TIWAG-
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Eduard-Wallnöfer-Platz 2
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TIWAG

Gewässerökologische Aspekte in Bezug auf das Sediment-Management

Martin Schletterer

River Science

… is a “*rapidly developing* ***interdisciplinary field*** *at the interface of the natural sciences, engineering and socio-political sciences.*
It recognises that the ***sustainable management*** *of contemporary rivers will increasingly require new ways of characterising them to enable engagement with the diverse range of stakeholders.*” (GILVEAR et al. 2016)

Sustainable Development Goals

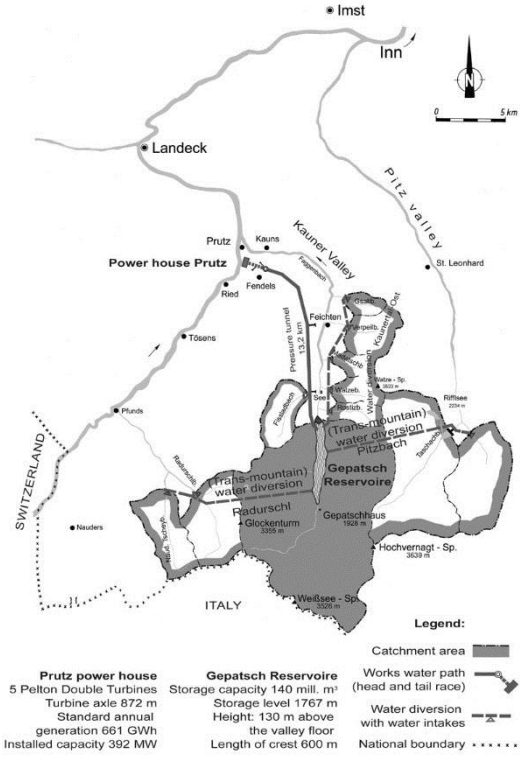
TIWAG

UNITED NATIONS

TRANSFORMING OUR WORLD:

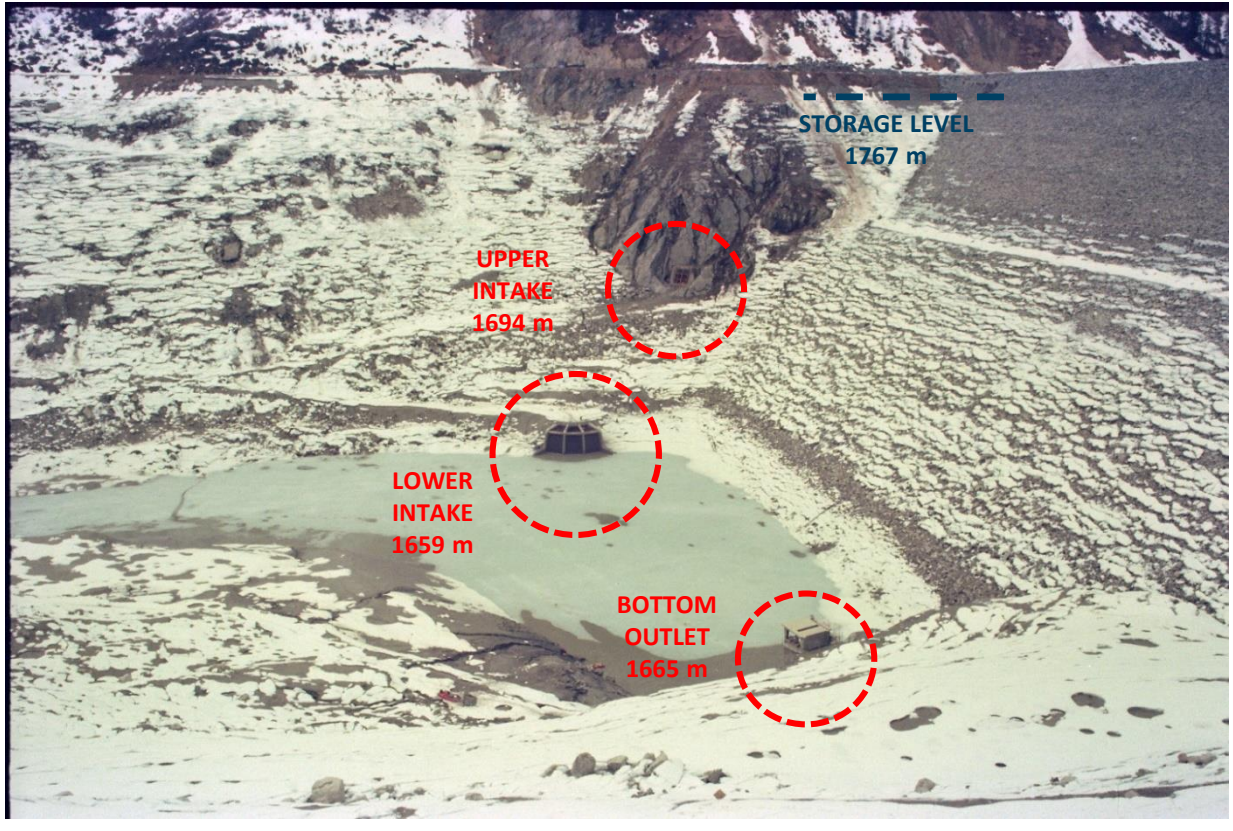
THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

Integrative sediment management



HPP Kaunertal
built between 1961 and 1965
storage volume of approx. 140 mio. m³
catchment 275 km²: 107 km² + 168 km²
head approx. 900 m (392 MW)
annual average capacity of 661 GWh

Integrative sediment management



Gepatsch Reservoir
May 1977

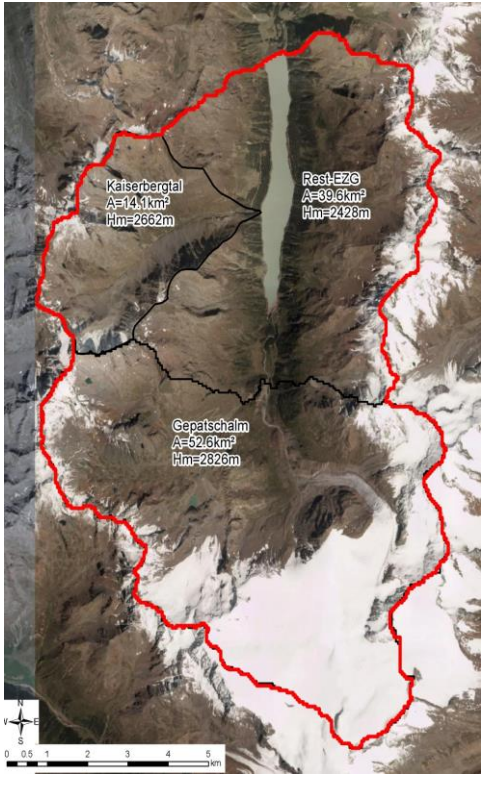
Integrative sediment management

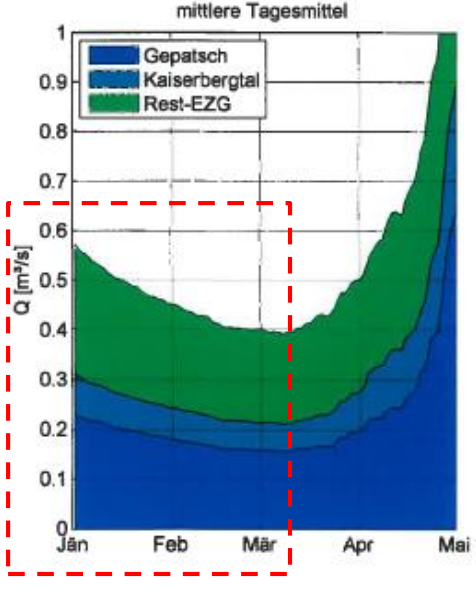
TIWAG

- **How to empty a reservoir?**

  - **reservoir flushing** aims the removal of sediments and takes place at high flow rates for short time periods (i.e. suspended sediment concentrations are high – similar to natural flood events).

  - **controlled drawdown** of a reservoir is often carried out in winter period with low flows (i.e. suspended sediment concentrations are relatively low, but the time of the emission is, depending on reservoir size, longer.





Integrative sediment management

TIWAG

Background

- There was the need to ***empty*** the ***Gepatsch-reservoir*** due to ***revision works*** (inspection of bottom outlet) in winter 2015/2016
- The ***federal decision*** BMLFUW-UW.4.1.11/0776-IV/2/2014 from the 30.3.2015 by the BMLUW ministry ***allowed*** the controlled drawdown. However, extensiv ***documentation*** of ***possible negative impacts*** on aquatic ecology was required.
- In ***contrast to flushing events*** it was ***not the aim*** during the ***controlled drawdown*** to ***remobilize sediments*** out of the reservoir (long period of controlled drawdown)

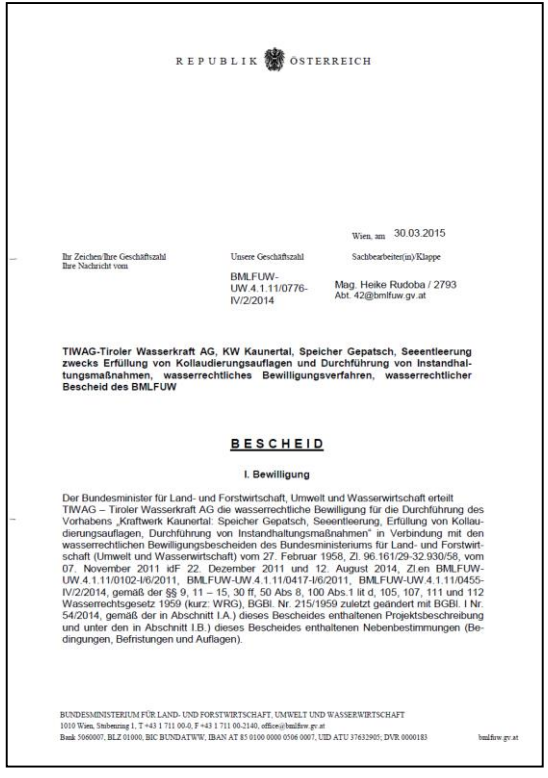
Timeline

pre-monitoring (autumn 2015)

detailled monitoring during the controlled drawdown (winter 2015 / 2016)

post-monitoring (spring 2016)

Integrative sediment management



REPUBLIK ÖSTERREICH

Wien, am 30.03.2015

Ihr Zeichen/Ihre Geschäftszahl / Ihre Nachricht vom

Unsere Geschäftszahl: BMLFUW-UW.4.1.11/0776-IV/2/2014

Sachbearbeiter(in)/Klappe: Mag. Heike Rudoba / 2793 Abt. 42@bmlfuw.gv.at

TIWAG-Tiroler Wasserkraft AG, KW Kaunertal, Speicher Gepatsch, Seeentleerung zwecks Erfüllung von Kollaudierungsauflagen und Durchführung von Instandhaltungsmaßnahmen, wasserrechtliches Bewilligungsverfahren, wasserrechtlicher Bescheid des BMLFUW

BESCHEID

I. Bewilligung

Der Bundesminister für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft erteilt TIWAG – Tiroler Wasserkraft AG die wasserrechtliche Bewilligung für die Durchführung des Vorhabens „Kraftwerk Kaunertal: Speicher Gepatsch, Seeentleerung, Erfüllung von Kollaudierungsauflagen, Durchführung von Instandhaltungsmaßnahmen" in Verbindung mit den wasserrechtlichen Bewilligungsbescheiden des Bundesministeriums für Land- und Forstwirtschaft (Umwelt und Wasserwirtschaft) vom 27. Februar 1958, Zl. 96.161/29-32.930/58, vom 07. November 2011 idF. 22. Dezember 2011 und 12. August 2014, Zl.en BMLFUW-UW.4.1.11/0102-I/6/2011, BMLFUW-UW.4.1.11/0417-I/6/2011, BMLFUW-UW.4.1.11/0455-IV/2/2014, gemäß der §§ 9, 11 – 15, 30 ff, 50 Abs 8, 100 Abs.1 lit d, 105, 107, 111 und 112 Wasserrechtsgesetz 1959 (kurz: WRG), BGBl. Nr. 215/1959 zuletzt geändert mit BGBl. I Nr. 54/2014, gemäß der in Abschnitt I.A.) dieses Bescheides enthaltenen Projektsbeschreibung und unter den in Abschnitt I.B.) dieses Bescheides enthaltenen Nebenbestimmungen (Bedingungen, Befristungen und Auflagen).

BUNDESMINISTERIUM FÜR LAND- UND FORSTWIRTSCHAFT, UMWELT UND WASSERWIRTSCHAFT
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Bank 5060007, BLZ 01000, BIC BUNDATWW, IBAN AT 85 0100 0000 0506 0007, UID ATU 37632905; DVR 0000183 bmlfuw.gv.at

38 clauses in the permit

- 18 technical ones
- 20 regarding ecology, monitoring and fisheries

in fulfillment of the clauses a R&D Project evolved:

Universität für Bodenkultur Wien
University of Natural Resources and Life Sciences, Vienna

Universität Stuttgart

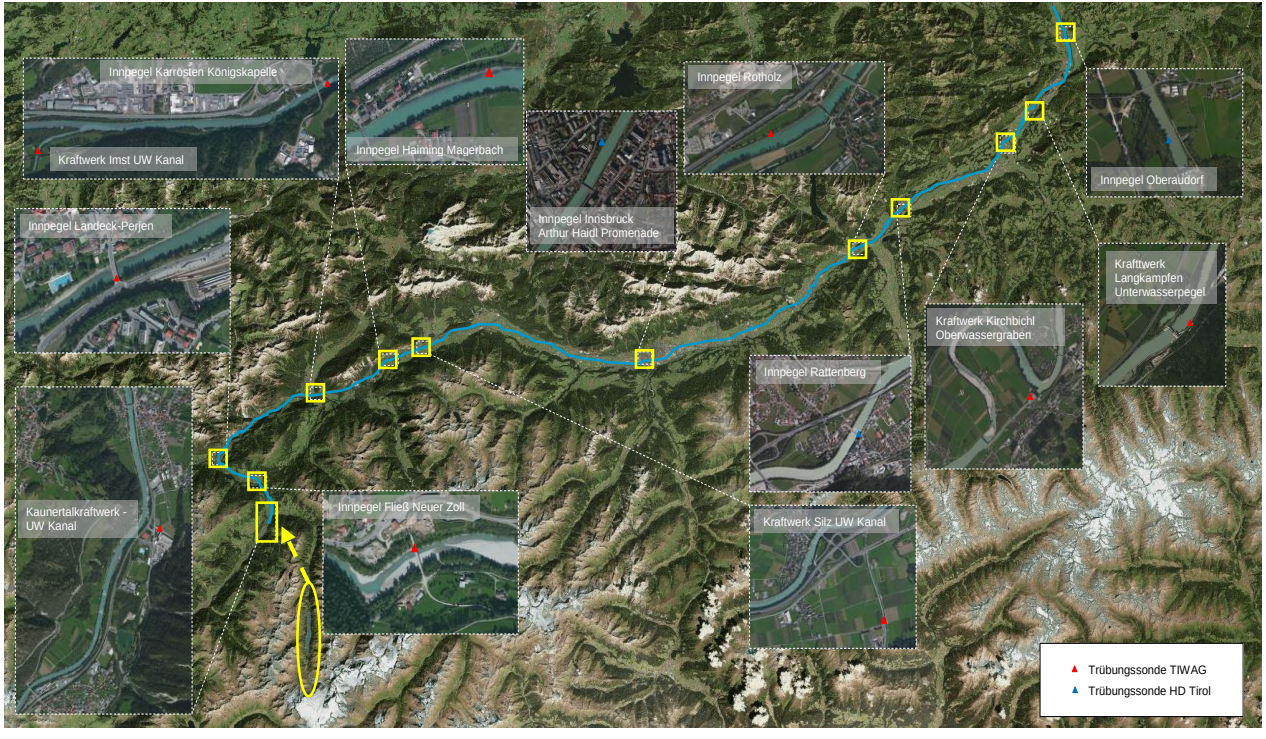
Versuchsanstalt für Wasserbau Hydrologie und Glaziologie

DWS Hydro-Ökologie GmbH
Technisches Büro für Gewässerökologie und Landschaftsplanung

ARGE Limnologie
angewandte Gewässerökologie GesmbH

Integrative sediment management

- Overview of continuous suspended sediment concentration



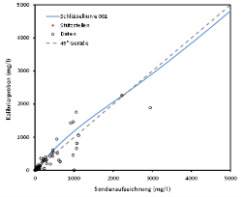
Monitoring set-up:

- 14 continuous turbidity / suspended sediment loggers
- 20 habitat-related turbidity measurements
- 64 km spawning habitat mapping
- 16 freeze-cores
- 18 fish-egg boxes
- Fine sediment deposit sampling on 43 gravel bars
- Evaluation of the connectivity of 53 tributaries (>10 km^2 EZG)
- Evaluation of the status of macroinvertebrates and fish

Integrative sediment management

Continuous turbidity measurements

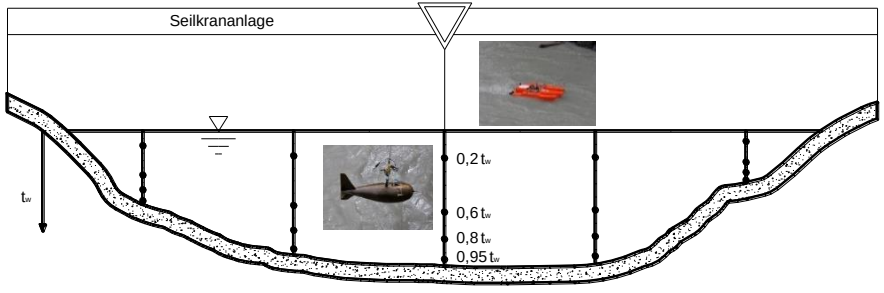




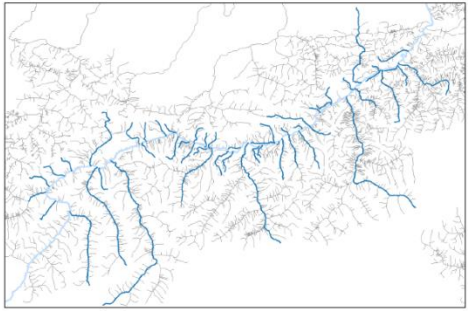
„Fish-egg boxes“

Freeze-core samping

Cross sectional suspended sediment

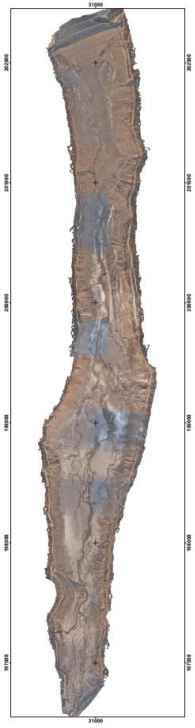


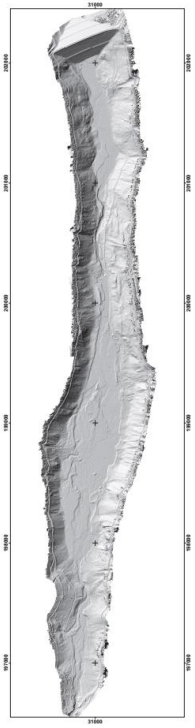
Evaluation connectivity tributaries



Integrative sediment management

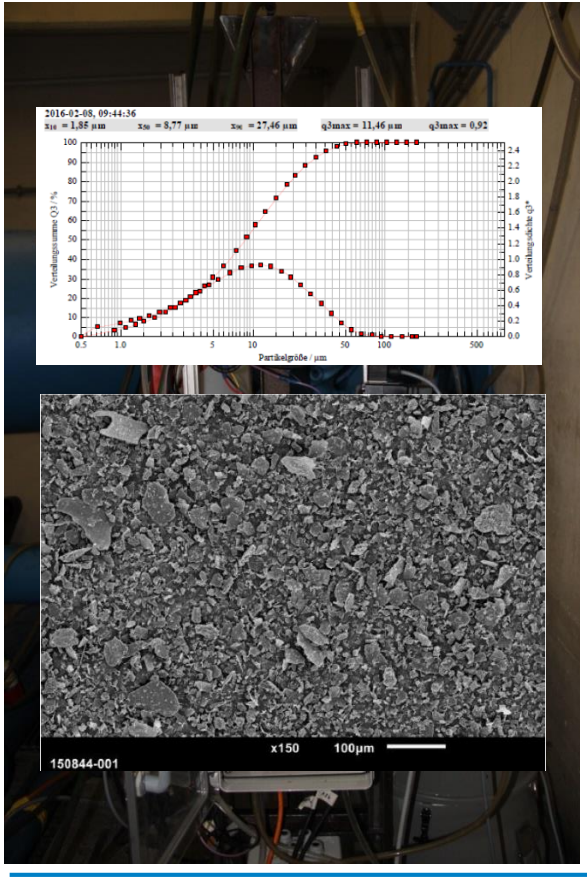
- **Results**





Boschi et al. (2017): PHOTOGRAMMETRIC ANALYSES FOR ***HIGH RESOLUTION BATHYMETRY OF THE GEPATSCH RESERVOIR*** (TYROL, AUSTRIA)

Integrative sediment management



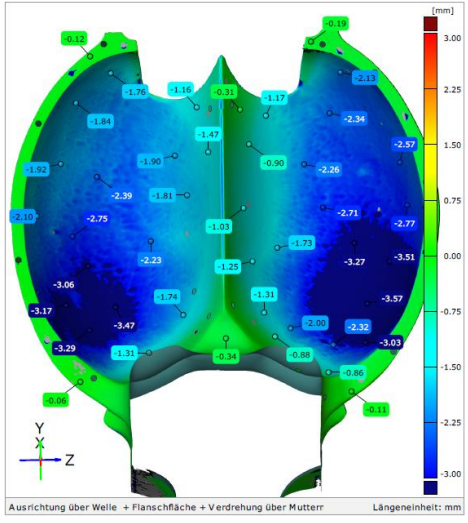
Measurements in the penstock: turbine abarasion

Coriolis Flow Density Meter (CFDM)

measures based on the Coriolis effect the mass flow rate of the water-particle mixture

LISST-StreamSide

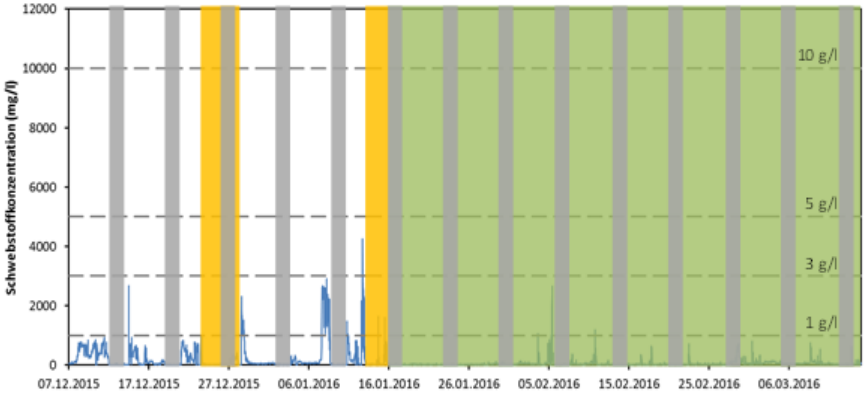
based on laser diffraction
particle sizes between 1.9 – 387 µm
concentrations between 0.01 – 8 mg/l



Integrative sediment management

TIWAG

- Suspended sediment concentration (mg l^{-1}) immediatelly downstream of HP in the period 07.12.2015 – 15.03.2016



During the controlled drawdown following thresholds were not allowed to be overtopped:

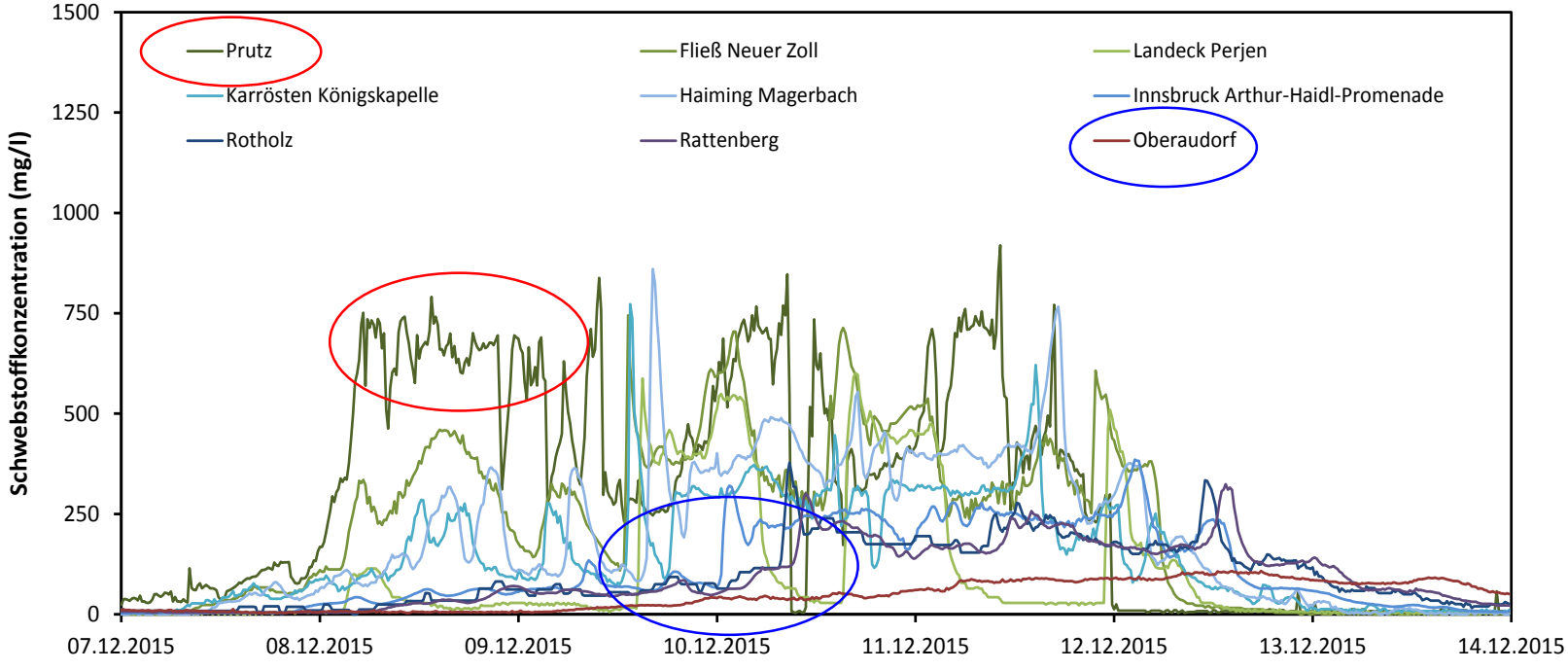
- max 1g/l – permanent
- max 3 g/l – up to 24 h
- max 5 g/l – up to 6 h
- max 10 g/l – up to 2 h

In terms of exceding the thresholds the discharges out of the reservoir had to be reduced until the required numbers are established once again.

Yellow = stop of powerplant for cleaning; grey = stop of power plant during weekends, green = cleaning works (database: TIWAG).

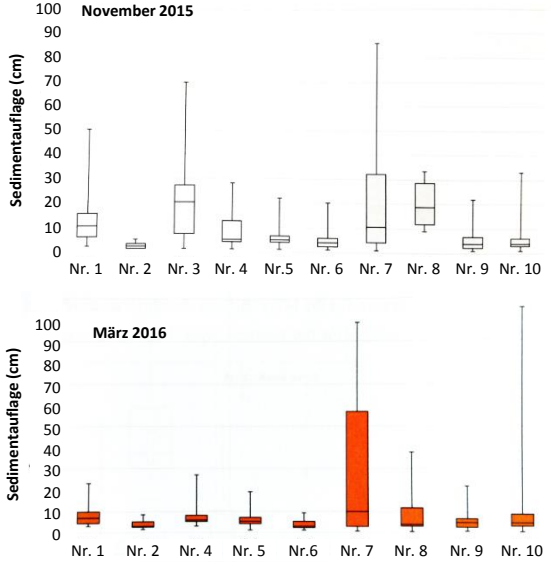
Integrative sediment management

➡ Longitudinal decrease of suspended sediment concentration



Integrative sediment management

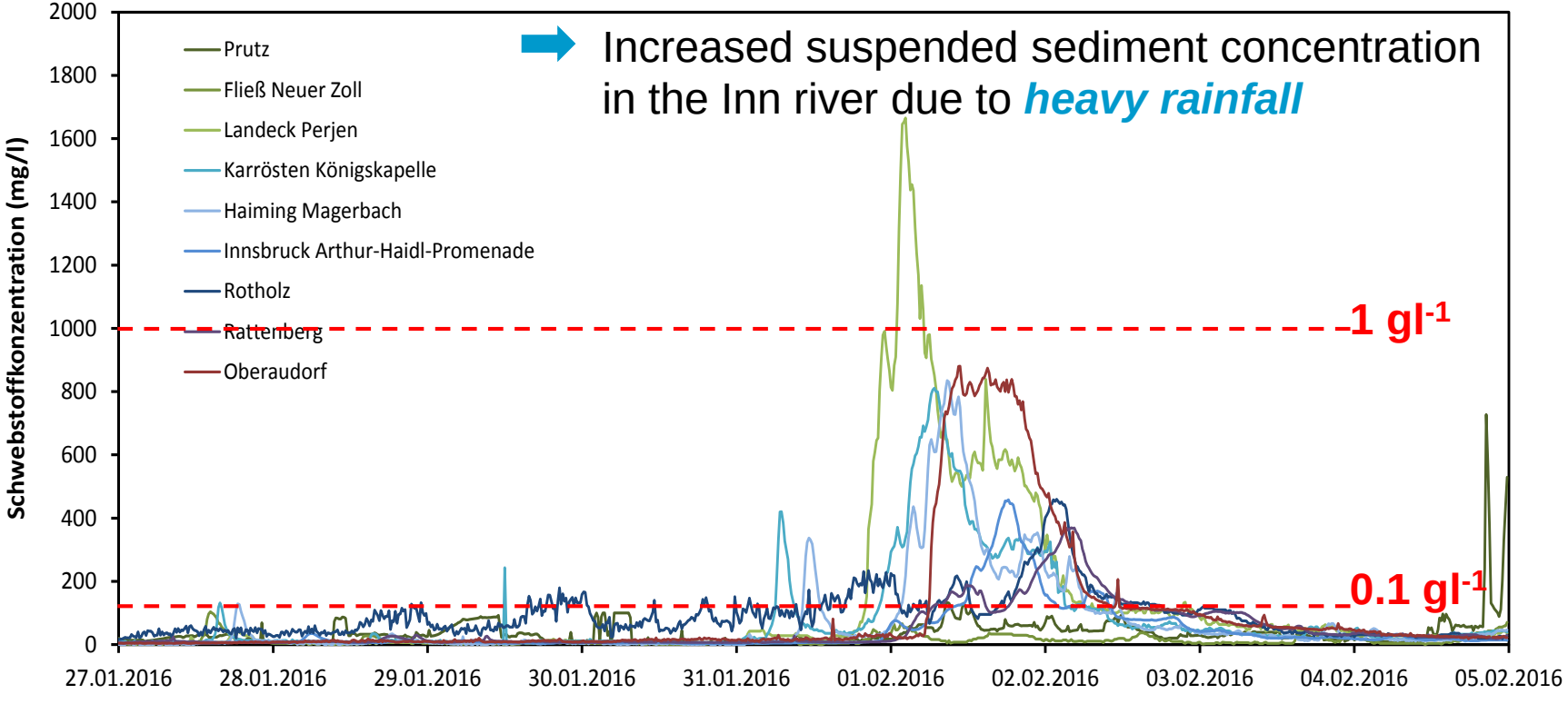
Fine sediment deposits on gravel bars



Kiesbänke 1-10

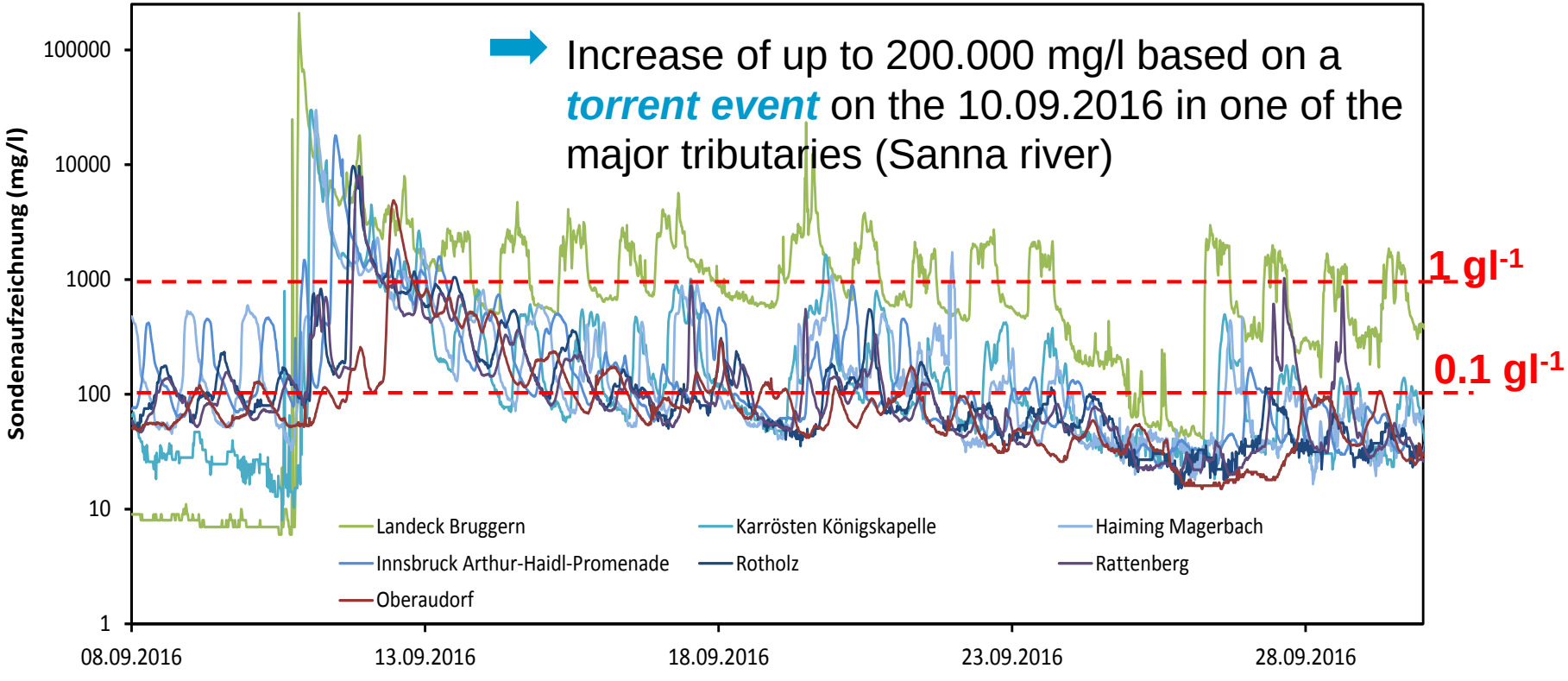
- Quantification of fine sediment deposits and their changes
- single-point measures (n > 25 on each gravel bar)
- No significant changes were documented: only 4 statistically significant differences, ***2x increases*** & ***2x decreases*** in the post sampling period

Integrative sediment management



Integrative sediment management

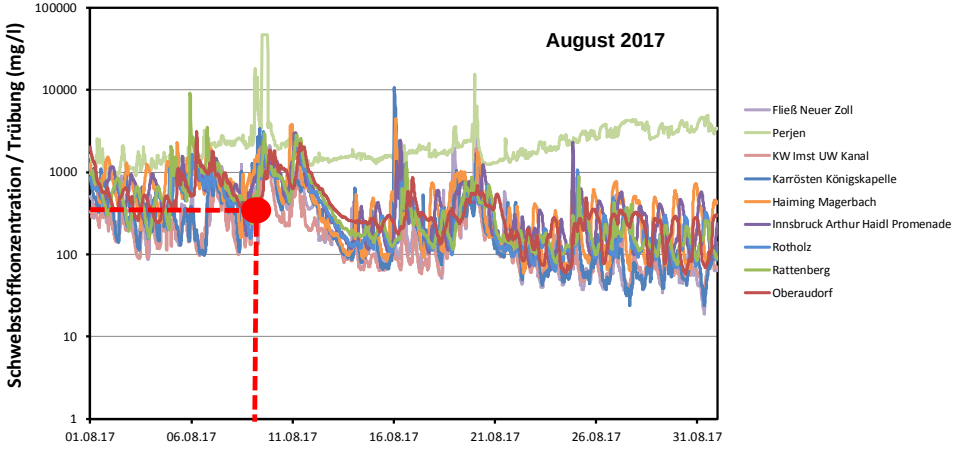
TIWAG



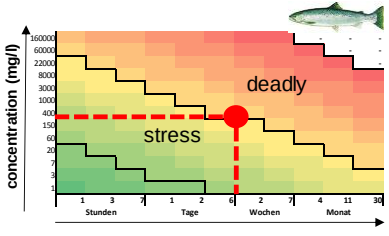
Integrative sediment management

Natural suspended load concentrations

➡ e.g. SSCs along the Inn river (August 2017)



SSC impact on fish as a function of concentration and duration



Jacob & Jensen (1996)

⟹ moderate stress: $y = 327{,}8x^{-0{,}9}$

⟹ loss in habitats: $y = 2616{,}7x^{-0{,}8}$

⟹ deadly: $y = 48008{,}5x^{-0.9}$

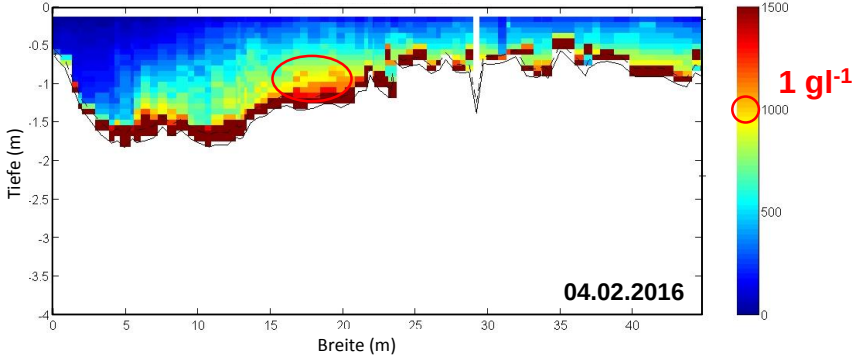
➡ ***High stress due to natural suspended sediment concentrations is given?***

Integrative sediment management

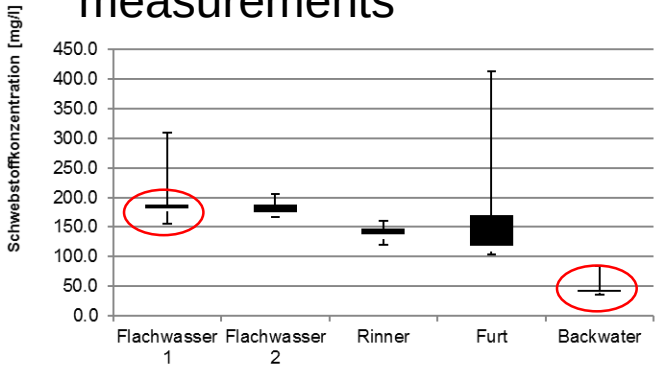
TIWAG

Interpretation of SSC is required

- Distribution of SSC in one of the cross sections during the controlled drawdown



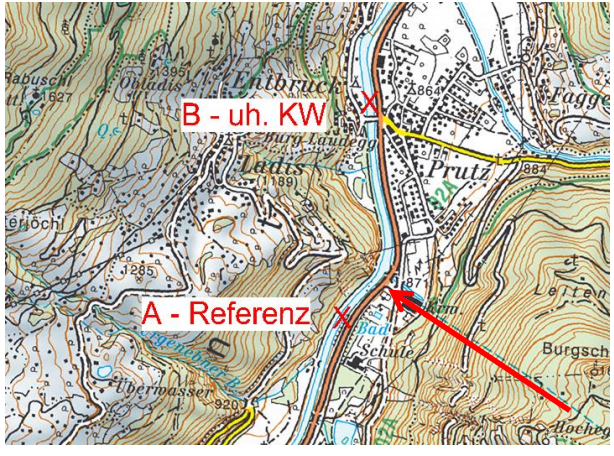
- Habitat related turbidity measurements

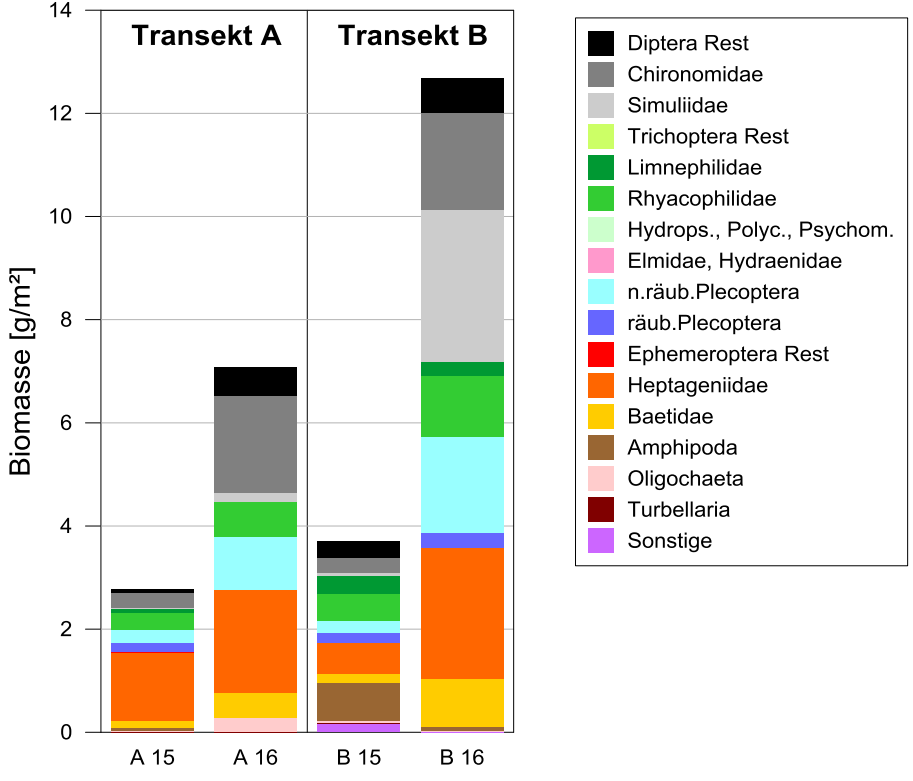


- ***Variability in the Cross sections need to be considered (refugial habitats)***

Integrative sediment management

BQE Zoobenthos

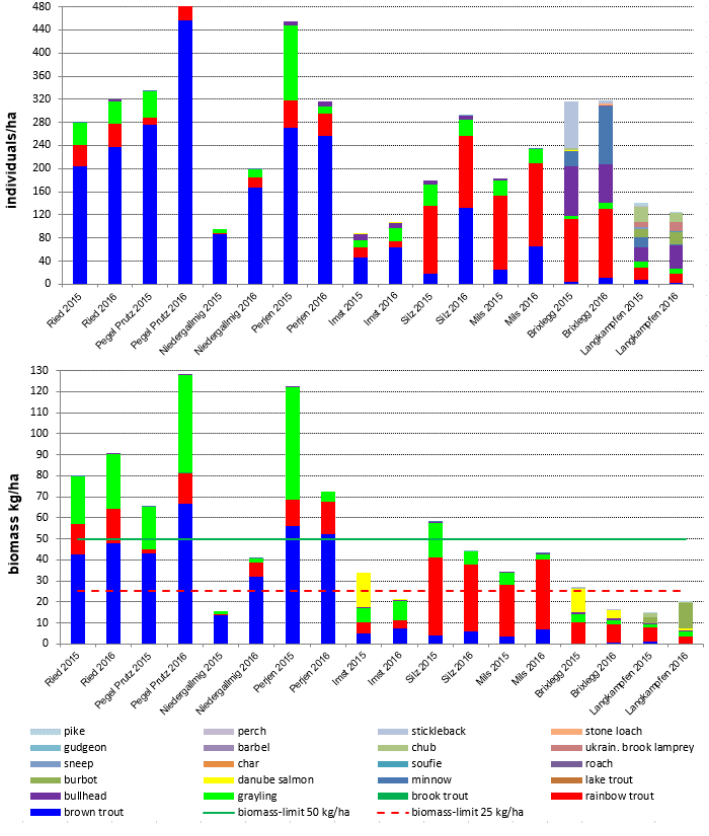




Integrative sediment management

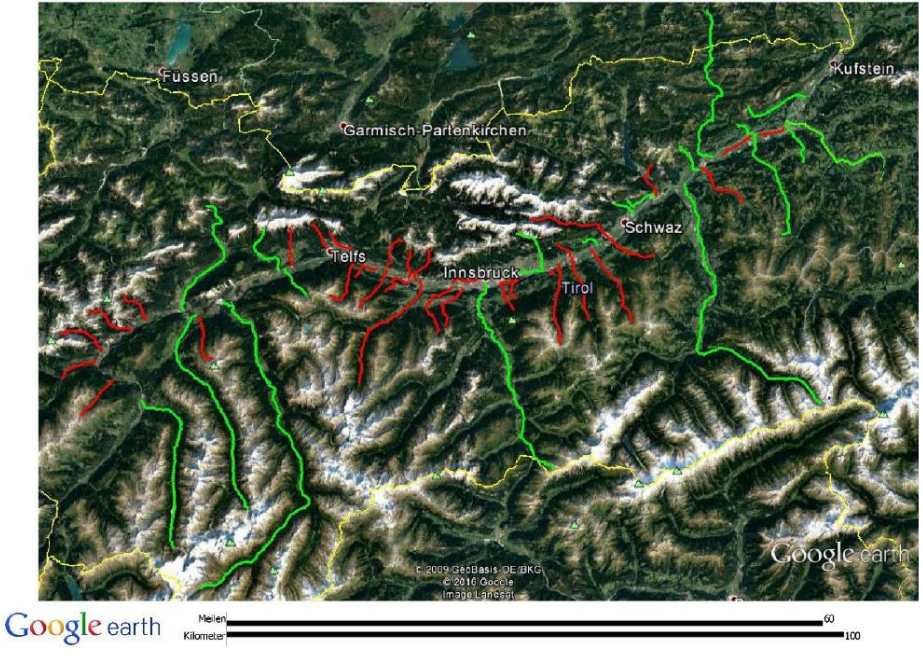
BQE Fish

	hatchability	survival
site 1 (reference, Fagge)	85%	89%
site 2 (reference, Inn)	57%	48%
site 3 (Prutz, upstream Fagge)	8%	0%
site 4 (Neuer Zoll)	83%	79%
site 5 (Imst)	lost	lost
site 6 (Stams)	75%	73%



Integrative sediment management

Evaluation of tributaries



Out of 53 tributaries:

- 38 % with required connectivity
- Upstream of the mouth:
  51 % natural bed surface
  34 % morphological diversity
  30 % spawning substrate
- ***21 % connectivity and spawning substrate***

Integrative sediment management

TIWAG

- ***Glacial influenced catchment*** of the Inn river ***naturally high suspended sediment concentrations*** occur during the months ***May until September***
- ***Precipitation events*** in parts of the catchment
- The ***controlled drawdown*** was necessary in the ***winter low flow period*** with ***natural low suspeded sediment concentrations*** causing temporary effects on the ***aquatic environment*** due to increased suspended sediment loads; - However, the monitoring revealed that the defined ***thresholds*** as well as the ***brakes*** (during weekends) supported environmental safety.
- ***Comparing pre- and post monitoring***, showed with the exeption of the ***development of brown trout eggs*** (at 1 site), ***no decline*** of the aquatic habitat status and target organisms like invertebrates and fish.

Further research needs → CD-Labor „Sedimentforschung und -management“

Modul 1 (Verein für Ökologie und Umweltforschung)

Verbund · TIWAG · Salzburg AG · kelag · ÖBB · ENERGIE AG · Ennskraft · oesterreichs energie · WIEN ENERGIE · EVN

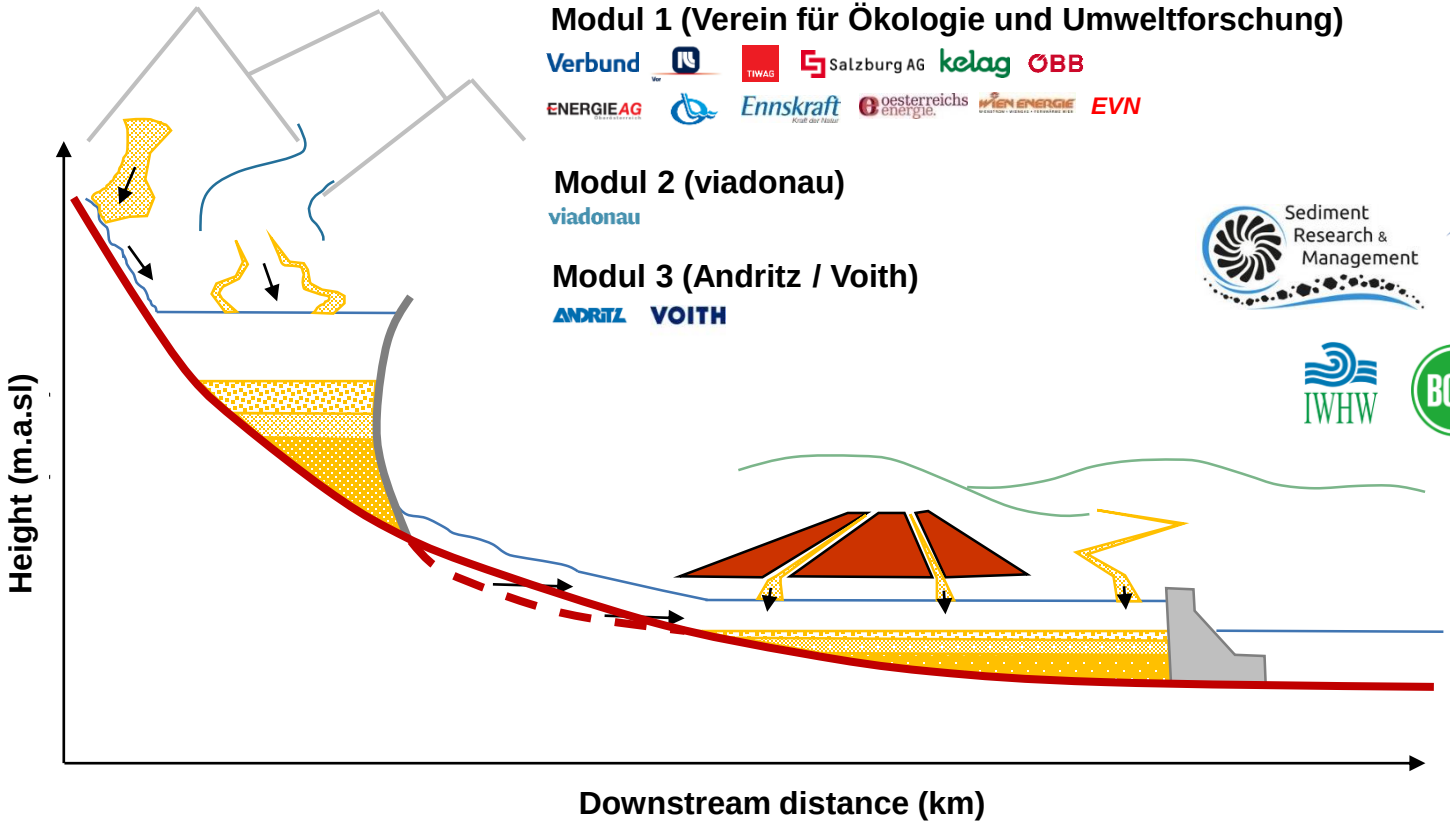
Modul 2 (viadonau)

viadonau

Modul 3 (Andritz / Voith)

ANDRITZ · VOITH

Sediment Research & Management · CD · IWHW · BOKU



Vielen Dank

für Ihre Aufmerksamkeit.

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