Best Practice Excursion "Gangbach" (Schächental, Uri)

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Schedule

Thursday, 12th June 2014	in the evening dinner ca. 20:00	Arrival, dinner and overnight stay in Hotel Höfli, Altdorf (optional) → more information see separate document "**how_to_reach.pdf**"
Friday, 13th June 2014	**dep. 08.15** dep. 08.45 ca. 11.45 dep. 13.00 dep. 16.10	**Departure from Hotel Höfli to the Gangbach catchment with minivans** 1st part of the excursion according to the excursion programme Lunch in restaurant Biel, Bürglen 2nd part of the excursion and subsequent return to Altdorf/Flüelen Departure of train from Flüelen and/or optional "after-work drink"

Local Management:	Beat Annen, Head of Office for Forest and Hunting, canton Uri
Overall Organisation:	Karl Grunder and Roland Stalder, oeko-b ag
Professional Support:	Frank Graf and Christian Rickli, WSL/SLF; Martin Frei, MFrei Infra GmbH

Main goal

Presentation and discussion of practical measures for protection against superficial land-slides in order to give input for applied research in respect of quantifying "Vegetation Effects on Soil Stability" (NRP 68 project).

Leading question

We want to timely maintain and improve soil stability with respect to preventing natural hazards! How can we profit from and appropriately apply vegetation?

Why the "Gangbach" area?

The "Gangbach" is the most important headwater of the dangerous mountain river "Schächen" (canton Uri) and subject of different studies and protection measures since more than a century. This is shown by many examples among which are of recent times:

- 1980: first standardised key-kit for geomorphological phenomena in torrent catchments (A. Sandri);
- 1982: one of the first courses held by the "Swiss Federal Forest Task Force for Torrent Control and Slope Stabilisation";
- 1987: international workshop on the "Consequences of Forest Damages to Mountain Rivers in Switzerland" organised by WSL.

Spatial context: Flood hazard caused by the "Schächen"

Bed-load played a key role in context with the disastrous floodings in 1910, 1977, and 2005. The main cause of the vast out-bursts was the overload of the lower course with bed-load and associated backwater at the river mouth of the "Schächen" into the "Reuss" and the resulting aggradation of the lined ditch of the "Schächen". After the floodings of 1910 and 1977 many headwaters of the "Schächen" were corrected and debris retention basins constructed. Furthermore, large areas were afforested and stabilised with joint technical and biological measures, particularly in respect of torrent control and slope drainage (1st part of the excursion). First measures were taken in 1932, when the Canton bought 70 hectares of land from the farmers in order to pursue the restoration project.

After the flooding of the valley bottom of "Uri" in 1987, the protection system has been renewed, reinforced and complemented. Nevertheless, the "Gangbach" remains the most important bed-load source and supplier of the "Schächen". Protection measures were calibrated based on a 100 years return period. The estimated replacement value of the protection measures in the "Schächen" catchment constructed from 1910 to 2005 adds up to 90-100 millions of Swiss Francs.

During the event of 2005, the most important amount of bed-load transport into the "Schächen" originated from the landslide "Lotter" of the "Gangbach" catchment (2nd part of the excursion). As a consequence of the 2005 floodings the cost estimate for protection measures planned for the period 2010-2016 of the lower course and river mouth of the "Schächen" into the "Reuss" was about 65 millions of Swiss Francs. However, only minor projects have been scheduled for the "Gangbach" catchment.

Characteristics of the "Gangbach" catchment

The upper part of the "Gangbach" catchment is characterised by steep rock faces of "Quintener" limestone and permeable screes. In the main part of the catchment that is formed by soft rock, in particular by "Wildflysch" shale, a densely branched network of watercourses has been developing. In the lower part of the catchment native limestone and roof slate are dominating (Fig. 1). Hydrology plays a key role in the catchment processes: in the upper part of the catchment water tends to infiltrate completely. Towards the bottom part of the catchment water is springing up causing shallow landslides which often evolve into mud flow or provoke deep seated landslides.

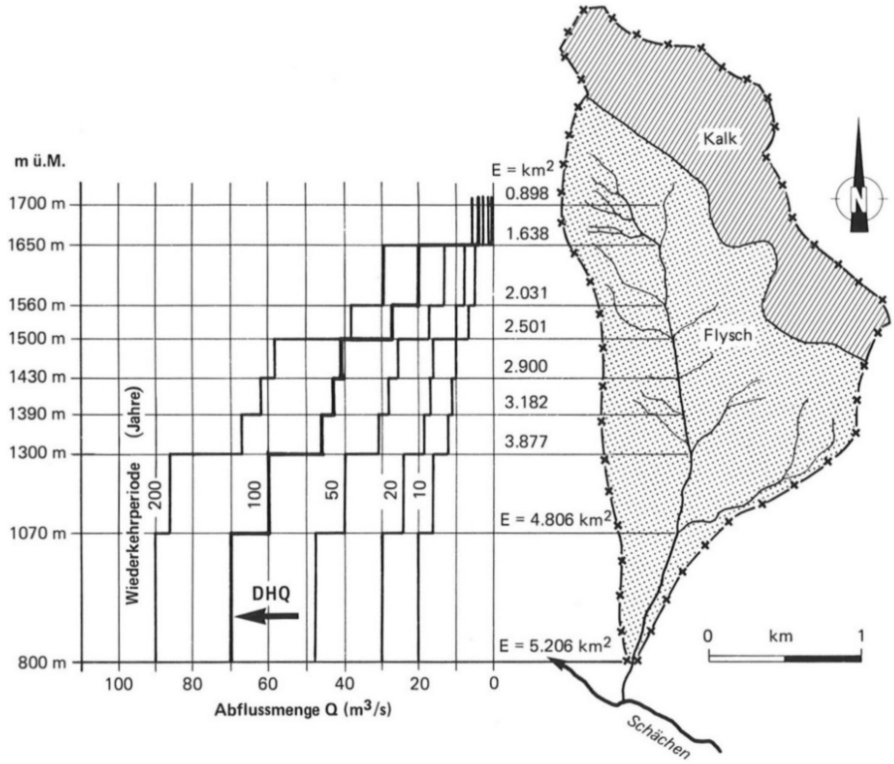


Fig. 1: Geology, network of watercourses, and design floods of the "Gangbach" (WSL 1987).

The area centroid of the "Gangbach" catchment is on an average altitude of 1700 m asl (Fig. 2).

The relative altitude distribution of the "Gangbach" catchment is distinctly convex and the age of development only approaching the medium stage. Therefore, the tendency for further deepening of the channel is still considerable (Fig.3).

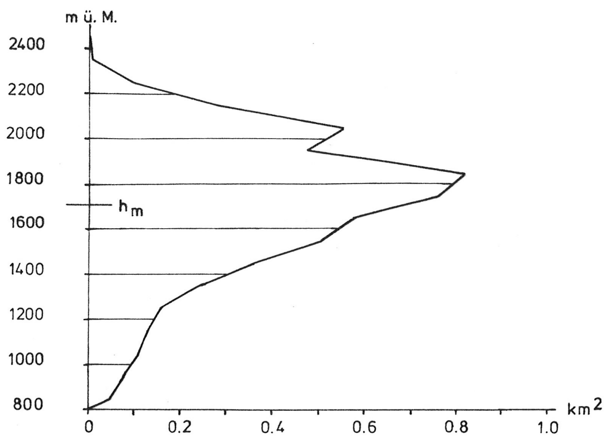


Fig. 2: Absolute distribution of altitude in the "Gangbach" catchment (Forest Service Uri/Forest and Hunting, 1982).

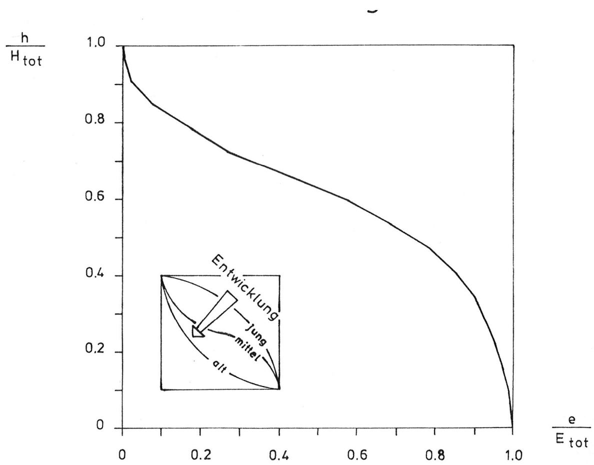


Fig. 3: Relative distribution of altitude in the "Gangbach" catchment (Forest Service Uri/Forest and Hunting, 1982).

Visited objects during the excursion

First Part

Upper montane to subalpine afforestation areas of different age, combined with drainage measures and technical stabilisation constructions. Variable soil depths of the erosion processes. Different development stages with different management and maintenance strategies.

- *Afforestation area 1 ("Äbnenegg"):*
  Afforestation and drainage measures from the 1920s established on areas of superficial to deep seated landslides. In the last couple of years the first regeneration cuts were applied within the management of protection forests; following the guidelines of NaiS (Sustainability in the Protection Forest).

- *Afforestation area 2:*
  More recent afforestation and drainage measures established on areas of superficial landslides. The drainage system was built to collect the water in this upper part of the catchment in order avoid massive infiltration which emerges down slope. After setting up the drainage system, afforestation was performed with the purpose of primarily controlling the fluxes of water considering both interception and infiltration. Plants were grouped in collectives with the intention of obtaining a "mosaic structure" (Rottenstruktur) typical for subalpine forests, allowing heterogeneity above- as well as belowground (root systems).

- *Afforestation area 3:*
  Afforestation and drainage from the 1940s established on areas of medium- to deep-seated landslides.

- *Afforestation area 4 ("Gigen"):*
  Afforestation from the 1990s, combined with technical measures against avalanche starting on medium-seated landslides.

Second Part

Initial vegetation stages and agricultural areas on steep slopes of the upper montane region. Variable soil depths of the erosion processes. Different requirements on the vegetation with corresponding strategies of management and maintenance.

- *Landslide "Lotter":*
  For a long time active area of medium- to deep-seated landslides.
  Largest landslide in the valley of the "Schächen" during the heavy rainstorms in 2005 with tremendous consequences on the bed-load discharge of the "Schächen".
  Combined with stabilising log crib-walls and drainage measures, the re-colonisation with protecting vegetation of areas affected by landslides plays a central role in torrent control and, particularly, in order to prevent bed-load transport. Currently, the maintenance measures are restricted to technical constructions (i.e. cleaning of the drainage channels) and do not consider care and maintenance of vegetation.

- *Agricultural area:*
  In recent years, the continuation of the agricultural use of the steep slopes has become more and more doubtful. However, in this particular case it has been agreed to continue, not least on behalf of decentralised settlements and biodiversity. In other regions, landslide affected areas have been afforested or left for natural re-afforestation. A site-adapted land-use is decisive for biodiversity as well as for an appropriate protection against erosion. The agricultural use may differ due to operational reasons.

Some practical questions/demands related to excursion and SOSTANAH

From Practitioners to Administration and Science:

1. Recommendation for application, justification, management, and maintenance of vegetation used for slope stabilisation with regard to long-term protection functions (superficial, medium- and deep-seated landslides).
   A main question is how and how long plants should be managed in the long-term, considering also economic issues.
2. Advantages and disadvantages of "artificially pushing" vegetation development on slopes affected by landslides/erosion compared to natural re-colonisation and succession processes?
   Vegetation self-regenerates; but do local environmental conditions meet the requirements to ensure this process?
3. How do plant succession processes affect soil weathering and soil aggregate composition (→ change in particle size distribution?) and what are the corresponding consequences for long-term slope stability?
4. What are negative effects of certain vegetation types in respect of (re-) stabilisation of slopes susceptible to superficial soil failure?

**In general, there is demand of more scientifically based information as well as data on the potential of vegetation to stabilise slopes and,
in particular, the need of long term monitoring of bioengineered slopes,
concerning both vegetation and hydrological aspects**

From Scientists to Practitioners:

5. What information and in which form is needed in respect of plant effects on slope stability – related to protection against superficial soil failure – in order to appropriately include vegetation into rehabilitation concepts and slope stability calculations?
6. What would change in hazard assessment and taking measures against superficial soil failure, if plant effects on slope stability are reliably quantifiable?

"Undirected":

7. Which are decisive vegetation parameters in order to appropriately consider plant effects on slope stability in safety analysis and to quantify them, respectively?

Further questions not directly related to SOSTANAH:

- Should original vegetation patches at the border and/or within a failed slope area be left although they were slipped or are partly cracked?
  What are advantages and what are the risks?
  What are the consequences in respect of the restoration strategy?
- How and within which time-scale does a stop of grazing/cultivation affect slope stability?
- How and within which time-scale does abandonment/a stop of fertilising affect slope stability?
- What consequences has a cutting back of vegetation applied for slope stabilisation with regard to root development?
  Is a cutting back after a longer period (~10 years) useful to further improve root growth?

"Snippets" of the discussions during the excursion

Prior to the excursion some questions related to the subject of "vegetation in slope stabilisation" were listed, on the one hand from the practitioner's point of view and, on the other hand, more specifically in respect of the NRP 68 project.

During the Gangbach excursion different matters were under discussion, if not necessarily all with regard to the questions found on the previous page. Some of the statements and speculations, based on our (persons present at excursion) current knowledge, are listed subsequently:

Drainage:
At site 1 of the excursion the drainage has been the main task in order to stabilise the slope.
The main goal in the long term is to decrease infiltration and to increase the water storage capacity. One of the important functions of plants is their ability/need to extract water from the soil – on a hot, dry day a solitaire mature birch (200'000 leaves) evaporates up to 400 L day^{-1}. In this area the afforestation – "Rotte" structure – particularly aims at areal drainage in combination with the technical constructions e.g. wooden channels with linear mode of operation.
This "drainage-function" (evapo-transpiration) of plants is first and foremost strongly correlated with the specific leaf area but shows species, seasonal, and age dependence, too. Consequently, in order to optimise "biological drainage" these aspects should be considered too, apart from site-specific and silvicultural requirements.

- combine needle and broad-leaved trees/brushes → particularly in spring, broad-leaved species have a lag until they take full effect of evapo-transpiration
- don't let the stands (Rotten) get too old → the peak phase in evapo-transpiration in the course of stand development is located in the "stand differentiation"/"stem exclusion" stage referring to young stands; age depending on association and altitudinal zone → furthermore, in this stage species diversity is high, above and below ground, with roots exploiting a large soil body
- don't let the stands (Rotten) get too dense → the more light, the more leaves and needles are produced, the more water is extracted from the soil

Conclusively, afforestation with specific functional traits needs careful planning including maintenance and care. Furthermore, it is wise to consider the historical development of the area, in particular land, housing, and cultivation development.

Diversity:
At site 3 the diversity question arose up yet again. Here, afforestation measures were combined with a change in agricultural practice. For some of the pastures and meadows it was agreed to stop grazing and fertilising, respectively, both strongly affecting diversity of plants and micro-organisms. In particular fertilising hampers migration of species from adjacent natural sites. Correspondingly, a species-poor and rather uniform vegetation cover establishes characterised by a likewise homogeneous and shallow root zone. Such an even root horizon constitutes an artificial sliding surface, where superficial slope failure is easily triggered.

- support/care of species diversity, in particular, with regard to rooting decrease the soil's susceptibility to superficial failure → prevention of artificial sliding horizons
- diverse associations are less prone to any kind of pathogenic attacks and more resistant against extreme climatic changes
- below ground diversity, above all symbiotic (micro-) organisms, e.g. mycorrhizal fungi, guides and spurs succession of plant associations → the lack of certain mycorrhizal fungal partners may considerably slow down or even stop such processes
- related to species diversity the differences of functional traits should also be taken into consideration → in the course of the development path of the succeeding associations: constructing, consolidatory, and degenerating species

What if … ?!?

In the last decades the application of eco-engineering measures steadily increased and, concomitant, the attempts to quantify the biological effects on slope stability. Although, considerable progress can be reported and different models are available today, vegetation doesn't play a leading part in calculations of safety factors against failure and prediction, still. Therefore, the question arises if anything would really change in hazard assessment and taking measures against superficial soil failure, if plant effects on slope stability are reliably quantifiable?

- from the Administration point of view changes would very well be possible, providing that soundly based information and applicable measures are available → first changes would probably concern the hazard maps
- from the Practitioners perspective the reliable quantification would well be appreciated in order to more consistently convince contractors to more rely on biological stabilisation measures – in combination with often indispensable technical support – with a long-term view …

- from the Scientists vantage point it was found, in laboratory experiments, that the development of alder roots within a 20 weeks growth period up to ø ≈1.5 cm cm^{-3} yielded an increase in the angle of internal friction Φ' from ≈34° to ≈40° compared to the non-planted soil both at a dry unit weight γ ≈15.5 kN m^{-3}
- furthermore, under similar laboratory conditions the increase in soil aggregate stability in soil with 20 weeks old alder plantlets compared to non-planted moraine was equal to the increase from moraine of a recent superficial landslide to a 25 year old *Alnetum incanae* – based on field samples – developed from almost exclusively planted alder yielding the same root length density ø =1.5 cm cm^{-3} as found in the laboratory (see above)
- comparison of field and laboratory data suggests the assumption that a 25 year succession process in the field is well reflected by the 20 week growth period in the laboratory as related to the relative increase in soil aggregate stability from control to planted samples → given the restriction of soil type (grain size distribution), e.g. GW-GC, soil aggregate stability seems a promising parameter in order to up-scaling from lab to nature …

Negative vegetation effects:

In order to get a comprehensive view on vegetation related to slope stability, negative, in particular, destabilising effects need to be considered too, e.g.:

- additional surcharge in respect of soil mechanics

- windthrow of (too) big trees and up-rooting of whole plates (root systems) including a large body of aggregated soil
- sudden disequilibrium in root permeated soil due to windthrow and/or bark beetle calamity with subsequent decay of the stabilising root systems
- increase in permeability and infiltration
- problems of driftwood, woody debris
- woody debris in deposition of landslides, hillslope debris flows, and avalanches

An appropriate consideration of negative vegetation effects influences important decisions with regard to the selection of species for plant association/stand formation as well as maintenance and care.

General remarks:
In respect of sustainable impact it seems indispensable to think in scenarios that satisfy long-term processes and development, such as the establishment of a vegetation cover protecting against natural hazards, e.g. superficial soil failure.
Reading and understanding nature as well as considering the history of the area where measures should be applied are important requirements within this context.
Likewise, maintenance and care are as important as are consideration of the development of the society's values, not least with regard to the "leisure/recreational behaviour". Referred to that, today's decisions affect, above all, future generations. If the focus is primarily on "natural protection measures", it has to be kept in mind that respective investments do not pay off immediately! This is an issue not to be neglected as it has to be kept in mind that "society does not perceive what cannot be seen", a fact that is not restricted to the prevention of disasters …
In order to create understanding and trust, scientifically based "quantification approaches" should be given the opportunity to be applied in the field where possible errors do not have catastrophic consequences. Monitoring of such "field laboratories" are a unique possibility to test, correct, and improve approaches and models for quantifying and predicting the effects of vegetation with respect to the protection against superficial soil failure …

Participants of the excursion

1	Annen	Beat	Cantonal Administration	organiser
2	Askarinejad	Amin	TU Delft / ETH Zürich	
3	Bebi	Peter	SLF / WSL	
4	*Braschler	Urs	Cantonal Office	
5	De Cesare	Giovanni	EPFL, Lausanne	
6	Frei	Martin	MFrei Infra GmbH	co-organiser
7	Graf	Frank	SLF / WSL	co-organiser
8	Greminger	Peter	Senior Consultant	
9	Grunder	Karl	oeko-b ag	organiser
10	Hählen	Nils	Cantonal Office	
11	Jommi	Cristina	TU Delft	
12	Rickli	Christian	WSL	co-organiser
13	Sandri	Arthur	Federal Administration	
14	*Springman	Sarah	ETH Zürich	
15	Stalder	Roland	oeko-b ag	organiser
16	Steiger	Urs	Swiss National Foundation	
17	Thali	Urs	Thali, Consulting Engineer	
18	Vergani	Chiara	SLF / WSL	
19	von Albertini	Nina	Ecol. construction support	
20	Yildiz	Anil	SLF / WSL, ETH Zürich	

* last-minute annulation due to sprained ankle

Impressions of the "Best Practice Excursion" in the Gangbach area, 13th June, 2014


Karl Grunder welcomes participants


Beat Annen introduces the area

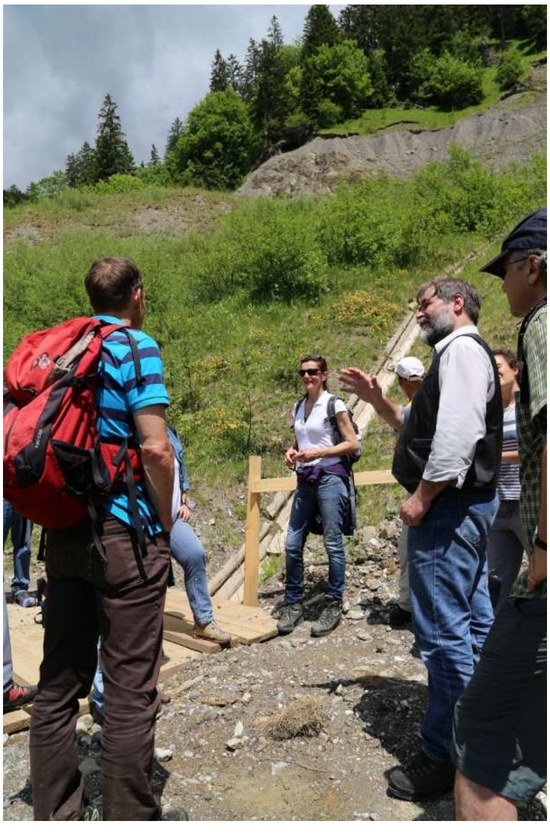

Last instructions before the start …

Animated discussions …

Beat Annen explains management strategies in order to stabilise steep slopes under cultivation

The "Lotter" landslide, main debris source of the 2005 event

Beat Annen explains the principles of combined stabilisation measures related to the "Lotter" landslide



Arthur Sandri particularises the view of the Federal Administration in respect of vegetation effects on slope stability

Object-related knowledge transfer

Meadow or forest for long-term stabilisation of steep slopes …?