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Federal Department of the Environment,
Transport, Energy and Communications DETEC

Federal Office for the Environment FOEN
Division hazard prevention

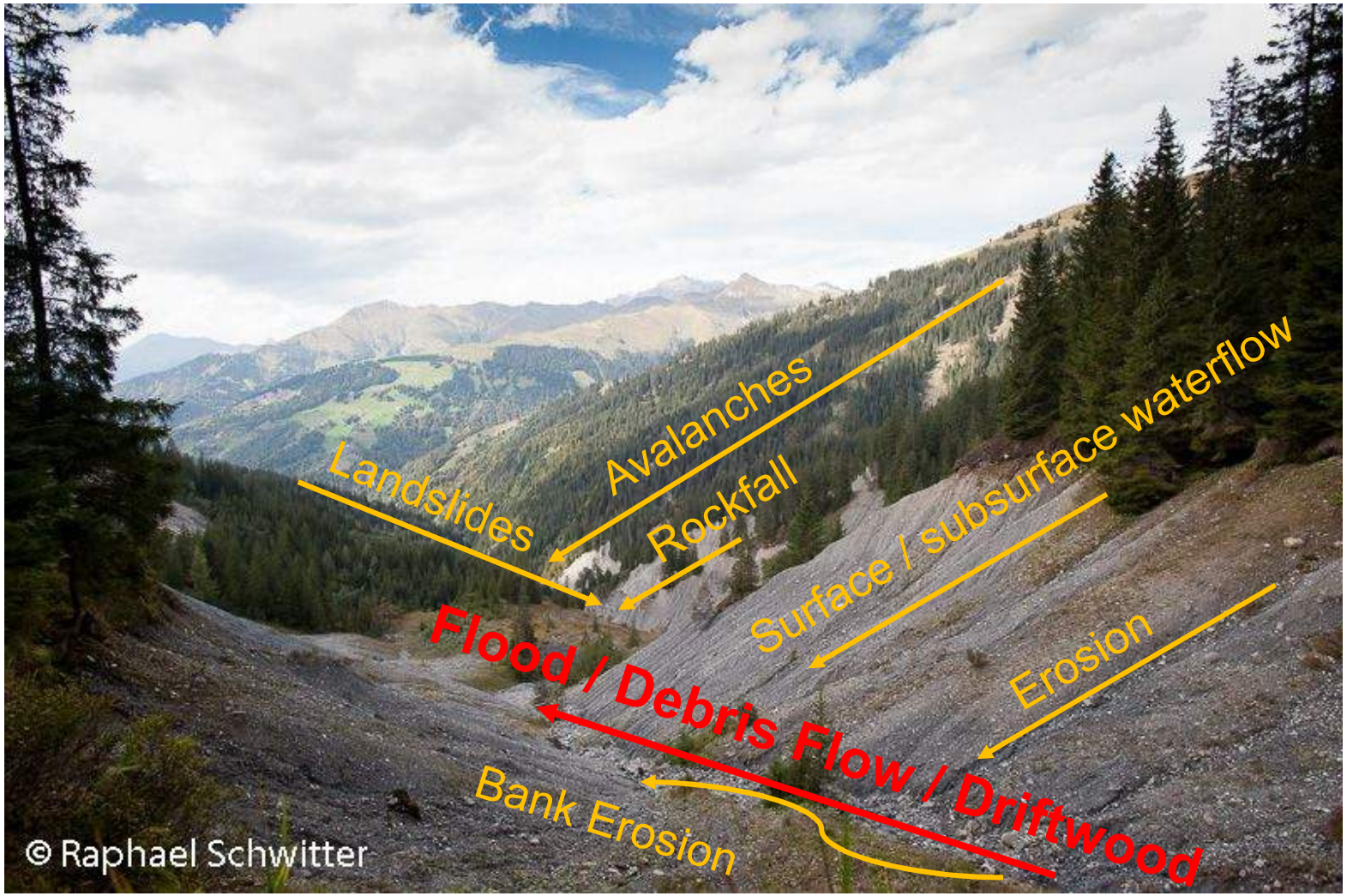
Effect of forests and check dams on water surface, bedload input and debris earth flow in Alpine watersheds

Dr. Benjamin Lange, 11. June 2018

Agenda

- Protection forests in catchments: delimitation
- Aims of protection forest management in catchments
- Target profiles for protection forests in catchments
  - Hazard-related targets
  - Site related targets
- Ideas for a good practice protection forest management in catchments
- Summary

Hazard-related Processes in Catchments



Protection Forest Management in Channel Slopes

Hazard processes in catchments:

Directly damage-related:
debris flow, driftwood, overbank sedimentatio
floods, …

related:
valanches,
w, rockfall, erosion
(bedload input), …

Protection forests should protect against all damage-related processes without creating an increasing risk of wood.

tion forests:

-related:
soi nent, reducing
ki energy, erosion
protection, …

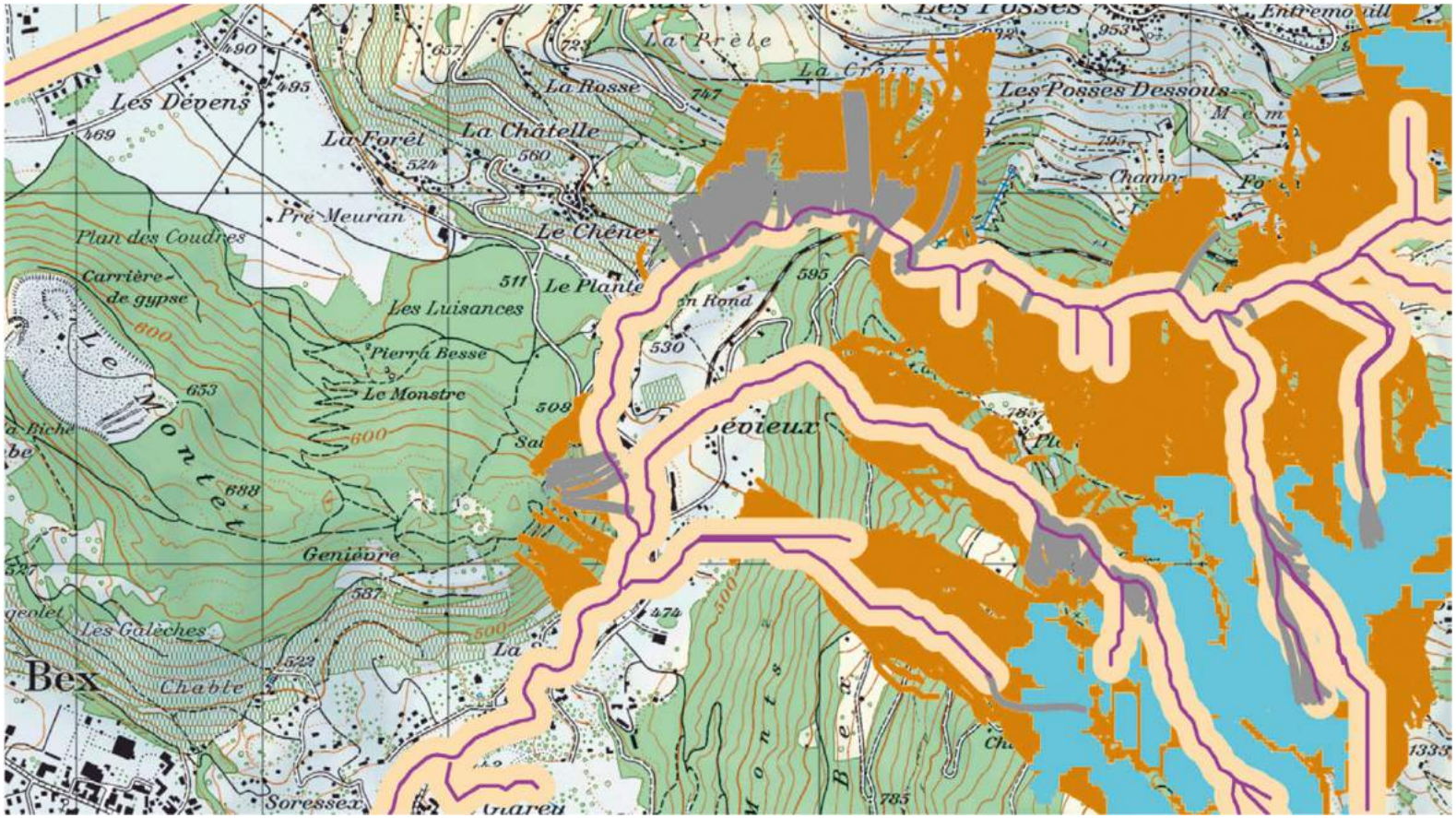
Indirectly process-related:
Interception, transpiration, soil properties, structure of snow cover, …

Assessability of the impact of forests

Table 2: Relevance of the protection measure „forest“ and its assessability. Green: relevance is possible and assessable. Yellow: relevance is only partially possible or relevance is only partially assessable. Red: no relevance or relevant, but not assessable.

Natural hazard process		Relevance of protection measure “forest”	
		possible	assessable
Avalanches	• Flowing avalanche	yes	yes
	• Powder avalanche	yes	yes
	• Snow glide	yes	yes
	• Ice avalanche	no	-
Fall	• Rock fall	yes	yes
	• Rock slide	yes (only small events)	yes
	• Rock avalanche	no	-
	• Ice fall	yes	yes
Water	• Flooding	yes	rarely
	• Debris flow	yes	yes
	• Erosion	yes	yes
Spontaneous landslides	• Shallow	yes	yes
	• Intermediate	yes	no
	• Deep	yes	no
Permanent landslides	• Intermediate	yes	no
	• Deep	yes	no
Sinkhole / Subsidence	•	yes	no

Protection forests in catchments



Purple: relevant channels; beige: 50 m buffer for driftwood, brown: landslides; grey: rockfall; blue: starting zones of avalanches

Aims of Protection Forest Management in Catchments

Protect ucture
relevan rocess

Aim: protection against relevant process
AND sustainability

nage

Target Profiles based on natural hazard processes

- Switzerland: target profiles for four natural hazards processes: avalanches, Landslides (including also erosion and debris flow), rockfall and torrents and floods.
- Target profiles includes requirements on the horizontal structure (gap size, max. length of openings in fall line, min. % of canopy cover), stability, target diameter, lying logs
- Requirements are legally binding when forestall measures are carried out.
- For rockfall: online tool

Example: target profile landslide

3.1 Target profile for forests providing protection against landslides, erosion and debris flows

Locality	Potential contribution of the forest	Hazard-related target profile: minimum requirements	Hazard-related target profile: ideal requirements
Zone of origin	**Large** In the case of shallow landslides (depth of slide surface at most 2 m) and of surface erosion	**Horizontal structure** Maximum opening size[3] 0.06 ha, if secured regeneration[1] exists 0.12 ha. **Horizontal structure** Canopy cover[2] permanently ≥ 40% Minimum requirements of site-related target profile accomplished **Mixture** In areas of transition between site types, the tree species composition of the moister / wetter site should be the target	**Horizontal structure** Maximum opening size[3] 0.04 ha, if secured regeneration[1] exists 0.08 ha. **Horizontal structure** Canopy cover[2] permanently and at a small scale ≥ 60% Ideal requirements of site-related target profile accomplished **Mixture** In areas of transition between site types, the tree species composition of the moister / wetter site should be the target **Stability carriers** No heavy trees and no trees prone to windthrow

Target profiles based on site conditions

- The most stable, and therefore sustainable, states of a forest are assumed to be represented by the range in variation of developments of a natural forest.
- The site-related target includes all important tree species of the climax stand.
- The stand structure should be diverse, with single trees or clusters able to resist disturbance, and regeneration should be continuous.
- The self-regulating process of the natural forest should be utilized to an optimum so that disturbances to the ecosystem can be kept to a minimum and the silvicultural interventions are as small as possible in the long term.

Site-related target: profiles for ± 100 forest site types, including requirements on: species mixture, stability (crown length, coefficient of slenderness, …) and regeneration (seedbed, saplings, …)

Target natural hazard:
horizontal structure
stability
target diameter

Target site:
Species mixtures
Stability
Regeneration

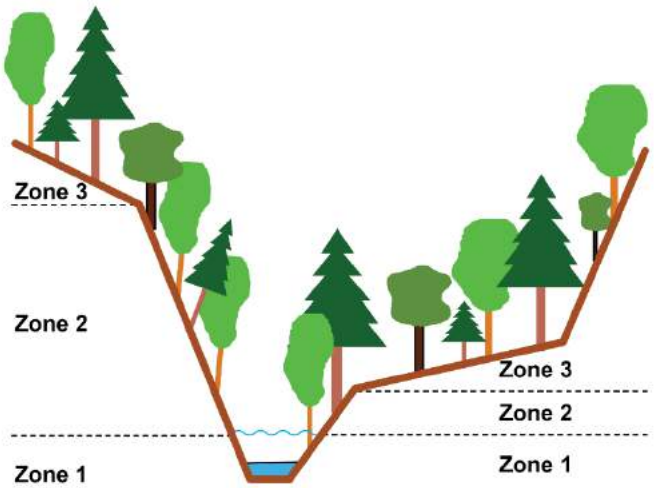
Target for protection forest management

Example of target profile

Municipality: Example	Locality: Example
1. Site type: Luzulo-Abietei-Fagetum typicum	
2. Natural Hazard: shallow landslides	
Stand and tree characteristics	***Target profile (including stand and natural hazard)***
Species mixture (type and degree)	Beech: 30 – 80 % Fir: 10 – 60 % Spruce: 0 – 30 % Sycamore maple: seed trees
Vertical structure (dbh variation)	Sufficient number of trees with development potential in at least 2 different dhb classes per ha
Horizontal structure (% cover, gap length, stem density)	Individual trees, possibly clusters, openings smaller than 0.06 ha, canopy cover permanently at least 40 %
Stability carriers	Crown length of fir at least 2/3, of spruce at least ½, coefficient of slenderness < 80, few trees leaning at extreme angles
Regeneration: small saplings (0.1 – 0.4 m tall)	At canopy closure < 0.6 at least 10 beech / fir per 0.01 ha (one sapling every 3 m)
…	…

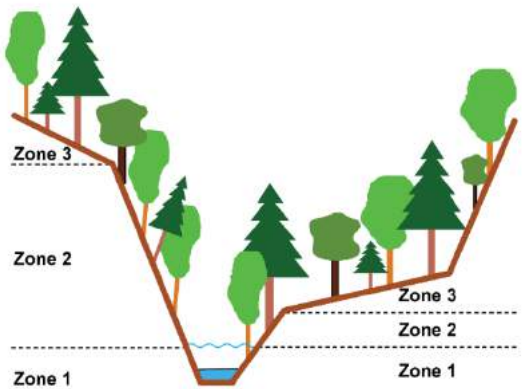
Ideas for protection forest management in catchments:

1. **Direct process area along the channel:** flood zone, debris flow zone
2. **Direct channel slope:** Area from that damage relevant material can be transported directly to the channel by natural hazards as landslides, avalanches or rockfall.
3. **Indirect channel slope:** Area from that damage relevant material can *not* be transported within to the channel by natural hazards.

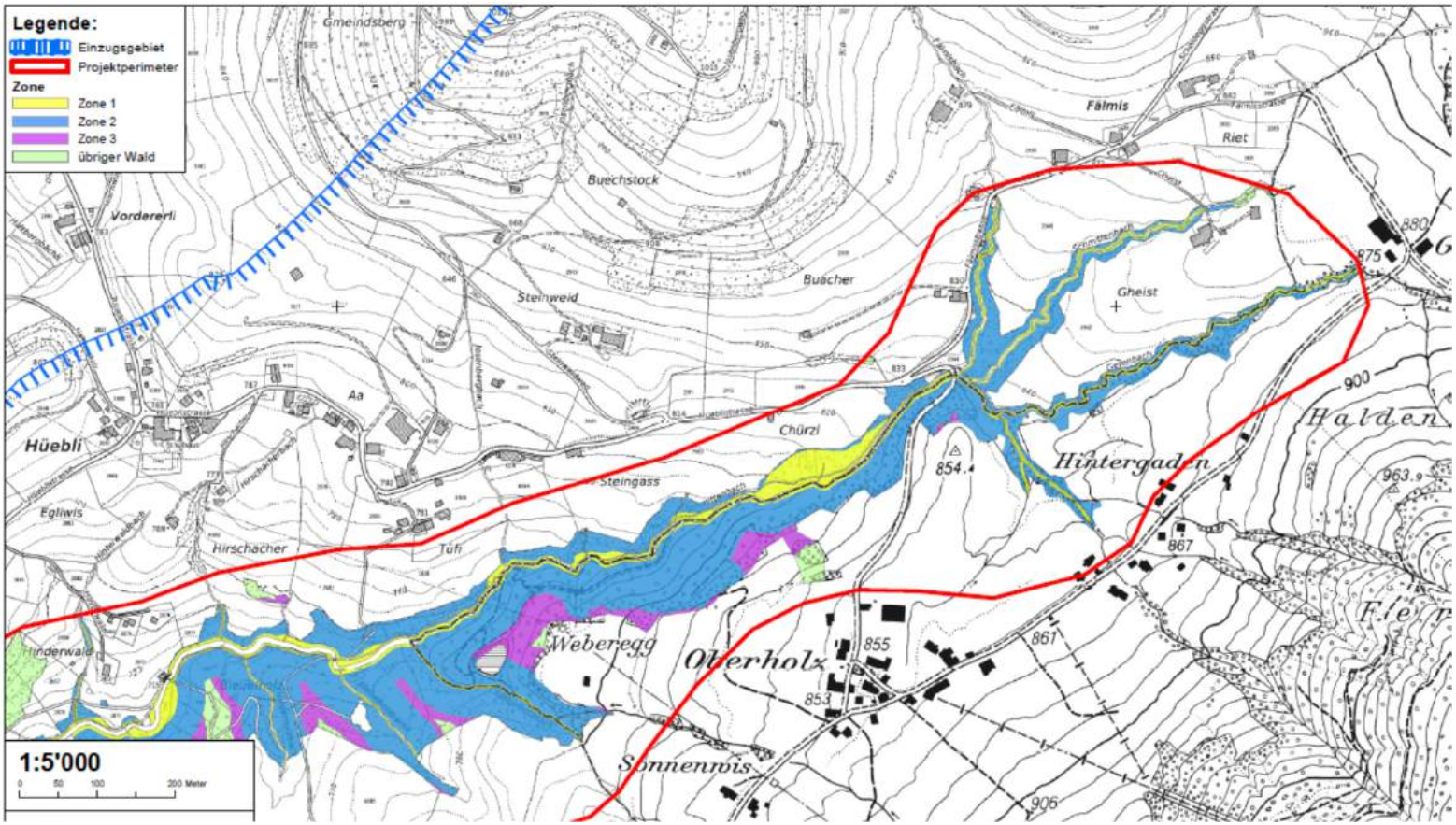


Aims of protection forest management in different zones

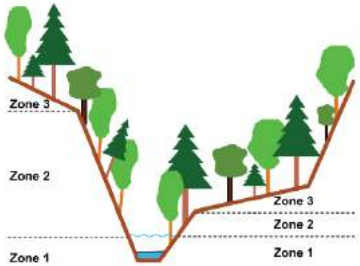
- **Zone 1**: no universe goals, dependent on situation
- **Zone 2**: reducing bedload and potential driftwood input
- **Zone 3**: reducing intensity and/or frequency of natural hazards in Zone 2



Ideas for Forest management in catchments



Summary



- Technical structures and protection forest complement each other
- Protection forest can reduce bedload and driftwood input
- Targets of a protection forest management includes hazard- and site related targets (stability and sustainability)
- The target structure of a protection forest in a catchment depends on its spatial location and the relevant natural hazard in the channel and the slope:
  - Process area along the channel: targets depends on the situation
  - Direct channels slopes: target structure according to the dominant natural hazard
  - Indirect channel slopes: no larger gaps, a certain canopy cover, species mixture


Thank you for your attention

Costs to remove and recycle driftwood from lakes / logjams

Location	Driftwood volume m³	Costs (CHF)	Cost / m³ (CHF)
Lakes of Thun, Brienz, Biel	31’000	2’300’000	**74.-**
Lake Luzern	1’000	150’000	**150.-**
Urnersee	10’000	630’000	**63.-**
Bremgarten	3’000	400’000	**133.-**
Aare, Bern	1’200	65’000	**54.-**