as shown in Figure 5).</p> <p>The GIS Platform for Interdisciplinary Environmental Research is based on the advanced cartographic framework in Scalable Vector Graphics (available as open source on the www.carto.net website), which was further developed in the user interface of the GeoVITe project. The geodata services for Swisstopo data are developed in close cooperation with the GeoVITe and COGEAR projects. The GeoVITe project aims to offer easy-to-use online access, inside the ETH domain, to the most important geodatasets provided by the Swiss national mapping agency for teaching and research purposes. The common usage of the hardware and software infrastructure for GIS service not only creates synergies among different projects but also offers higher performance, stability and longer maintainability after the end of one individual project.</p> <p>Due to licensing restrictions of Swisstopo data, the GIS platform services will be available only within the ETH domain. The GIS platform is not meant to replace SensorMap (which remains as the outreach product).</p> <p>Deliverable: A prototype interface.</p>					

GIS based interface: Interface description for accessing available sensor data of the project partners using Web Services		Documentation	24	WP1.2	1
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Deliverable complete

The documentation of all aspects of the GIS platform (not just the interface functionalities) was prepared in the form of a scientific paper that was accepted at the 7th ICA Mountain Cartography Workshop (workshop theme: Mountain Mapping and Geospatial Information Retrieval). The title of the paper is "GIS Platform for Interdisciplinary Environmental Research".

Deliverable:

Scientific article. (Iosifescu I. and Hurni L. (2010). GIS Platform for Interdisciplinary Environmental Research, in Proceedings of the 7th ICA Mountain Cartography Workshop, Borsa, Romania)

GIS based interface: Implementation of the Web Service Interface for first incoming sensor data of the project partners		Software	20-24	WP1.2	1
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Deliverable complete

The implementation of the first incoming sensor data of the project partners in the GIS based interface was successful. The public test data provided by SLF was integrated in the prototype of the Web-based GUI of the GIS platform. Figure 2 presents examples of test visualizations for real-time sensor measurements provided by SLF (temperature, wind direction, solar radiation, and sensor status) overlaid with background swisstopo data provided by IKG.

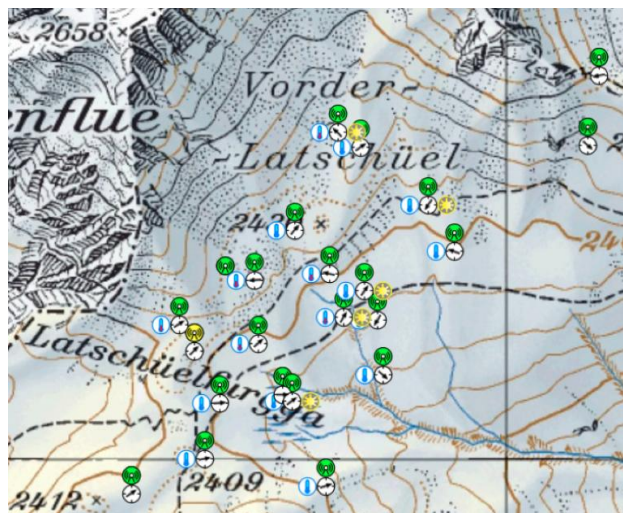


Figure 6: Examples of test visualizations for sensor data provided by SLF with background swisstopo data provided by IKG (c) swisstopo (5704 000 000)

The addition of new sensor data depends on the stable deployment/configuration of GSN instances by the project partners responsible with sensor data provision.

GIS based interface: Web Service Interface implementation progress report for available sensor data of the project partners		Report	24	WP1.2	1
<p>Deliverable complete</p> <p>The scientific paper published at 7th ICA Mountain Cartography Workshop also describes the background and technical information regarding the implementation of sensor data in a GIS based interface. The available project data is announced on Data">http://www.swiss-experiment.ch/index.php/SwissEx>Data, and the up-to-date list of sensors can be retrieved in GML format, as for example http://montblanc.slf.ch:22001/gsn?REQUEST=901 (for SLF data).</p> <p>Currently, GSN instances from SLF and Permasense are available and usable for the integration in the GIS platform. The SLF installation was always kept up-to-date and Permasense had to update their GSN installation in order to support the latest functionality for GML export. The COGEAR project plans the provision of GSN instances until the end of 2011 (after the instrumentation deployments). Other SwissExperiment partner projects have similar schedules or have yet to announce their GSN deployments.</p> <p>Deliverable: Scientific article. (Iosifescu I. and Hurni L. (2010). GIS Platform for Interdisciplinary Environmental Research, in Proceedings of the 7th ICA Mountain Cartography Workshop, Borsa, Romania)</p>					
GIS based interface: Implementation of cartographic tools for visual data mining		Software	24	WP1.2	1
<p>Deliverable in progress</p> <p>Task started. Deliverable rescheduled for month 42, in order to synchronize with the tasks from other partners.</p> <p>The cartographic tools will improve the possibilities of deriving new information by offering visualization of interpolated sensor measurements and by allowing users to define class boundaries and set thresholds interactively.</p>					
GIS based interface: Final version of the GUI Web Interface, Bug fixing		Software, Support	36	WP2.1	1
<p>Deliverable in progress</p> <p>Task started. Deliverable rescheduled for month 42, in order to synchronize with the tasks from other partners.</p> <p>The GIS platform was also given an unified design with the projects COGEAR and GeoVITe.</p>					

GIS based interface: Maintenance		Software, support	12-48	WP1.3	1
<p>Deliverable in progress</p> <p>The provision of GIS services has considerable requirements regarding the computing infrastructure, which in turn causes high acquisition and maintenance costs for hardware and software. It is possible to support these costs as IKG makes use of synergies with currently related projects COGEAR and GeoVITe (SwissExperiment is allowed to use the GIS infrastructure and platform of the COGEAR and GeoVITe projects).</p>					

Deliverables ETHZ/SED Föh:

Deliverable	Collaborating institutions	Deliverable type	Due month	Milestone	WP
Seismic instrumentation in the Valais	COGEAR partners	Report	24	WP4.6	4

Deliverable complete

Densification of the high-gain seismic network in the region is complete. The stations are complemented with the network of new strong motion stations in Visp and the Matter valley, described below, that will be used to test ground motion prediction models. Preferred locations have been identified for four semi-broadband stations, and all stations were installed by the end of 2010. Additionally, the SED provided matching funds for the purchase and installation of a broadband sensor in the region, in a tunnel near Fiescheralp. If possible, GPS stations will be co-located at some of these sites; the sites presently installed are described below. All new seismic stations are fully integrated into the Swiss Digital Seismic Network (SDSNet) by SED (ETHZ), with real time continuous communication. This provides a significant reduction in the threshold magnitude for earthquake detection throughout the upper Valais region. Seismic events occurring in the target region of Brig - Visp – Matter valley have excellent azimuthal station coverage at close distances and produce extremely reliable event locations and depths. The report describing the high-gain network was delivered in 2010:

John Clinton, Philipp Kästli, Donat Fäh, 2010. Seismic instrumentation in the Valais. Project Swiss Experiment

Deliverable for WP 4.6. Report SED/SwissEx/R/001/20101010, Swiss Seismological Service ETH Zürich, 10.10.2010.

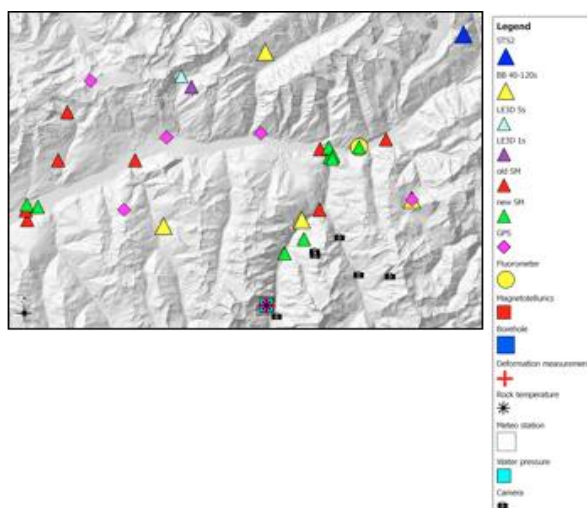


Figure 7. Present status of sensors (top) and plan for the full system at the end of COGEAR in 2012.

Integration in GSN

The GSN software concept bases on data structures for key-value pairs, where the key is a timestamp, while the value may be of any data type (numeric, string, or binary object as e.g. an image). Data is transmitted as single key-value pairs in near real time, and stored in a file or database table row per value. Displaying and data analysis tools base on the assumption that a single value is a useful statement on the state of an environment parameter. This is well adapted for sensors such as temperature or wind speed. Usually such values are measured in intervals of seconds to hours. Among the COGEAR collected data, it fits well for data types originating from geochemical and hydrophysical measurements. However, GSN is not adequate for seismic (accelerometer as well as broadband) data, for conceptual as well as for technical reasons. Therefore, COGEAR does not plan to internally stream, or externally offer seismic data via GSN. However, it is considered to test state of health data for seismic instruments which are sampled at lower frequencies.

GPS instrumentation in the Valais	COGEAR partners	Report	30	WP4.6	4
<p>Deliverable complete</p> <p>While the metadata concerning the GPS instrumentation has been introduced into the COGEAR database, the GPS reference network is still expanding and updated. Two receivers have been purchased (in-kind GGL) for replacement of lightning-damaged stations at Varen and Erde. The fixed station network now consists of 6 stations in operation, 2 in replacement, 2 under construction. Totalling 10 stations. This number will probably be enlarged independently of COGEAR. Half of the stations are relayed to Swisstopo and operationally analysed. As soon as all stations are mounted, all receivers will also be connected to Swisstopo. Data is also streamed to GGL where deformation analyses will be carried out.</p> <p>All the stations are to be kept alive beyond the project's end corresponding to GGL's means (as committed to CCES). Four stations are closely co-located with seismic stations. A second GPS receiver installation is planned for the seismic station at Fiescheralp which samples data at the rate of 100 Hz. The purpose of this station is so that we can analyse small and fast co-seismic ground movements in parallel to the seismic recordings.</p>					
Instruments for short-term earthquake precursors	COGEAR partners	Report	30	WP4.6	4

Deliverable complete.

We took the first steps in Switzerland for the installation of permanent multi-sensor instrumentation for the detection of possible non-seismic short-term earthquake precursors. The area of interest is the Valais, with focus on parts of the Rhone, Visper and Matter valleys. The installations include a multi-sensor geochemical station at Brigerbad fully operating since April 2011, and a continuous magnetic sensor that will be installed at Embd. The COGEAR project now has paved the way for a serious study of possible correlations between dissolved gas concentration changes, magnetic anomalies and earthquakes. The report describing the instruments for short-term earthquake precursors was delivered in 2011:

Álvarez-Rubio, S., D. Fäh, Y. Abdelfettah, W. Balderer, F. Leuenberger, P. Kästli, E. Schill, H. Surbeck, R. Tanner, P. Zweifel, 2011. Non-seismic short-term earthquake precursors. Project COGEAR, Deliverable Module 2d, SwissExperiment WP4.6. Report SED/COGEAR/R/008/20110907, Swiss Seismological Service, ETH Zürich, September 2011.

Geochemical sensors at Brigerbad

A monitoring device was designed with a fixed dedicated wavelength interval of 20 nm, 369 nm excitation wavelength and 389 nm wavelength from the emitted fluorescence signal (instead of using a much more expensive synchronous scanning instrument, which would scan the whole fluorescence spectra between 200 and 800 nm). Since 26.8.2009 such a specially designed fluorometer has been installed at the Brigerbad thermal spring. With this instrument the fluorescence is measured in 3 channels of different wavelengths. The fourth channel records the turbidity of the water, because the turbidity influences the fluorescence measurements and is used therefore as internal correction parameter of the fluorometer itself. In addition to the above measurements, the water temperature is measured at the same time intervals as the other parameters.

On 19.4.2011 the system was extended to incorporate the Nucfilm M_54 sensor system, which measures radon, CO₂, and CH₄ gases by sensors placed in a closed air circuit coupled to the water. The data is recorded continuously. The radon sensor is a 20 ml Lucas-cell coupled to a photomultiplier. Alpha particles emitted by decaying radon and radon daughter products like Po-218 and Po-214 interact with the solid scintillator (ZnS:Ag) inside the Lucas-cell. The light pulses produced are detected by a photomultiplier and are counted. The count rate is then a measure for the radon concentration. The CO₂ and CH₄ sensor modules are dual beam non-dispersive IR-absorption instruments, tuned to the absorption bands of the respective gases.

The data measured by the multi-sensor system is updated once an hour, stored locally and sent to SED. This non-seismic data will, in future, be transferred to the servers in SED and accessed by different solutions: COGEAR metadata frontend, GSN data stream and arlink server. At present, a first phase of data retrieval is being implemented including the final data transmission to SED and storage scheme. The data recorded can be accessed via the internet <http://multisensor.ethz.ch/manage> (username and password are needed).

Magneto-Telluric Sensors

The instruments were purchased after an evaluation of different possible solutions. Due to the difficulties of installing and operating electric components of MT sensors, and as we are primarily interested in signal fluctuations, we restricted our measurements the magnetic part. Moreover, electric sensors are more sensitive to the locally high levels of anthropogenic noise. We selected magnetic coils rather than other sensors such as fluxgates. The full magnetic instrumentation (coils, datalogger) are Metronix instruments from Metronix Messgeräte und Elektronik GmbH. The coil magnetometers cover a wide frequency range from 0.0001Hz up to 50 KHz. Despite their wide bandwidth, they show outstanding low-noise characteristics, extremely low temperature drift of input offset voltage and offset current and a stable transfer function over temperature and time. The instruments are presently tested at SED and prepared for permanent installation.

For the site selection magneto-telluric surveys were carried out by the Group of Geomagnetism of the University of Neuchâtel in the target area limited (to the north) by the Rhone River and (to the south) by the Swiss-Italian border. This study was not fully conclusive, however was used to establish potential sites for a permanent installation. The installation of the magnetic sensor is planned for autumn 2011 in an isolated tunnel at site Embd. The necessary infrastructure for a continuous operation can be established since SED operates a seismic broadband sensor at the same location. The magnetic station will be operated with remote access during a period of about 6 months to verify if the site is adequate for permanent continuous operation.

Multi-sensor monitoring system in the Visp area	COGEAR partners	Report	30	WP4.6	4
<p>Deliverable in progress</p> <p>Geotechnical sensors at the Visp site</p> <p>The site selection for the borehole installations including strong-motion instruments and geotechnical sensors has been finalized. A number of geophysical and geotechnical measurements have been performed in 2011 to assure the adequateness of the site. The measurements included active and passive seismic measurements, driven penetration tests and the analyses of the hydrological conditions. The administrative procedures for the drilling are in progress. Measurements in the boreholes will include pore water pressure transducers distributed over depth as well as a SAA (Shape Accelerometer Array) measurement of acceleration and deformation in 3 components over depth, and strong motion sensors at depth.</p> <p>Strong-motion sensors at the Visp site</p> <p>Instrument evaluation and site selection for the strong motion sensors have been finalized. A semi-permanent array consisting of 12 stations was deployed in Visp and Mattertal during the winters 07/08 and 08/09. The analysis of the recorded earthquake data allowed for the selection of potential sites for the surface strong motion installation. In Visp, the COGEAR project installed 4 new accelerometric stations to better understand the amplification on the Rhone sediments and in the basin edges. Three sites are now permanent. They are: the Visp Obere Stapfengasse (SVIO) station, a rock site station in the old city centre and the Visp Litterna (SVIL) station, on the Rhone sediments in the centre of the city, and site Visp Terbinerstrasse (SVIT) on the alluvial fan close to the hospital. A temporary station is installed next to the Rhone river, in the middle of the basin (CHVI3). Its definitive location will be close to the borehole location. In the boreholes strong motion sensors are planned at three depths levels.</p> <p>In addition, a permanent station of the old SSM Network (SVIP) is running in the middle of the Rhone valley to the West and is part of the strong motion renewal project in 2011/2012. Tests showed that this site was not acceptable for a new station so that another site in the Rhone basin has to be selected in 2011 accounting also for the borehole location.</p> <p>Integration in GSN</p> <p>The long-term measurements of the pore water pressure measurements can directly be integrated into GSN as they also provide information about ground water table changes. The dynamic portion of the geotechnical measurements as well as the seismic stations will produce too much data, which has to be analyzed. GSN integration of seismic sensors is described above.</p>					

Multi-sensor monitoring system in the Matter Valley	COGEAR partners	Report	30	WP4.6	4
<p>Deliverable complete</p> <p>Geotechnical sensors at the Randa rock slope</p> <p>A prototype dynamic strain measurement system was installed at the Randa in-situ laboratory in summer 2008 by the EngGeo group (ETHZ). Long-guage fiber optic strain sensors were installed at three measurement intervals within an existing 120 m deep research borehole. They have since been recording data continuously with a system uptime of roughly 90%, and a number of triggered transient signals were recorded at 100 Hz for brief 30 s intervals. The down-hole sensors are expected to remain in operation for 3 to 6 years. Additionally, two surface cracks with a long history of continued movements were also instrumented with new FO strain gauges. Two temporary short-period seismometers were placed at the Randa site in June 2009 by SED (ETHZ) and operated through October 2009. One sensor was located within the unstable part of the rock slope, while the second sensor was placed in the stable area and served as a reference. Special installations were necessary to ensure reliable power supply and internet connectivity.</p> <p>Geotechnical sensors installed at the Randa test site through project COGEAR are summarized in the report:</p> <p>Jeffrey Moore, Valentin Gischig, Edward Button, and Simon Loew (2011). Instrument evaluation, site selection, and installation of permanent instrumentation, Deliverable 3b.1.3.2 for COGEAR, Engineering Geology, ETH Zurich.</p> <p>Strong motion sensors in St.Niklaus and Grächen</p> <p>In St. Niklaus and Grächen, the SSMNet renewal project allowed us to install new accelerometric stations in 2010. The stations are fully integrated into the database by SED (ETHZ), with real-time continuous communication. Details are given in the SwissEx report:</p> <p>John Clinton, Philipp Kästli, Donat Fäh, 2010. Seismic instrumentation in the Valais. Project Swiss Experiment Deliverable for WP 4.6. Report SED/SwissEx/R/001/20101010, Swiss Seismological Service ETH Zürich, 10.10.2010.</p> <p>Integration in GSN</p> <p>Integration of Randa geotechnical sensors in GSN is now at an advanced stage. The critical first step was achieved in 2010 with the installation of a new broadband internet connection at Randa. Our internet connection shares infrastructure with outside project partners (including other CCES groups) in the Matter valley, and our Randa site also serves as a relay point distributing internet to nearby research sites. Integration of our multi-component monitoring system in GSN began in early 2011 through collaboration with Nick Dawes. All active sensors at Randa (including those sensors installed in previous projects) have been integrated in GSN, with data publically available online. A Randa field site page was implemented within the SwissEx web portal (http://www.swiss-experiment.ch/index.php/Fieldsite:Randa), and a special page for visualizing basic COGEAR data from Randa was also created (http://www.swiss-experiment.ch/index.php/Cogear_data). GSN integration of seismic sensors is described above.</p>					
Data infrastructure for COGEAR data	IKG, LSIR	Software, Report	48	WP4.6	4

Deliverable in progress

Database and Instrumentation in COGEAR:

The development of a common distributed database and GIS Platform is an important element of COGEAR.

In COGEAR, it was found that in a multidisciplinary environment, researchers perform data acquisition very differently, either with automatic acquisition systems such as sensors or with manual field studies followed by data processing in laboratories. It was also identified that similar data acquired by different groups can have different schemas (e.g. different granularity, different relevant attributes, and different naming schemas). Either way, they use different software packages and different formats for storing their data. These formats and procedures are best suited for their research intentions and it is not desired to disrupt their established individual workflows.

The solution was to add a distributed database management layer on top of their established workflows. In this manner, the researchers can continue to acquire data, create models, perform simulations and obtain results in their individual manner. Moreover, as the researchers are physically distributed in various places in Switzerland, the COGEAR project decided for a common infrastructure distributed over the Internet.

In COGEAR, it was agreed to use the free and opensource database PostgreSQL (PostgreSQL, 2010) due to its proven stability, its compatibility with opensource GIS software and its (absence of) licence costs. The free and open source nature was one of the major factors that influenced the decision, as commercial products usually have licence and/or training costs that prove to be prohibitive for small research projects.

The concept of distributed data access of COGEAR project allows for flexible, evolving database schemas that are adapted to the specific research tasks of the individual partners while allowing for low maintenance costs. Redundancies and inconsistencies in the data are avoided since a data provider has to store his data in the various PostgreSQL geospatial databases that were created.

The distributed database concept has been successfully tested with all partners in relation to existing seismological relevant data (but not including real-time sensor data). For the integration of the sensor data, initially the COGEAR project decided also for a database centric integration. Initially, the sensors measurements available after the COGEAR 2011 instrumentation deployments were planned to be integrated (automatically or manually) in the corresponding PostgreSQL database with custom procedures to be developed for each individual sensor data source (e.g. from log files, csv files).

With the SwissExperiment project, the COGEAR project decided to abort the direct database management of sensor data. Instead, the live sensor data will be managed through Global Sensor Networks (GSN). GSN is a software middleware designed to facilitate the deployment and programming of sensor networks and alleviates the effort of developing custom code for the automatic management of sensor measurements in PostgreSQL databases.

In the beginning, the GSN was incompatible with the GIS centric database developments of COGEAR. In order to enable interoperability with GSN instances, IKG developed the export functionality for GSN allowing export of dynamic sensor metadata and data on demand as GML.

In addition, at the beginning of the fourth year all remaining technical problems in the way of a successful deployment of the COGEAR instrumentation with GSN were solved. The COGEAR infrastructure is already functioning based on PostgreSQL geodatabases and PostgreSQL is now supported as database back-end in GSN. In addition the GIS Platform ensures full compatibility and interoperability between the COGEAR and SwissExperiment technologies.

In conclusion, the technical integration of the COGEAR distributed database infrastructure based on PostgreSQL and the sensor infrastructure managed with GSN is fully supported. Based on the functional technical solution, during 2011, the COGEAR partners plan to make their COGEAR live sensor-data available through GSN. The sensor network is continuously growing and we expect to have the full network running by the beginning of 2012.

Project Workshops:

The technical discussion regarding the integration of the sensors in the GSN system has advanced. There were 2 meetings that focused on the discussion between COGEAR partners and SwissEx. It includes the annual project meetings in Visp in January 2011, and the workshop "Data and Sensor Integration Workshop - Coordination with SwissEx" on July 11, 2011, in Zürich.

Processing strategies and tools for real-time systems related to earthquake observations	COGEAR partners	Software, Report	48	WP4.1	4
<p>Deliverable in progress</p> <p>An automatic classification system was tested that allows the detection and identification of different types of seismic events (earthquakes, explosions, landslides) in a continuous data stream. A new training approach originally introduced for monitoring active volcanoes is used which showed great promise when only a limited amount of training data is available. As soon as interesting events are identified the classification system can be build-up from scratch allowing the continuous data stream to be scanned immediately for corresponding events. In order to show its usage and capabilities the method will now be applied to a data set recorded in the Swiss Alps.</p>					
Education in Seismology: Description of products		Report	24	WP5.1	5
<p>Deliverable in progress</p> <p>The report describing the work in education in seismology (for the period 2008-2010) was delivered to SwissEx in year 2:</p> <p>Sauron, A. and F. Haslinger, 2010. Education and Outreach. Program plan 2008-2010. Project Swiss Experiment. Deliverable for WP 5. Report Swiss Seismological Service ETH Zürich 10.10.2010 SED/SwissEx/R/001/20101010</p> <p>In year 3, the most of the development effort was targeted at improving the training program for school teachers. As seismology is not covered in the standard curricula, nor a topic usually covered in teacher education, the SED has developed a training program for participating teachers, comprising 3 blocks:</p> <ul style="list-style-type: none"> • 4 day teacher-training workshop at the school: <ul style="list-style-type: none"> • the goals of these training days, held in the form of mini-seminars and lectures, are: • 1) In-depth explanation and training on the seismic station installed at the school; • 2) Familiarization with the tools and data available on the Seismo-at-School website, and other program activities, to foster enhancement of seismology and earth science education in schools and gymnasiums. • Seven of such courses were held in 2011, partly in collaboration with the O3E project (Sion, VS (January), Turin, Italy (February), Bellinzona, TI (March), Nyon, VD (April), Lausanne, VD, April, Turin, Italy (May)) • Teacher workshops at ETH Zürich: <ul style="list-style-type: none"> • These workshops comprise lessons by SED researchers on seismological topics, combined with visits to the FocusTerra exhibition and the earthquake simulator. 6 seminars were held in 2011 (17 Jan; 6/7 Apr; 14 Apr; 25 May; 8 Jun; 23 Jun). • International conference with teachers and researchers: <ul style="list-style-type: none"> • 32 teachers from Switzerland, France, Italy and Portugal have shared experience and educational concepts during a 3 day conference (seminar) from 12-14 January 2011 at Sophia-Antipolis (Antibes, France). <p>We have also developed an “experimental approach” to Seismology (together with 20 teachers, who participate in the “Seismo-at-School” program). Over 5 months, each teacher spent 1 day per week on the design of experiments and posters that are now being set up at ETH next to the earthquake simulator, together with accompanying “educational flyers” that allow the students to work with the experiments and carry the experience back to the classroom.</p>					

Education in Seismology: Final report		Report	48	WP5.1	5
<p>Deliverable in progress</p> <p>In this work package we achieved the implementation of a strong foundation for enhancing and improving seismological education in schools in Switzerland. The collaboration with the EU-Interreg / Alcotra project O3E, and the collaboration with the GLOBE initiative allowed for a good integration of our efforts on European level and a wide dissemination of information about the project in the community of teachers.</p> <p>The installation of seismic stations in schools, as cornerstone of the “Seismo-at-School” project, is key to promote awareness of earthquakes as environmental hazards. The 6 stations currently installed (Bülach, Lausanne, Sion, Wattwil, Zürich, Bellinzona) are equipped with “scientific grade” seismometers and recorders, and continuously record seismic activity. Both the real-time and seismic event data are available via the project website www.seismoatschool.ethz.ch. This website also includes a rich set of data processing software such as travel-time calculation, seismic phase determination, signal processing, earthquake location, and so on. Through these data and software, the teachers and students learn basic seismic knowledge, and understand the concepts of seismic risk. Besides the permanent seismic stations, the schools also use other nonpermanent stations such as the SEP seismometer system, and the Stanford QCN system with a USB accelerometer (to teach students in the classroom). The “Seismo-at-School” network also uses 15 permanent SED stations to provide high quality seismic data, thus increasing the accuracy of earthquake location, as well as to elevate the interaction between the scientists at SED, and the teachers and students in the schools.</p>					

Deliverables EPFL/ISIM Charbon:

Deliverable	Collaborating institutions	Deliverable type	Due month	Milestone	WP
Hydromon sensor network	AGE, VonRoll	Working sensor network	6	WP3.5	3
Deliverable complete.					
Prototype disdrometer software	LTE	Software, support	24	WP3.8	3
Deliverable complete. References: A. Berthoud, S. Burri, C. Bruschini, A. Berne, E. Charbon, tone of the tem with an USB accelerometer to teach IISW, Onuma – Hokkaido, June 2011 A. Berthoud, C. Bruschini, A. Berne, E. Charbon, “Disdrometer Design & Test”, on SwissEx website					
Prototype disdrometer hardware	LTE	Hardware, support	24	WP3.5	3
Deliverable complete Last year we had to re-tapeout the chip due to an error of the foundry masks. The chip fabrication was completed in July this year and the chip was successfully tested. All the specifications were met or exceeded. Of particular interest was the noise, ½ of what was expected and the frame rate 2x faster than expected. This was due to an improvement in the technology and a foundry overestimation of parasitics, respectively. Reference: S. Burri, Y. Maruyama, F. Piazza, and E. Charbon’ “A 512x128 Single-Photon Image Sensor with Global Shutter and Massively Parallel Readout”, Unpublished.					
Hydromon data analysis package	AGE, VonRoll	Software for data analysis	18	WP3.5	3
Deliverable complete.					

Deliverables EPFL/LTE Berne (these were not included in the SwissEx workplan):

Deliverable	Collaborating institutions	Deliverable type	Due month	Milestone	WP
Mobile radar field campaign	LSIR	Hardware	6-48	WP3.8	3
<p>Deliverable complete</p> <p>The field campaign involving LTE's weather radar, video-disdrometer and optical disdrometers ended in July 2011, and all instruments were brought back to EPFL. The data collection period is finished and LTE will focus on data analysis.</p> <p>Processing and visualization routines have been developed to check the collected radar data and build a database. A couple of snow events have been selected in collaboration with SLF in order to investigate the spatial structure of snowfall and snow accumulation over the Wannengrat site.</p> <p>Deliverables: Muth, X., M. Schneebeli and A. Berne, 2011: "A sun-tracking method to improve the pointing accuracy of weather radar", Atmos. Meas. Tech. Discuss., vol.4, p.p5569-5595. Schneebeli, M. and A. berne, "An extended Kalman filter framework for polarimetric X-band weather radar data processing", J. Atmos. Ocean. Tech., in revision.</p>					
Disdrometer prototype deployment	ISIM	Hardware	18	WP3.8	3
<p>Deliverable complete</p> <p>The new chip has been mismanufactured, and was hence not available in the end of 2010 as initially expected. The modification of the prototype to include the new chip has therefore been delayed. The image processing algorithms applied to the data collected by the prototype have been further developed to improve the quality of the analysis and to reduce the computation time.</p> <p>Deliverables: A. Berthoud, S. Burri, C. Bruschini, A. Berne and E. Charbon, 2011: A disdrometer based on ultra-fast SPAD Cameras. International Image Sensor Workshop, Hokkaido, Japan. A. Berthoud, S. Burri, C. Bruschini, A. Berne and E. Charbon, 2011: A disdrometer based on ultra-fast SPAD Cameras. Imaging and Applied Optics: OSA Optics and Photonics Congress, Toronto, Canada.</p>					

Deliverables EPFL/DISAL Martinoli

Deliverable	Collaborating institutions	Deliverable type	Due month	Milestone	WP
A series of distributed, power-aware, intelligent algorithms for Sensorscope stations to capture environmental events of interest by modifying the local activity patterns of a node and exploiting inter-node information sharing.	LCAV	Software/firmware, test data	24	WP3.6	3
		Publications (2 conference papers)	24, 36		
<p>Deliverable in progress</p> <p>We have developed a measurement board which is capable of monitoring the power consumption of a SensorScope station. It can also determine the amount of generated (solar cell) and stored (battery) power. This information is made available to the station's main controller which enables it to adapt its sampling and routing strategy to this information. Four power board prototypes were tested in an outdoor experiment involving 7 stations. In addition we have characterized the power consumption characteristics of the SensorScope station in a controlled lab experiment. The results showed that the power board was capable of correctly assessing the stations' power related parameters but that its reliability in outdoor setting had to be improved. A recent experiment carried out in collaboration with LCAV for cleaning the overall software running on the SensorScope stations has allowed us to substantially increase the reliability of all the station modules including the power board. We will soon run a second series of intensive tests on 10 SensorScope stations and early next year, we will produce a larger series of power boards (12). Due to the unexpected software engineering difficulties, we have reduced our publication ambitions on this task (compensating with further unplanned publications on other tasks below) but still target a conference publication on this original system design before the end of the project.</p>					
Active control algorithms of the stations based on the annotations of an environmental model, e.g. to adapt the sampling rates of a sensor station based on a model based characterization of an event	LCAV	Software/firmware	36	WP3.6	3
		1 publication (journal paper)	48		
<p>Deliverable in progress</p> <p>For the time being, we have not been working directly on model-based approaches for changing the pattern of activity of a SensorScope station. We have however carried out some preliminary steps to embed geostatistical techniques in the in-network information processing. In particular, we have explored a distributed approach to outlier detection based on spatial correlation between nodes. Under this regime we attempted to cross-validate the measurements from one node by comparing its value with a value estimated using only its neighbours' measurements and some basic geostatistical interpolation techniques. However, the usefulness of this approach depends highly on the degree of spatial correlation in the measured process, as well as the ratio of network density to communication range. Based on results collected in previous SensorScope deployments, it would seem that in their typical configuration, these deployments are not dense enough to utilise spatial correlation in the measured environmental fields.</p>					

Multihop routing, in-network processing (data compression, verification, tagging)	LCAV	Software, test data	24	WP3.6	3
<p>Deliverable in progress</p> <p>We carried out a literature search to find the algorithm best suited for the given problem. The CONCH algorithm was selected for further evaluation. Its performance has been tested on a large simulated data set, as well as on several historic and newly collected data sets. A publication on this topic was presented at DARS 2010 (the corresponding proceeding book will only appear in 2012, see last year publication list). The results are promising and provide new insights into the potential of spatio-temporal compression. The CONCH algorithm has been ported to TinyOS and has been run on all stations in the 7 station deployment described above. While the spatio-temporally compressed data is transmitted over the network, the full data set is stored locally on the station using the dedicated SD card. This allows us to determine the savings in the amount of data transmitted while at the same time ensuring that the required sample accuracy and density has been maintained. Due to the unreliability of both the power board in outdoor settings and the logging driver of the SD card, no quantitative data on the power saving of the CONCH algorithm have been gathered. Both these problems have now been fixed and we hope that the imminent experimental campaign with 10 stations will allow us to carry out a more quantitative analysis of the power saving results.</p>					
Anemometer development	LCAV	(possible design and 1 redesign phases), design considerations	36	WP3.6	3
<p>Deliverable in progress</p> <p>The wind tunnel upgrade has been completed and we now have a controlled environment to test and calibrate future versions of the anemometer. We are now in the process of evaluating the capability of a modified version of a thermistor-based wind sensor module developed for a miniature distributed robotic platform in the framework of the Distributed Odor Localization project (see fund matching projects) to resolve both the wind speed and direction.</p>					
Anemometer development, refinement and integration	LCAV	Optimised prototype (2 nd redesign) interfaced to the SensorScope stations, test data	36	WP3.6	3
		1 publication (conference)	48		
<p>Deliverable in progress</p> <p>In cooperation with EFLUM, we have investigated the use of the very same thermistor-based technology to enable sensible heat flux measurements. This extremely cheap sensory module needs high sampling rates (5 to 30 Hz) in order to be competitive with traditional ultrasound-based heat flux measurement but it requires only simple preprocessing in the node. A series of experiments has been carried out to evaluate the performance of this integrated sensory module in the field compared to more expensive standard instruments (ultrasound-based methods for heat flux). A journal publication which provides an in-depth comparison of the two methods and an analysis of the required sampling rates is in preparation. We also integrated the thermistor with 5 of our deployed 7 Sensorscope stations and have collected sensible heat flux data from all 5 stations. An extended abstract has been submitted to the 2012 IEEE Sensors Applications Symposium (SAS 2012).</p>					
Automated, event-driven sampling schemes for water-quality issues	EAWAG	Software/firmware, test data, 1 publication (peer-reviewed conference paper)	48	WP3.6	3

Deliverable not to be completed

Given the additional technical difficulties encountered in the other tasks and the limited amount of manpower specifically working on this project, we have decided to focus our efforts on the tasks mentioned above (all concerned with measurements in air) in order to maximize possible publication opportunities. We will therefore not carry out this task before the end of the project.

Intelligent sampling schemes, power management algorithms and model-based active control algorithms

SLF

Software/firmware, test data, 1 publication (peer-reviewed conference paper)

30

WP3.6

3

Deliverable complete

Timeline:

WP1 milestone 1: Integration of data
No significant delay

WP1 milestone 2: Baseline SwissEx data infrastructure completion
Complete

WP1 milestone 3: Advanced infrastructure development completion
Completion of the publication on data quality processing will be delayed until month 24.

WP2 milestone 1: Comparison of SensorMap vs. IKG GIS interface
Complete

WP3 milestone 1: SensorScope 2nd Generation Network
Complete

WP3 milestone 2: Setup of Calibration and Measurement Team
In progress

WP3 milestone 3: Long distance communication links
Complete

WP3 milestone 4: Permasense 2nd Generation Network
Complete

The work on the data management system has been very labor intensive. This is partly due to the lack of in-house knowhow but also due to overload of our partners at EPFL due to many requests and many simultaneous activities. The work on GSN based data management supporting PermaSense sensors is now well under way and consolidating but it still needs more time than was anticipated at first. Further steps that require attention are in data analysis and visualization.

Deviation from the workplan: A custom solution to suffice the data handling requirements of PermaSense has been sought. A possible re-integration with the current Swiss Experiment infrastructure (wiki) is currently being investigated.

WP3 milestone 5: Hydromon self organising wireless network
Complete

WP3 milestone 6: SensorScope 3rd Generation Network
In progress

WP3 milestone 7: SensorScope extreme environment test deployment on Wannengrat
Complete

WP3 milestone 8: Completion of RADAR, LIDAR and Disdrometer and development of DTS

The disdrometer chip test has been delayed by 12 months due to the fabrication issues. Now the test plan, completely self-funded is back on track and we expect to complete it by project end. Field tests in the mini-prototype are subject to funding.

WP3 Milestone 8: SensorScope deployment
Complete

WP3 Milestone 8: LIDAR field campaign and development
Complete

WP4 milestone 1: Integration of CCES projects into the SwissEx infrastructure
Continuing

The following changes are to report for the third year within the RECORD part of SwissEx:

Philipp Schneider left Eawag at the end of year 2 of SwissEx. He was substituted by Anne-Marie Kurth. This change has no consequences on the level of CCES funding required. Anne-Marie will work in SwissEx beyond the end of the RECORD project until the finalization of SwissEx. Thus, it will strengthen the collaborations within SwissEx and the ongoing projects at the RECORD sites.

WP4 milestone 2: Precipitation measurement campaign in alpine terrain
Continuing

WP4 milestone 3: Vispa catchment measurement campaign
Continuing

WP4 milestone 4: Wiki and GSN workshops
Continuing

WP4 milestone 5: Creation of a pool of SensorScope Stations for multiple use in campaigns of the participating CCES projects
Complete

WP5 Milestone 1: End of each education 'campaign'
Continuing

Publications:

Peer Reviewed Publications:

- S. Simoni, S. Padoan, D. Nadeau, M. Diebold, A. M. Porporato, M. Amilcare, G. Barrenetxea, F. Ingelrest, M. Vetterli, M. B. Parlange. Hydrologic response of an alpine watershed: Application of a meteorological wireless sensor network to understand streamflow generation. *Water Resources Research*, vol. 47, p. W10524, 2011.
- J.M. Turowski, A. Badoux, D. Rickenmann: Start and end of bedload transport in gravel-bed streams. *Geophysical Research Letters*, 38, L04401, doi:10.1029/2010GL046558, 2010.
- J.M. Turowski, D. Rickenmann: Measuring the statistics of bedload transport using indirect sensors. *J. Hydr. Eng.*, 137(1): 116-121, 2011.
- D. Perler, A. Geiger, F. Hurter; 4D GPS water vapor tomography: new parameterized approaches. *Journal of Geodesy*, p 1-12, Online publication date: 8-Mar-2011
- P. Schneider, T. Vogt, M. Schirmer, J.A. Doetsch, N. Linde, N. Pasquale, P. Perona, O.A. Cirpka. Towards improved instrumentation for assessing river-groundwater interactions in a restored river corridor. *Hydrology and Earth System Sciences*, 15(8), 2531-2549, 2011.
- T. Vogt, E. Hoehn, P. Schneider, A. Freund, M. Schirmer, O.A. Cirpka. Fluctuations of electric conductivity as natural tracer for bank filtration in a losing stream. *Advances in Water Resources* 33, 1296-1308, 2010.
- A.D. Popescu, D. Dash, V. Kantere, A. Ailamaki; Adaptive query execution for data management in the cloud, *Proceedings of the second international workshop on Cloud data management - CloudDB '10*, pp. 17-24, 2010
- I. Paparrizos, H. Jeung, K. Aberer; Advanced Search, Visualization and Tagging of Sensor Metadata, accepted to *Proceedings of the IEEE International Conference on Data Engineering (ICDE)*, 2011.
- S. Sathe, H. Jeung, K. Aberer; Creating Probabilistic Databases from Imprecise Time-Series Data, accepted to *Proceedings of the IEEE International Conference on Data Engineering (ICDE)*, 2011.
- T.G. Papaioannou, S. Sarni, K. Aberer, S. Simoni, M. Parlange, M. Bavay and M. Lehning; Automated Model-driven Simulation and Visualization of Field Sensor Data, 2011.
- T. G. Papaioannou, M. Riahi, K. Aberer. Towards Online Multi-Model Approximation of Time Series. In *MDM 2011 - 12th International Conference on Mobile Data Management*, 2011.
- P. Haghani, S. Michel and K. Aberer, Tracking Hot-k Items over Web 2.0 Streams, In *Proceedings of the 14. Database Systems for Business, Technology, and Web (BTW 2011)*, 2011.
- N. Bonvin, T.G. Papaioannou, K. Aberer, Autonomic SLA-driven Provisioning for Cloud Applications, 2011.
- H. Jeung, "Mobile Sensor Databases", in the proceedings of *Mobile Data Management 2011*
- P. Haghani, S. Michel, K. Aberer, The gist of everything new: personalized top-k processing over web 2.0 streams, *Proceedings of the 19th ACM Conference on Information and Knowledge Management (CIKM)*, 2010.
- K. Aberer, S. Sathe, D. Chakraborty, A. Martinoli, G. Barrenetxea, B. Faltings and L. Thiele, OpenSense: open community driven sensing of environment, *Proceedings of the 2010 ACM SIGSPATIAL International Workshop on GeoStreaming, (IWGS)*, 2010.
- Z. Yan, Traj-ARIMA: A Spatial-Time Series Model for Network-Constrained Trajectory, *3rd ACM SIGSPATIAL International Workshop on Computational Transportation Science (CTS)*, 2010.

- Z. Yan, L. Spremic, D. Chakraborty, C. Parent, S. Spaccapietra and K. Aberer, Automatic Construction and Multi-level Visualization of Semantic Trajectories, 18th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (ACM GIS), 2010.
- Z. Yan, C. Parent, S. Spaccapietra, D. Chakraborty, A Hybrid Model and Computing Platform for Spatio-Semantic Trajectories, Proceedings of 7th Extended Semantic Web Conference (ESWC), pp. 60-75, 2010.
- H. Jeung, M.L. Yiu, X. Zhou and C.S. Jensen, Path Prediction and Predictive Range Querying in Spatial Network Databases, The VLDB Journal, Vol. 19, Nr. 4, pp. 585-602, 2010.
- T.G. Papaioannou, S. Sarni, K. Aberer, S. Simoni, M. Parlange, M. Bavay, M. Lehning. Automated Model-driven Simulation and Visualization of Field Sensor Data. In European Geosciences Union General Assembly 2011, Earth & Space Science Informatics, 2011.
- C. Tobin, L. Nicotina, M.B. Parlange, A. Berne, A. Rinaldo. Improved interpolation of meteorological forcings and hydrologic implications for a Swiss alpine region. Journal of Hydrology, vol. 401, num. 1-2, p. 77-89, 2011.
- D. Nadeau, E. Pardyjak, C. Higgins, H. J. S. Fernando, M.B. Parlange. A Simple Model for the Afternoon and Early Evening Decay of Convective Turbulence Over Different Land Surfaces. Boundary-Layer Meteorology, 2011.
- R. Mott, M. Schirmer, M. Bavay, T. Grünwald, M. Lehning; Understanding snow-transport processes shaping the mountain snow-cover, The Cryosphere Volume: 4, Issue: 4, Pages: 545-559, 2 December 2010

Conference Proceedings:

- M. Schirmer; The RECORD-Project - River restoration with complex hydrological and ecological interactions. RCRC11, Monte Verità, Switzerland. 2011.
- M. Schirmer, E. Mitchell; River restoration with complex hydrological and ecological interactions: The RECORD-Project. Latsis Symposium, EPF Lausanne, 15.-17. November, 2010, oral presentation.
- M. Schirmer, T. Vogt, P. Schneider, O.A. Cirpka. Quantification of bank filtration in restored and channelized sections of a losing stream reach using time series of natural tracers determined by point and distributed sensors. XXXVII IAH 2010 World Congress on "Groundwater Quality Sustainability", 12.-17. September, 2010 in Krakow, Poland, oral presentation. Invited.
- M. Schirmer, T. Vogt; River restoration - complex hydrological and ecological changes: The RECORD-Project. Action Field Symposium, Eawag, 7. September, 2010, oral presentation.
- T. Vogt, M. Schirmer, O.A. Cirpka: Quantification of River-Groundwater Interaction by Means of Natural Tracers at a Restored River Section. RCRC11, Ascona, Switzerland, 13.- 18. March 2011.
- T. Vogt, M. Schirmer, O.A. Cirpka: Heat Transport upon River-Water Infiltration investigated by Fiber-Optic High-Resolution Temperature Profiling. AGU Fall Meeting 2010, San Fransisco, USA, 13. – 17. December 2010.
- N. Ceperley., Water use by Sclerocarya birrea Agroforestry Trees in Sudanian Savanna: Application of Wireless Sensor Networks. European Geosciences Union (EGU) General Assembly, Vienna, Austria, April 8, 2011.

- D. Nadeau, E. Pardyjak, C. Higgins, H. Huwald, F. Bärenbold, M.B. Parlange. Thermal Circulation Patterns and Turbulent Fluxes along Steep Mountain Slopes. Annual Meeting of the European Geosciences Union, Vienna, Austria, 3-8 April 2011
- N. Ceperley., Evaporation over a Heterogeneous Mixed Savanna-Agricultural Catchment using a Distributed Wireless Sensor Network. American Geosciences Union (AGU) General Assembly, San Francisco, USA, December 15, 2010.
- D. Nadeau, E. Pardyjak, C. Higgins, H.J.S. Fernando, M.B. Parlange. A Simple Model for the Afternoon and Early-Evening Decay of Turbulence over Different Land Surfaces. Annual Meeting of the European Meteorological Society., Zurich, Switzerland, 13-17 Sept. 2010.
- A. Berthoud, S. Burri, C. Bruschini, A. Berne, E. Charbon: A disdrometer based on ultra-fast SPAD Cameras. International Image Sensor Workshop, Hokkaido, Japan, 2011.
- A. Berthoud, S. Burri, C. Bruschini, A. Berne, E. Charbon: A disdrometer based on ultra-fast SPAD Cameras. Imaging and Applied Optics: OSA Optics and Photonics Congress, Toronto, Canada. 2011.
- Z. Chen, G. Barrenetxea, M. Vetterli. Distributed Successive Approximation Coding using Broadcast Advantage: The Two-Encoder Case. 48th Annual Allerton Conference on Communication, Control, and Computing, 2010.

Posters:

- W.C. Evans, A. Bahr, A. Martinoli: ENAC Research Day 2011, June 2011
- W.C. Evans, A. Bahr, A. Martinoli: NCCR MICS Scientific Conference 2011, June 2011
- M. Schirmer; River restoration with complex hydrological and ecological interactions: The RECORD-Project. Latsis Symposium, EPFL, 17.-20. October, 2010, poster presentation.
- T. Vogt, P. Schneider, S. Huntscha, L. Mächler, S. Huxol, E. Hoehn, J. Hollender, R. Kipfer, M. Schirmer, 2010: Travel time related behavior of micropollutants and gas exchange at a restored river. Presented at the CCES Latsis Symposium, Zurich, November 2010
- A. Paschalis, P. Molnar, P. Burlando: Dependence structure in the weights of a multiplicative random cascade for rainfall, Poster Presentation, European Geosciences Union General assembly 2011, Vienna Geophysical Research Abstracts, Vol. 13, EGU2011-7578, Vienna, Austria.
- A. Paschali, P. Molnar, P. Burlando: Quantification of the effects of measurement precision on scaling estimators, Geophysical Research Abstracts, Vol. 13, EGU2011-7642, Vienna, Austria
- A. Paschalis, P. Molnar, P. Burlando: Influence of instrumental precision on scaling estimators, Hydrology Seminar (ZHydro2010), November 2010, ETH Zurich.
- F. Hurter, D. Perler, A. Geiger; Using GNSS receivers to monitor atmospheric water vapor in Zermatt in Symposium Posters CCES-Latsis Symposium, 15.-17. November, 2010, ETH Zuerich, Switzerland, 2010.
- M. Savina, P. Burlando; The highest X-band radar in Europe; first achievements. Poster presentation at the European Radar Conference ERAD, September 2010, Sibiu.
- M. Schneebeli, A. Berne, S. Jolivet, M. Savina, P. Burlando; Observation of Alpine Precipitation with X-band Radars. Poster presentation, Latsis Symposium, November 2010, ETH Zurich.

- M. Savina, A. Fardel, P. Burlando; A local area weather radar for the canton Wallis. Poster presentation, Latsis Symposium, November 2010, ETH Zurich.
- M. Savina, P. Burlando; A local area weather radar on the Klein Matterhorn. Poster presentation, Hydrology Seminar (ZHydro2010), November 2010, ETH Zurich.
- M. Savina, P. Burlando; Precipitation field driven weather radar conversion. Poster presentation at EGU2011. Abstract EGU2011-7737, 2011, Vienna.
- M. Savina, P. Burlando; Precipitation measurements in the Alpine environment by a cost-effective X-band weather radar. Poster presentation at EGU2011. Abstract EGU2011-7647, 2011, Vienna.
- J. Schneider, R. Hegglin, M. Nitsche, J.M. Turowski, D. Rickenmann (2010): Studying sediment transport in mountain rivers using RFID Tracers. Poster presentation at CESS Latsis 2010 Symposium, ETH Zürich.
- A. Berthoud, S. Burri, C. Bruschini, A. Berne, E. Charbon. A Disdrometer Based on Ultra-fast SPAD Cameras. IISW, Onuma – Hokkaido, June 2011.
- T. Mande, N. Ceperley, G. Barrenetxea, A. Repetti, H. Yacouba, S. Tyler, M.B. Parlange. Convective and nonconvective rainfall partitioning over a mixed Sudanian Savanna Agriculture Catchment: Use of a distributed sensor network. AGU 2010.
- M.H. Daniels, E. Pardyjak, D. Nadeau, G. Barrenetxea, W. Brutsaert, M.B. Parlange; A method for obtaining distributed surface flux measurements in complex terrain. AGU 2010

Conference Presentations (No Paper)

- H. Jeung; Mobile Sensor Databases, tutorial.12th IEEE International Conference on Mobile Data Management, 6-9 June, 2011, Luleå, Sweden.
- M. Nitsche, D. Rickenmann, J. M. Turowski, A. Badoux, J. W. Kirchner: Evaluation of bedload transport predictions using different flow resistance equations for large scale roughness in steep mountain streams. Geophysical Research Abstracts, Vol. 13, EGU2011-14006, 2011.
- D. Rickenmann, J. M. Turowski, J. B. Laronne, R. Barzilai, H. Habersack, H. Seitz (2011): Experience from an indirect bedload transport measuring system with geophone sensors. Geophysical Research Abstracts, Vol. 13, EGU2011-175
- J. Schneider, J.M. Turowski, D. Rickenmann: Comparing fractional bedload transport equations with field data. Geophysical Research Abstracts, Vol. 13, EGU2011-5493-1, 2011.
- J.M. Turowski, A. Badoux , D. Rickenmann: Start and end of bedload transport in gravel-bed streams. Geophysical Research Abstracts, Vol. 13, EGU2011-209, 2011.
- F. Hurter, D. Perler, A. Geiger, Monitoring atmospheric water vapor in the Zermatt region with GNSS in Abstract Volume 8th Swiss Geoscience Meeting, 19.-20. November, 2010, Fribourg, Switzerland, 2010

- D. Perler, F. Hurter, E. Fabian, E. Brockmann, D. Leuenberger, D. Ruffieux, A. Geiger, M. Rothacher; GNSS meteorology: Activities in Switzerland, COST (European Cooperation in Science and Technology) 2010, Cologne, Germany , 16. - 19. November, 2010.
- F. Hurter, D. Perler, A. Geiger; Verwendung von GNSS zur Bestimmung des atmosphärischen Wasserdampfes in Zermatt, Der Alpenraum und seine Herausforderungen an Orientierung, Navigation und Informationsaustausch : AHORN 2010, Bad Tölz, Germany, 11. - 12. November 2010
- F. Hurter, D. Perler, A. Geiger, Verwendung von GPS zur Bestimmung des atmosphärischen Wasserdampfes im alpinen Raum, PhD box of Schweizerische Studienstiftung, Zürich, Switzerland, 11. December, 2010.
- M. Savina, P. Molnar, P. Burlando; Long-term persistence in radar precipitation in complex terrain. Oral presentation at the International Precipitation Conference IPC10. June 2010, Coimbra.
- M. Savina, P. Burlando; The highest X-band radar in Europe: first achievements. Proceeding for the 6th European conference on radar in meteorology and hydrology - ERAD 2010 (ISBN 978-973-0-09057-4), 2011.
- B. Schächli, P. Molnar, P. Burlando; Precipitation gradients along hillslopes estimated from rain gauge transects, oral presentation at EGU 2011

Book Chapters

- J.L. Berenguer, V. Luyet; Le cahier d'activités de la météo, CRDP, 80pp, 2010.
- V. Luyet; La météo et ses processus vus au travers des stations de mesure. EPFL, 40pp., 2011.
- E. Charbon, M.W. Fishburn, R. Wakler, R.K. Henderson. SPAD-Based Sensors. Springer, Eds. D. Stoppa and F. Remondino., 33pp.

Press Articles

- E. Charbon. Single-Photon Detection. Optics Photonics News, 2011.
- Gérer les données climatiques en temps réel depuis son salon. Le Nouvelliste, p. 24 Jun. 2011.
- Les Alpes deviennent un laboratoire à ciel ouvert. Bilan, N 03, p. 67-69, Feb. 2011.

Workshops

- I. Rolewicz, M. Catasta, H. Jeung, Z. Miklos, K. Aberer, Building a Front End for a Sensor Data Cloud, In Proceedings of International Workshop on Cloud for High Performance Computing (C4HPC), 2011.
- M. Savina, P. Burlando; Application of LAWR in Alpine region, Invited lecture at the pre-ERAD course in Local Area Weather Radar, September 2010, Sibiu, Romania.
- O3E international workshop in Nice, January 2011

PhD theses

- P. Haghani; Efficient Processing of Queries Ranking in Novel Applications, PhD Thesis EPFL, 2010

Master theses

- N. Quoc Viet Hung; A Benchmark for Evaluating Data Stream Modeling Techniques, MSc thesis EPFL, 2010.
- R. Hegglin, Beiträge zum Prozessverständnis des fluvialen Geschiebetransport. Masterarbeit (H. Kienholz, Univ. Bern; D. Rickenmann, WSL, J.M. Turowski, WSL). 2010

Outreach activities

- Classroom intervention and hands on demonstration of the sensorscope stations to primary and middle school classes (4)
- Guided tours for the teachers and other stakeholders (4)
- WSL Jubilee celebrations in Birmensdorf, Leuk and Davos

Other publications:

- M. Nitsche, J.M. Turowski, A. Badoux, M. Pauli, J. Schneider, D. Rickenmann, T.K. Kohoutek (2010): Measuring stream-bed morphology using range imaging. In: River Flow 2010, Dittrich, Koll, Aberle & Geisenhainer (eds), Bundesanstalt für Wasserbau ISBN 978-3-939230-00-7, p. 1715-1722.
- J. Schneider, R. Hegglin, S. Meier, J.M. Turowski, M. Nitsche, D. Rickenmann (2010): Studying sediment transport in mountain rivers by mobile and stationary RFID antennas. In: River Flow 2010, Dittrich, Koll, Aberle & Geisenhainer (eds), Bundesanstalt für Wasserbau ISBN 978-3-939230-00-7, p. 1723-1730.
- A. Arion, H. Jeung, K. Aberer, S. Michel, Efficiently Maintaining Distributed Model-Based Views on Real-Time Data Streams, EPFL-REPORT-164207, Ecole Polytechnique Federale de Lausanne, 2011.
- D. Rickenmann, B. Fritschi; Bedload transport measurements using piezoelectric impact sensors and geophones. In: Gray, J.R., Laronne, J.B., and Marr, J.D.G. (eds), Bedload-surrogate monitoring technologies, U.S. Geological Survey Scientific Investigations Report 2010-5091, p. 407-423, available only online from <http://pubs.usgs.gov/sir/2010/5091/papers/listofpapers.html>. 2010.