

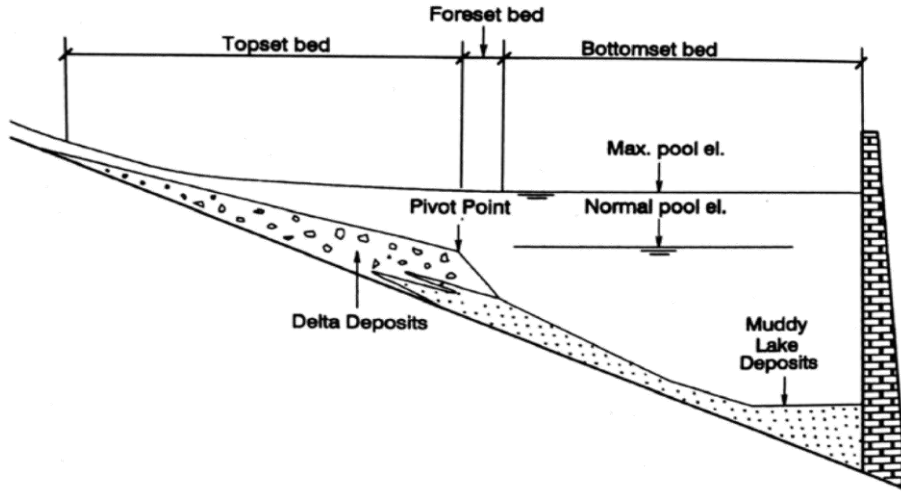
HydroPower Summit, 05.02.2020

# Research on Sediment handling at HEPPs

Nils R  ther, PhD  
Professor



# Sediment and Hydro Power



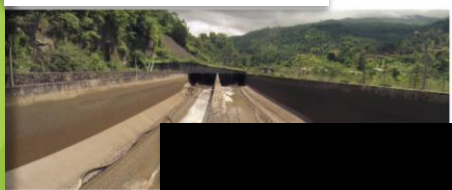
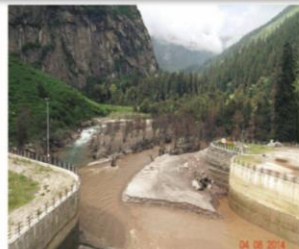
Morris et. al (2010)



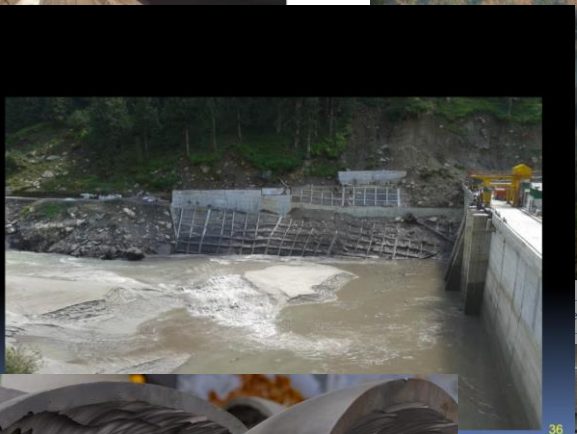
Chief Joseph Dam Bridgeport, Washington



NHPCL



ment Workshop Tirana, 21.  
on Stele and Hanne Novik,  
@hannestevik and hanner.novik@multi



ed Costs



Questions?  
[www.tinguiriricaenergia.cl](http://www.tinguiriricaenergia.cl)



# Sediment and Hydro Power



*Photo: Nils R ther, NTNU*

August 2014  
Banja Dam site  
Devoll river catchment

# Sediment and Hydro Power



February 2017  
Downstream Kokel bridge  
Devoll river catchment

*Photo: Nils R ther*

*Photo: Massimo Guerrero*



August 2018  
Downstream Kokel bridge  
Devoll river catchment

# Sediment and Hydro Power



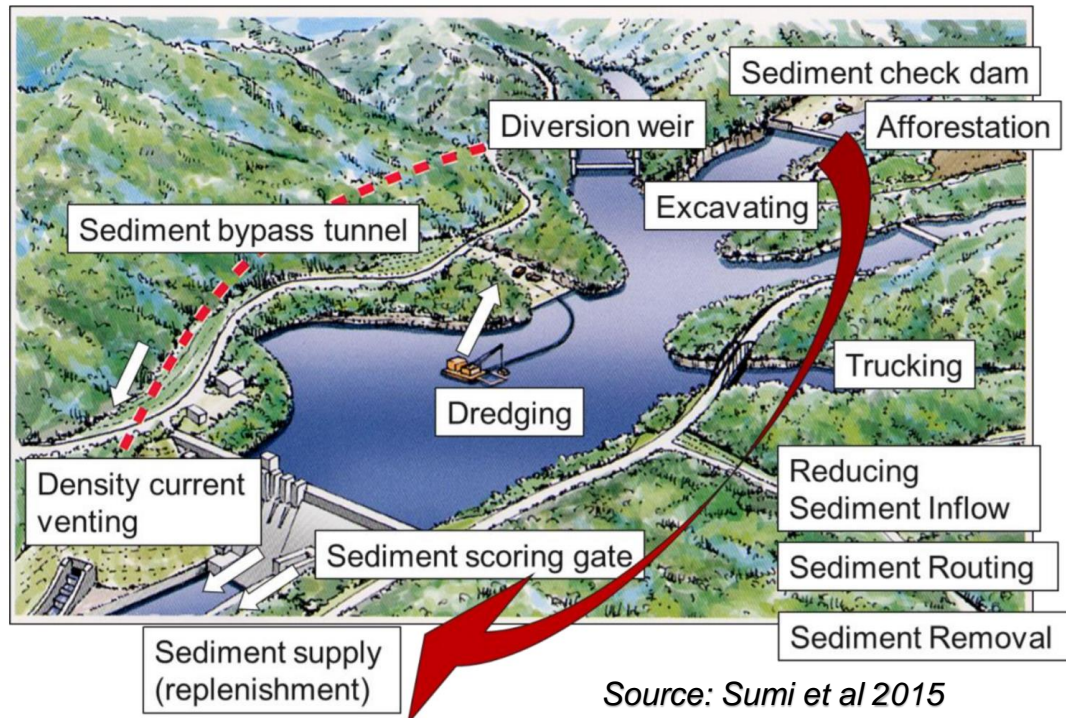
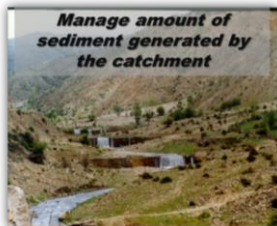
*Photo: Nils Rüter*

Intake to a Norwegian Hydropower scheme

# Sediment and Hydro Power

- **What is the problem**
  - Reduced lifetime due to sedimentation
  - Turbine destructions
  - High maintenance costs
  - Lower efficiency
- **What is the solution?**
  - Mitigation measures after sedimentation has occurred
  - Mitigation integrated in the design process of the HEPP with physical and numerical modeling
  - Both of this solution require a highly accurate knowledge of the amount of the sediments coming into the system.

# Sediment and Hydro Power

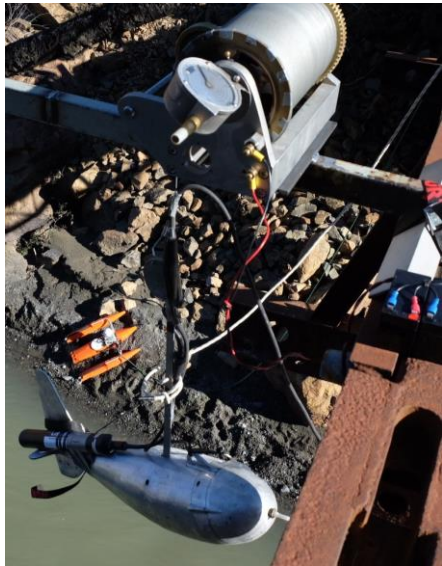


Source: Sumi et al 2015

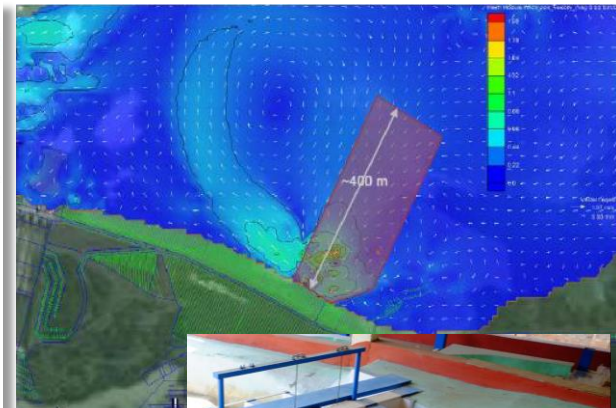
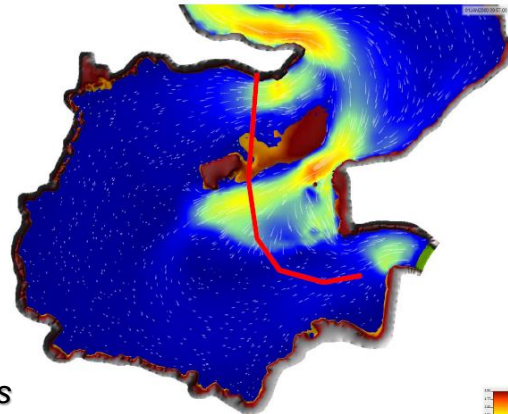


# Sediment and Hydro Power

*Numerical models*



*Conventional sediment transport measurements*



*Physical models*



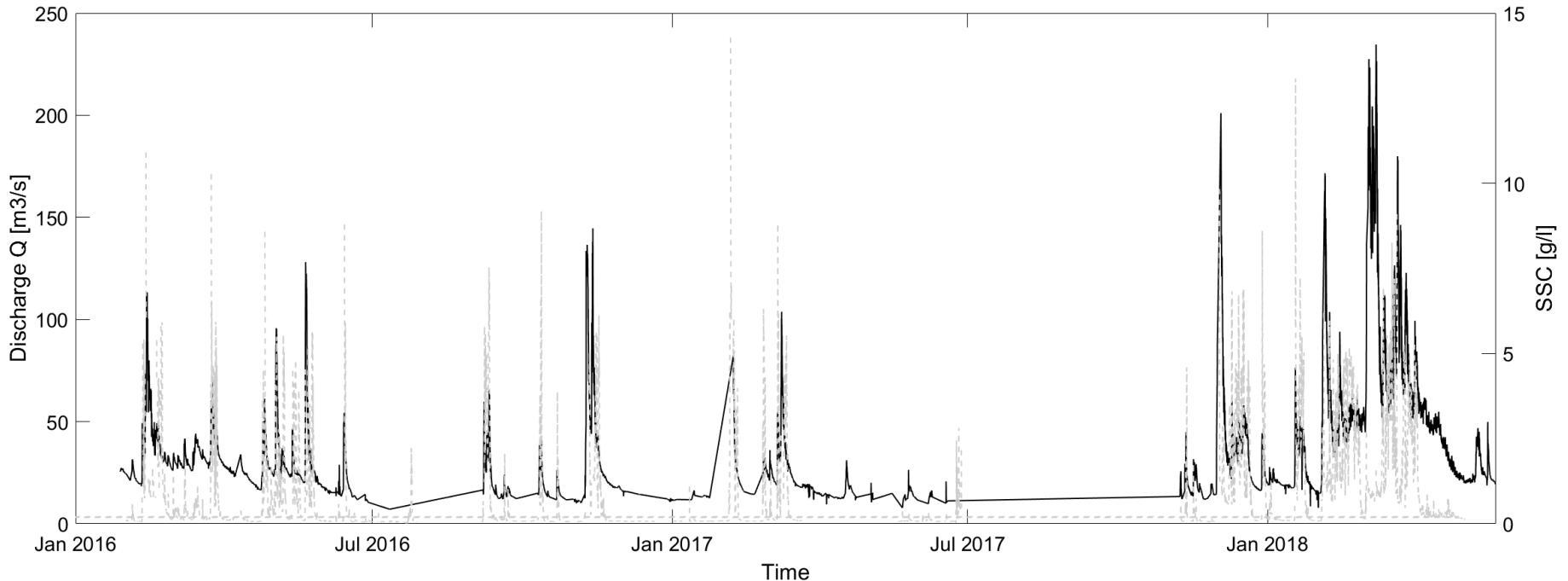
# SediPASS Monitoring SSC

HOW?

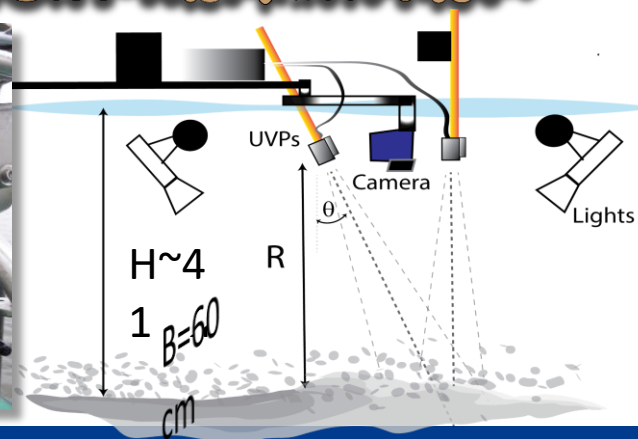
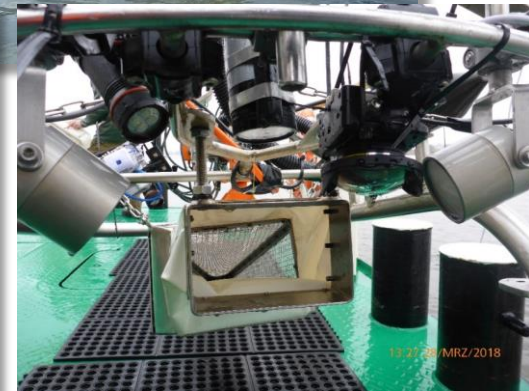
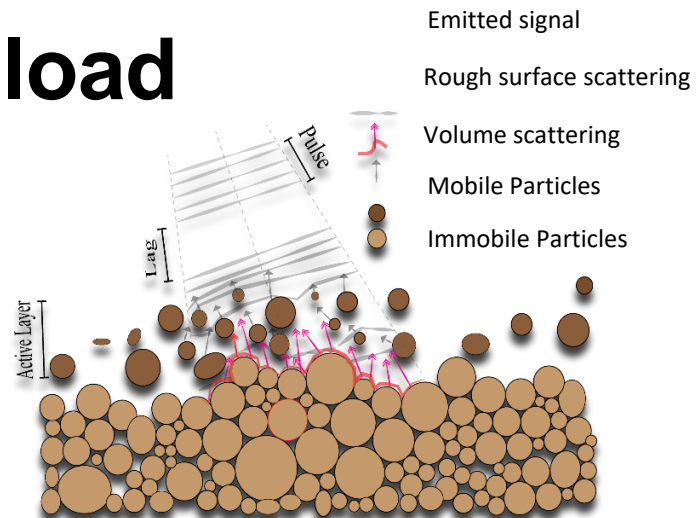


# SediPASS Monitoring SSC

## All SSC and Discharge



# SediPASS Monitoring bed load



# WP 1.3 SEDIMENT HANDLING

**A1.3.1:** Toolbox for sustainable, resilient and cost-effective sediment handling at hydro power reservoirs. *NTNU, IBM*

- **Optimizing** the use of existing and new innovative, technical solutions for sediment handling at hydro power plants; Development a toolbox for sustainable and **cost-effective** sediment handling.
- Parametric design of hydraulic structures
- Numerical modeling, Digitalization, Instrumentation, AI

In close cooperation with Statkraft, SN Power, Multiconsult, Norconsult, Sedicon



*Binga Reservoir*



*Physical model in the Lab*

# WP 1.3 SEDIMENT HANDLING

**A1.3.1:** Toolbox for sustainable, resilient and cost-effective sediment handling at hydro power reservoirs. *NTNU, IBM*

MSc students for Spring 2019

**Pratik Bijukchhe** HPD MSc programme *“3D CFD modeling of sediment transport at Paso Ancho HPP, Panama”* SEDICON

**Sudhir Man Shrestha** HPD MSc programme *“Physical modelling of Pressurized flushing with lightweight material”* SediPASS

**Dipesh Nepal** HPD MSc programme *“3D CFD modelling of flow and sediment transport in Binga reservoir”* HYDROCEN

**Wondwosen Dejenne Lemma** HPD MSc programme *“Numerical modelling of sediment transport in the residual reach of Schiffmühle HPP – Evaluating sediment management from an ecohydraulic perspective”* FitHYDRO

**Ujjwal Shrestha** HPD MSc programme *“Structure from motion technique applied to hydraulic physical scale models”* SediPASS



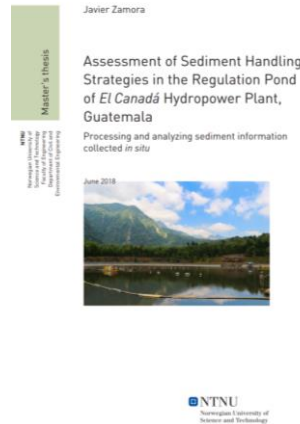
Peaking pond at El Canada HPP



Binga Reservoir

# WP 1.3 SEDIMENT HANDLING

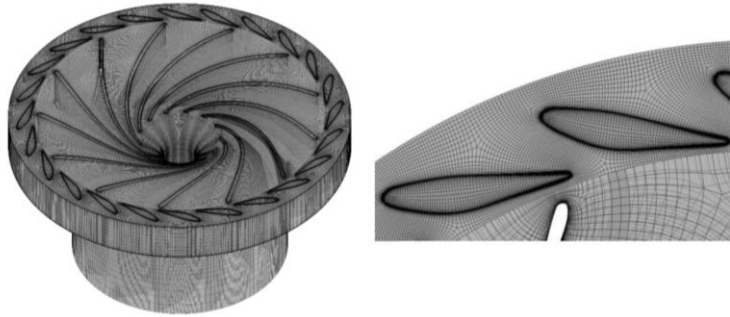
**A1.3.1:** Toolbox for sustainable, resilient and cost-effective sediment handling at hydro power reservoirs. *NTNU, IBM*



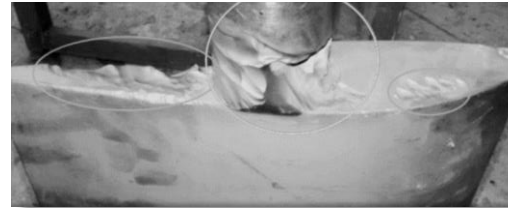
**Javier Zamorra** HPD MSc programme *“Assessment of Sediment Handling Strategies in the Regulation Pond of El Canadá Hydropower Plant, Guatemala”*

# WP 1.3 SEDIMENT HANDLING

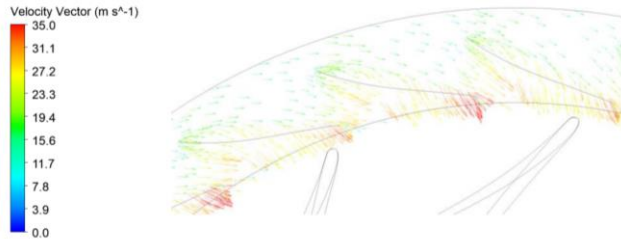
## A1.3.2: Sediment handling in Francis turbines, *NTNU*, *EPT*



Computational domain showing entire mesh and the enlarged one near guide vanes

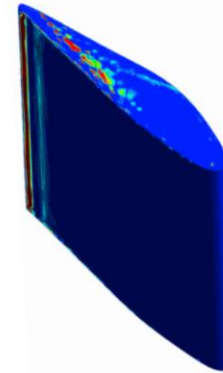
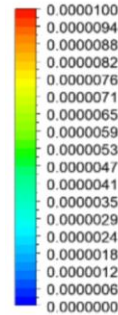


Eroded Guide vane, Archaya et al, 2019

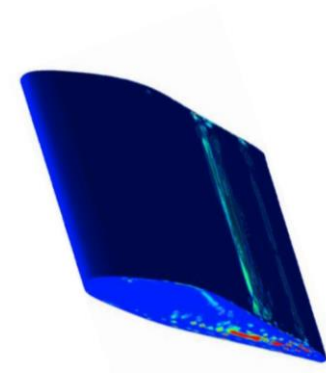


Leakage flow pattern as seen by velocity vectors

Sediment Erosion Rate Density (kg m<sup>-2</sup> s<sup>-1</sup>)



(a)



(b)

Erosion pattern on GV (a) Pressure Side and (b) Suction side



# WP 1.3 SEDIMENT HANDLING

## A1.3.3: Combined sediment and fish bypass solutions, win-win?



Sediment bypass tunnel outlet at Solis HEPP Switzerland

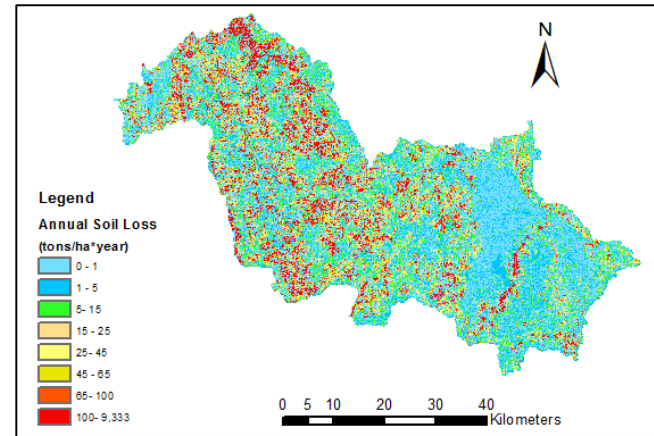


Fish ladder at John Day Lock and Dam, U.S. Army Corps of Engineers

# WP 1.3 SEDIMENT HANDLING

**A1.3.4.** Tool for the assessment of sediment loads and measures from river basins to reservoirs SINTEF Energi AS

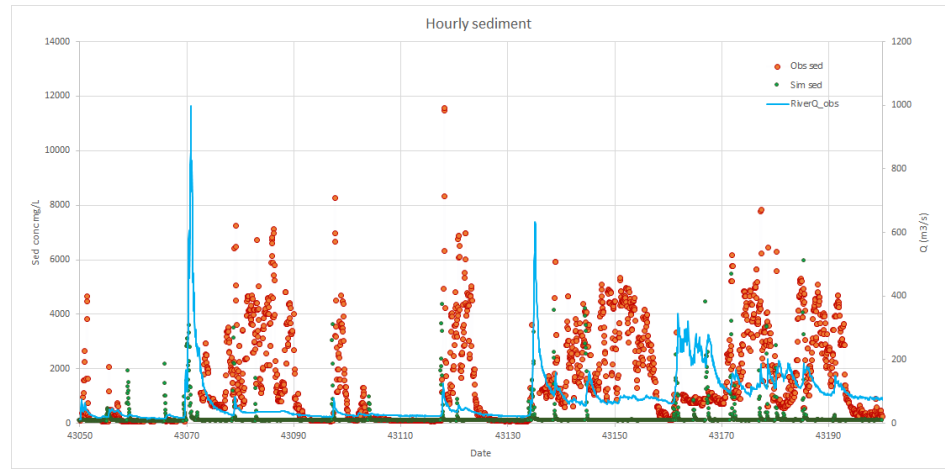
- Ongoing Activity: *“Calibration of SWAT model for short term events of sediment yield estimation for Banja reservoir”*
  - Sub daily simulation was challenging due to the fact that different sediment algorithm did not work properly



# WP 1.3 SEDIMENT HANDLING

## Catchment sediments

- **Setup a SWAT model for Devoll and try to simulate single rain events.**
- **Identify individual landslides event in the catchment with satellite pictures.**
- **Correlate individual events with the monitored SSC at Kokel**



# WP 1.3 OPEN CALLS



*Illustration: Tom Jacobsen*

Intake to a Norwegian Hydropower scheme

*Photo: Nils R ther*





***Thank you for  
your attention***