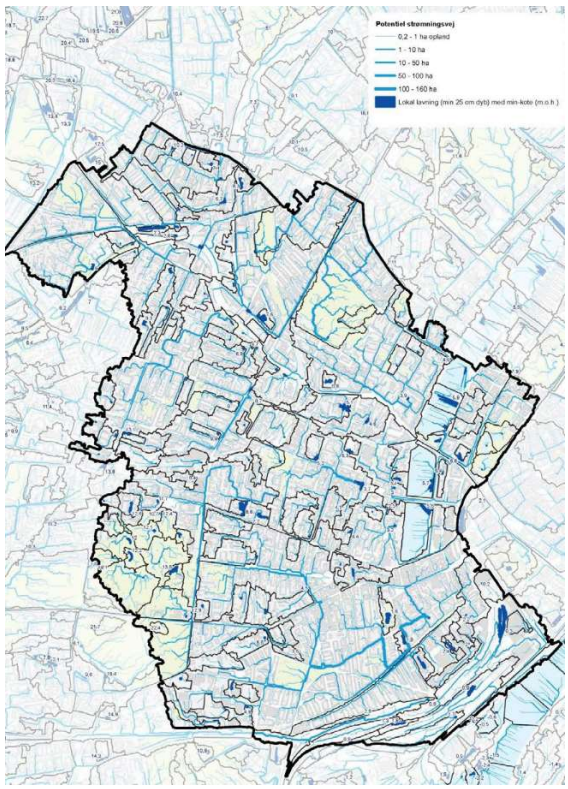
NTNU

Faculty of Engineering Science and Technology
Department of Hydraulic and Environmental Engineering

Tittel	Nedbørsfeltplan for vannbevisst byutvikling
Type	Masteroppgave (for en eller to studenter)
Kontakt / veileder	Manuel Franco Torres (NTNU/Multiconsult) manuel.f.torres@ntnu.no Tel.40046568
Sted	Trondheim kommune

Short description with pictures/Kort beskrivelse med et bilde

Mange norske kommuner sliter med fragmentering i beslutningsprosesser i vannforvaltning. Først, fordi den tilgjengelig informasjon er ikke integrert for å oppnå en helhetlig vurdering av problemet, og andre, fordi de forskjellige disipliner er ikke vant til å jobbe sammen.



Denne oppgave vil skape et pilotprosjekt for en helhetlig vurdering a overvannshåndtering i en nedbørsfelt i Trondheim. Det inkluderer en rekke studier, blant annet: hydrologisk, geologisk, transport, vannmiljø, urban, økonomisk, regelverk, og kommunikasjon.

Denne oppgaven legger ikke vekt på å finne eller teste nye verktøy for disse studiene (som andre masteroppgavene jobber med), med i stedet sikter mot å bruke allerede kjente verktøy og kombinere alle resultatene samme i en helhetlig vurdering.

Denne oppgaven skal utvikle seg inne forskningsprogrammet Klima2050, og den studenten (eller studentene) som ønsker å jobbe med denne oppgaven skal ha oppfølging fra NTNU, Trondheim kommune og Multiconsult. Studenten skal få en verdifull erfaring og skaffe seg en helhetlig og tverrfaglig forståelse av overvannutredning i Norske kommuner.

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Faculty of Engineering Science and Technology
Department of Hydraulic and Environmental Engineering

Tittel	**An intercomparison of Eflow management in European rivers** Økologisk tilpasset vannføring i regulerte vassdrag i Europa
Type	Project / Master thesis
Kontakt / veileder	Knut Alfredsen/Tor Haakon Bakken/ Jo H. Halleraker
Sted	Trondheim/field visits to selected catchments

Short description with pictures/Kort beskrivelse med et bilde

Background and scope: Hydrological alteration by flow abstraction and subdaily flow fluctuation from hydropower is among the most significant pressures on river ecology in many countries. The Water Framework Directive (WFD) require sufficient flow regimes together with other measures for restore or rehabilitate the ecological conditions, by the best approximation to ecological continuum, if not exemptions from the objectives needs to be applied. Irreversible modification of hydromorphology (hymo) might lead to designation of water bodies as heavily modified, if e.g. restoration measures politically are considered to have significant adverse effect on e.g. hydropower or the wider environment. Still, some flow and ecological continuity is required to be in line with WFD, to ensure a sustainable management of river ecology. Hydropower is considered to be an important and clean source of energy supply in many countries. However, to ensure sustainability of hydropower with regard to all relevant UN sustainability goals such as clean energy, climate and nature friendly, several ecological measures are relevant to mitigate negative impacts from hydropower development as much as possible. A common European mitigation library of relevant measure to be considered, have therefore recently been linked to WFD guidelines, as a basis for a common implementation strategy in guidelines (CIS no 4, no 31 and no 36[1]).

Hypothesis:

1. The full potential of hydrological data for sustainable management by combining available data-sources, have not been utilized fully for assessing and classifying flow alteration in many countries according to WFD.
2. Water and river flow management have huge user interests, and criteria for judging adverse effects and cost-efficiency of ecological flow is not sufficient transparent nor comparable, and thereby not fulfilling core principles of sustainable water management in several European countries.

[1] http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm

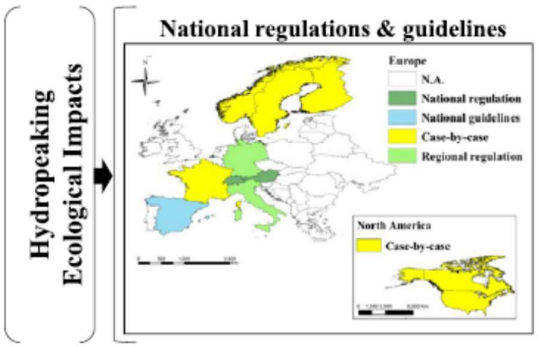
3. Hydrological modifications have not been managed in a comparable way, and there is a lack of common understanding of how this pressure should be managed in a consistent way.

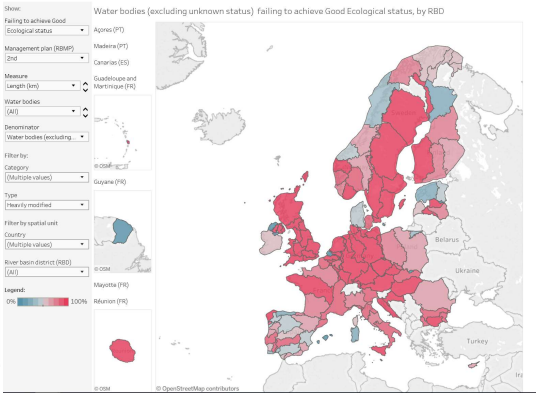
R&D questions:

- What can be considered as emerging good and no-good management practice with regards to level of mitigation for common types of flow modifications?
- Are the same degree of alteration classified in a comparable way for type-specific rivers?
- What is the importance and characteristics of the following factors for Eflow levels?
- What is the dominating mitigation measures for rivers with modified flow?

Material and methods:

- International collaboration with flow alteration data from several rivers in Europe
- Hydrological indexes (modelled or monitored before/after hydropower development) from a number of rivers/countries will be assessed and compared to officially reported water body WFD data (pressure, ecological condition and objectives in WISE[2])





[2] https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/ecological-status-of-surface-water-bodies

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Faculty of Engineering Science and Technology
Department of Hydraulic and Environmental Engineering

Tittel	**An evaluation of management regimes to halt land use change in permanent protected catchment** Vurdering av arealbruksendringer i varig verna vassdrag
Type	Project / Master thesis
Kontakt / veileder	Knut Alfredsen/ Jo H. Halleraker
Sted	Trondheim/field visits to selected catchments

Short description with pictures/Kort beskrivelse med et bilde

Background and scope:
For species diversity and ecological status in both terrestrial and freshwater ecosystems, land-use change with loss or drastical alteration of habitats, has had the largest relative negative impact on nature since 1970 (IPBES 2019[1]). Land use changes and the interlinkage between freshwater and terrestrial ecosystems as well as cumulative effects are less studied in a Norwegian context. The availability of physical data of land use change, from various sources (e.g. LIDAR – hoydedata.no, historical aerial photos – Norge i bilder, Remote sensing – Copernicus) and technologies (e.g. GIS based modelling, machine learning and artificial intelligence) that are relevant for ecological status have exploded the last decade. Still, there is a R&D need for a more effective ecological relevant use and management integration of such data, e.g. to assess cumulative ecological impacts, and quantify relative impact of multiple pressures on ecological indicators across spatial scale and nature types. Ca 25 % of the catchments in Norway are permanently protected, though a sequence of protection plans (Verneplan I – IV), to protect a variation in the Norwegian river nature (https://www.miljostatus.no/vernede-vassdrag/).

However, no real evaluation have been carried out to clarify if the more strict management regime have been successful, regarding land use change before versus after they become protected.

Hypothesis:
The management of permanent protected water courses (verna vassdrag) in Norway do only partly ensure best approximation to ecological continuum and have been partly neglecting other land use change than large hydropower with significant impacts on biodiversity dependent on rivers"

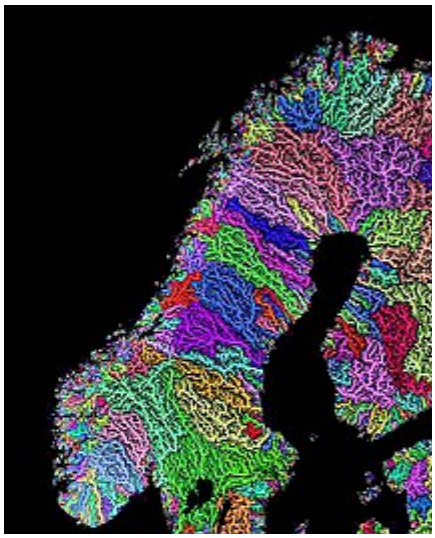
[1] https://www.ipbes.net/news/ipbes-global-assessment-summary-policymakers-pdf

R&D questions:

- What is the relative impact and ecological effects from various significant physical alteration from land use (pressures) on ecological functioning (indicators)?
- What is the status and impacts in Norwegian river corridors in protected water courses and to what extent have the national protection guidelines been followed?
- To which extend do the Norwegian river management ensure best approximation to river continuum (according to WFD) and implementation of best available techniques for caretaking of biodiversity (according to the Biodiversity act)? With regards to both longitudional and lateral continuity for both sediments, species and energy of importance for ecological functions also for semi-aquatic nature types (e.g. floodplains)
- Multiple stressors and its importance for management of river ecosystems

Material and methods:

- Qualitative assessment of land use change from historical aerial photos (semi-automatical/or automatically) in a selection of Norwegian catchments, with focus on endangered aquatic and semiaquatic nature types (habitats) such as riparian vegetation, oxbow lakes etc.
- Assess land use changes and exemplify application of physical data in a selection of catchments with different management regimes (water body characteristics from Vann-nett.no)
- Postprocessing of LIDAR-data to detect historic morphological alteration of river channels and riparian zonation (100 meter-zone along the main river-channel)
- Qualitatively assessment of land use change and spatial scale of dynamic nature types
- Explore the feasibility of machine learning to analyse the ecologically most significant hydromorphological alteration



+ Riverscape bilde fra…

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Faculty of Engineering Science and Technology

Department of Hydraulic and Environmental Engineering

Tittel	Modelling inflow to culverts for E6, Helgeland Sør
Type	Hydrological modelling
Kontakt / veileder	Knut Alfredsen, Edvard Sivertsen SINTEF/Klima2050, Statens Vegvesen
Sted	Trondheim

Over the latest years the ability to use the DDD hydrological model for simulating flow in small ungauged catchments with an hourly time step has been developed and tested in Work Package 2 the Klima2050 centre (http://www.klima2050.no). This will potentially allow us to simulate extremes in a continuous model which can improve the design flood computation and also let us investigate the effects of catchment wetness and other catchment conditions. The purpose of this project is to test this model for a practical case. Tasks in the project:

1. Model setup for a number of small catchments along E6 in the southern part of Helgeland. Evaluate the calibration of the model against data series transferred using different approaches and against any small catchment with available data found in the region.

2. Find the design rainfall for the catchment, and simulate design floods for each catchment under different antecedent conditions in the catchment. Evaluate the design floods against standard methods for design flood computation for each of the catchments.

3. Based on the results from 2), use the risk framework for culverts to evaluate the possibility of culvert failure for each catchment.

4. Do an assessment of how land use changes or changes in climate may affect future design floods for one or two of the selected catchments.

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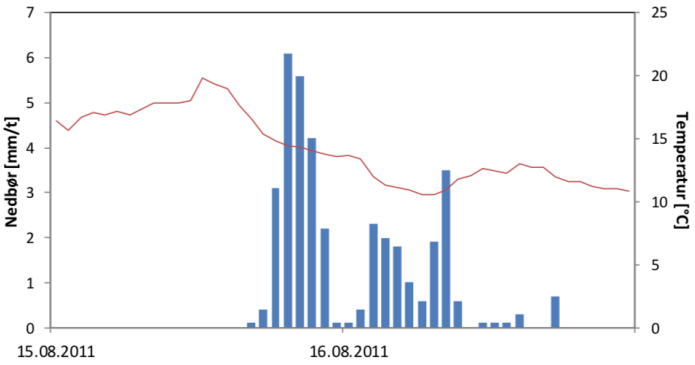
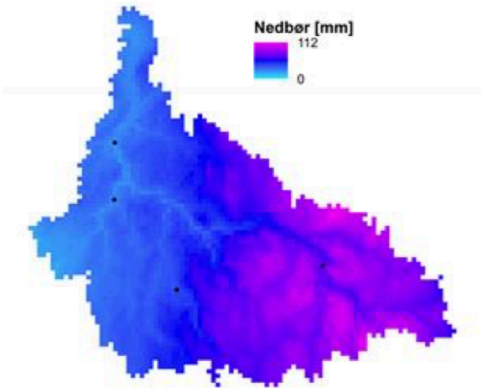
Department of Hydraulic and Environmental Engineering

Tittel	Hydrology tasks 2020
Type	Hydrological modelling
Kontakt / veileder	Knut Alfredsen + others
Sted	Trondheim





(Ida Eggen, 2016)

This is a collection of possible assignments in hydrology. They are relatively short in the description, contact me for more information.

1. Distributed model for NTE. This task is focused on setting up a distributed model for Nord Trøndelag power company for their catchment in Namsvatn, Meråker and Follavatn. The model should use simulated Arome data as input, and these should be compared to similar data from Storm. A possible autumn project related to this is to evaluate snow data from Børgefjell to see if these can be represented with data outside the national park.

2. Radar hydrology. Recent phd work at NTNU has generated improved radar precipitation fields for the Hurum radar in southern Norway. The purpose of this task is to utilise the radar data in a distributed hydrological model to evaluate the simulated runoff against other rainfall products. The particular interest here is small catchments with intense short duration rainfalls.

3. Simulation of low flows. Calibrate and test hydrological models to simulate low flows in regulated streams. The data should be used to evaluate the current minimum flow regime against the real low flow values.

4. Water temperature. A task related to simulation of water temperature from catchments and into rivers, and water temperature computations in rivers. Effects of climate on temperature is an important component here, and studies of climatic change and temperature effects can be a sub topic. Some interest in programming is beneficial for this task.

NTNU

Faculty of Engineering Science and Technology

Department of Hydraulic and Environmental Engineering

Tittel	Evaluation of the River1D ice model
Type	Hydraulic modelling
Kontakt / veileder	Knut Alfredsen
Sted	Trondheim

River ice is common in all cold climate countries in winter and can lead to both environmental and engineering issues. Ice on water intakes, ice induced floods, frazil and anchor ice and ice breakup are all processes that are annual occurrences, but still there is a lack of knowledge of these processes in Norwegian rivers and particularly related to quantification. Some numerical ice models exist, but most of them are developed for larger Canadian or American rivers and not particularly suited for smaller and steeper Norwegian rivers. The commercial MIKE-ICE model has been used with some success, but is complicated and costly. Recently, the River1D model has been upgraded with more ice processes and seems to be an interesting option. The purpose of this task is to test this model.

1. Set up and run the River1D model for Orkla from Grana power plant to the Bjørset intake. Calibrate the model on observed flow and water level data. Calibrate water temperature against observations.

2. Compare results from the ice simulation in the model setup in 1) with data collected previously for this reach and presented in Timalsina et al. 2013. This will also involve a comparison with results from MIKE-11 which was used in the previous study.

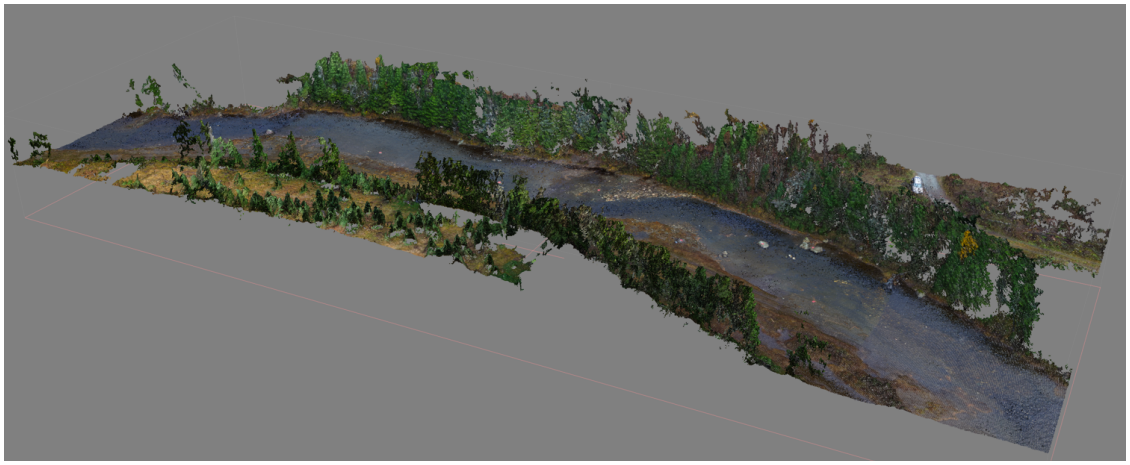
3. Compare model results against Sentinel 2 satellite pictures to assess spatial ice coverage from the model against observed data

4. Test model parameter sensitivity and describe which parameters are most important in the model calibration. Test the models ability to quantify ice production both spatially and temporally over the winter season.

5. Write the thesis as a scientific paper and present the results at the IAHR ice conference in Trondheim in June 2020.

NTNU
Faculty of Engineering Science and Technology
Department of Hydraulic and Environmental Engineering

Tittel	Using LiDAR and drone data in hydraulic modelling
Type	Data analysis and or hydraulic modelling
Kontakt / veileder	Knut Alfredsen
Sted	Trondheim



Point cloud from drone photogrammetry

The availability of LiDAR and Drone data has greatly increased the potential for hydraulic analysis in rivers and landscapes. Detailed data makes it possible to create very detailed models for analysing both low flows and floods. Several projects have been undertaken lately on river modelling, modelling floods in roads and modelling effects of extreme rainfall on urban areas. There are a number of topics that still need investigations, and this is an overview of potential tasks for master thesis related to using drone and LiDAR as input data. All can be taken as a single task, or we can combine elements of the tasks into something you find interesting.

1. Comparison and evaluation of LiDAR and Drone point clouds. Here we will fly drones over areas where we have LiDAR data and compare accuracy. Topics will involve the number of ground control points, use of an RTK GPS drone, accuracy of models based on drone photogrammetry and an evaluation of potential other uses of high precision data, e.g. for substrate size evaluation or for vegetation mapping. Image analysis methods can also be included.

2. Hydraulic modelling based on LiDAR data. Projects related to modelling hydraulics in Årdalselva, Lærdalselva and Gaula. Model calibration, model validation and sensitivity analysis of model parameters. HEC-RAS has been used as a model in many previous projects and is also the preferred tool here.

3. HEC-RAS is the model of choice for the tasks we have done so far with LiDAR. In this project we will compare simulations from HEC-RAS with other hydraulic models, e.g. Delft3D or Telemac to understand similarities and differences in the models

4. Modelling of alterations of river geometry. Weir removal projects in Nea, replacement of Syvde weirs with other constructions in Lærdal, artificial habitat constructions in several rivers. This is now used as a tool in many rivers for rehabilitation and mitigation of reduced flows, and an interesting topic to study is the stability of such constructions. This topic can also be related to sediments and shelter availability

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Faculty of Engineering Science and Technology

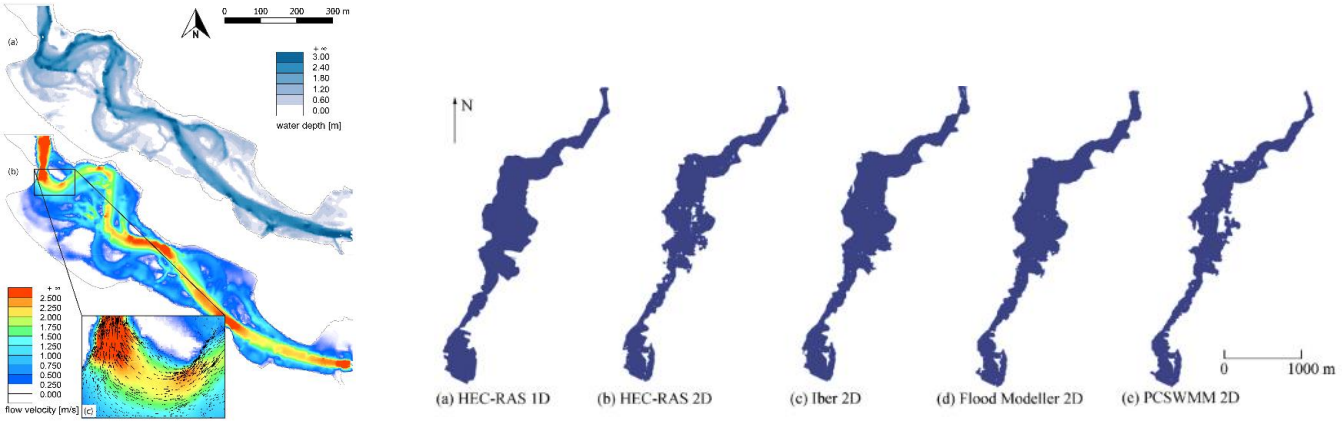
Department of Hydraulic and Environmental Engineering

Tittel	**Hydraulic model suitability for hydrodynamic analysis based on LiDAR data of steep rivers**
Type	Prosjekt/Master oppgave
Kontakt / veileder	Adina Moraru, Knut Alfredsen
Sted	Trondheim, Norway

Short description with pictures/Kort beskrivelse med et bilde

Advanced topographic-modelling methods such as LiDAR or Drone photogrammetry provide high-resolution digital elevation data, which contributes to an increasing hydrodynamic modelling reliability, provides more accurate information and facilitates decision-making.

The aim of this master thesis is to compare two-dimensional hydrodynamic simulations on steep rivers based on LiDAR input data carried out in at least two different software (*e.g.* HEC-RAS 2D *versus* Iber2D, Telemac-Mascaret, Flood Modeller-TUFLOW, REEF3D, ANUGA, Gerris, etc.) in order to determine their suitability to identify the most sensitive parametres during changing environmental conditions. The research focus will be on identifying critical parametres in steep rivers and defining the performance of hydrodynamic models by contrasting numerical simulations and documented observations in low, normal and extreme (*i.e.* flooding) flow conditions. The outcome of this comparison will contribute to highlight the importance of detailed geographic data in hydraulic modelling as well as the limitations of state-of-the-art fluid solvers. The candidate is expected to have knowledge on hydrodynamics and be willing to master a new hydraulic modelling package if not previously familiar with it.



Figures show: Left) 2D water depth (DWM) (a) and depth-averaged flow velocity (b) based on 3D LiDAR point cloud (from Mandlburger et al., 2015); Right) comparison of flood areas simulated with different models for the same return period (from Pinos & Timbe, 2019).

Tittel	Weir removal and adjustment in regulated rivers - methods and analysis
Type	Hydraulic modelling, GIS
Kontakt / veileder	Knut Alfredsen, Håkon Sundt
Sted	Trondheim

Weir removal and adjustment in regulated rivers - methods and analysis

Weirs were traditionally introduced to rivers to increase the water covered area mainly for aesthetic reasons and but also thought to have ecological relevance. Today, we know that weirs can disrupt the fish from moving between river sections and decrease the amount of native fish species popular among fishermen. Thus, weir removal or weir adjustment is being considered in many regulated rivers as a way to re-establish the river to its original form. In environmental design projects, manipulating weirs can be part of mitigation measures of ecological (i.e. fish and invertebrates) and morphological (the physical environment) relevance.

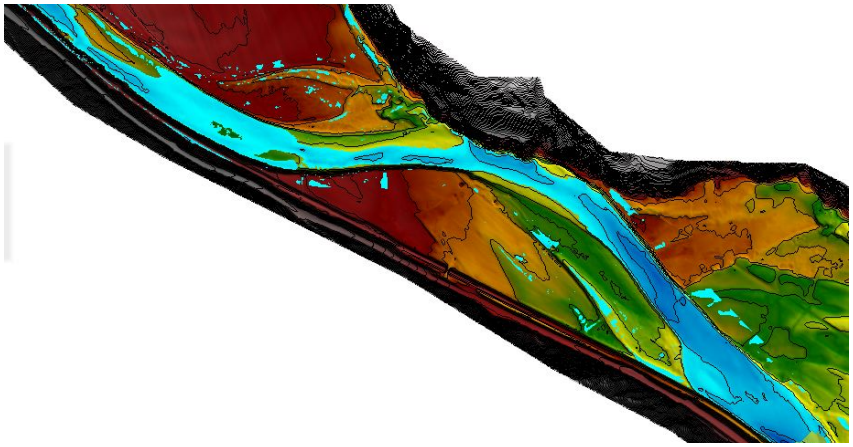
The master student will do the following:

- Literature study on weir removal and weir adjustment
  - Find and summarize examples of weir manipulation projects
  - Set up potential ways of manipulating a weir
- Field work sessions for setting up a full terrain model for the riverbed in relevant river sections
  - Measure terrain using GPS, echo sounding, drones or other available equipment
- GIS analysis for manipulation of riverbed terrain
  - Set up original terrain files (from point cloud to raster) in GIS
  - Manipulate terrain files using available methods and establish different terrain scenario files as input to hydraulic modelling
- 2D hydraulic modelling of scenarios for weir removal and weir adjustment
  - Set up and calibrate a 2D hydraulic model for the river reach
  - Introduce the different terrain scenario files and simulate each of them
- Summarize the findings in a report

The results will be relevant for investigating the potential hydraulic properties of river sections before and after weir manipulation. The analysis will be part of the HydroCEN environmental design case study project in River Nea in Mid-Norway.

Tittel	Vurdering og bruk av LiDAR data for vassdragsmodellering i regulerte vassdrag.
Type	Hydraulic modelling, GIS, environmental analysis
Kontakt / veileder	Knut Alfredsen, Morten Stickler, USN
Sted	Trondheim

Vurdering og bruk av LiDAR data for vassdragsmodellering i regulerte vassdrag.



Bruk av fjernmålingsdata er i dag og framover et viktig verktøy for generell vassdragsforvaltning. Utvikling av LiDAR i form av grøn laser data gjer det mogleg å utvikling av terrengmodeller av vassdrag for heilskapleg vurdering og modellering av hydrauliske forhold. Verktøyet gjer det og mogleg å vurdere bio-fysiske forhold med en tverrfagleg tilnærming som tidlegare ikkje var mogleg.

Kvina (Agder fylke, Sør Norge) er nylig kartlagt med grøn laser data- ALB (Air LiDAR Bathymetry). Kvina som regulert vassdrag vil nå vurderes med fysiske tiltak for å betre miljøforhold i vassdraget. Dette gjelder særskilt på anadrom strekning med to lokale vannkraftverk. Overordnet føremål med arbeidet vil vere å etablere en hydraulisk modell for en delstrekning av Kvina, og simulere vassdekt areal for ulike vassføringar. En viktig del av arbeidet vil også vere å validere ALB data gjennom samanlikning av manuelt målte data med RTK-GPS med laser data. Arbeidet vil være viktig input for lokal forvaltning og framtidige tiltak.

Prosjekt vil verte gjennomført som eit samarbeid mellom NTNU ved Knut Alfredsen og Universitetet Sør-Øst Norge ved Morten Stickler. Det lokale forvaltningslaget Kvina elveeigarlag vil være oppdragsgjevar. Studentoppgåva vil innehalde følgjande delar:

1. Dataprosessering og klargjering for bruk i HEC-RAS. Det er ein føresetnad for prosjektet at måledata frå NVE på LAS format er gjort tilgjengeleg. Det trengs både data for geometrien til elva og for vassflata med tanke på vurdering av om modellen reknar rett.

2. Oppsett av modellen og kalibrering mot observert vassflate. Arbeidet her er tilrettelegging av modellen sine berekningselement og tilpassing av modellparametre slik at modellen på best mogleg måte simulerer den vassflata som er observert under målinga med grøn laser. Her vil vi og bruke eigne data for å verifisere modellen.

3. Køyring av ulike vassføringar (lavvassføring, middelvassøring) for simulering av vassdekt areal og vurdering av endringar i hydrauliske tilhøve (t.d. vassdjup, vasshastighet).

4. Feltarbeid i Kvina for å måle inn kontrollpunkt for vurdering av vasslinje ved hjelp av GPS og samstundes lage eit sett med georefererte ortofoto ved hjelp av drone for å ytterlegare vurdere kor god modellen er. Dette må vi fortrinnsvis gjeres på låg vassføring en gong i løpet av våren.

5. Om mogleg skal data frå modellen kombinerast med registrerte gyteområder og gjennomføre vurdering av effektar frå endra vassføring på gyteområder for laks (Atlantisk laks).

Budsjett: Dekkes av lokale elveierlaget.

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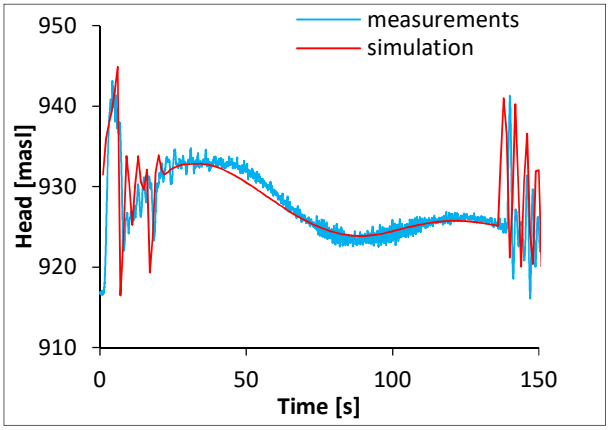
Faculty of Engineering Science and Technology

Department of Hydraulic and Environmental Engineering

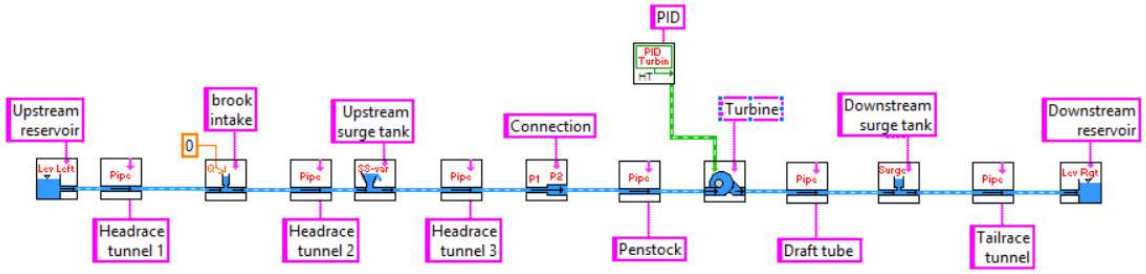
Tittel	Numerical simulation of a hydropower plant operated in pump mode
Type	Master thesis
Kontakt / veileder	Livia Pitorac, Leif Lia, Kaspar Vereide
Sted	Trondheim

Short description with pictures/Kort beskrivelse med et bilde

Nowadays, hydropower plant developers encounter more and more challenges when it comes to being topical. The industry has to reinvent itself in order to integrate in the renewable-energy focused power system. Thus, the operational strategy of hydropower plants needs to change accordingly. Moreover, worldwide, development of large hydropower schemes is criticized from an environmental impact point of view. All these challenges need to be addressed and solved, and redesigning old hydropower plants to pump storage plants could be one solution.



The aim of this master thesis is to investigate numerical simulations of a hydropower plant operated in pump mode. The work is focused on analyzing the effect of a booster pump, over the hydraulic system's mass oscillations. Investigations regarding the mass oscillations in the tailrace tunnel are of most interest, and the final scope of the study is to analyze possible mitigations (redesign of downstream surge tank). The numerical simulations will be carried out using 1D tool implemented in the LVTrans software.



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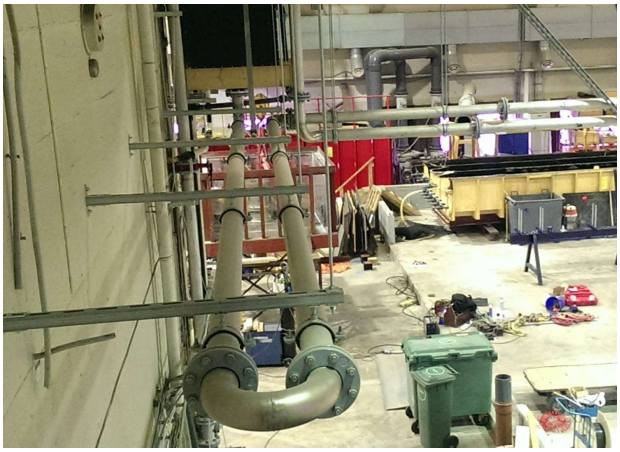
Faculty of Engineering Science and Technology

Department of Hydraulic and Environmental Engineering

Tittel	Physical modelling of transients in hydropower plant tunnel systems
Type	Master thesis
Kontakt / veileder	Livia Pitorac, Leif Lia, Kaspar Vereide
Sted	Trondheim

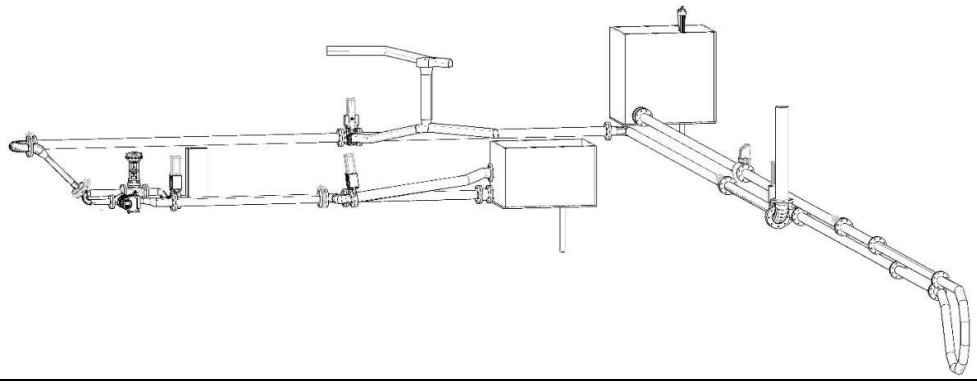
Short description with pictures/Kort beskrivelse med et bilde



Being topical is a challenge that hydropower plant developers are constantly encountering nowadays. The power market is constantly changing in order to accommodate renewable energies, and hydropower has to do accordingly. Moreover, worldwide, development of large hydropower schemes is critizised from an environmental impact point of view. All these challenges need to be addressed and solved, and redesigning old hydropower plants to pump storage plants could be one solution. In most Norwegian hydropower tunnels, there is a number of surge tanks, brook intakes and unplugged adits, which gives a higher complexity to the hydraulics system.

The scope of this master thesis is to analyze the effect of an unplugged adit to the stability of hydraulic system of a hydropower plant. In the specific case of an adit outlet connected to a reservoir, the behavior of the mass oscillations is very dependent on the reservoir level, thus analyzing how these two components are connected is of interest. In the work, physical modelling of mass oscillations is to be performed, using a hydraulic model developed at the Hydraulic Laboratory, at NTNU.

The topic is part of a larger project on physical modelling of reconstruction of existing hydropower plant to pumped storage plants.



NTNU

Faculty of Engineering Science and Technology
Department of Hydraulic and Environmental Engineering

Tittel	**An ecological sustainability assessment of European rivers** Økologisk bærekraftig vannforvaltning i Europa
Type	Project / Master thesis
Kontakt / veileder	Tor Haakon Bakken/ Jo H. Halleraker
Sted	Trondheim/field visits to selected catchments

Short description with pictures/Kort beskrivelse med et bilde

Background and scope:
Ecology-based sustainable development indicators (SDIs), which were uncommon three decades ago, have evolved as strategic instruments in many government's policy toolbox. Since the 1990s, increasing environmental concerns have stimulated the development of numerous indicators, based on solid monitoring. However, several studies on the policy interface from SDIs, highlight an in general weak or actually lack of real impact on corresponding action or policies, and several environmental objectives as well as UN SDIs shows a negative trend. The European Water Framework Directive (WFD) have been an obligation since 2000. For most countries in Europe, a second version of the River Basin Management Plans have been revised, and ecological conditions as well as pressure data have been reported for more then 100 000 water bodies. The main aim for this is to safeguard an ecological based sustainable use of water, e.g for hydropower, land use change and other drivers.

Hypothesis:

1. Despite comparable use of SDI class boundaries, extensive effort in reporting, the use of exemptions and management practice seems to vary considerably, with an in general low level of ambitions towards a sustainable use of water across Europe.
2. Justification or reason for business as usual (prior to WFD), and extensive use of exemptions leads to much less implementation of measures than the relevant articles in WFD have been designed for.

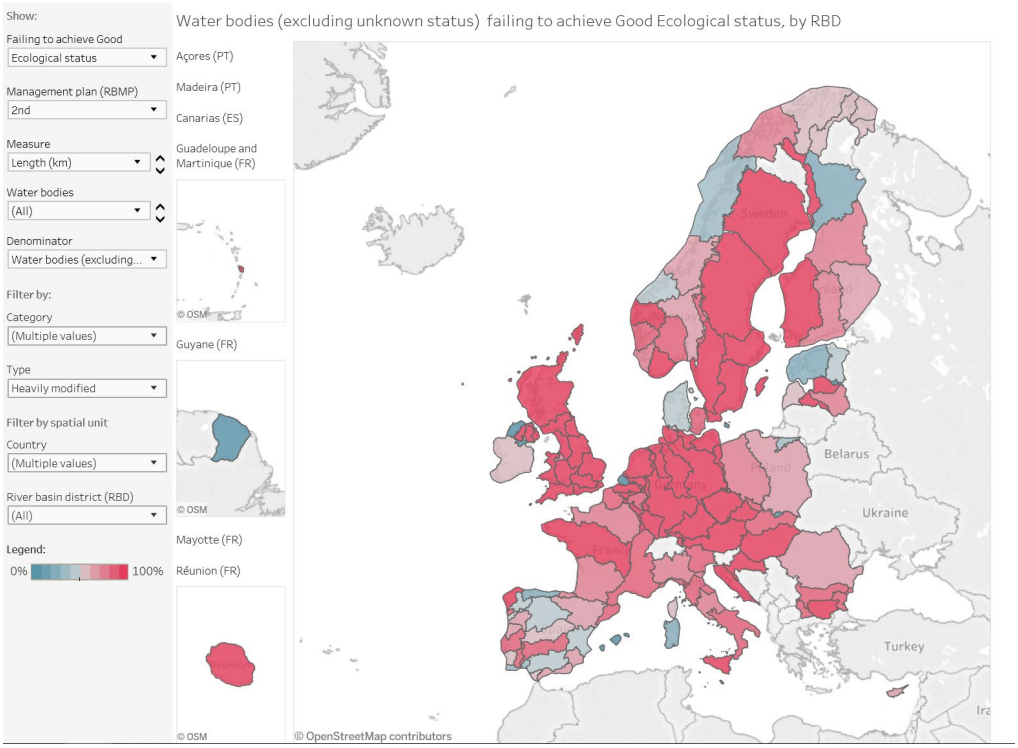
R&D questions:

- What is the main factors deciding upon ambition levels of reaching the WFD objectives in a selection of implementing countries?
- What is the determining factors for level of ecologically justified sustainable use of water resources:
- How comparable are physical alteration of water bodies assessed and mitigated?
    - Are there indications of varying significance level for impacts and ecological effects?
    - Do technical issues like e.g. size of water bodies play a major role?

- Do management traditions or political issues override more evident based ecosystem management?
- What can be learned and improved from SDI development and WFD implementation that are relevant for development of other ecological indicators for other ecosystems and regions?

Material and methods:

- Country-wise review of WFD implementation with recommendations from DG ENV (European Commision)[1]
- Synthesis and analysis of the WFD reported date to WISE[2] with main focus on;
  - Nordic and alpine countries
  - Pressures from land use and impacts from physical modified rivers and lakes
  - Share of water bodies with improved ecology
  - Extend of exemptions
  - Comparison of natural vs heavily modified water bodies



[1] https://ec.europa.eu/info/news/commission-reviews-progress-made-water-quality-and-flood-risk-management-2019-feb-26_en

[2] https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/ecological-status-of-surface-water-bodies

NTNU

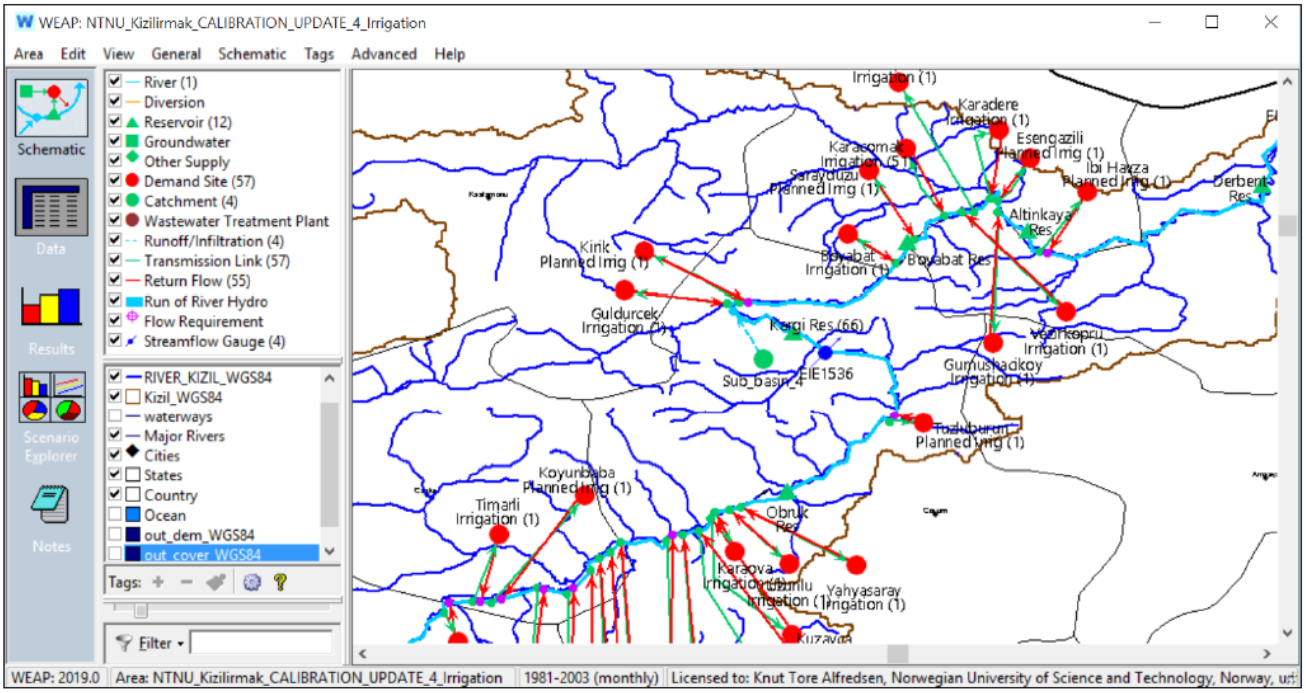
Faculty of Engineering Science and Technology

Department of Hydraulic and Environmental Engineering

Tittel	Assessment of the wider hydrological risks of hydropower projects
Type	Project and master thesis
Kontakt / veileder	Tor Haakon Bakken
Sted	Trondheim, with field visits

Short description with pictures

The production of electricity from hydropower is exclusively determined by the availability of water. Upstream water use such as irrigation and drinking water supply, down-stream constraints and climate change are just some of the factors that can pose a risk to the hydropower producer. The relationships between these factors can in many river basins be very complex, introducing large uncertainties to future revenues. Tools to analyze the wider under-standing of the hydrological risks in river basins with multiple and geographically distributed water uses have to a limited extent been applied in the long-term planning of hydropower projects. The use of such tools will reduce the financial risk of a project, as well as providing a basis for dialogue between stakeholders.



The project proposed will run the hydrological and water allocation model WEAP (Water evaluation and planning tool) in a selected regulated river basin. The basin should experience (now or in the future) competition of water resources and potential risk of conflicts between water use, and climate change scenarios indicating larger water stress. The project will:

- Configure WEAP for a selected river basin (can be based on the student's choice of basin)
- Define a set of scenarios for future changes in water use and availability
- Simulate the effect on the different water users
- Investigate potential mitigating measures to reduce potential conflicts over the water resources

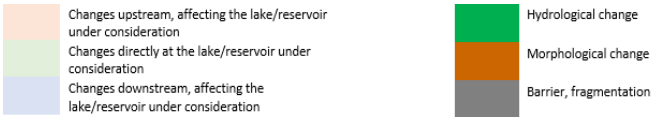
NTNU

Faculty of Engineering Science and Technology
Department of Hydraulic and Environmental Engineering

Tittel	Testing and evaluation of a hydromorphological classification system for lakes and reservoirs
Type	Project and master thesis
Kontakt / veileder	Tor Haakon Bakken
Sted	Trondheim, with field visits

Short description with pictures

Hydromorphological alterations are one of the main pressures in many countries in EU and one of the dominant factors why surface water bodies are not in high or good ecological status. In Norway, hydropower regulation is the single most important pressure, causing deviations from natural conditions in both rivers and lakes. Recently, there have been initiatives in Norway to establish a hydromorphological classification system for rivers and lakes/reservoirs, respectively. Presently, the classification system for rivers undergo testing by a group of researchers closely collaborating with regional authorities, while the similar classification system for lakes/reservoirs has not yet been tested. The aim of the thesis would be to test and evaluate the classification.



Class	Code	Description
1		Near-natural
3		Slightly to moderately modified
5		Extensively to severely modified

The student must collect available literature, maps and data related to the tasks specified. The following shall be carried out during the project/thesis:

- Selection of lakes and reservoir to classify according to the newly developed classification system for lakes and reservoirs
- Carry out the actual classification, based on publicly available data and information
- Supplement and/or verify the classification by field work/visits, if needed
- Compare the hydromorphological classification with the existing ecological classification of the same lakes/reservoirs
- Evaluate the classification system

NTNU

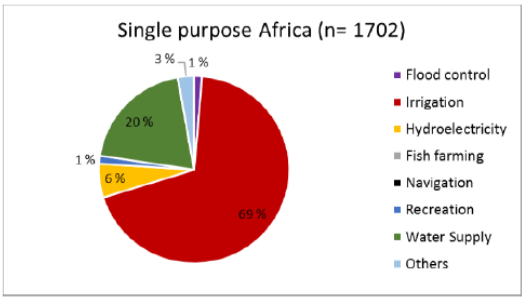
Faculty of Engineering Science and Technology

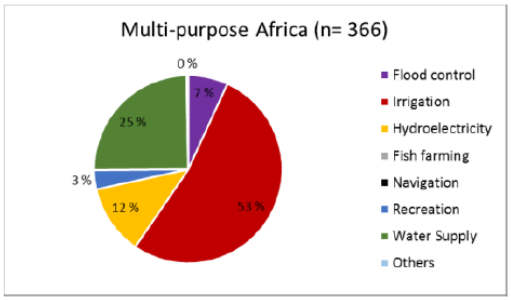
Department of Hydraulic and Environmental Engineering

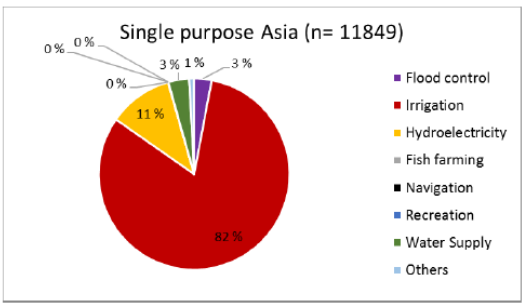
Tittel	Retrofitting of dams & reservoirs without hydropower
Type	Project and master thesis
Kontakt / veileder	Tor Haakon Bakken
Sted	Trondheim, and field visit

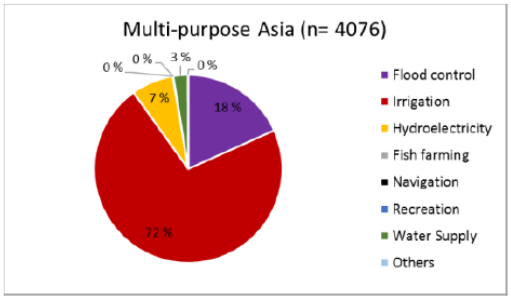
Short description with pictures

Background: A large number of the world's large dams and reservoirs are built for other types of use than hydropower production, in particular in Asia and Africa. According to the statistics in the ICOLD database, being the most complete inventory of large dams and reservoirs, only 6% of the single purpose dams in Africa and 11% of the single purpose dams in Asia are used for hydropower production. While the same numbers for multi-purpose dams/reservoirs are 12% and 7%, respectively (see figures). For this reason, it might be likely that hydropower can be produced from some of this infrastructure with limited costs of installation (the dams is already built), and with limited new environmental and social impacts.









This project aims at analyzing the possibility of retrofitting some of the dams/reservoirs for hydropower production, by selecting a number of case studies in Asia or Africa. The project will investigate:

- what hydropower technology that can be feasible to use on these non-hydropower dams/reservoirs
- what the possible impacts (if any) could on the existing use of the dams/reservoirs
- identify potential barrier for global deployment of the idea (of retrofitting)
- estimate the global hydropower potential from these non-hydropower dams/reservoirs

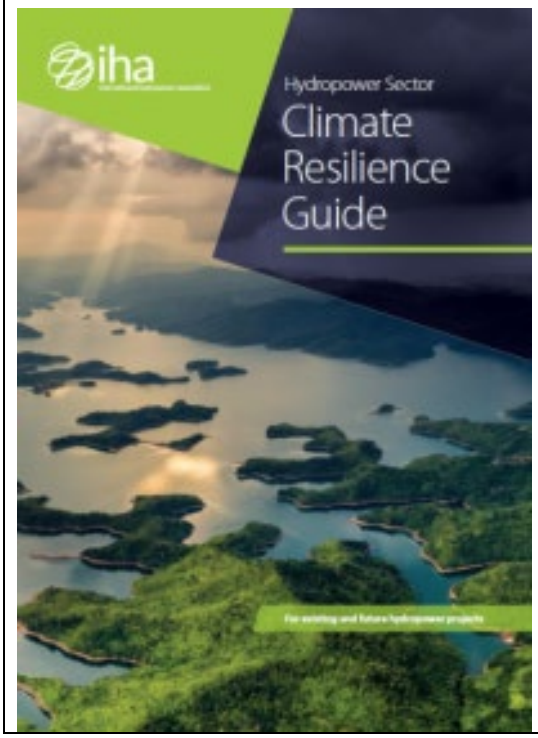
NTNU

Faculty of Engineering Science and Technology
Department of Hydraulic and Environmental Engineering

Tittel	Valuing climate and drought services from hydropower reservoirs
Type	Project and master thesis
Kontakt / veileder	Tor Haakon Bakken
Sted	Trondheim, and field visit

Short description with pictures

Background: Hydropower reservoirs are primarily built for the purpose of storing water for electricity production in periods of limited natural runoff. This infrastructure has also shown to provide valuable services beyond electricity production, by reducing floods and securing availability of water for other purposes during droughts. The value of these additional services are, however, to a limited extent acknowledged and quantified. The International Hydropower Association (IHA) has launched The Hydropower Sector Climate Resilience Guide, technical guidance to help the hydropower industry become more resilient to the impacts of climate change. The guide will support investors, owners and developers to make informed decisions about how to plan build, upgrade and operate hydropower systems in the face of increasingly variable climatic and hydrological conditions.



The project aims at testing the IHA climate resilience guideline by carrying out a case study in a region where the climate change is expected to introduce changes in the annual discharges as well as the variability of the high and low flow conditions. A central part of this would be to set up a hydrological model and run a set of climate change scenarios, provide feedback on the further refinement of IHA climate resilience guideline and input to how climate resilience services from hydropower reservoirs should be quantified.

https://www.hydroworld.com/articles/2019/05/iha-releases-guide-to-help-hydropower-build-resilience-to-climate-change.html

NTNU

Faculty of Engineering Science and Technology
Department of Hydraulic and Environmental Engineering

Tittel	Future Snow
Type	Feltobservasjon/modellering
Kontakt / veileder	Oddbjørn Bruland/Knut Alfredsen
Sted	Trondheim

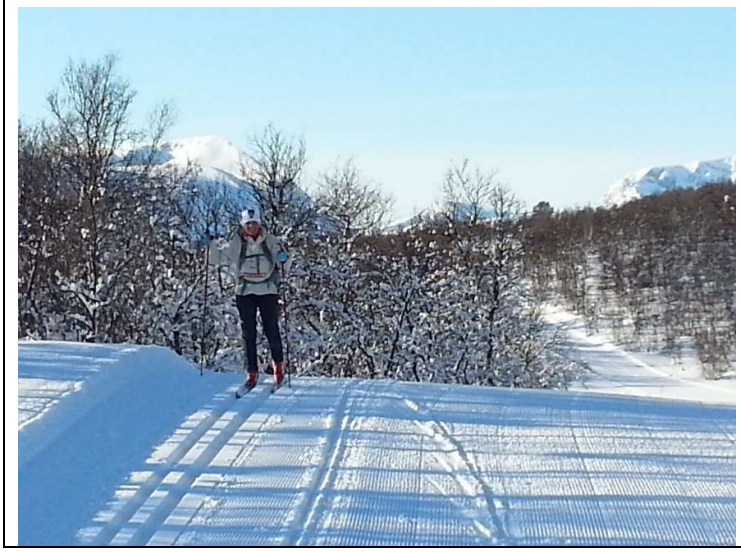
Short description with pictures/Kort beskrivelse med et bilde

Snow is an important resource for the Hydropower companies and for ski resorts.
Nevertheless is natural snow handled simplistic both in the hydropower models and even less in planning of ski resorts. A reason for this is that the processes controlling the snow storage are complex.

In this project the focus will be on modelling the snow accumulation, the snow redistribution and snow melt and compare this to observations and geographical caracteristics.

And also to evaluate the consequenses of climate change on the snow storage.

A project would be to learn and use the snowtran 3d model and comparing to earlier observations
A master would be observations of snowstorage field (3 field visits), modelling, analysis and climate change evaluations



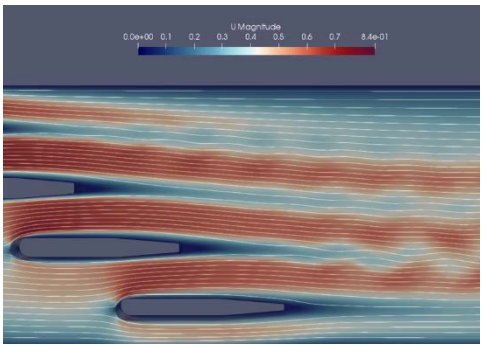
Faculty of Engineering Science and Technology
Department of Hydraulic and Environmental Engineering

Tittel	2D Large Eddy Simulation (LES) of vortex shredding around eco-friendly trash-rack bars
Type	Eco-hydraulic numerical study
Kontakt / veileder	Knut Alfredsen knut.alfredsen@ntnu.no Marcell Szabo-Meszaros marcell.szabo-meszaros@sintef.no
Sted	Trondheim

Short description with pictures/Kort beskrivelse med et bilde

The classical trash-racks, placed at the entrance of intake channels of hydropower plants, had one main purpose to protect the turbine from floating debris. The new era of trash-racks or so-called eco-friendly bar-racks is emerging to protect also the environment, for instance by guiding wandering fish into a safe bypass route.

Fish can utilize eddies in certain sizes and follow them as hydraulic clues. The eco-friendly bar-racks can provide such environment, however they require adequate techniques to study them in prior of implementation. Numerical simulations offer vast amount of possibilities to analyse hydrodynamics and Large Eddy Simulations (LES) approach is suitable to investigate shredded vortexes around bar-racks, in favour of known fish preferences.



The topic offers an opportunity to deepen the applicant's knowledge in advanced numerical modelling with OpenFOAM, visualize the outcome in ParaView and to interpret the hydraulic outcome of the study from the perspective of different fish species (e.g.: Atlantic salmon, European eel, Brown trout).

The expected tasks during the semester are the followings:

- Familiarize with different eco-friendly bar-rack designs (bar profiles)
- Familiarize with the 2D and LES approaches in OpenFOAM software
- Set-up and calibrate a 2D model with LES approach, visualize the outcome by ParaView
- Study and analyse different bar-rack profiles and layouts (flow and vortex characterization)
- Combine the simulated hydrodynamics with known preferences of fish species
- Conclude the findings and propose promising bar-rack solutions

NTNU

Faculty of Engineering Science and Technology

Department of Hydraulic and Environmental Engineering

Tittel	Using an unmanned aerial vehicle to enhance hydraulic modelling for habitat restoraration measures in Ljungan River
Type	Master Thesis
Kontakt / veileder	Ana Adeva Bustos (SINTEF), Knut Alfredsen
Sted	NTNU/SINTEF

Short description with pictures/Kort beskrivelse med et bilde

The Ljungan river located in Sweden, is a regulated river where habitat restoration measures have been carried out to restore the river to its situation before being affected by timber floating channelization (Figure 1). Today, we have a hydraulic model build up with LiDAR data for the bathymetry input and HEC-RAS 2D for before the restoration measures (Figure 2), we want to simulate, validate and quantify the uncertainties for the situation after the habitat restoration measures. In order to do this, fieldwork will be carried out in Ljungan, data will be collected using an unmanned aerial vehicle (UAV) and the structure from motion method will be applied to create a digital elevation model of the river banks morphology (Figure 3). In addition, water surface elevation, velocities measures and substrate composition could be collected in order to validate and complement the hydraulic model results. Findings from this project will be valuable to show the potential of combining UAH with hydraulic models as tools for design and planning of mitigation/restoration measures.

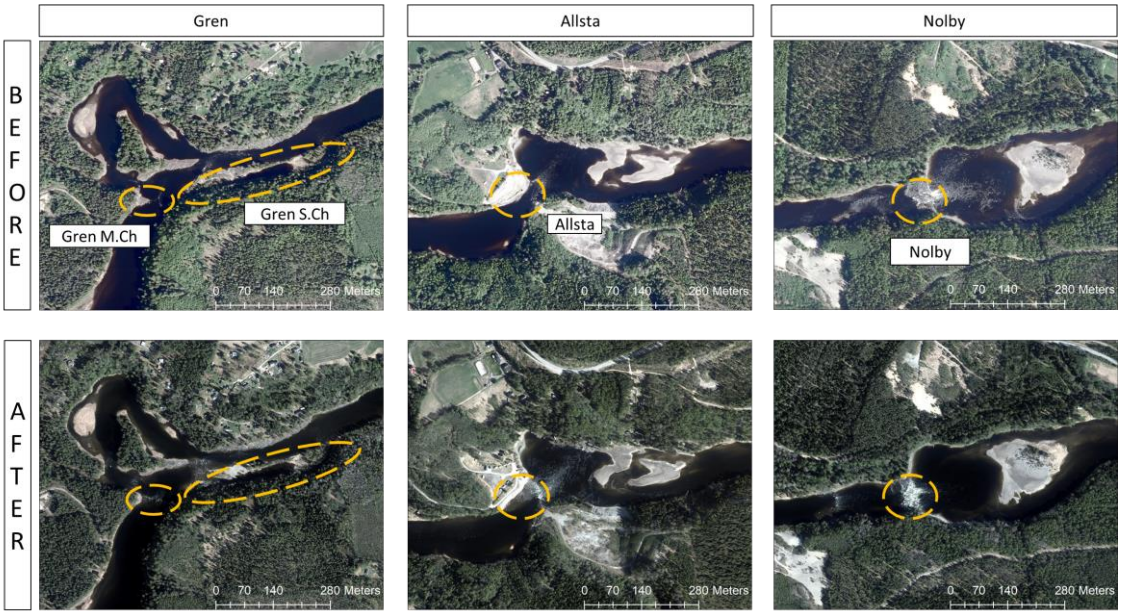


Figure 1. Three locations in Ljungan before and after the habitat restoration measures.

Norwegian University of Science and Technology

Date 29/05/2019

Our reference

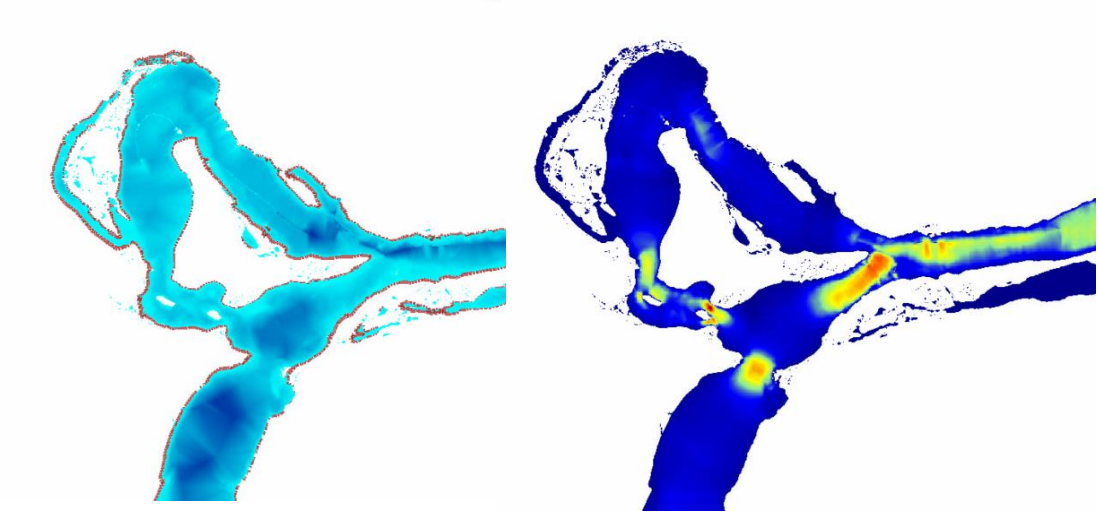


Figure 2. Depth (left) and velocity (right) modelling results from HEC-RAS 2D before the restoration measures at Gren location.

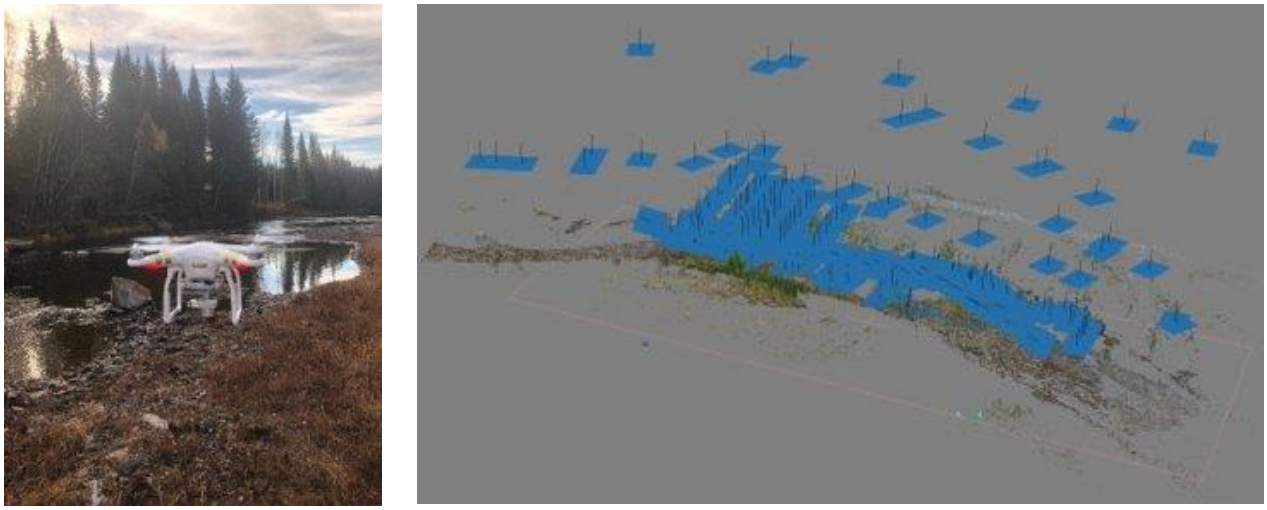


Figure 3. UAV (left) and structure from motion method (right) from Knut Alfredsen.

NTNU

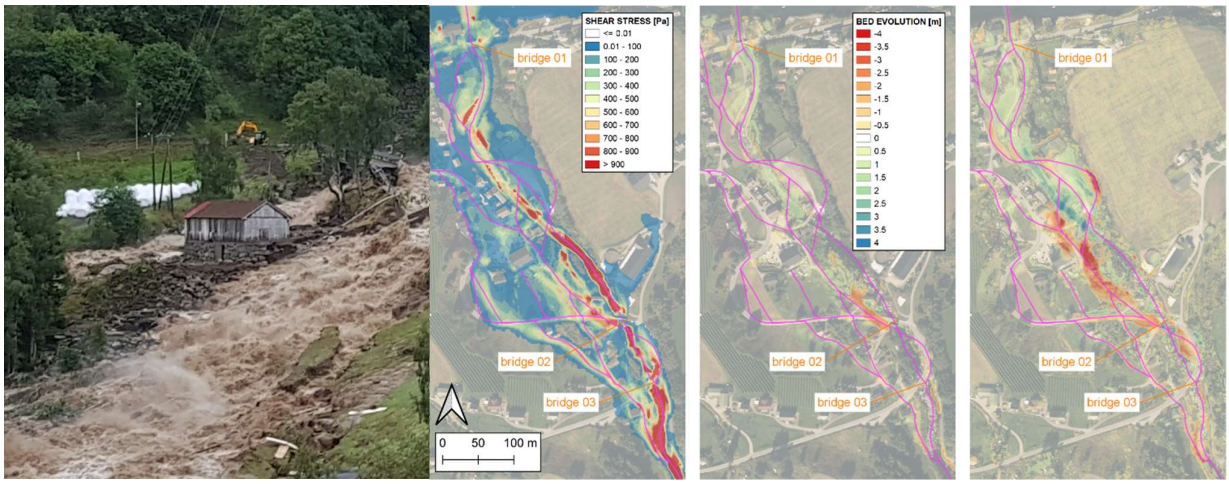
Faculty of Engineering Science and Technology

Department of Hydraulic and Environmental Engineering

Tittel	Numerical simulations of bed load sediment transport in steep rivers
Type	Master oppgave
Kontakt / veileder	Michal Pavlíček, Oddbjørn Bruland
Sted	Trondheim

Short description with pictures/Kort beskrivelse med et bilde

Aim of this master thesis is to investigate numerical simulations of bed load transport in steep rivers. The student will numerically simulate free surface flow and bed load transport in steep rivers using one of the available 2D numerical models (e.g. Telemac-Mascaret, REEF3D, Iberaula, Delft3D). The thesis could be focused on steady and unsteady flow.



Documentation and the results of numerical simulation of Utvik flash flood in 2017

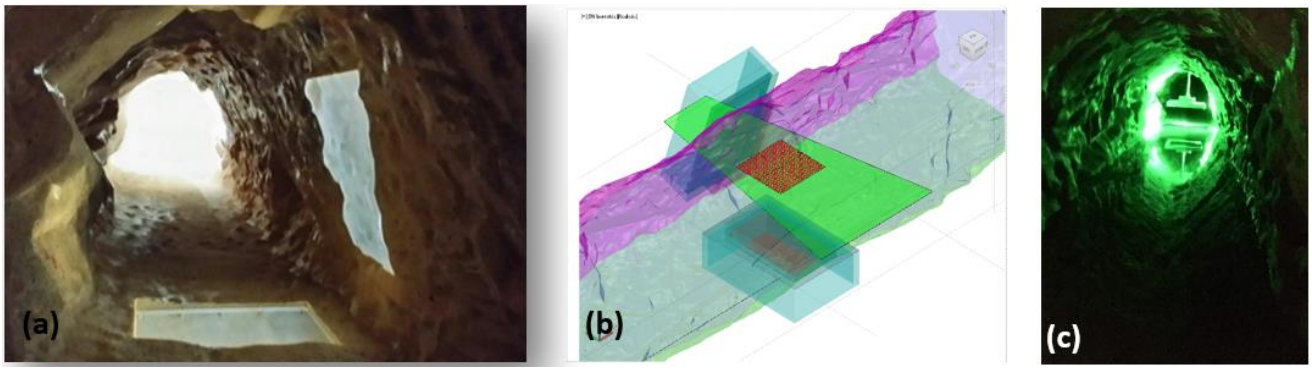
NTNU

Faculty of Engineering Science and Technology
Department of Hydraulic and Environmental Engineering

Tittel	Hydraulics in unlined hydropower tunnels
Type	Project/Master oppgave
Kontakt / veileder	Christy Ushanth Navaratnam, Jochen Aberle, Pierre-Yves Henry
Sted	Trondheim, Norway

Short description with pictures/Kort beskrivelse med et bilde

Hydropower tunnels represent an important feature in Norwegian hydropower systems. They are used for the transport of water from reservoirs for power production and to provide the controlled release of flood flows from reservoirs. The quantity of water that can be conveyed through a tunnel depends on its friction, and many of the Norwegian hydropower tunnels are unlined, i.e. the tunnel walls are left untreated after excavation. The friction caused by rough tunnel walls is generally quantified by empirical approaches, tabulated values, or photographic methods.
This thesis is affiliated with the research project *TunnelRoughness* and laboratory experiments on scaled models of Norwegian hydropower tunnels. The aim of the thesis is to determine the energy losses in the scaled models and investigate the hydrodynamics, in particular, the turbulent flow field obtained from Particle Image Velocimetry (PIV).



(a) A view into a milled tunnel with access widows for PIV measurements, (b) & (c) Visual impression from PIV measurements (Photos: Pierre-Yves Henry and Christy Ushanth Navaratnam)

NTNU

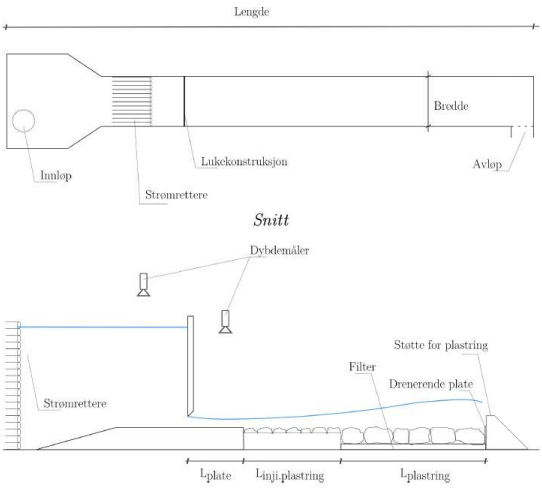
Faculty of Engineering Science and Technology

Department of Hydraulic and Environmental Engineering

Tittel	Laboratory experiment on sizing riprap in steep rivers
Type	Master oppgave
Kontakt / veileder	Michal Pavlíček, Oddbjørn Bruland
Sted	Trondheim

Short description with pictures/Kort beskrivelse med et bilde

Laboratory experiment will be focused on sizing riprap on river bed and banks in supercritical flow conditions. The aim of the experiment is to find a proper formula to design the riprap rock diameter in steep rivers. The student will participate on the experiment set-up, measurements and analyzing the results. The sluice gate in the horizontal flume will be used to model the flow conditions similar to steep rivers.



Similar experiment performed in IBM hydraulic lab in 2013.

NTNU

Faculty of Engineering Science and Technology
Department of Hydraulic and Environmental Engineering

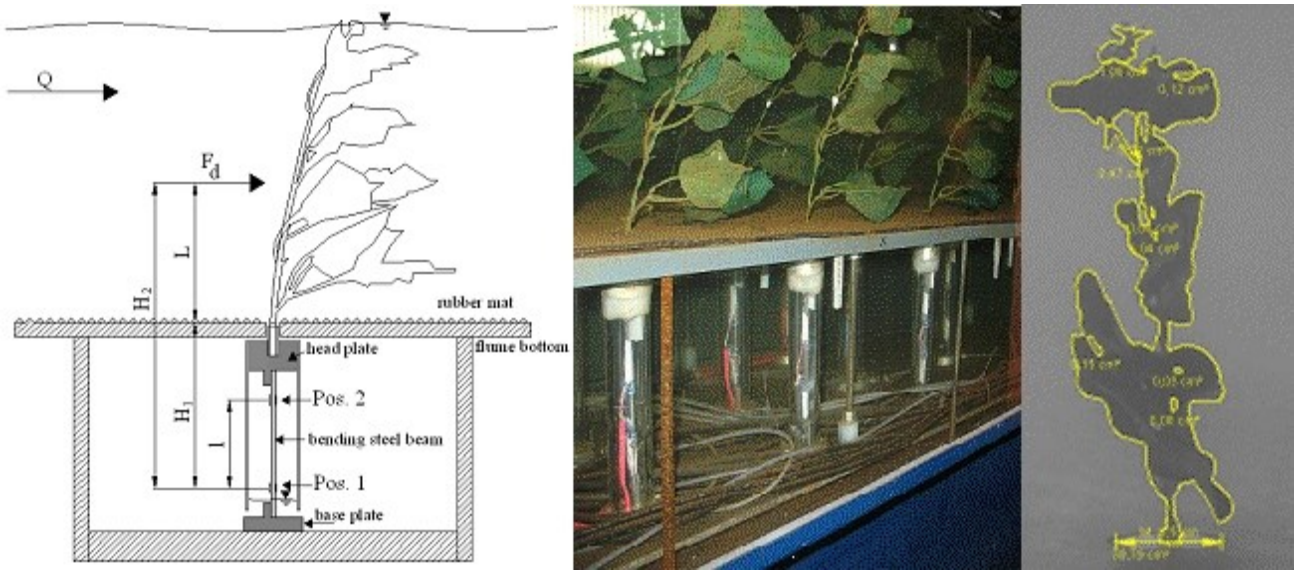
Tittel	Hydromechanics of aquatic vegetation
Type	Data analysis (from laboratory)
Kontakt / veileder	Pierre-Yves Henry – Jochen Aberle
Sted	NTNU Trondheim, in collaboration with 2 other EU universities

Short description with pictures/Kort beskrivelse med et bilde

Aquatic vegetation is everywhere in our streams, rivers and coastlines, and yet, their effects on hydraulics is often neglected or reduced to a set of simple bulk parameters. Aquatic vegetation is a living organism, thus characterized by complex morphologies and a dynamic interaction with its (hydraulic) environment. In direct link with past and on-going research, the proposed project would focus on analyzing a set of simple experiments to unveil some of the basics of vegetation hydromechanics.

The main tasks of the student would be to:

- Develop the image analysis and vegetation detection in Matlab/Octave
- Explore the vegetation's hydromechanics by linking hydraulics, drag forces & coefficient, and plant position



Experimental set-up to investigate the vegetation hydromechanics @TU Braunschweig (J. Aberle)

Different datasets are available for achieving these goals:

- Flexible silicone surrogate tests (cylinder & kelp - NTNU).
- Live plant and stress tests (on-going test with TU Braunschweig, U. Loughborough & NTNU).

In particular, the student will be able to assist researchers from NTNU and U. Loughborough in the analysis of the experimental datasets from state-of-the-art instrumentation. For this reason, this project is suited to a motivated student with scripting capabilities.

The potential outcomes of the project are:

- Deepening of the drag coefficient parametrization of real vegetation, essential to the proper representation of vegetation in hydraulic models.
- Impact of hydraulics and plant health on vegetation reconfiguration.
- Work within the framework of the Hydralab+ EU-project, in collaboration with TU Braunshweig and U. Loughborough.

Kelp forest and kelp reconfiguration test @NTNU (K.M. Norderhaug/P.-Y. Henry)

NTNU

Faculty of Engineering Science and Technology
Department of Hydraulic and Environmental Engineering

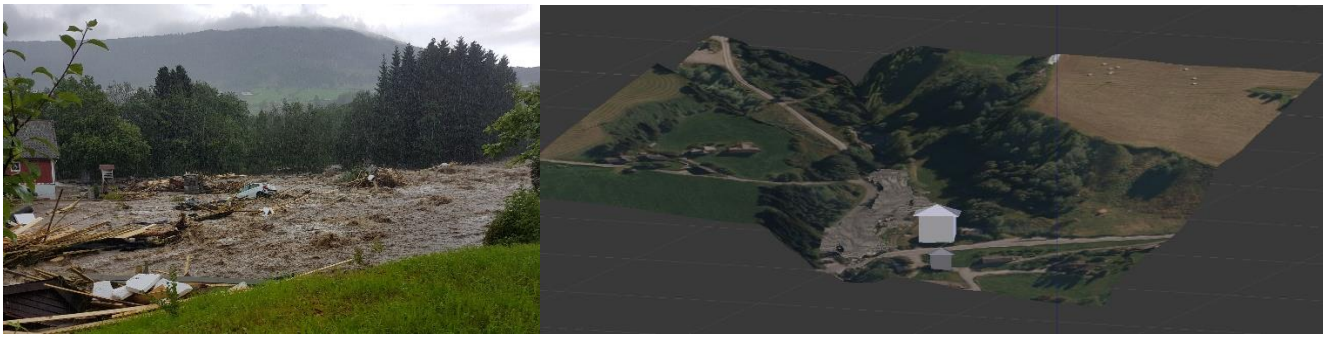
Tittel	**Optimisation of hydrodynamic fluid simulations in steep rivers for flood visualization**
Type	Prosjekt/Master oppgave
Kontakt / veileder	Adina Moraru, Oddbjørn Bruland, Nils Rüther
Sted	Trondheim, Norway

Short description with pictures/Kort beskrivelse med et bilde

This thesis is held within the World of Wild Waters (WoWW) project and aims at creating an integrated understanding of causes and effects of Flash Floods in ungauged steep rivers by constructing realistic flood scenarios and real-time numerical simulations based on real data, and improve risk assessment and its communication to stakeholders and decision-makers. The prediction accuracy required to implement risk alleviation measures is a core issue when addressing flood risk assessment.

The aim of this master thesis is to improve flood simulations in steep rivers through more efficient simulation models. The gathered knowledge will help develop a methodology that will increase flood simulation efficiency (*e.g.* improving simulation speed without truly compromising on the precision of the outcome), eventually contributing to the state-of-the-art of real-time fluid simulations. The resulting scenarios will be implemented into a visualization platform (*e.g.* Virtual Reality/Extended Reality), furtherly used in decision-making.

The student involved in this project should have interest in Computational Fluid Dynamics (CFD) and natural hazards, as well as be inclined to research on efficiency and optimisation techniques. The candidate must be familiarised with hydraulics and fluid dynamics.



Figures show documentation on a recent flood event (Utvik, 2017) and its simulation in a 3D environment.

NTNU

Faculty of Engineering Science and Technology

Department of Hydraulic and Environmental Engineering

Tittel	**Possible topics at cooperating Universities in Europe.** *Tema ved andre universiteter i utlandet*
Type	Prosjekt/Master oppgave
Kontakt / veileder	Nils Rüther
Sted	Budapest, Stuttgart, Munich

Short description with pictures

University of Budapest in Hungary:

Since more than 10 years we cooperate with Assoc. Professor Sandor Baranya. He is willing to supervise on the following topics:

- Numerical modeling of river flows-morphodynamics in different scales (SSIIM, REEF3D, Delft3D, ADH, SRH2D, HEC-RAS 2D, HEC-RAS 1D, …)
- Field measurements of ship generated waves, erosion effect, sediment resuspension
- Numerical modeling of ship generated waves, erosion effect, sediment resuspension
- Ecohydraulics modeling
- Drone based measurements (SfM, LSPIV)

University of Stuttgart in Germany:

Since more than 8 years we a cooperating with various researchers at the department of Hydraulic Engineering and Water Resources Management:

- This work focuses on the numerical modeling of a channel bend with a 2D numerical model with an automated calibration system. More info: http://www.iws.uni-stuttgart.de/lehre/studienarbeit_thema.php?Stud_Arbeit=271
- This topic deals with the quatification of suspended sediment loads with Acoustic measurement devices.

University of Munich in Germany:

We have a continous exchange of students with the department of hydraulic engineering at the University of Munich. Possible studies are related tot he following topics:

- 3D CFD modeling of Fish passages
- River engineering with physical and numerical models.

https://www.wb.bgu.tum.de/en/location/versuchsanstalt-obernach0/obernach-infrastruktur/

NTNU

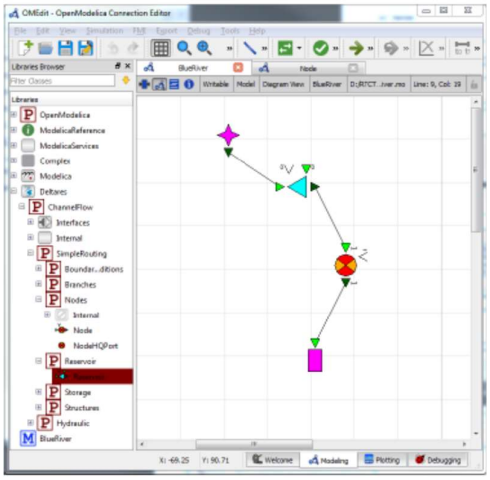
Faculty of Engineering Science and Technology

Department of Hydraulic and Environmental Engineering

Tittel	**Optimization of energy production of run-of-the-river and storage hydropower plants** *Hydraulic modeling (simplifications of the Saint-Venant equations, memory equation, turbine equation) and mathematical optimization with RTC (Real Tine Control) tools*
Type	Master oppgave
Kontakt / veileder	Elena Pummer, Bernhard Becker (Deltares)
Sted	Trondheim, visit in Delft (Netherlands) possible

Short description with pictures

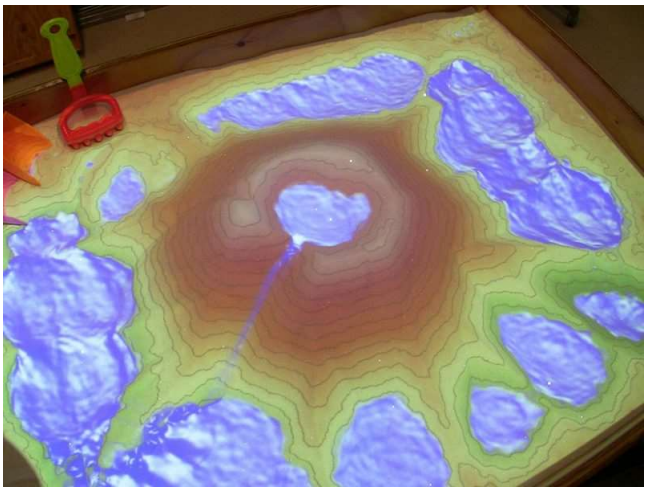
Optimizing a hydraulic system for power generation from hydropower leads to nonlinearities. Aim of the thesis is to show the limit of applying a linearization (constant water level difference) and to show the methods of "piecewise linear" and "homotopy" to consider nonlinearities. In doing so, various management goals (maximization energy production, specification of power output, level compliance, environmental requirements, hydro-peaking) and various system configurations (single power plant, power plant cascade, run-of-river power station, and storage power plant) shall be considered. Hydraulic modeling (simplifications of the Saint-Venant equations, memory equation, turbine equation) and mathematical optimization with RTC (Real Tine Control) tools will be used.

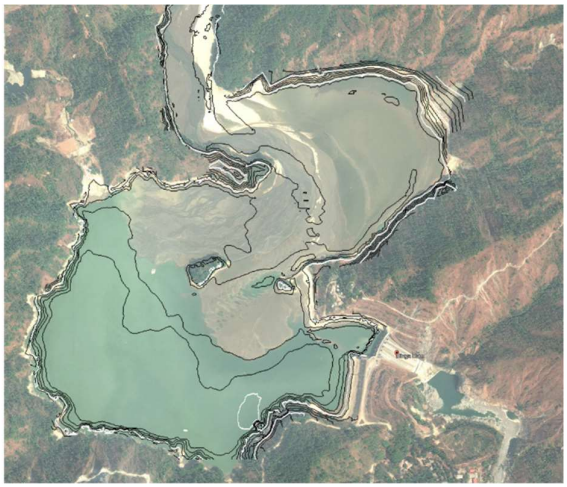


Tittel	**Full Use of an Augmented Reality Sandbox in a Sediment Model**
Type	Master oppgave
Kontakt / veileder	Kordula Schwarzwälder, Elena Pummer, Usha Shrestha
Sted	Trondheim

Short description with pictures

Aim of the thesis is to adapt the augmented reality sandbox software and to use it for sediment placement. A test environment will be built up. As a test case, the Binga physical model, which is about sediment management of the Binga dam on the Philippines is planned.





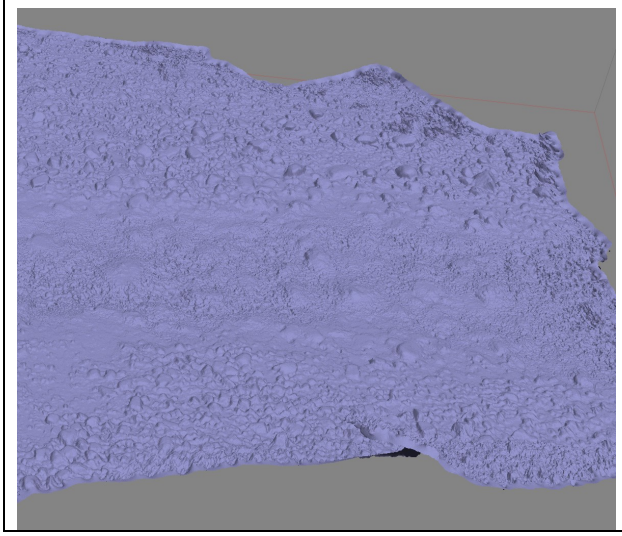
Date Our reference

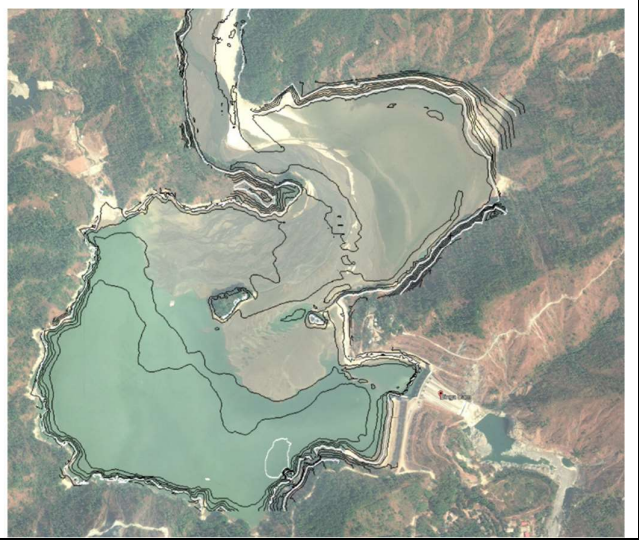
Norwegian University of Science and Technology

Tittel	**Bed Load Transport Estimation Using Structure from Motion**
Type	Master oppgave
Kontakt / veileder	Kordula Schwarzwälder, Elena Pummer, Usha Shrestha
Sted	Trondheim

Short description with pictures

Aim of the thesis is to set up a 3D Model for a specific test case. A possible test case is the Binga physical model study which is about sediment management of the Binga dam on the Philippines.





NTNU

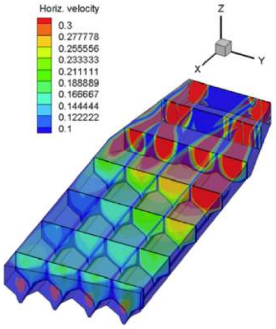
Faculty of Engineering Science and Technology

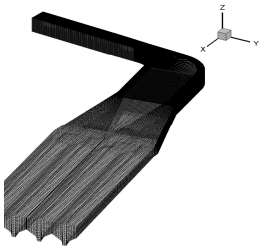
Department of Hydraulic and Environmental Engineering

Tittel	**CFD modeling of sediment transport in physical models under complex flow conditions.** *Numerisk modellering av sediment transport i laboratoriet under komplekse strømningsforhold*
Type	Prosjekt/Master oppgave
Kontakt / veileder	Nils Rüther
Sted	Trondheim

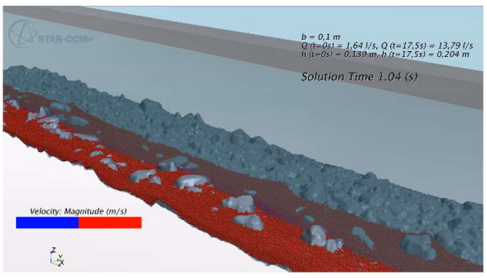
Short description with pictures

The work will be done within the framework of HydroCen within the workpackage 1 and the working task 1.3 sediment handling. We deal with all kind of innovative solutions to handle sediment loads at hydro power plants by means of physical, numerical models as well as with field investigations.
Your task will be to apply either of this methods in order to bring forward new solution that will help provide a better toll for the planning and operation of hydro power plants exposed to high sediment yield. The pictures below are exampls of what could be investigated. The work will be conducted in close supervison of the PhD student in that project.





Numerical model of the desander facilities at Mai Kohla Hydropower plant.



Discrete element modeling of sediment particles

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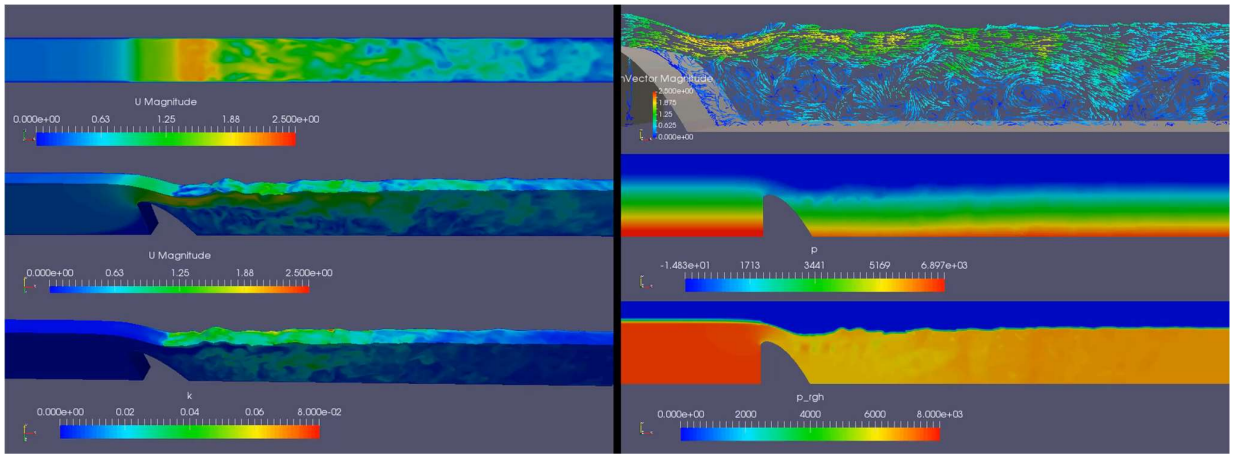
Tittel	**Hybrid modelling of flow over wiers** *Hydrid modellering av enkelte former av flomløp*
Type	Prosjekt/Master oppgave
Kontakt / veileder	Nils Rüther
Sted	Trondheim

Short description with pictures

The task within this study is to measure and modelt he flow over different type of weirs. The so-called hybrid approach is taking advantage of both, the physical and numerical model results. The student shall be either interessted in working in the lab with modern measurement devices or in working with a 3 dimensional numerical CFD program.



NTNU

Faculty of Engineering Science and Technology
Department of Civil and Environmental Engineering

Tittel	Overvåking for sikkerhet og analyse av betongdammer
Type	Prosjekt/Master oppgave
Kontakt / veileder	Fjóla G. Sigtryggsdóttir
Sted	Trondheim

Kort beskrivelse med et bilde

Overvåking av dammer i driftsfasen er viktig for å bevare sikkerheten. Damsikkerhetsforskriften gjør krav om at vassdragsanlegg overvåkes slik at forhold som kan føre til reduksjon av anleggets sikkerhet kan avdekkes så tidlig som mulig. Dette innebær at kunne identifisere prosesser som kan påvirke sikkerhet til dammer og dermed muliggjøre planlegging av tiltak, og/eller gi varsel om unormale situasjoner.

Denne oppgaven går ut på å investigere overvåking og instrumentering tilknyttet valgte betongdammer. Hensynet er at gi oversikt om generelt instrumentering av slike dammer og hvordan overvåkingsdata brukes driftsmessig for sikkerhetsvurderinger. Dette inkluderer investigering av mulig bruk til vurdering av dammens tilstand, og da revurdering av damsikkerhet og bekreftelse på at krav i damsikkerhetsforskriften er oppfylt. Oppgaven inkluderer valg av tilpassende dammer, samt mulig analyse av overvåkings data, og/eller stabilitets analyse av en eller flere av de valgte betongdammene, dersom mulig bruk av overvåkings data, versus annet tiltak, er vurdert.

Studenten bør ha interesse for analyse av betongdammer, samt investigering og analyse av data og informasjon. Studenten bør også ha interesse for at lære seg godt at kjenne damsikkerhetforskriften, og relevante retninglinjer/veiledere, for eksempel retningslinjer for overvåking og instrumentering av vassdragsanlegg. Oppgaven vil knyttes prosjekt WP1.2 Damsikkerhet i HydroCen.

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Faculty of Engineering Science and Technology
Department of Civil and Environmental Engineering

Tittel	Breaching of rockfill dams
Type	Prosjekt/Master oppgave
Kontakt / veileder	Fjóla Guðrún Sigtryggsdóttir
Sted	Trondheim

Short description with pictures/Kort beskrivelse med et bilde

Embankment dams are vulnerable to excess through-flow as well as overtopping. In Norway embankment dams are usually earth-rockfill dam with erosion protection comprising placed riprap on the upstreaan and downstream slope and at the crest. The breaching mechanism of this embankment dam type has not been investigated to the fullest, and the current practice is to use breaching parameters that are derived without consideration of embankment dam type and material. The breaching parameters are required for estimating the flood resulting from dam breach, and thus ultimately influences consequence classification of the dam and consequent dam design requirements. Data from large-scale tests carried out in Norway around 2003 is available (see figure above) with important information on breaching behaviour of rockfill dams. This data has not been analysed to the fullest. Additionally, physical model tests are planned in relation to the project WP1.2 on Dam safety within the research center HydroCen.

The aim of this master project would be to investigate breaching parameters in the literature and compare to the large scale test data available. Investigation and analysis of the large scale data would be part of the tasks carried out.

Faculty of Engineering Science and Technology
Department of Civil and Environmental Engineering

Tittel	Kartlegging og analyse av erosjonsskader knyttet miljølaster på fyllingsdammer i Norge
Type	Prosjekt/Master oppgave
Kontakt / veileder	Fjóla Guðrún Sigtryggsdóttir
Sted	Trondheim

Short description with pictures/Kort beskrivelse med et bilde

Målet for prosjektet er å få mer kunnskap om hvor vidt miljølaster har ført til erosjon av oppstrøms skråninger på norske fyllingsdammer. Fokuset vil være på miljølaster som påvirkes av klimaendringer og har betydning for damsikkerhet. Dette inkluderer vindbølger og is.

Fyllingsdammer er utsatte for oppskylling av vindgenererte bølger. Bølgeoppskylling kan føre til erosjon og forskyvning av oppstrøms plastringsstein. Oppstrøms skråning er viktig med tanke på erosjonsbeskyttelse og effektiviteten av beskyttelsen er blant annet avhengig av plastringsteinenes størrelse og tyngde. Situasjoner med islast kan føre til ustabilitet av plastringstein og videre svakhetssoner i oppstrøms skråning. Designkriterier for steinstørrelse i oppstrøms skråningen må være basert på passende miljølastparametere for beregning av bølgepåkjenning og islast. Dammer i Norge må revurderes regelmessig ifølge Damsikkerhetsforskriften. Denne oppgaven går ut på å kartlegge, utfra revurderingsrapporter og mulig annen dokumentasjon, fyllingsdammer som har vært utsatt for bølgeerosjon og/eller påkjennelser fra islast. Valgte tilfeller skal videre analyseres utfra tilgjengelige metoder i litteraturen, blant annet med oppbygging av hendelsestre og analyse av risiko.

Studenten bør ha interesse for analyse, design og bygning av fyllingsdammer, investigering og analyse av data og informasjon; investigering av eksisterende dammer, og at lære seg godt at å kjenne damsikkerhetforskriften, og releventa retningslinjer og veilederer knyttet fyllingsdammer.

NTNU

Faculty of Engineering Science and Technology

Department of Hydraulic and Environmental Engineering

Tittel	Regionalization of hydrologic parameters for small ungauged catchments
Type	Hydrologic Modelling
Kontakt / veileder	Nitesh Godara, Oddbjørn Bruland
Sted	Trondheim

Short description with pictures/Kort beskrivelse med et bilde

There are many small catchments in Norway which has faced disastrous flash floods in recent years but because of dysfunctional gauging station at the moment or being ungauged catchment, it is difficult to identify the hydrologic properties of the floods later on for research or other purposes.

One of the solution for this problem is to regionalize the hydrologic parameters of the ungauged catchment by comparing it to a gauged catchment having similar characteristics.

This research will mainly focus on the small and steep Norwegian catchments and learning to use the ShyFT model for the hydrologic modelling for these catchments but the research is not bound to use only this model, the student can use another suitable model too.

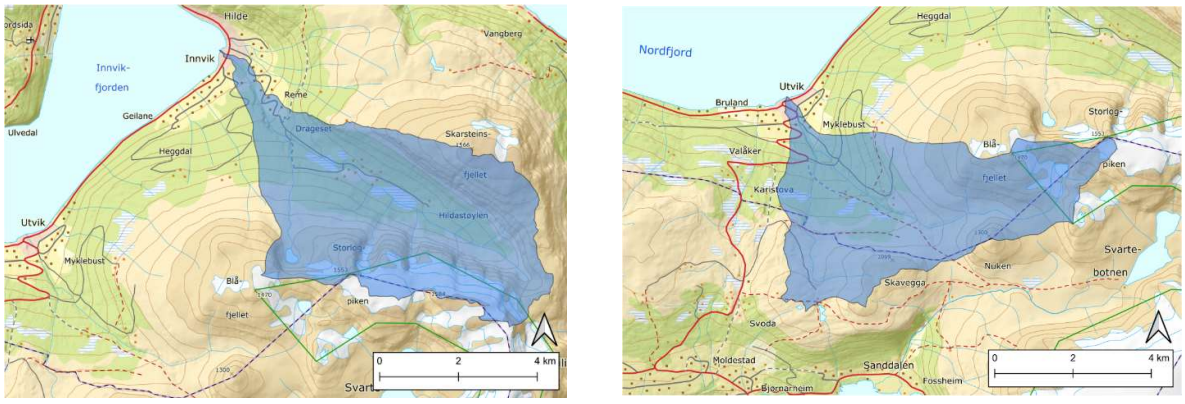

Fig: Two small steep catchments (Innvik, Utvik) in sogn og Fjordane, Norway