

Historical review on 50 years of hydrological and environmental research in the Alptal

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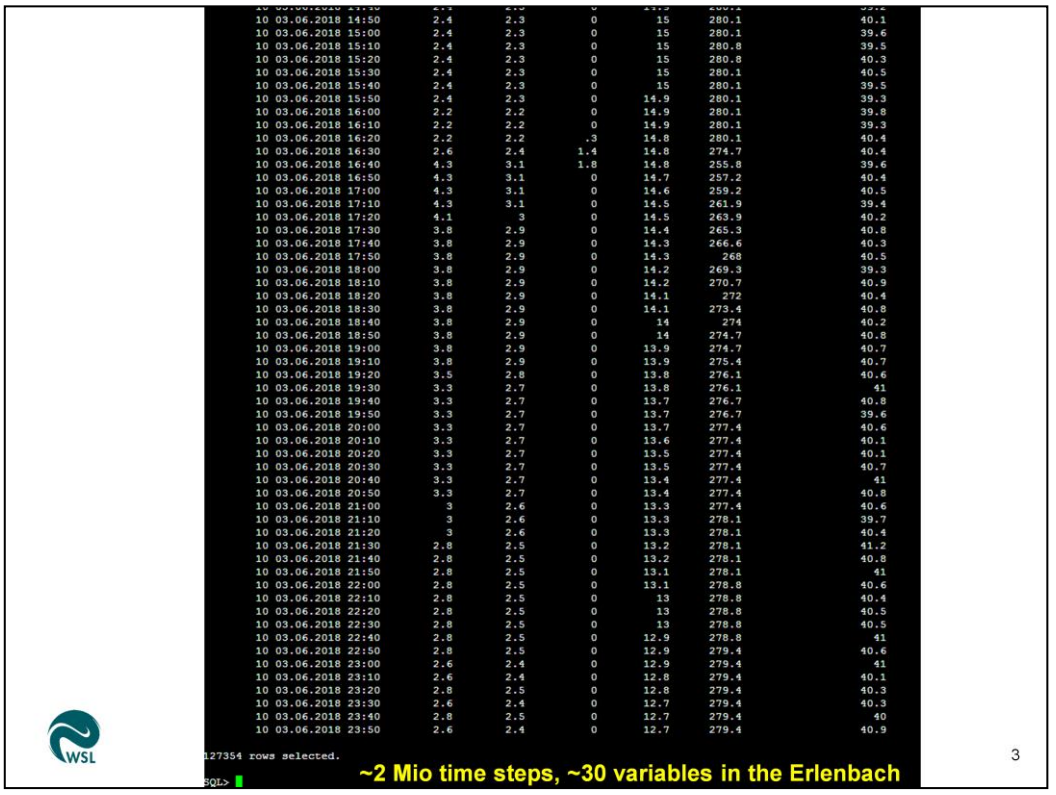
Dear colleagues,

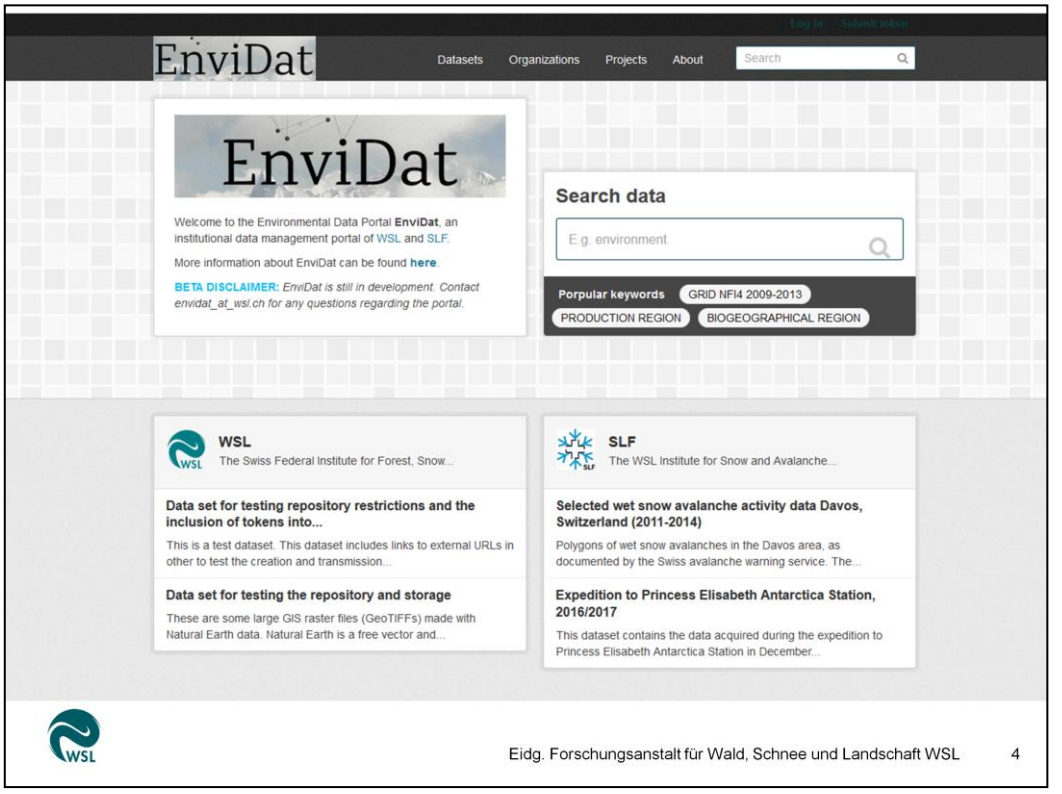
Let me introduce you to the legacy of 50 years of research in the Alptal. This here is the archive next to my office at WSL. Somebody who would enter here for the first time would be overwhelmed by the bulk of old photographs, handwritten notebooks, technical plans or manuscripts.



Even more impressive is the crowd of digital data, digital photos, analyses and publications that has accumulated over the last 15 to 20 years on our servers. The WSL oracle data base includes a total of ??? measured variables and ???? values.

Do you know this situation from your own working place?

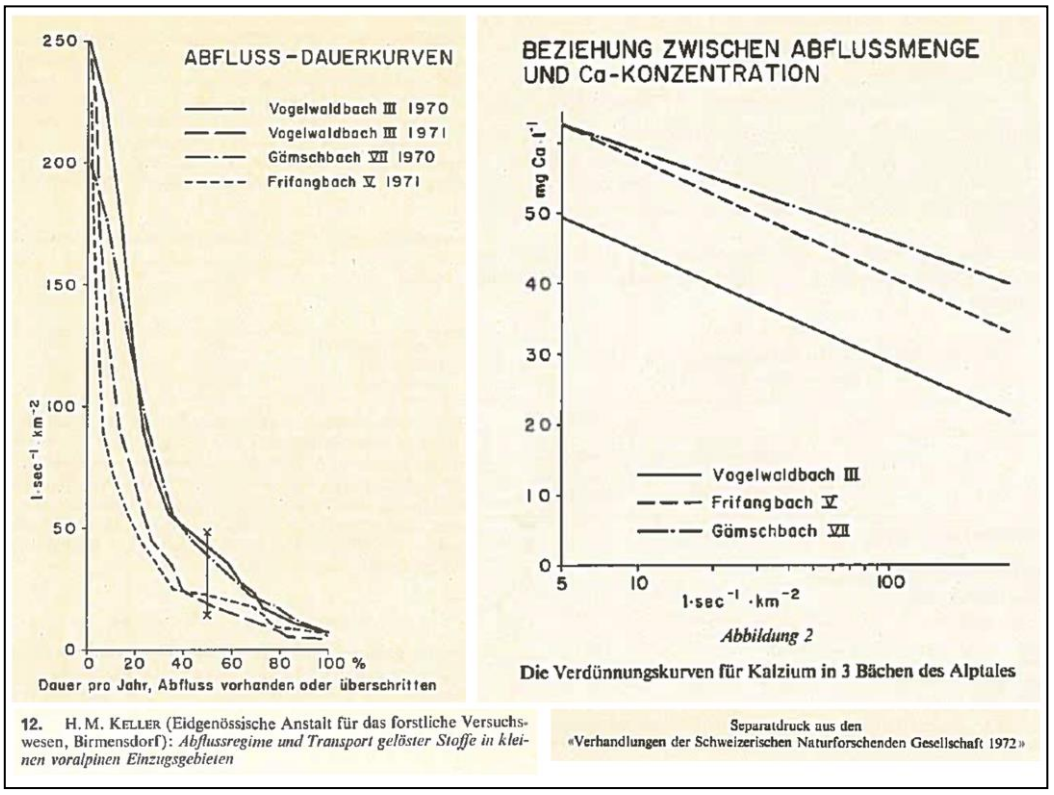
We feel completely overstrained and unable to cope with this flood of information and data.



It is now current practice to create data portals to provide an open access to such data. For example, WSL has recently launched a data portal called "envidat.ch" where interested scientists or students can easily search for specific long-term observations.

Also, new methods are currently under development to extract knowledge from such a huge amount of data (key word: data mining and machine learning).

But let's have a look at how 50 years of data from the Alptal have been exploited in the past. By doing so, we can see how our way of doing research has changed in the course of the past 50 years.



In the first decades of the Alptal research the studies and publications were rather descriptive. Research questions were primarily curiosity driven and were not guided by clear hypotheses. I would like to exemplify this with a figure from an early publication by Hans M. Keller. Here you see ….

By the way, I take the opportunity to mention that for this jubilee all publications of Hans Keller have been digitized and published on our web site.

Looking back to this period, we can also notice that Hans was the only person to publish results from the Alptal in national or international journals.

And finally, it's worthwhile mentioning that all this work was financed by in-kind funding of one institution.

Extreme events, such as floods in 1974, 1984, 1999 and 2005, wind storms or heat waves (2003) had a very large influence on the research in the Alptal. They triggered specific research questions, supplied most interesting data and observations and caused dismay and solidarity.

National Research Programs and EU-projects

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With the early National Research Programs (14) and (31), and the first EU-funded project (NITREX) Alptal was brought in a national, or international context.

With these projects, the focus of the Alptal research was extended from the streams to the ecosystem.

New sensors and technologies

Throughout the years, the Alptal site was useful for **testing new measurement technologies and sensors**.

One example was a four-component radiation sensor that was moving along a 10-m long bar across the forest to measure the spatial variation of the sub-canopy radiation balance – both in winter and summer.

Or different technologies to quantify sediment transport in the torrents, as you will see later today and on the excursion tomorrow.

So in conclusion, the Alptal research showed very nicely that innovation in the observation technology is heavily stimulated by the need and the questions of …

Numerical modelling

Hydrological Basis of Ecologically Sound Management of Soil and Groundwater
(Proceedings of the Vienna Symposium, August 1991). IAHS Publ. no. 202, 1991.

Simulating soil moisture and runoff components to estimate variability of streamflow chemistry

H. M. KELLER & F. FORSTER

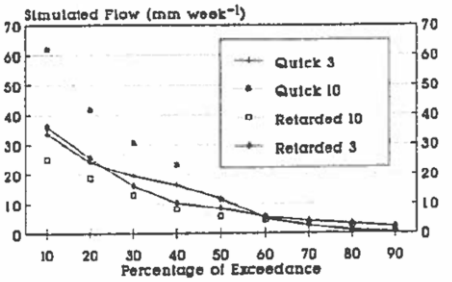

FIG. 1 Frequencies of simulated surface flow and interflow, as components of streamflow in basins 3 and 10, Alptal: Weekly totals 1985 - 87.

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Computer-based **numerical models** for the simulation of runoff or nutrient dynamics did not exist when the Alptal observatory was set up. The first such models were developed at the end of the 1970-ies. Very soon, the team of Hans Keller started to apply the Brooks model to the Alptal sub-catchments to explain observed differences between the catchments.

Numerical modelling

Evaluation of forest snow processes models (SnowMIP2)

Nick Rutter,[1] Richard Essery,[2] John Pomeroy,[3] Nuria Altimir,[4] Kostas Andreadis,[5]

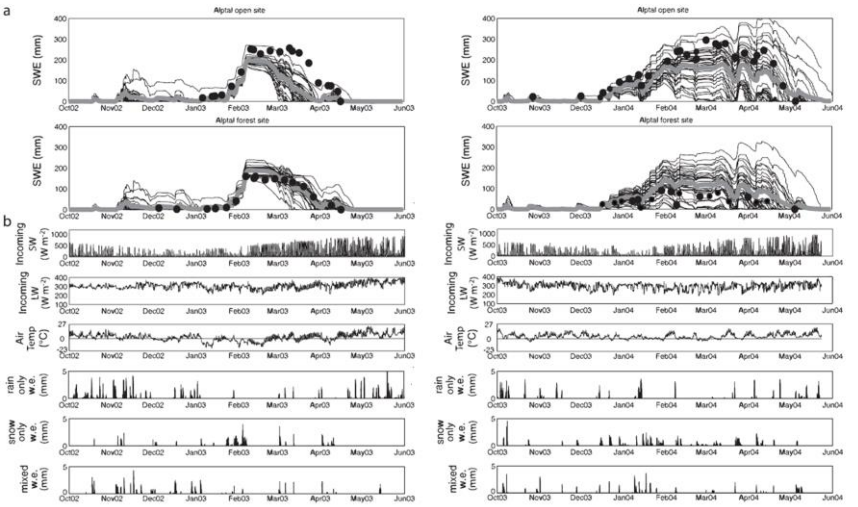
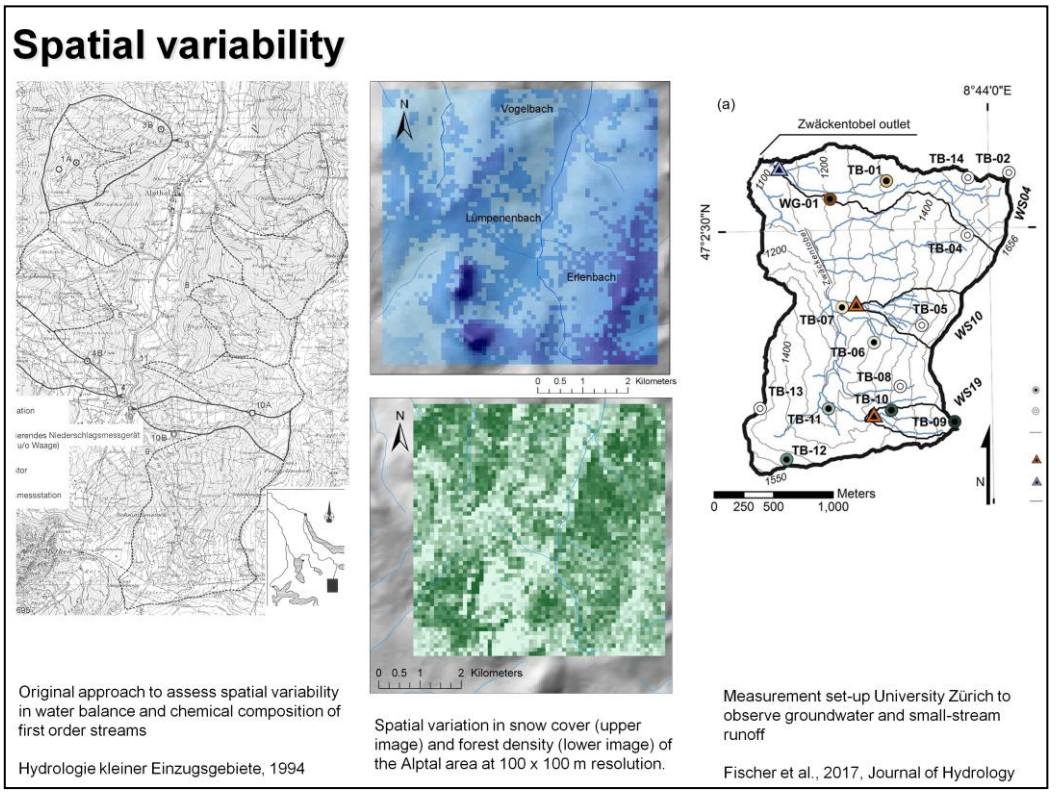


Figure 1. (a) Alptal observed SWE (black dots), individual modeled estimates (black lines), and the average of all modeled estimates (gray line). (b) Meteorological variables; see text for definition of mixed precipitation.

In the past twenty years, a large number of numerical models have been validated with Alptal data to test specific process formulations. For example, data from the Alptal was used in a comparison of 33 forest snow models from allover the world showing the enormous spread of simulated snow water equivalent in the forest.

Today, we can't imagine hydrological or environmental research without numerical modelling; and these are getting more and more sophisticated. However, a comprehensive validation against long-term data, such as the one from the Alptal, will always be the backbone of these models.



One of the key-words in environmental research is **«spatial variability»**. It's interesting to see how approaches to assess spatial variability changed in the course of the past 50 years:

In the beginning of the Alptal research, the first-order catchments of approximately 1 km2 area were treated as units with specific characteristics; and the aim was to explain systematic variabilities in runoff or water quality based on these characteristics.

In the 1990-ties, several studies on plots of a few square meters started to illuminate spatial variability at much smaller scale.

More recently, the hydrology group of University Zürich started a comprehensive network of observations at an intermediate scale by looking at single channel segments and sub-areas of the first-order catchments.

What is the appropriate scale to study spatial variability? I'm not sure we have a definite answer to this question, but we certainly agree that ……

Chemical composition

1975 1984 2016

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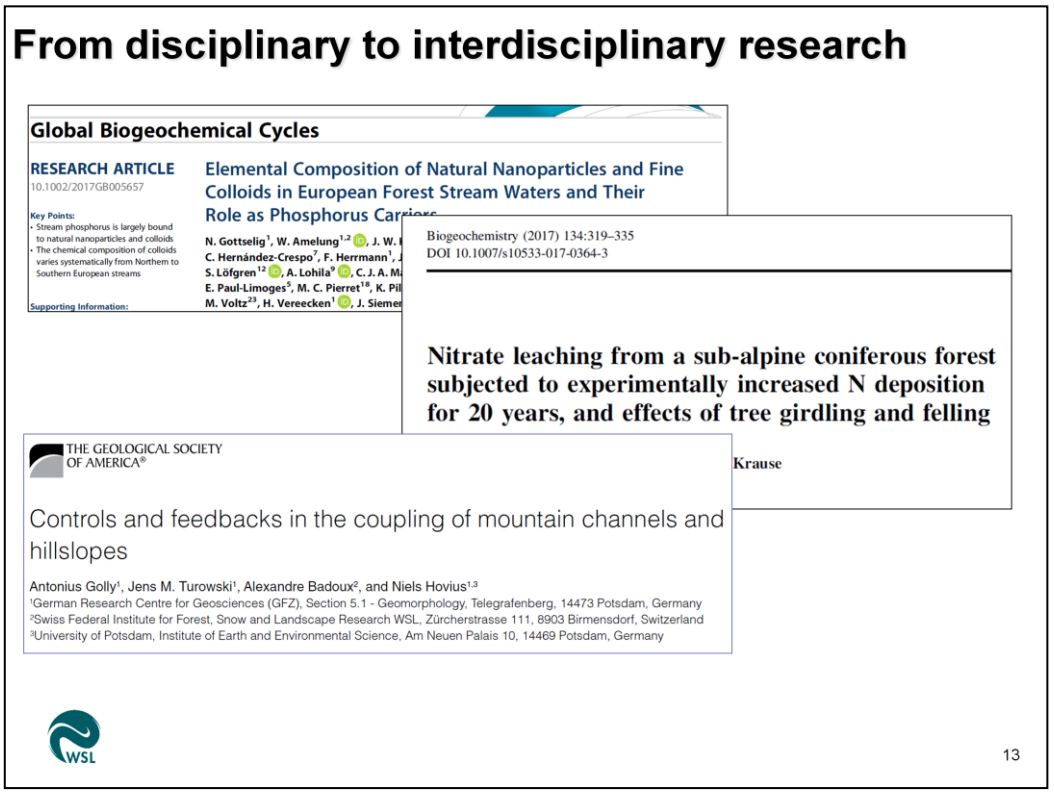
The **assessment of the chemical composition** of the stream water in the Alptal is another illustrative example how our way of researching has changed in the past 50 years:

- In the beginning, this work was was very much curiosity driven. The chemical composition of such torrents was just unknown. The water was collected manually to determine a relationship between chemical concentration and discharge.
- Over the years, these measurements became more systematic and long-term oriented with better strategies to sample and store the water. In 2003 our chemical measurements became part of the National River Monitoring and Survey Programme (NADUF) with the overall objective to assess long-term trends in stream water quality.
- And more recently, the chemical measurements in the Alptal became even more sophisticated. In 2016 one of the first on-line sampling and analysis system worldwide for small streams was set up in the Erlenbach with the aim to learn something about runoff generation by looking at very high-resolution chemical data.



The history of research in the Alptal also nicely shows how environmental research has turned from a purely disciplinary mode into cross-disciplinary approaches.

The activities of Hans Keller and his team were assigned to the classical field of forest hydrology, whereas it is nowadays difficult for me to correctly denote the current research activities.

Recent publications with data from the Alptal include nanoparticles, forest management, geomorphological processe as well as climate and land use change.

This trend shows clearly that researchers have understood that future environmental challenges can only be solved with interdisciplinary approaches.

Conclusions

In conclusion, I believe – and hope you agree - that the history and the development of the Alptal research is quite representative for a general development in environmental research in the course of the past 50 years.

To be aware of the ideas, successes and failures of our antecessors seems to be essential when we look at our current and upcoming research activities. That's what I take from looking back to the history of this longterm research.