Raske og hyppige endringer av vannstand og vannføring

Fysiske virkninger i vassdragsmiljøet

Knut Alfredsen, NTNU

Roser Casas-Mulet, Davide Vanzo, Tyler King, Håkon Sundt, Svein Jacob Saltveit, Ånund Killingtveit, Ana Garcia Escudero Uribe, Thibault Boissy, Nils Rüther, Stefan Spiller, Netra Timalsina

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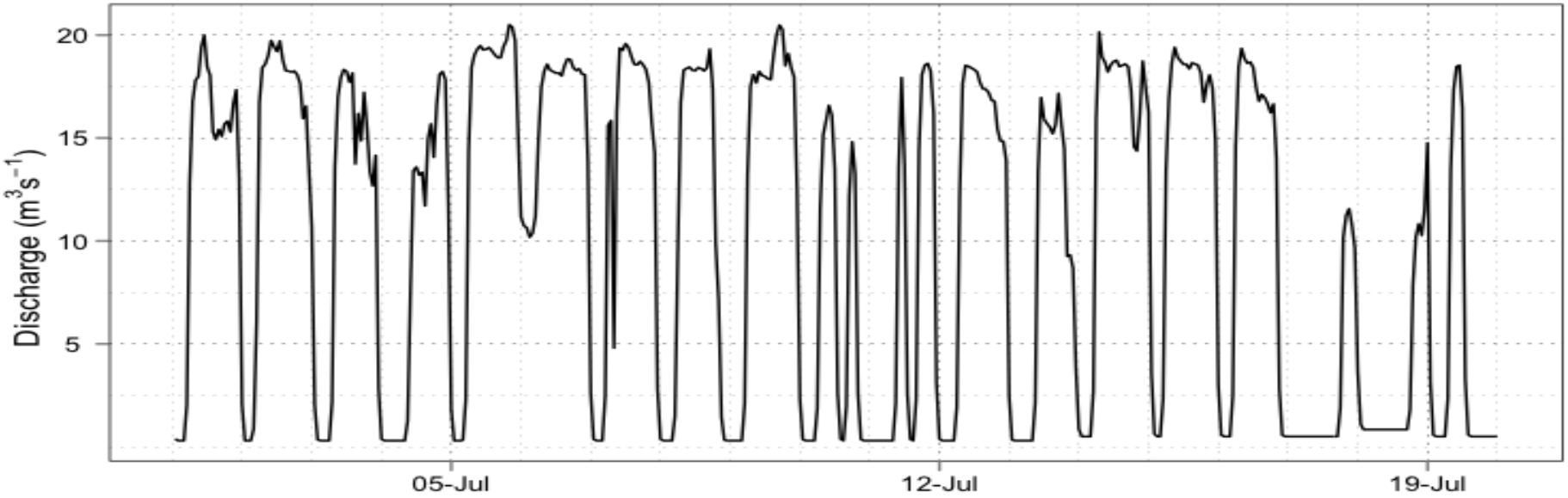
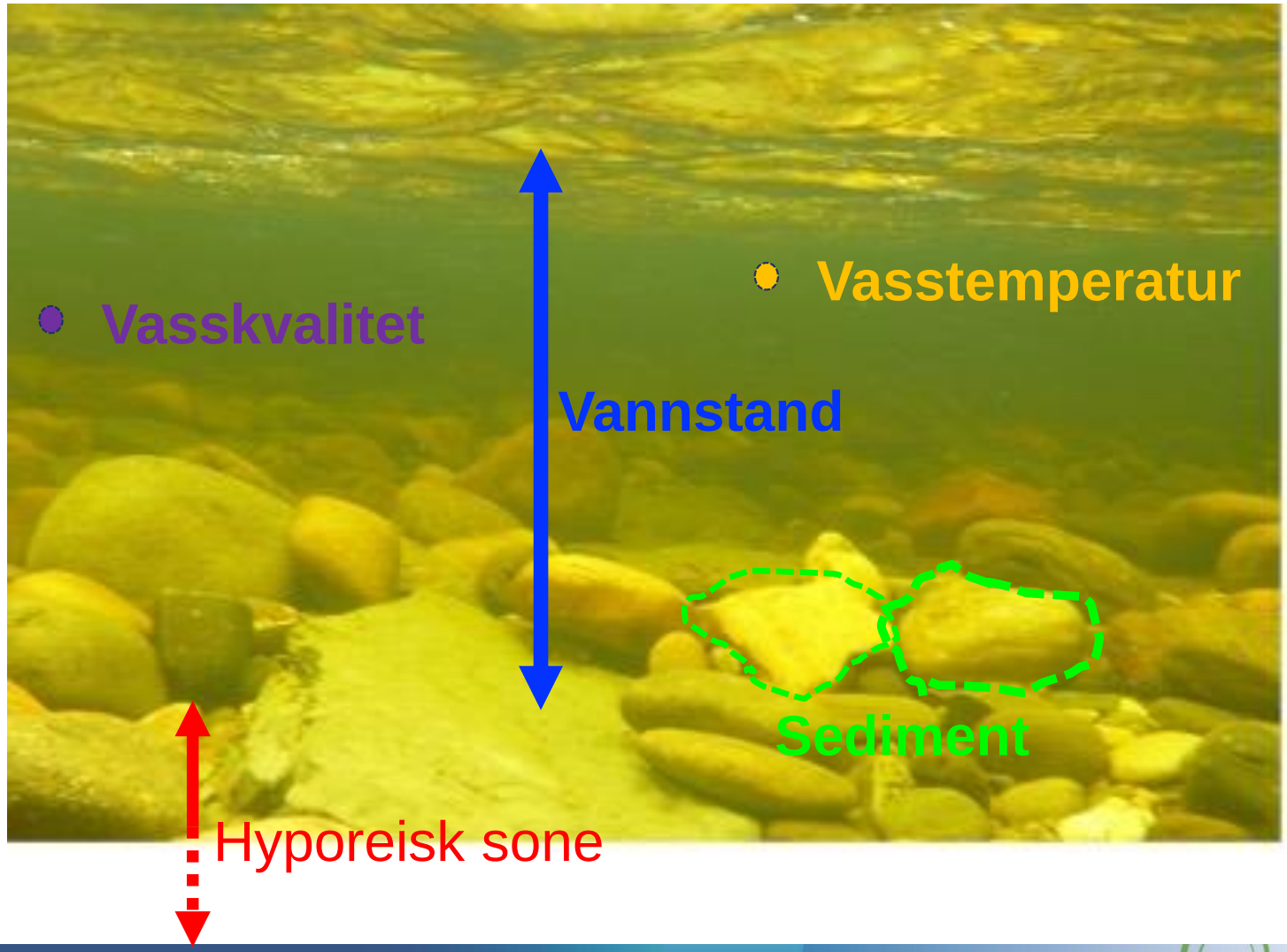
Effektkøyring



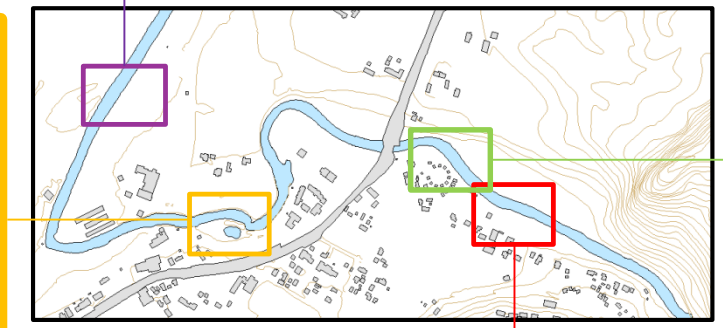
Verknader

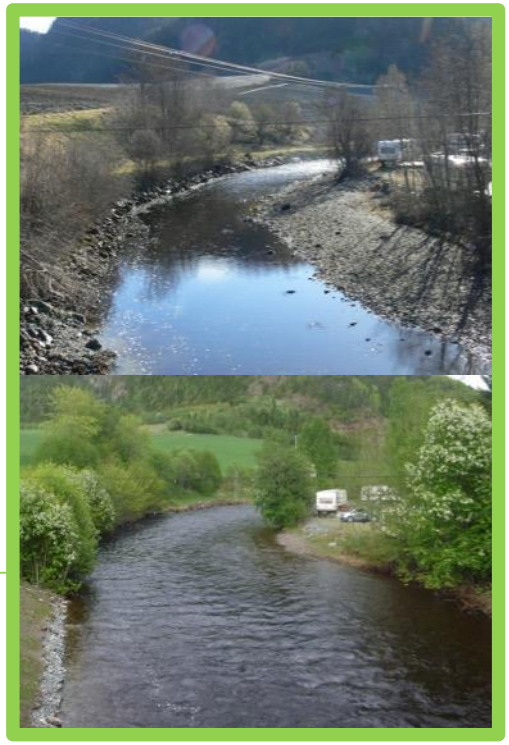


Fysisk habitat

II

Studieområde





All photos: Roser Casas-Mulet

Feltmålingar

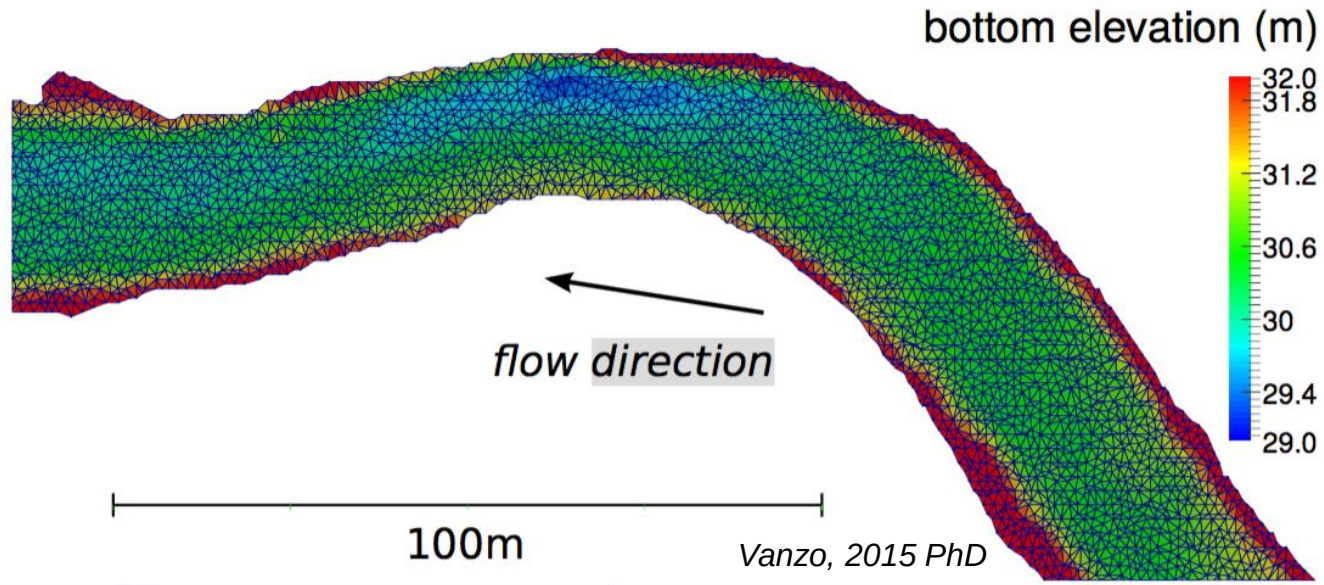




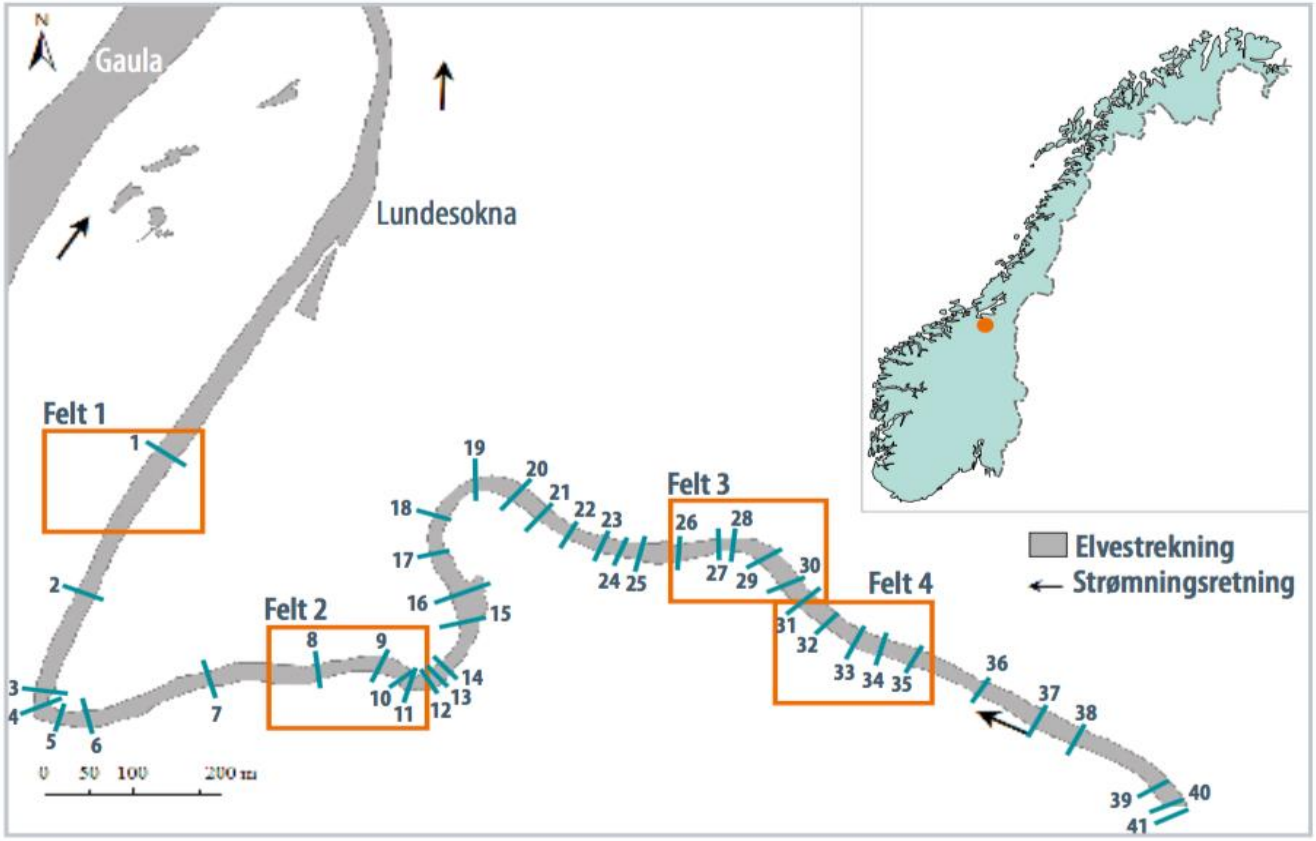


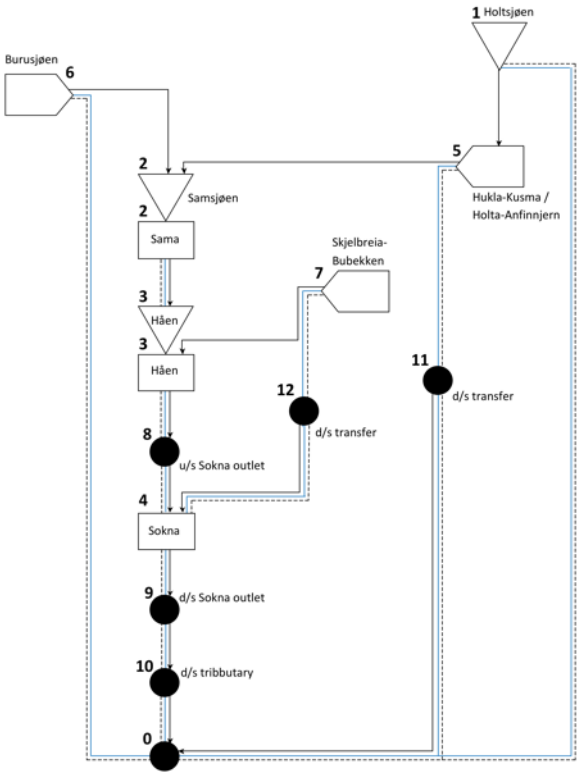

Bruk av modellar

- For å kunne føresjå korleis effektkøyring påvekar fysiske tilhøve treng vi å sette opp modellar for påverka strekningar.
- Ulike tilnærmingar finst, både 1D, 2D og 3D modellar er testa i prosjektet.
- Nokre problemstillingar:
  - Simulering av typiske variable (nedtapping, uttørking,….)
  - Kor nøyaktig grunnlag trengs for å gjere dette?
  - Kor stor skala kan vi jobbe på?
  - Oppsett og kalibrering



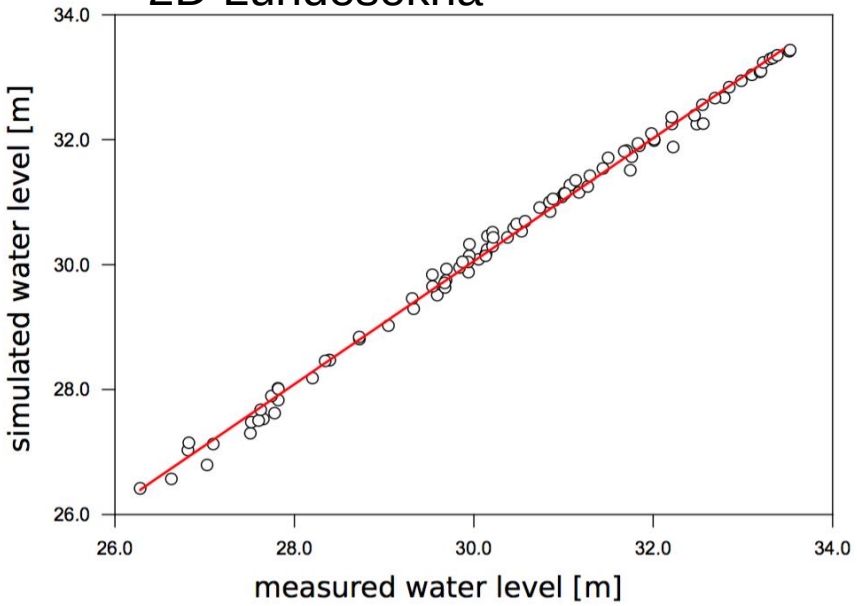
Vanzo, 2015 PhD



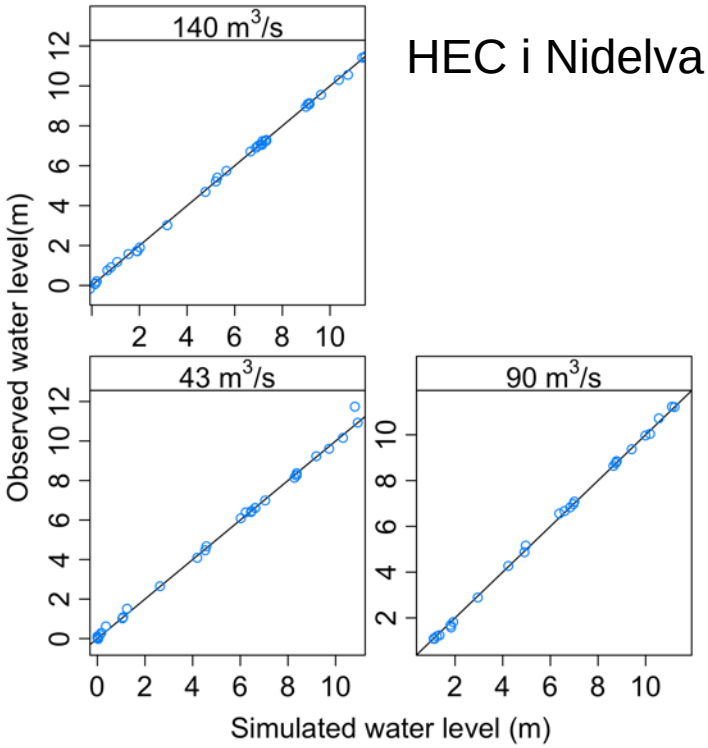


Modellkalibrering

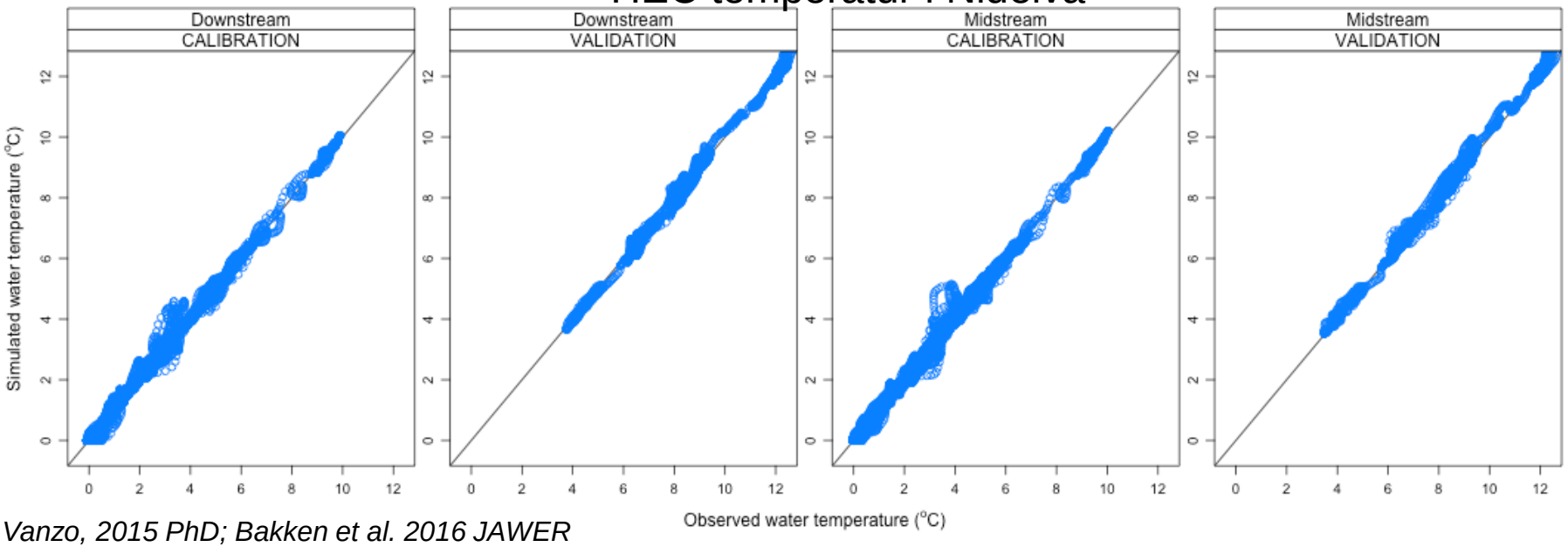
2D Lundesokna



HEC i Nidelva



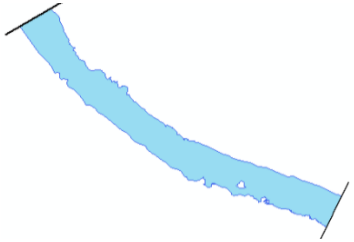
HEC temperatur i Nidelva



Vanzo, 2015 PhD; Bakken et al. 2016 JAWER

Presisjon i simulering av tørrlegging

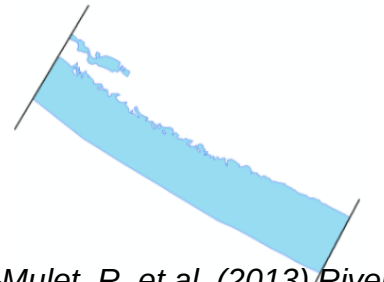
Felt 1

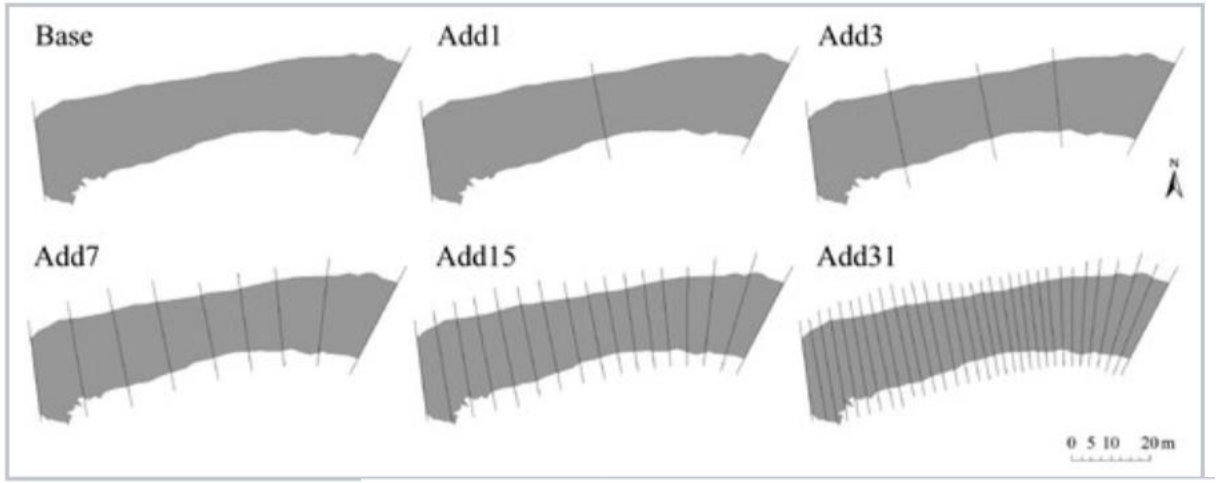


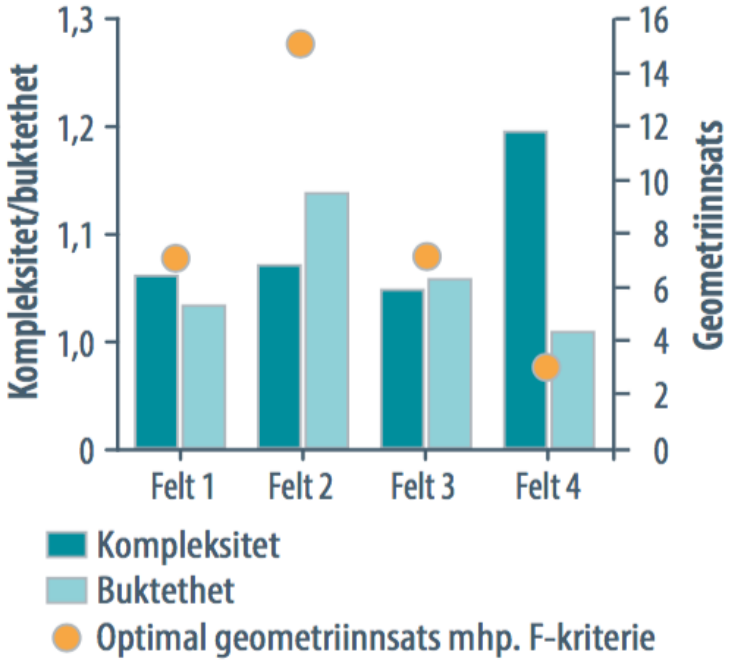
Felt 2

Felt 3

Felt 4

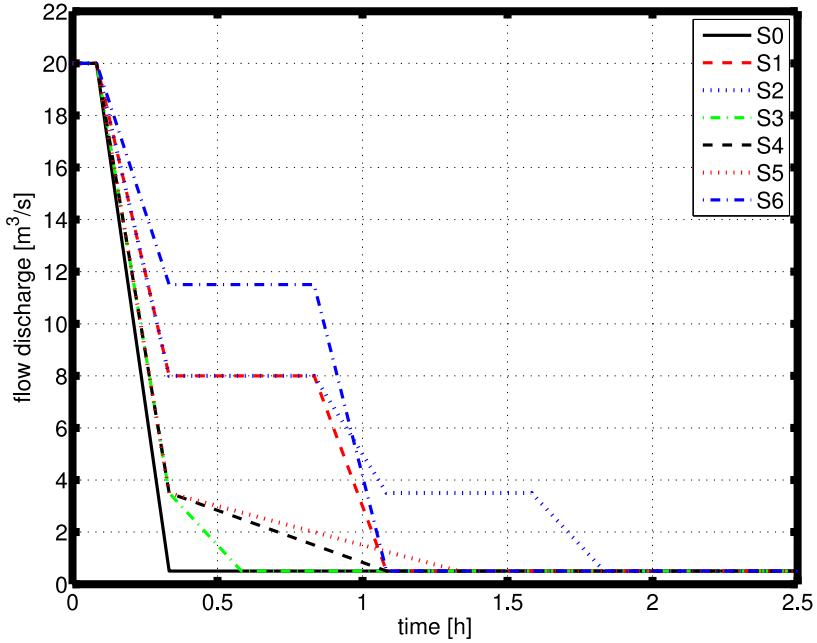


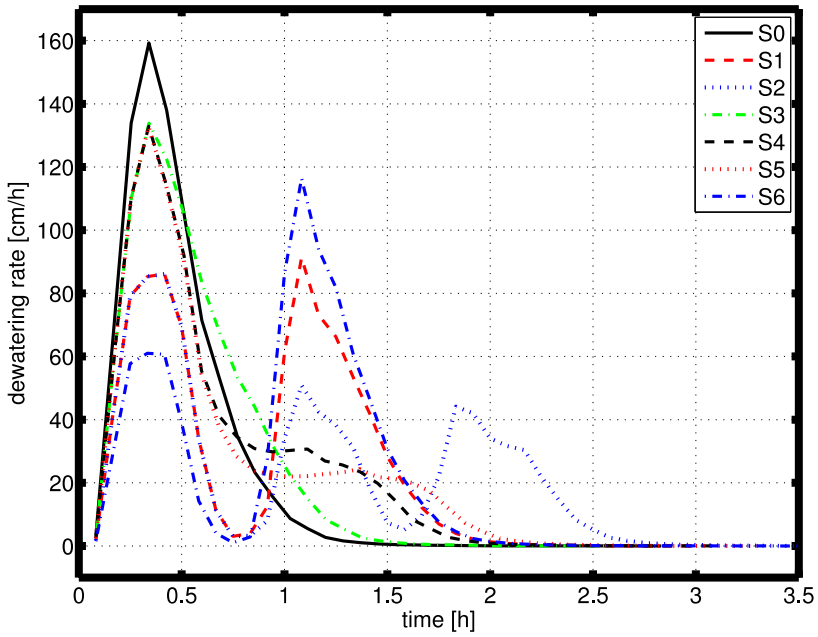


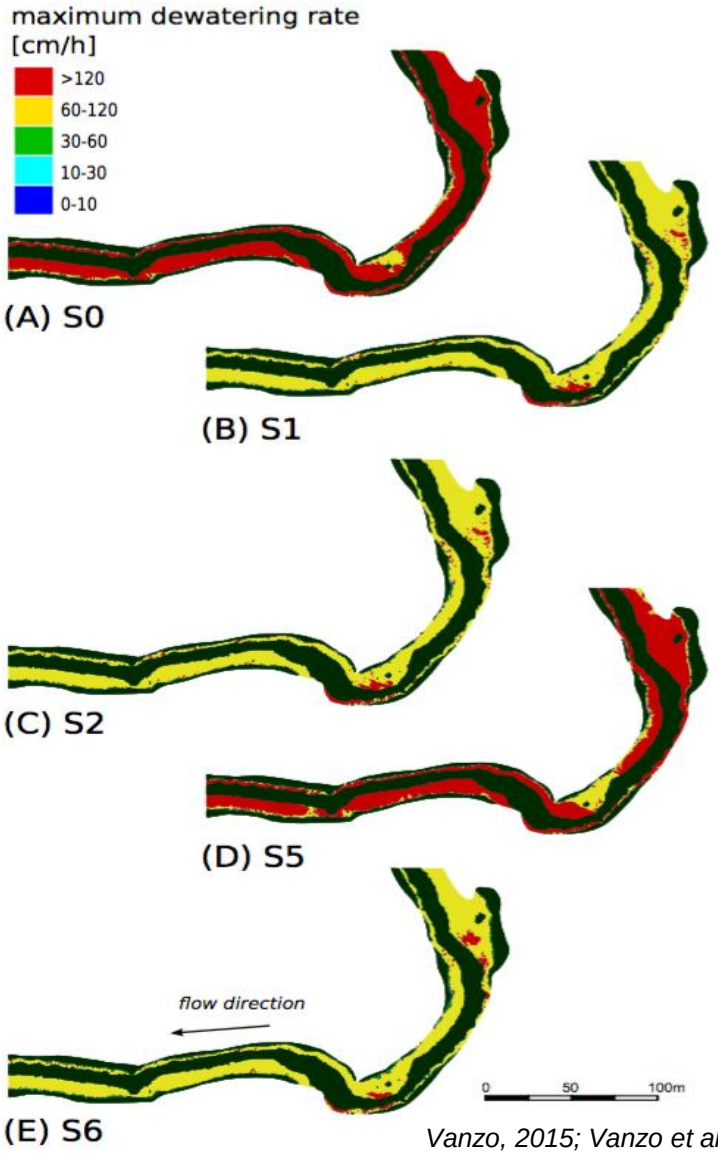


Casas-Mulet, R. et al. (2013) River Research and Applications

Tørrlegging

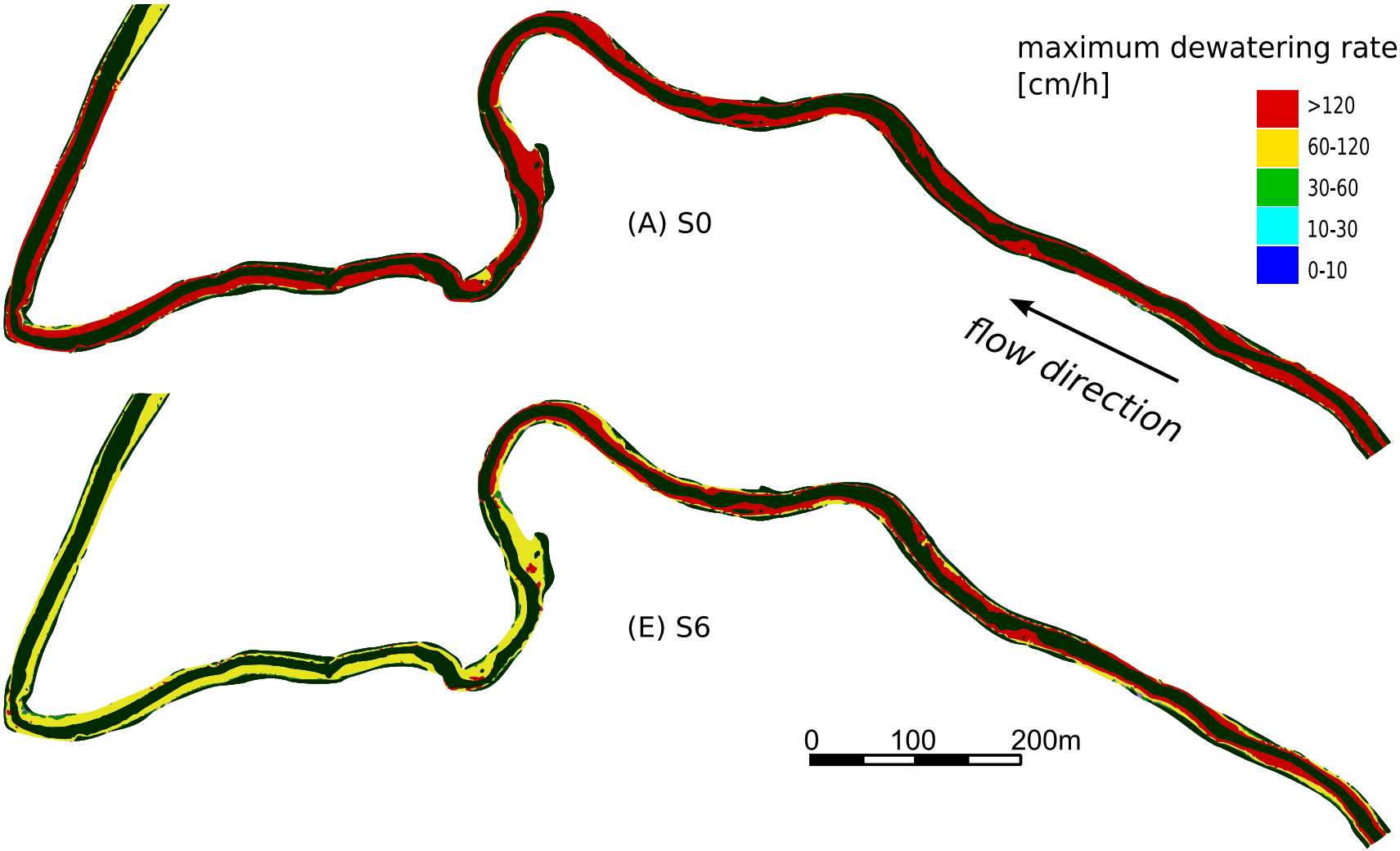






Vanzo, 2015; Vanzo et al. 2014 14th ISE

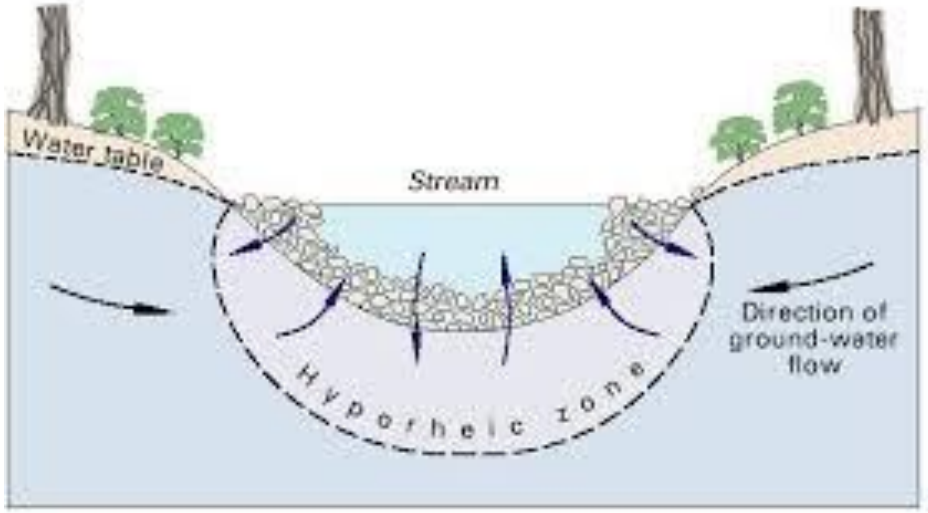
Tørrleggingsrate



Vanzo, 2015; Vanzo et al. 2014 14th ISE

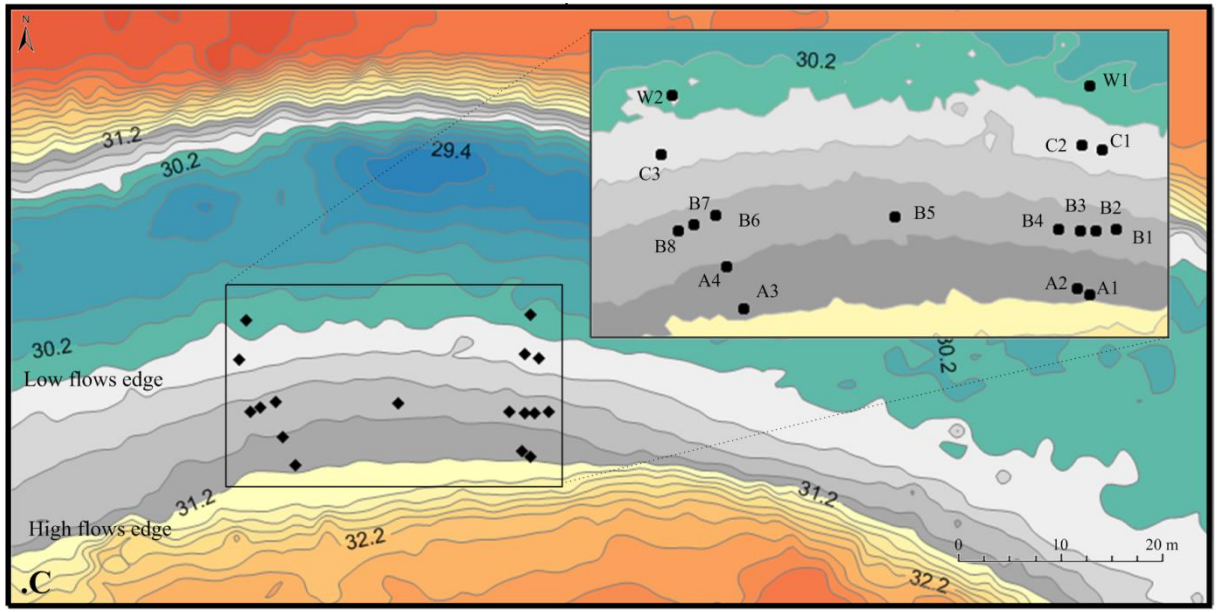
Vatn i grunnen (hyporeisk sone)

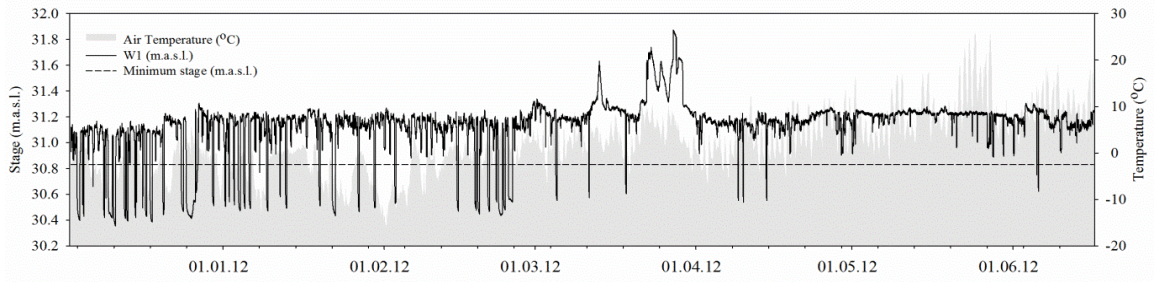
- Interaksjon mellom overflatevatn og hyporeisk sone viktig for mange funksjonar:
  - Egg
  - Botndyr
  - Sediment
  - Stranding av fisk



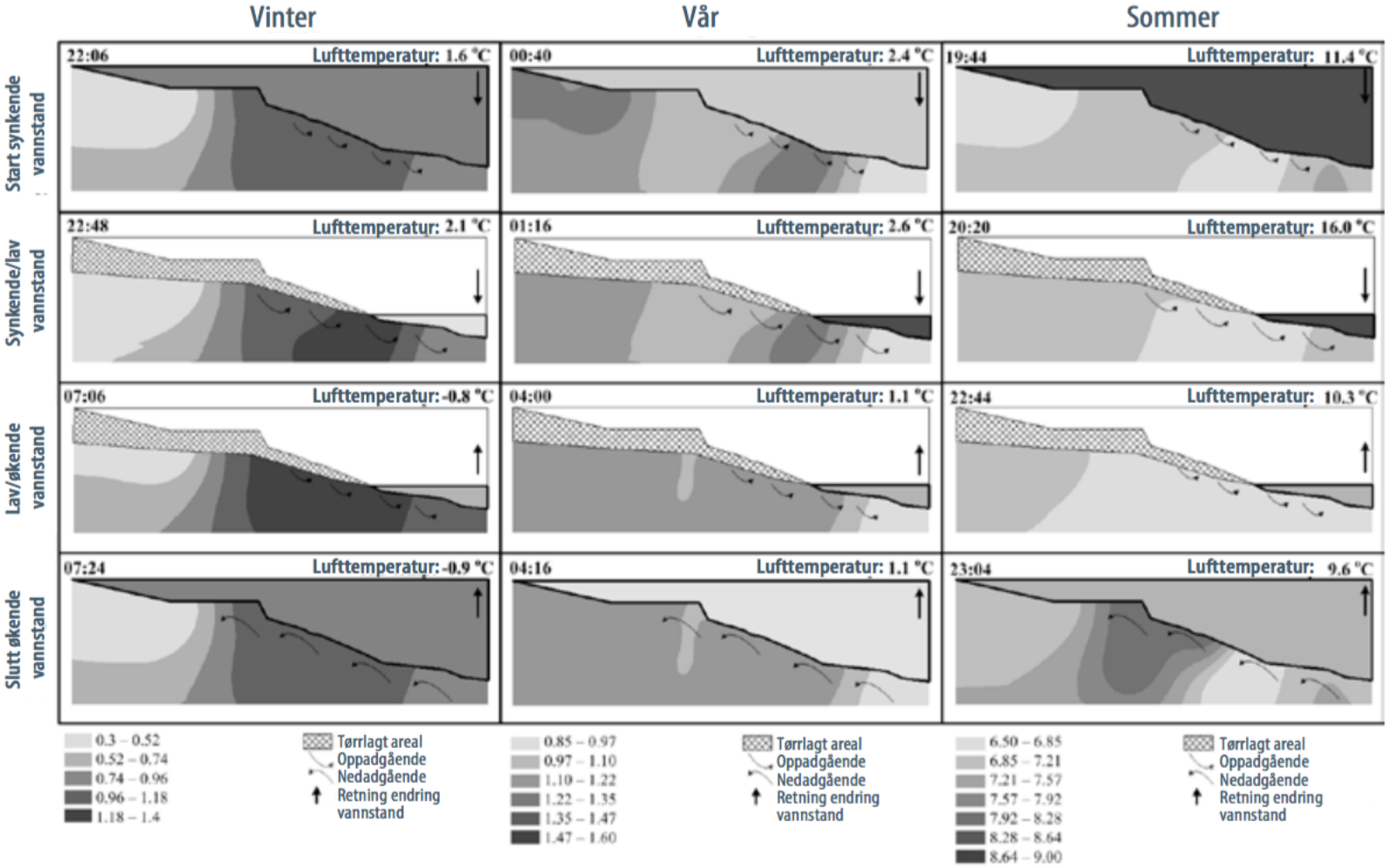
www.usgs.gov

Vatn i grunnen - instrumentering





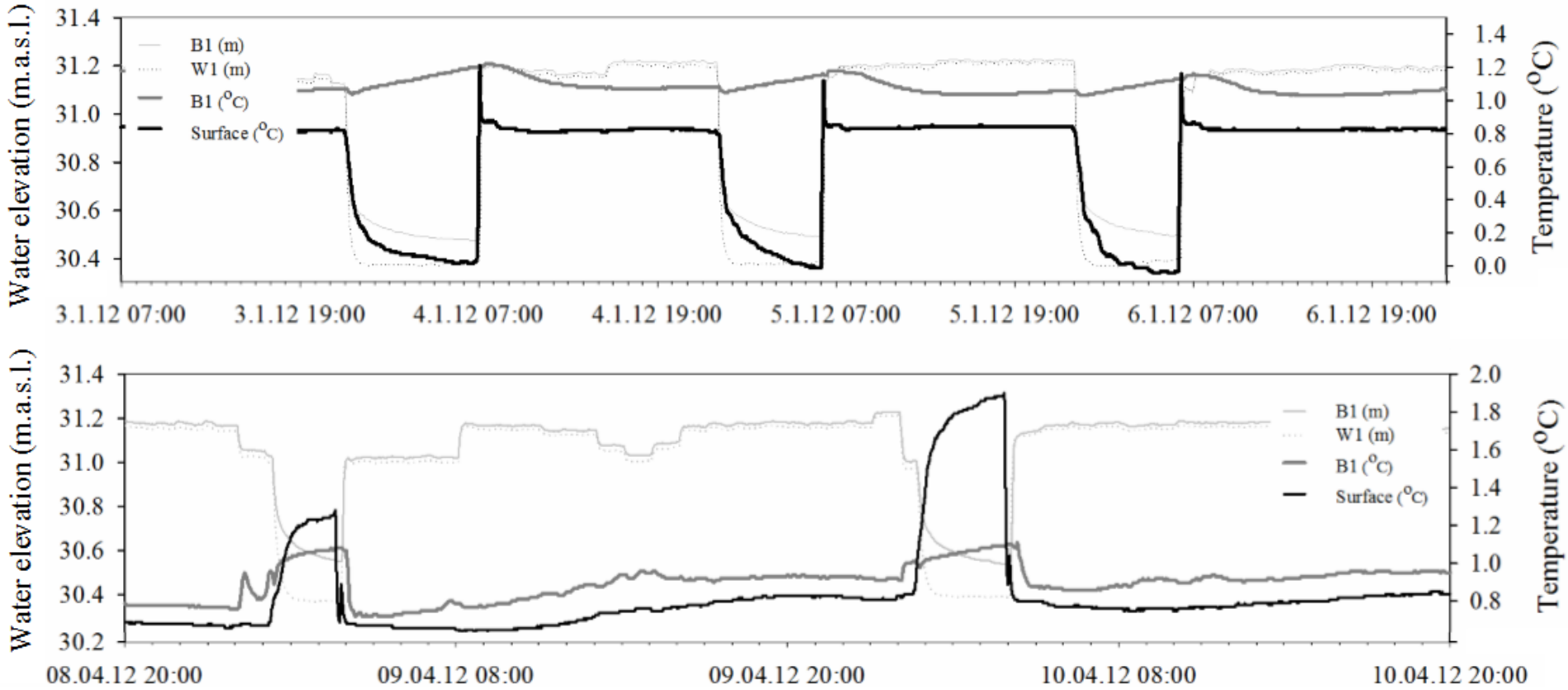
Vatn i grunnen - resultat



Casas-Mulet, R. (2014) Hydrological Processes

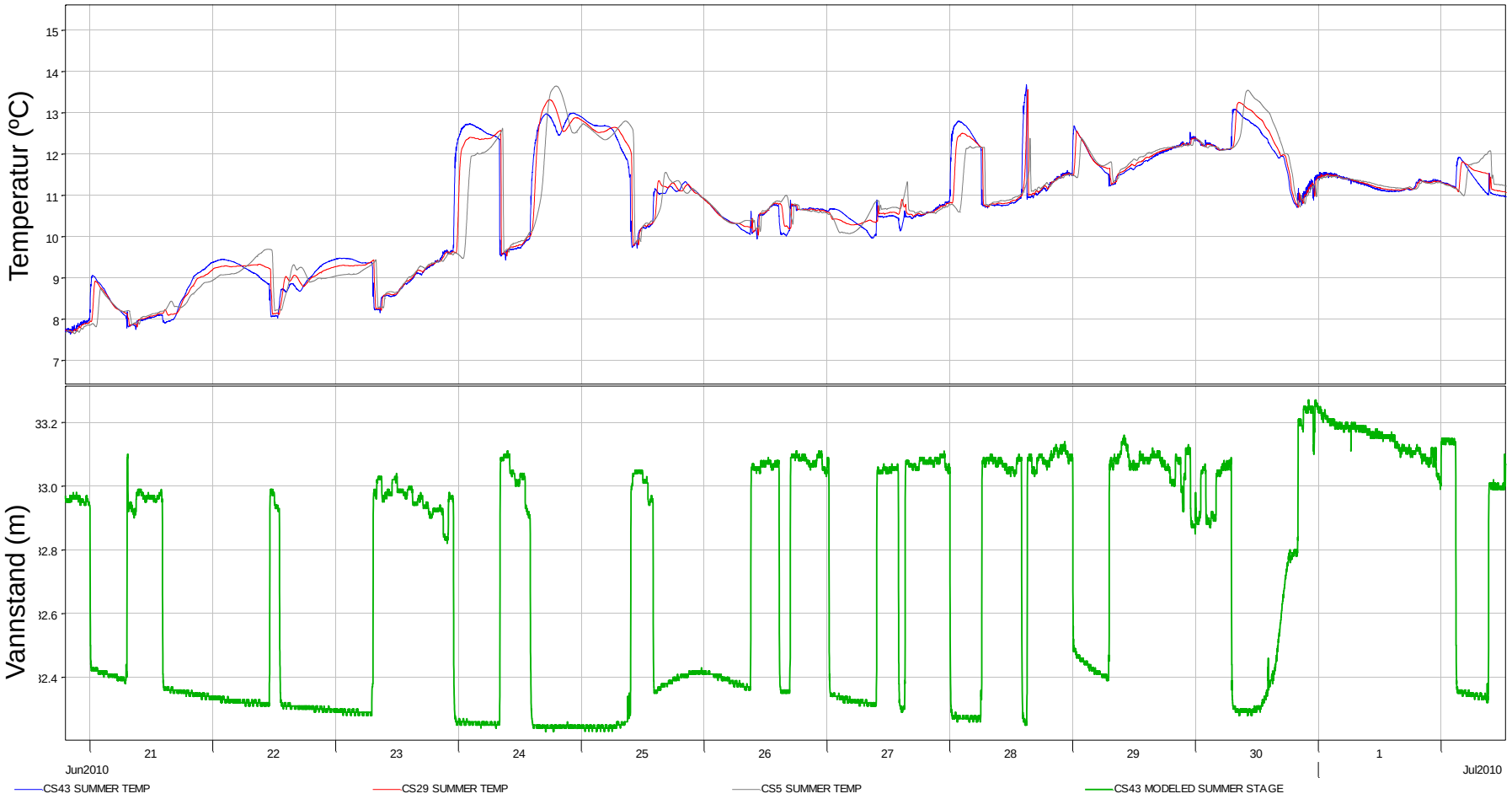
Temperatur

- Temperatur overflate/grunn for vinter (øvre) og vår (nedre)



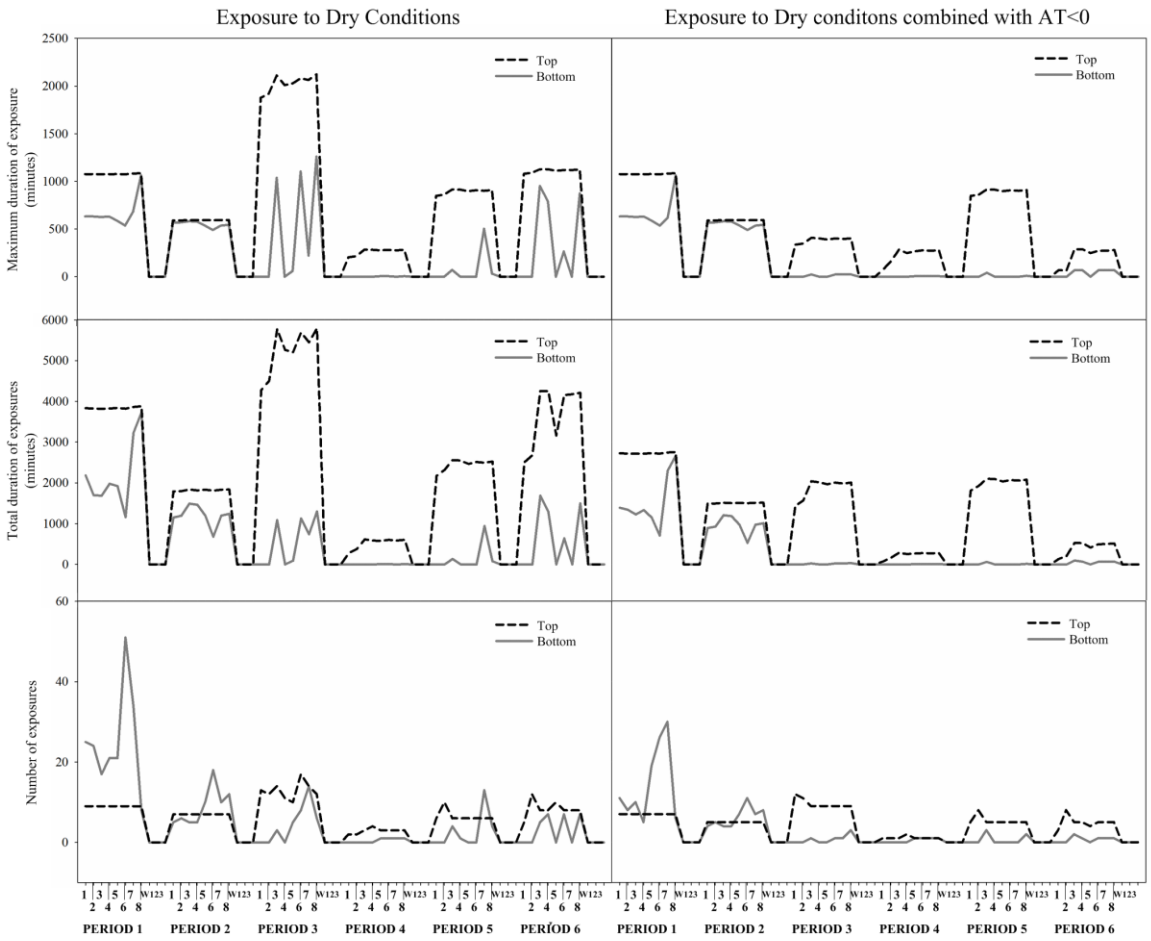
Casas-Mulet, R. (2014) Hydrological Processes

Simulert “thermopeaking”



Frost

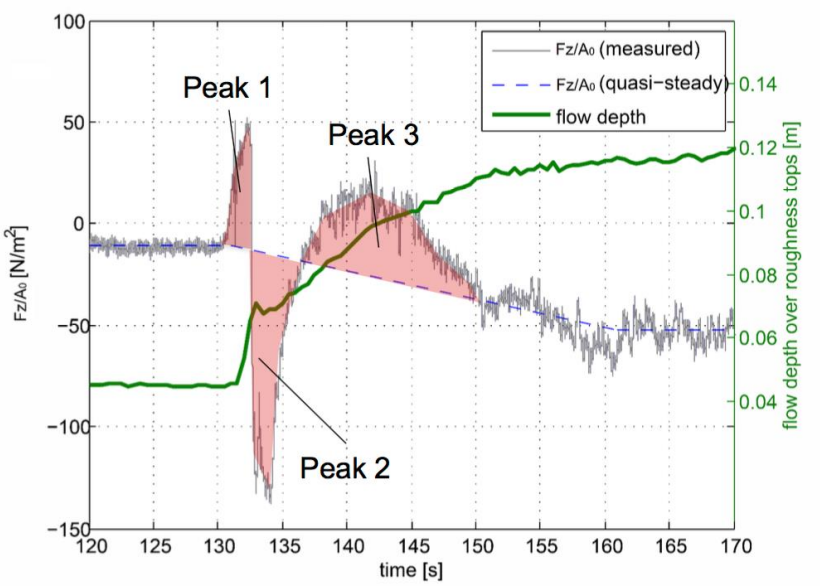
- Ei temperatureffekt som vart observert er frost i tørrlagde delar av substratet når elva var nedtappa i kalde perioder
  - Fører til frysing av smådammar med vatn
  - Frosten trenger ned i grunnen, som kan føre til frysing i gytegroper.



Casas-Mulet, R. (2014) River Research and Applications; Casas-Mulet, R. (2016) Fisheries Management and Ecology

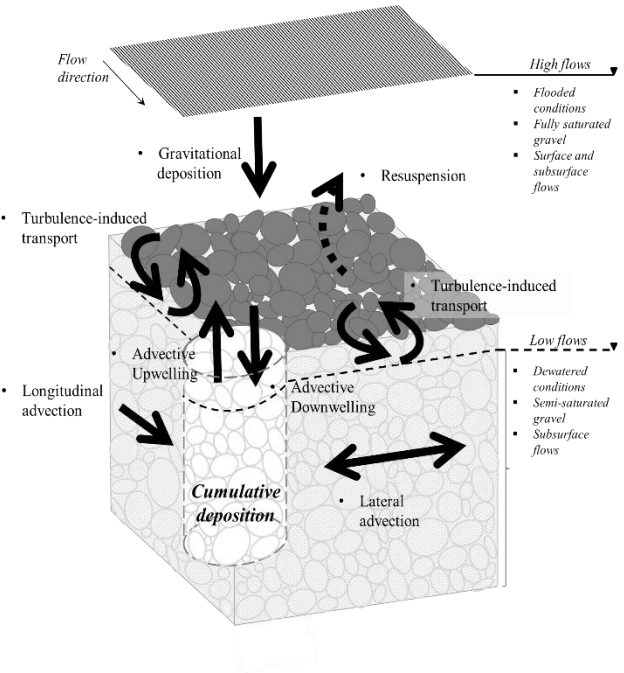
Sediment

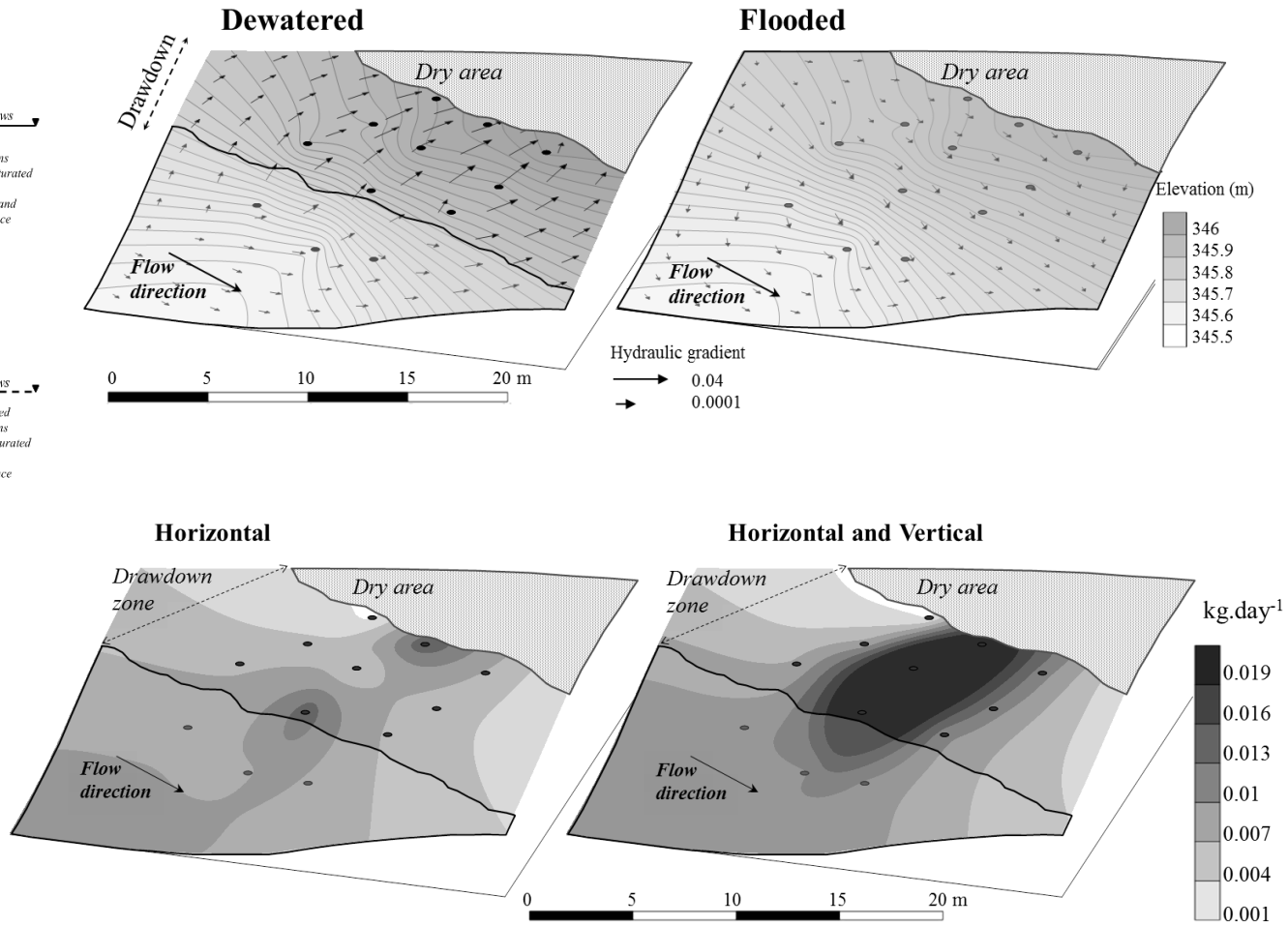
- Statisk, armert botnsediment
  - Lite tilførsel av sediment frå oppstraums side
  - "Pakking" av sedimentet.
  - Reduksjon i holrom og skjul over tid
  - Motstand mot erosjon
  - Varierende vassføring gir fører med seg dynamisk "løft" og skjerkrefter.



Spiller & Rüther (2014)

Sedimentakkumulering

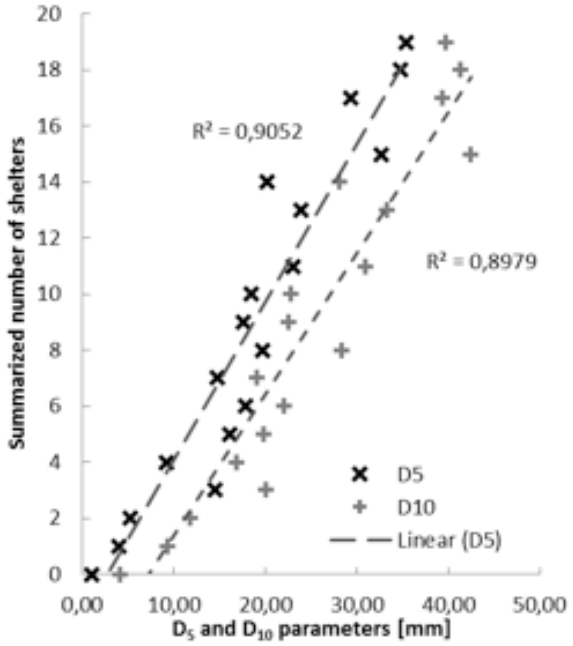


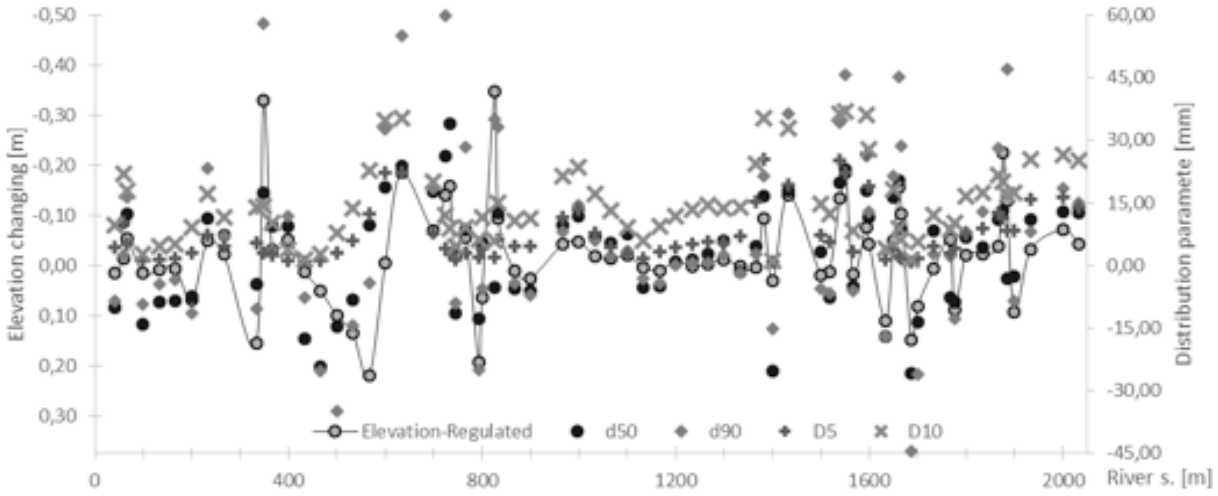


Casas-Mulet et al. (in prep)

Langtidsverknad på skjul

- Samanheng mellom skjul og kornstorleik etablert
- Simulering av utvikling av skjul over tid som funksjon av vassføring

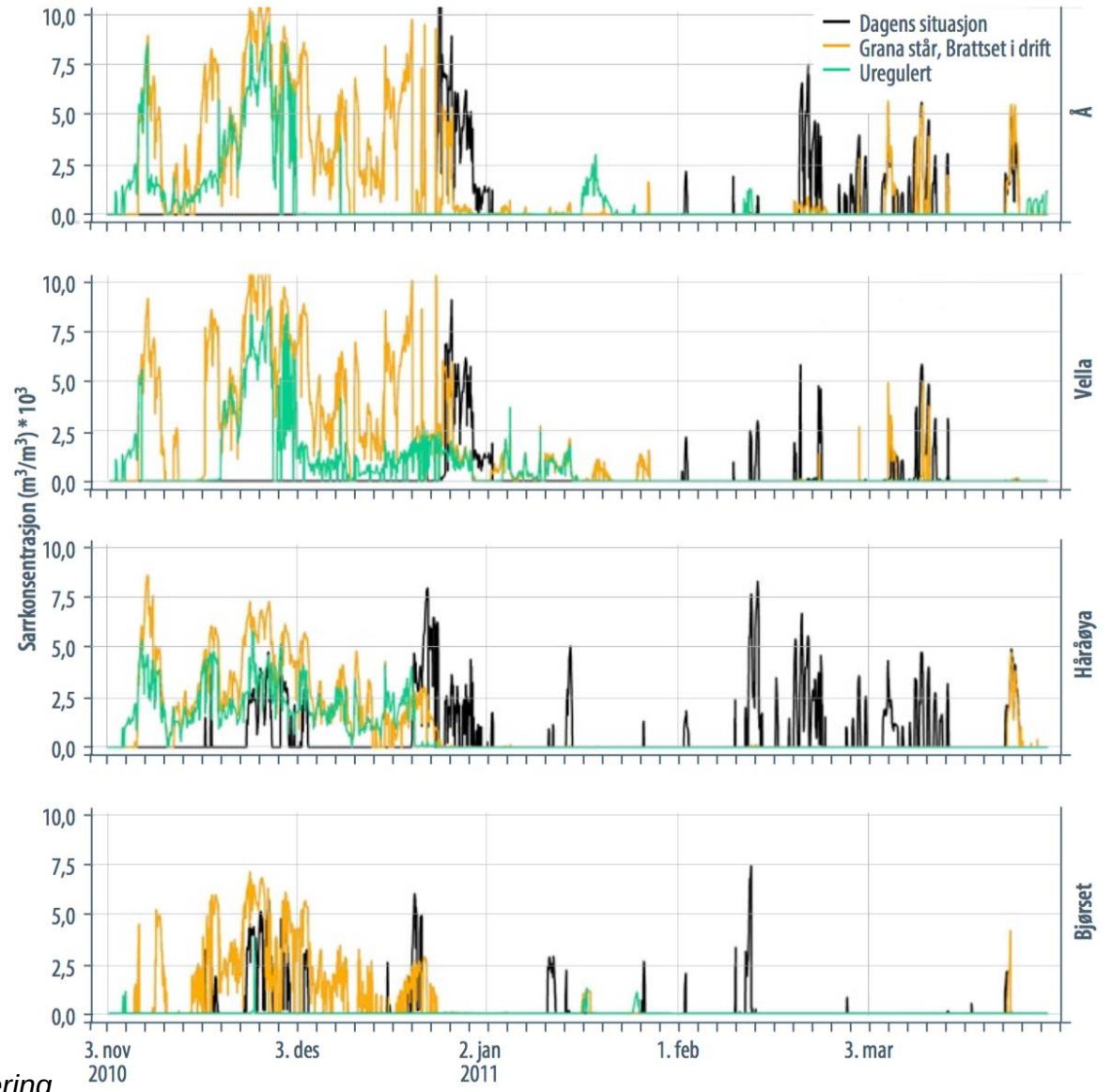




Szabo-Mezaros et al. (in prep)

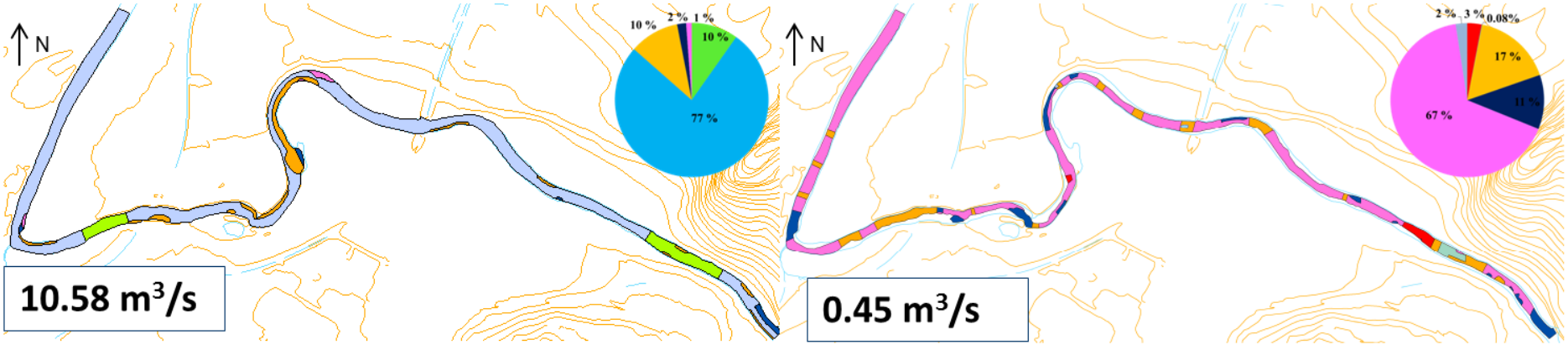
Is

- Simulering av sarr ved ulik regulering i Orkla
  - Simulert naturleg viser stabilt isdekke. Sarr mest i starten på vinteren
  - Aukande regulering gir meir sarrproduksjon og mindre stabilt isdekke
  - Effekt av tapping av varmt produksjonsvatn



Timalsina (2013) Journal of Cold Regions Engineering

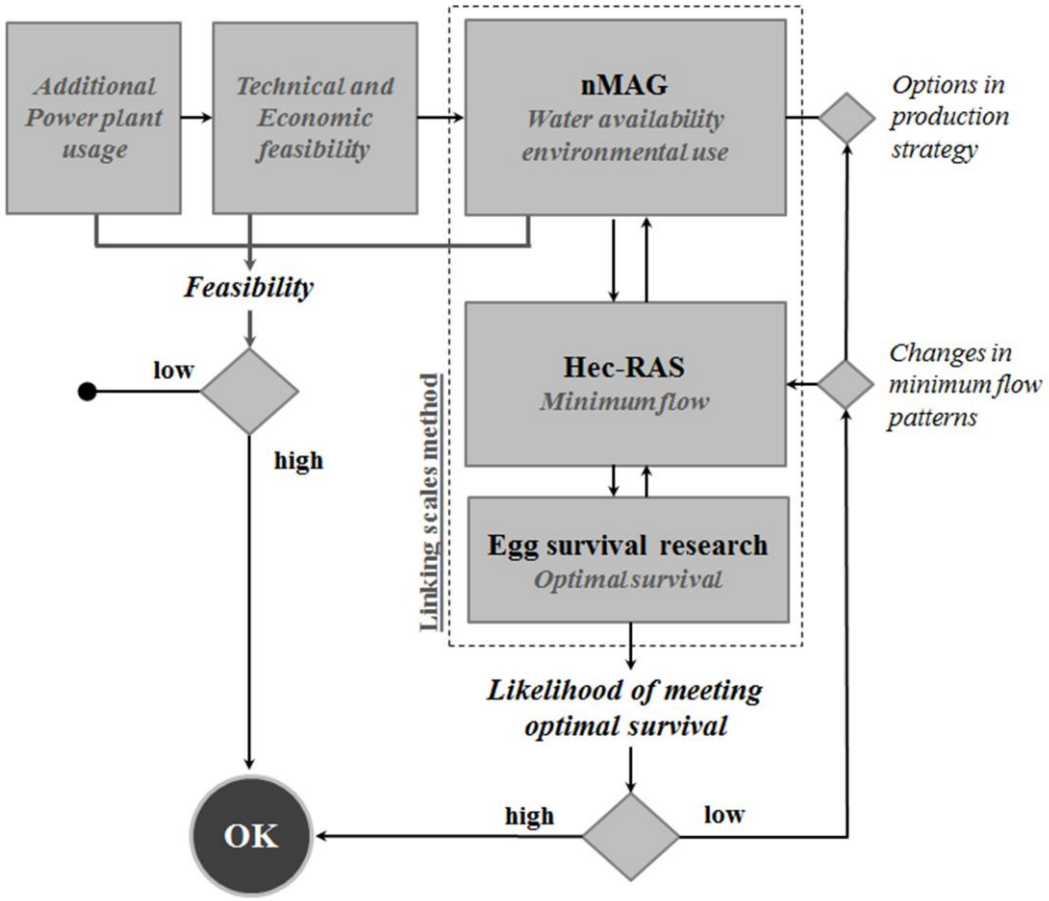
Habitat



Vannføring [m³/s]	Treffprosent	% treff i forhold til de enkelte kriterier			
		Overflate-struktur	Helning vannspeil	Hastighet overflaten	Vanndybde
20,6	95,1	97,6	100,0	100,0	97,6
16,4	80,5	85,4	95,1	100,0	95,1
10,6	61,0	75,6	97,6	92,7	92,7
0,45	61,0	95,1	100,0	80,5	82,6

Casas-Mulet, R. et al. (2014) International Journal of River Basin Management

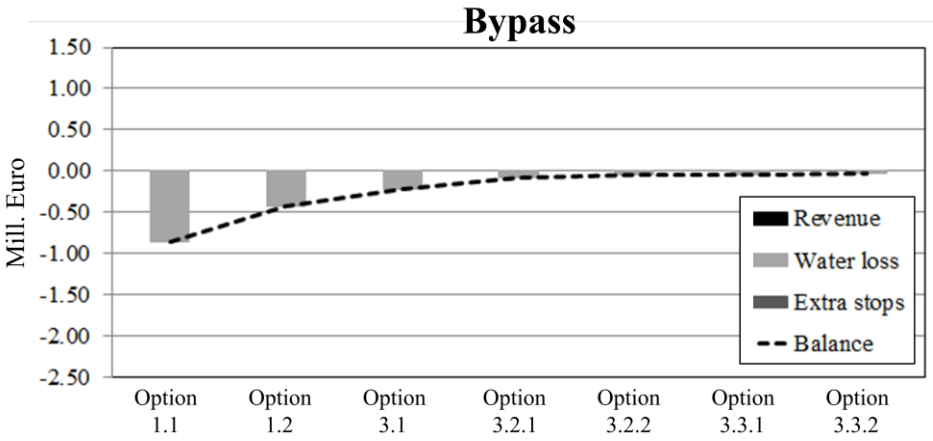
Modellintegrasjon for tiltak

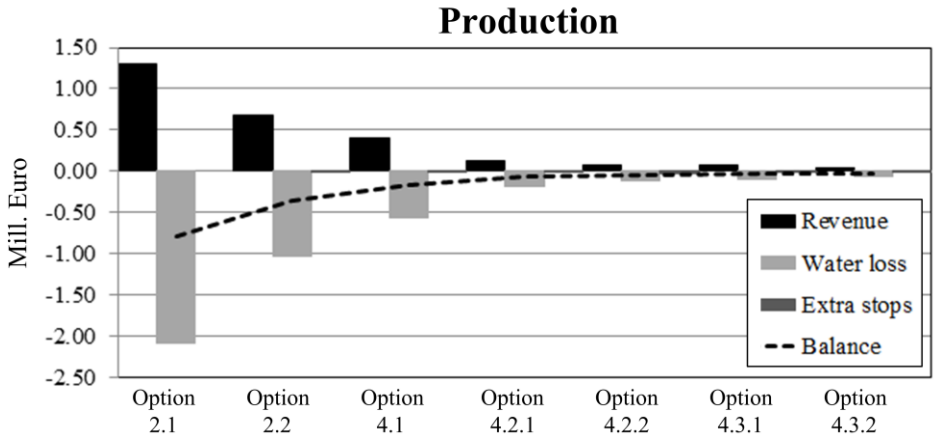


Options	Description
Options 1.	**Permanent bypass of 3.5 $m^3 s^{-1}$ during**
Option 1.1	*All year round*
Option 1.2	*From 1 October to 31 March*
Options 2	**Permanent production of 8 $m^3 s^{-1}$ during**
Option 2.1	*All year round*
Option 2.2	*From 1 October to 31 March*
Options 3	**Bypass of 3.5 $m^3 s^{-1}$ when**
Option 3.1	Production flows are below 3.5 $m^3 s^{-1}$ and AT <0 °C
	Bypass for the whole period
Option 3.2.1	Production flows are below 3.5 $m^3 s^{-1}$ and AT <0 °C for ≥3 h
	Bypass for 2 h every 3 h
Option 3.2.2	Production flows are below 3.5 $m^3 s^{-1}$ and AT <0 °C for ≥3 h
	Bypass for 1 h every 3 h
Option 3.3.1	Production flows are below 3.5 $m^3 s^{-1}$ and AT <0 °C for ≥6 h
	Bypass for 2 h every 6 h
Option 3.3.2	Production flows are below 3.5 $m^3 s^{-1}$ and AT <0 °C for ≥6 h
	Bypass for 1 h every 6 h
Options 4	**Produce 8 $m^3 s^{-1}$ when**
Option 4.1	Production flows are below 3.5 $m^3 s^{-1}$ and AT <0 °C
	Produce for the whole period
Option 4.2.1	Production flows are below 3.5 $m^3 s^{-1}$ and AT <0 °C for ≥3 h
	Produce for 2 h every 3 h
Option 4.2.2	Production flows are below 3.5 $m^3 s^{-1}$ and AT <0 °C for ≥3 h
	Produce for 1 h every 3 h
Option 4.3.1	Production flows are below 3.5 $m^3 s^{-1}$ and AT <0 °C for ≥6 h
	Produce for 2 h every 6 h
Option 4.3.2	Production flows are below 3.5 $m^3 s^{-1}$ and AT <0 °C for ≥6 h
	Produce for 1 h every 6 h

Casas-Mulet, R. (2014) Fisheries Management and Ecology

Resultat tiltak





Options		Likelihood of meeting optimal embryo survival	Feasibility: Water volume used (%)	Feasibility: Economical (%)	Feasibility: Technical	Additional usage of turbines (%)
1 Permanent Bypass of 3.5 $m^3 s^{-1}$	1.1.	Very likely	31.8	−17.0	Not feasible	0.0
	1.2.	Likely	15.1	−8.1	Not feasible	0.0
2 Permanent Production of 8 $m^3 s^{-1}$	2.1.	Very likely	77.5	−16.5	Feasible	44.4
	2.2.	Likely	37.0	−6.8	Feasible	21.4
3 Conditional Bypass of 3.5 $m^3 s^{-1}$	3.1.	Very likely	7.3	−4.2	Not feasible	0.0
	3.2.1.	Very likely	2.4	−1.4	Not feasible	0.0
	3.2.2.	Very likely	1.5	−0.9	Not feasible	0.0
	3.3.1.	Likely	1.3	−0.7	Not feasible	0.0
	3.3.2.	Likely	0.7	−0.4	Feasible	0.0
4 Conditional Production of 8 $m^3 s^{-1}$	4.1.	Very likely	20.0	−3.4	Feasible	10.1
	4.2.1.	Very likely	6.5	−1.3	Feasible	3.3
	4.2.2.	Very likely	4.1	−1.1	Feasible	2.1
	4.3.1.	Likely	3.4	−0.7	Feasible	1.7
	4.3.2.	Likely	2.0	−0.5	Feasible	1.0

Casas-Mulet, R. (2014) Fisheries Management and Ecology

Oppsummering

- Ved start og stopp vil bølgjer (vatn og temperatur) forplante seg nedover i vassdraget, både i overflata og i hyporeisk sone
- Interaksjon mellom overflate og vatn i grunnen er viktig.
- Frost kan vere eit problem ved nedtapping
- Regulering reduserer stabilitet i isdekke, eller fjernar dette heilt.
- Modellverkty kombinert med presisjonsoppmåling gir godt grunnlag for vurdering av verknader og for målretta tiltak.