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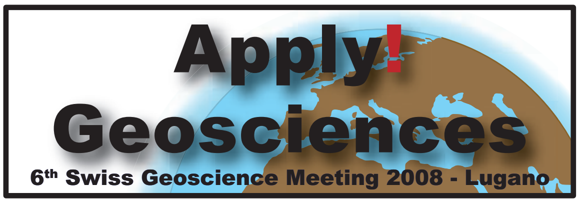

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0. Plenary Session

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The art of using weather radars for hydrology in the Alps

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To use weather radars in mountainous regions is like pitching tents during snowstorm: The practical use is obvious and large – but so are the problems.

The most obvious strength of weather radars is their ability to make four-dimensional "radiography" of precipitation with time and space resolution of a few minutes and a few km over a large area of more than 100 thousand km^2. The applications of the Swiss weather radar network range from providing four-dimensional monitoring of precipitation systems and wind information in the forecast office, to quantitative precipitation measurement for hydrogeological risk management, hail mapping for insurance business, as well as identification, tracking, and extrapolation of thunderstorms for public warnings.

Successfull operation of weather radars in mountainous regions, however, requires appropriate system design and sophisticated data processing. Of particular difficulty are the elimination of ground echoes and the correction of errors caused by shielding of the radar beam by mountain ranges. The paper presents the Swiss solution with focus on 10 years of progress in operational applications. This includes thunderstorm ranking, wind profiling, as well as nowcasting heavy orographic precipitation. A novel promising solution is to generate an ensemble of radar precipitation fields. Each member of the ensemble is a possible realization of the unknown true precipitation field given the observed radar field and knowledge of the space-time error structure of radar precipitation estimates. The real-time implementation of the radar ensemble generator coupled with a rainfall runoff model in the framework of the hydrometeorological forecast demonstration project MAP D-PHASE is one of the first experiments of this type worldwide.

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Simple models for complex hydrologic behavior: a challenge for basic research and engineering

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An old joke defines a 'scientist' as someone who wants to understand a problem without solving it, and an 'engineer' as someone who wants to solve a problem without understanding it. Hydrologists need to defy these stereotypes, both to advance the science of hydrology and to solve practical water resource problems. Effectively solving water resource problems will require better scientific understanding of hydrologic processes. Conversely, and perhaps less obviously, a deeper respect for the practical realities of real-world problems will help to advance the science of hydrology.

Recent progress in hydrologic science is challenging the intuitively appealing and computationally convenient models that have been the foundation for engineering approaches to streamflow forecasting and contaminant transport problems. For example, although catchments have often been conceptualized as linear reservoirs, it has become clear that the intrinsic nonlinearity of many hydrological processes is essential to understanding catchments' rainfall-runoff behavior. Similarly, although subsurface transport and mixing in catchments has often been modeled by tank reactors with exponential residence time distributions, there is now clear evidence that typical residence time distributions in real-world catchments are markedly non-exponential. At smaller scales, contaminant transport has often been modeled by Gaussian plumes although field data clearly show that many contaminant plumes are dramatically non-Gaussian. The immediate challenge is to capture these kinds of real-world complexities in prediction and analysis tools that are still useful in an operational context.

For scientific reasons as well as practical ones, hydrology needs new conceptual models that make the complex realities of hydrological systems understandable and analytically tractable. In attempting to embrace the full complexity of hydrological systems, many hydrological models have not only become too complex for operational use; they have become too complex to be understood, too highly parameterized to be rigorously tested, and too data-hungry to be widely applied.

These considerations point to the need to develop new models which find a 'middle path' between the conceptually simple linear models often used in engineering approaches, and the complex spatially distributed models often used in research hydrology. The goal of such 'gray box' models is to capture the aggregate behavior of complex hydrologic systems directly in their governing equations, so that complex model structures and elaborate mathematical schemes are not required.

Catchment hydrology is controlled by processes and material properties that are known to be complicated, highly coupled, heterogeneous on all scales, and poorly characterized by direct measurement. This observation raises the question of how one can identify the appropriate constitutive equations that describe the large-scale behavior of these complex heterogeneous systems. Here I show that some small catchments can be usefully characterized as first-order nonlinear dynamical systems, and that one can infer their nonlinear governing equations at catchment scale, directly from field data. This approach assumes that discharge depends on the aggregate volume of water stored in the catchment, but makes no a priori assumption about the functional form of this storage-discharge relationship, instead estimating it from rainfall-runoff data.

This approach not only allows one to predict streamflow from measurements of rainfall, but also allows one to "do hydrology backwards": that is, to infer effective rainfall and evapotranspiration at whole-catchment scale, directly from fluctuations in streamflow. This approach also directly explains the relationship between the power spectra of the incident precipitation and the resulting streamflow fluctuations. Thus it allows one to understand how catchments filter rainfall fluxes that are complex in space and time, yielding streamflow fluctuations that are predictable over wide ranges of time scales.

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Annual Opening and Closure of Alpine Valleys

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Alpine tunnels in hard rocks induce small surface deformations as a result of groundwater drainage and associated pore pressure reduction. As shown in the example of the Zeuzier Dam, strong groundwater inflows to deep tunnels (1000 meters or more) in fractured limestones can lead to surface settlements and horizontal strains which can result in fracturing concrete arch dams within a lateral distance of a few kilometers. The Gotthard Base Tunnel (GBT), currently under construction in the central part of the Swiss Alps, runs close to 3 existing arch dams (Curnera, Nalps, Santa Maria) contributing to a hydropower system owned by Kraftwerke Vorderrhein AG (KVR). The excavation front as of fall 2008 is at the upstream end of lake Nalps (subsection Sedrun direction South) and at below Piora valley (subsection Faido direction North). In order to maintain safe operations of these hydropower dams and not unnecessarily stop tunnel excavations, a comprehensive surface deformation monitoring system has been installed in the surroundings of the Gotthard Base Tunnel, which is in operation since 2001/2002. This system includes automatic tachymeters, borehole extensometers, high-precision leveling, and differential GPS.

Shown here are some of the results of this monitoring project, which comprises the total station measurements of 6 local tachymetric networks installed in 2000 and 2001. These local networks are either located at the dam sites or 1.0-3.5 kilometers before (north or south of) the dams and focus on deformations within cross sections perpendicular to the valley axes. Some of these monitoring areas have not been affected by the Gotthard Base Tunnel or any other underground construction for a period of 6 years. These long-term “background” measurements are critical for the understanding of tunnel induced deformations and the definition of intervention thresholds. On the other hand this data set offers new insights into the natural deformations occurring in the three valleys located above or close to the Gotthard Base Tunnel route (from West to East: Val Curnera, Val Nalps and Val Medel/Termine).

The observed natural deformations are significant and include seasonal variations in horizontal and vertical distances measured at different elevation across these valleys. A rapid closure of the valley is observed in spring, followed by a slow opening in fall and winter. The observed annually reversible horizontal strains measured across Alpine valleys are in the order of 1 to 3 E-5. For example, at 250 m elevation above valley bottom, the separation of the sidewalls is 550 meters and changes annually by up to 17 mm. These strains also include minor vertical components and mainly occur mainly in planes oriented normal to valley axes. Preliminary investigations with hydromechanically coupled models (equivalent poro-elastic or discrete elastic fracture models) indicate that these strains are most probably related to annual variations in groundwater table elevation, controlled by recharge from snow melt in spring and early summer.

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Peak oil or not peak, that is the question

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Peak oil or not peak, that is the question

The whole world is looking at the price of the barrel of oil with a renewed interest since the beginning of 2008, and it became a common subject of discussion if not of worries. Most people and all sorts of experts are also speculating on the world oil reserves, and the most often asked question is: for how long do we have oil? Unfortunately, and despite the experts confident statements, any answer to that question is bound to be wrong, so is any speculation on the future price of the barrel. It is clear that there is still a lot of oil around and certainly some major quantities to be found in the near future, but what is certain is that, one day, we will run out of oil, and this is the only certainty regarding this global problem.

So, we certainly need to worries about the reserves, but on the short term the worries is about the capacities of production of the oil exporting countries. Any oil geologist would know that producing oil is an intricate business, blending technologies, a bit of luck and geological know-how, the latter being the most important, as structures in which the oil is trapped can be highly complicated in terms of distribution and quality of reservoirs, and often also in terms of structural trapping, to speak only of the obvious problems. To increase oil production is not a simple affair, in many instances it would take years to do so intelligently in order not to jeopardize future production. So, the hope that from the 80 M bpd production of a few years ago, a figure of 100 M bpd could be reached in the coming 10 years is a real gamble, and might prove to be impossible, despite the reserves. As the demand will certainly persist (at least from emerging countries such as China), we can be sure that the price of the barrel will go up. On the other hand, if it goes up too much, consumption will slow down, but slowing the consumption of oil means a decrease in economic profit and will inevitably run into recession. Then, can some sort of balance be found? it could be possible if speculation was not part of the game and if large parts of the world population were indeed ready to decrease their standard of living,. This sounds really unrealistic!

On the longer term, and as shortage there will be, a proper track of actions should be taken in order to avoid any sort of major worldwide crisis touching mainly the trading of merchandises, the main oil consuming factor in our modern world. Indeed, everything is transported, including billions of people on a daily basis, and mainly with oil. If we just wait for the shortage to come, we shall face major disasters such as famines and industrial and social unrests in the populated areas of the planet, so, everywhere... It has been shown that mitigation programs starting 20 year before the oil production peak are necessary in order to avoid a major crash in production, thus a major crash of the society. Some mitigation programs were started some years ago with the implementation of new and alternative sources of energy, but so far these are absolutely unable to replace oil for transportation of goods and people. Proper worldwide mitigation programs in term of reduction of oil in transportation just do not exist, and as most experts agree that we have already passed the oil peak, it seems that an oil crash is inevitable.

Thus, we shall be forced to travel less and buy locally. Most of us might be ready to do so, but can we do it? The main problem here is that politicians cannot implement and encourage such a responsible behaviour and for several reasons; the first one being that they just don't care about it, by ignorance or willingly, the other main reason is that the economy is not working in that direction whatsoever, the persistent "philosophy" being: the cheapest the better! And the politicians have no say in that process.

So, the solution is really in the hands and consciousness of the consumers, everyone of us... Besides a pro-active behaviour to buy locally, we should realised and be convinced that chasing the cheapest product is a highly egoistical behaviour, it may give us the illusion to generate jobs in some remote parts of the world, but what we give to these people is a promise for poverty and struggle for life in which millions shall perish. If we cannot change our consumer habits so easily –although we might soon be forced to do so, we could at least try to change our consciousness and open to the fact that the rich exist because the poor exist, and try to do our best for this situation not to remain for ever.

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Hochwasserschutz in der Schweiz - eine Generationenherausforderung

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Das Unwetterjahr 1987 gilt in der Schweiz als das Schlüsseljahr für den Paradigmawechsel im Hochwasserschutz. Aus der breit angelegten Ursachenanalyse wurden wichtige Schlüsse für die Zukunft gezogen. Man musste Abschied nehmen vom Glauben an die absolute Sicherheit. Die einfachen Rezepte mussten durch differenziertere Betrachtungsweisen abgelöst werden.

In den letzten 20 Jahren häuften sich die Schadenereignisse:

1987 (Uri), 1993 (Brig), 1999 (Mittelland), 2000 (Wallis), 2002 (Appenzell a. Rh., Graubünden), 2005 (17 Kantone betroffen), 2007 (Aargau, Solothurn, Bern, Waadt); Stürme in den Jahren 1990 (Vivian) und 1999 (Lothar); Lawinenwinter 1999. Seit 1987 hat sich offensichtlich die Frequenz von extremen Ereignissen erhöht. In den letzten 20 Jahren ereigneten sich 7 von 17 Hochwasser-Grossereignissen der letzten 200 Jahre.

Mit der Klimaerwärmung muss davon ausgegangen werden, dass die Anzahl Extremereignisse weiter zunehmen wird. Eine Anpassung der Schutzmassnahmen an die Auswirkungen des Klimawandels wird somit zu einer Herausforderung der ganzen Gesellschaft. Hinzu kommt, dass eine Reihe grosser wasser- und waldbaulicher Schutzmassnahmen erneuerungsbedürftig sind, weil sie die heutigen Anforderungen nicht mehr erfüllen. Erneuerungen und Sanierungen sind zwingend, wenn der entsprechende Schutz weiterhin gewährleistet bleiben soll. Eine angemessene Sicherheit des Wirtschafts- und Lebensraums ist eine wichtige Voraussetzung für eine volkswirtschaftliche Entwicklung.

Trotz den Bemühungen zeigt die Schadenstatistik der letzten 35 Jahre eine Vervierfachung der Schäden in der 2. Hälfte der Periode.

Um der ungünstigen Schadensentwicklung begegnen zu können, muss ein integrales Risikomanagement umgesetzt werden. Schäden können nur vermindert oder verhindert werden, wenn alle Beteiligten im Rahmen ihrer Handlungsmöglichkeiten ihre Verantwortung wahrnehmen. Nur wenn alle Massnahmen die zur Schadensminderung beitragen ergriffen werden, führt dies zu einer wirkungsvollen Schadensreduktion. Damit ist auch klar, dass die ganze Gesellschaft mit dieser Herausforderung konfrontiert ist.

Es stellt sich nun die Frage, wer was auf welcher Ebene dazu beitragen kann.

Aufgrund einer umfassenden Aufgabenanalyse des Bundesamtes für Umwelt im Bereich der Gefahrenprävention zum Ziel „Sicherheit für Mensch, Umwelt und Sachwerte“ (gesetzlicher Auftrag), wurden die verschiedenen prioritären Handlungsschwerpunkte ermittelt.

Wichtig ist das Bewusstsein, dass eine einzelne beteiligte Instanz allein die Sicherheitsziele nicht erreichen kann. Eine gute Zusammenarbeit, Koordination und Kommunikation ist Grundvoraussetzung. Es gilt also dafür zu sorgen, dass alle Beteiligten, auf allen Stufen, ihre Aufgabe optimal erfüllen und gut zusammenarbeiten.

Der Bundesrat hat dazu wichtige Entscheide zur Stärkung der Gefahrenprävention gefällt.