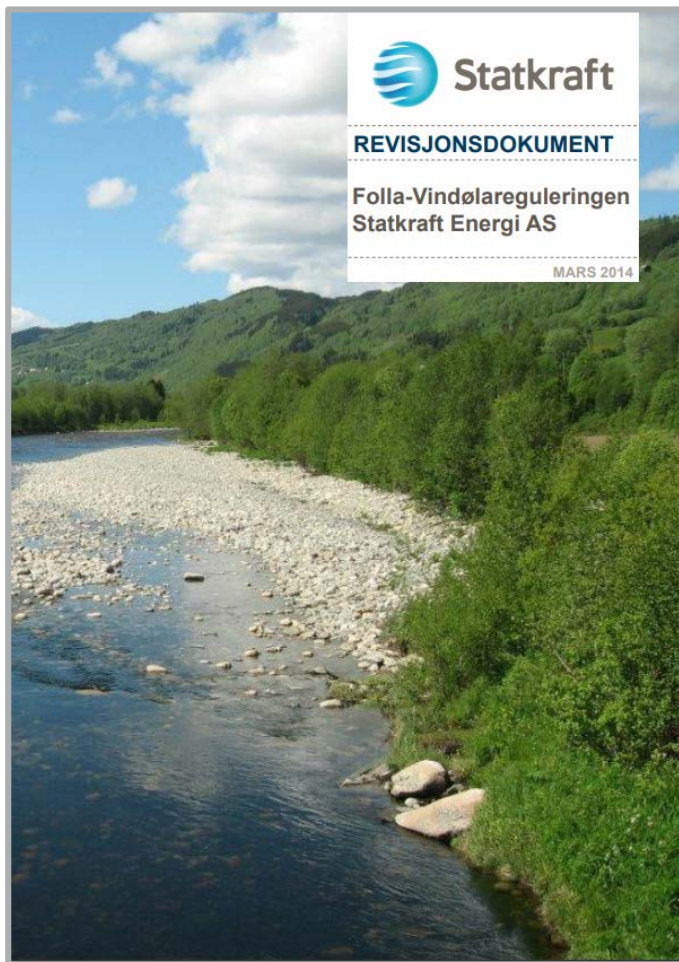
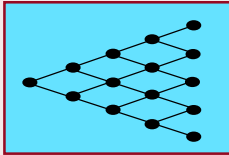
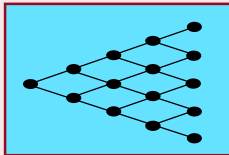
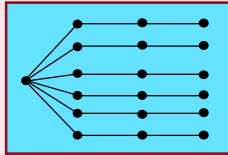


# What does NVE need from hydropower modelling?



# Comparison of Vansimtap, Prodrisk and Fansi

| Attribute \ Model                 | Vansimtap  | ProdRisk   | Fansi  |
|-----------------------------------|--|--|--|
| Inflow resolution                 | Weekly   | Daily  | Weekly   |
| Head effect in strategy           | No   | Yes  | Yes  |
| <b>Individual water values</b>    | Single reservoir   | Yes  | Yes  |
| Solution method                   | SDP  | SDDP   | SFS  |
| Time use                          | Fast   | Slow   | Slow   |
| <b>Uncertainty representation</b> |  |  |  |



# Test set-up

- II watersheds
- Default parameters
- Qualitative comparison of results

```
from nve_modell.prosjekt.prt import RunTest

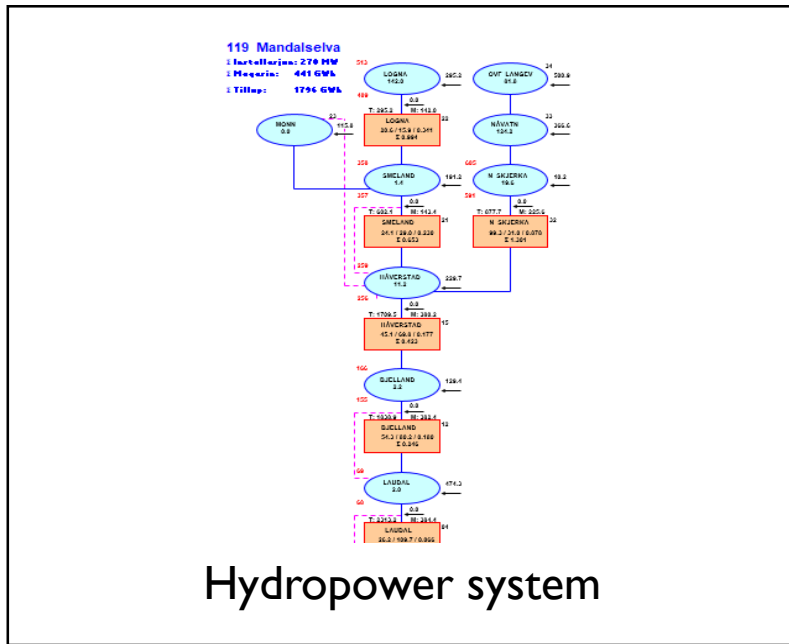
conf = dict()
conf["omrnavn"] = "BARDU"
conf["path_output"] = "test_bardu_2"
conf["path_detd_fil"] = "input/MALSELV_H.DETD"

conf["scenarioer"] = [
    {
        "navn" : "vansimtap",
        "modell" : "vansimtap",
    },
    {
        "navn" : "prodrisk",
        "modell" : "prodrisk",
    },
    {
        "navn" : "fansi",
        "modell" : "fansi",
    },
]
```

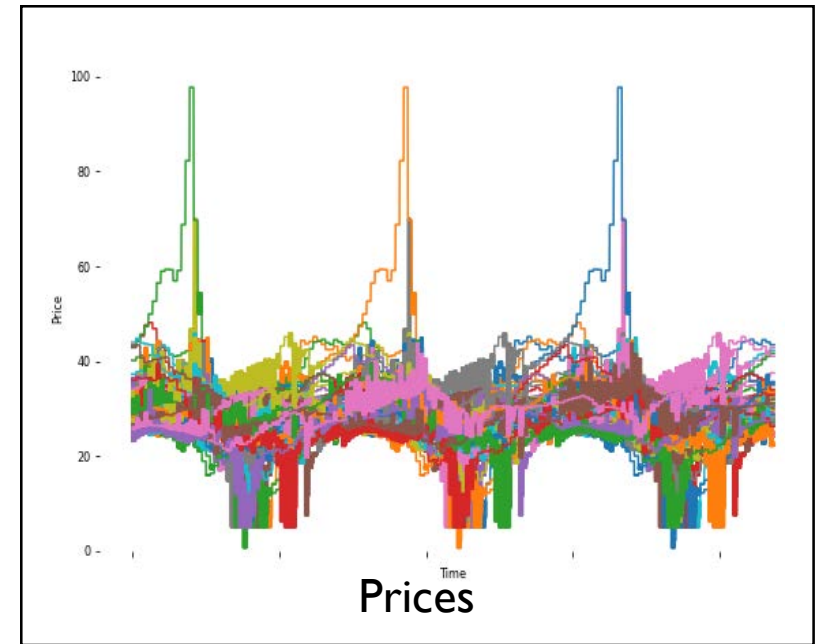
| New Volume (D:) ▶ Prosjekter ▶ 2018_Prodrisk ▶ Testsystem ▶ test_bardu_2 |                  |               |
|--|------------------|---------------|
| Name   | Date modified    | Type          |
| fansi  | 11.07.2018 11:08 | File folder   |
| prodrisk   | 11.07.2018 11:05 | File folder   |
| vansimtap  | 11.07.2018 10:57 | File folder   |
| RunTest.pkl  | 11.07.2018 11:08 | PKL File      |
| tid.txt  | 11.07.2018 11:08 | Text Document |

# Using Fansi for one watershed

Area 1



Area 2



99999 MW

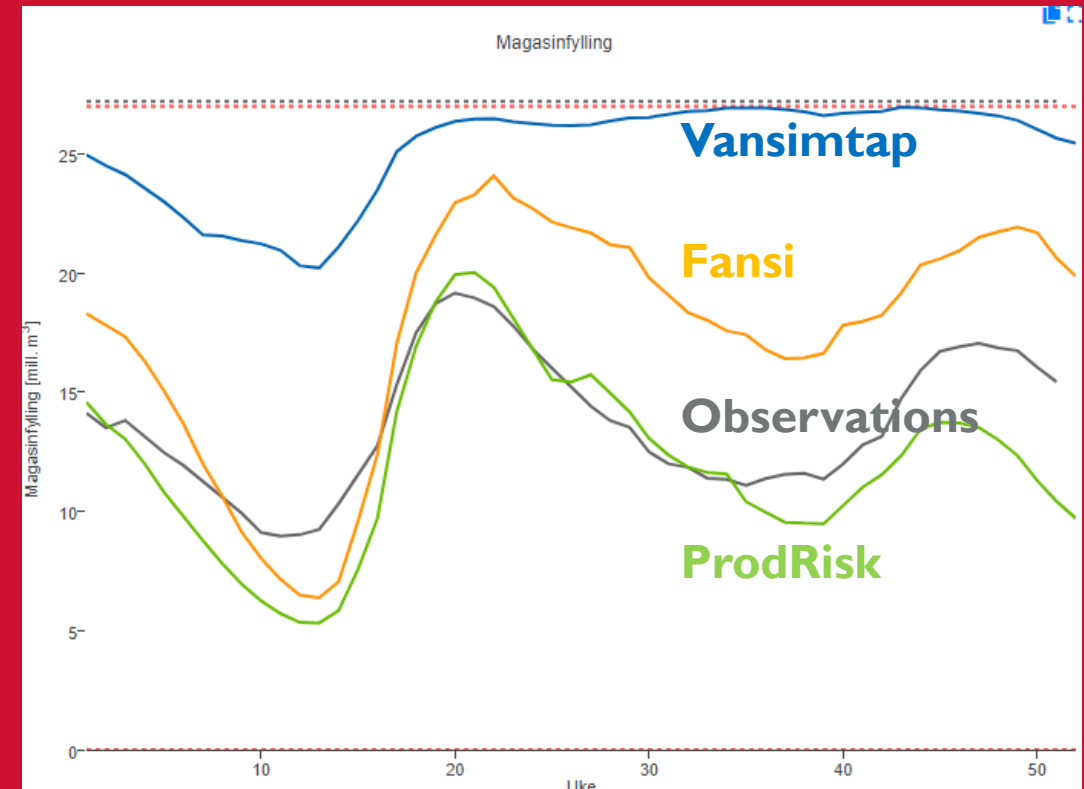
Unlimited capacity



## ProdRisk & Fansi give higher revenue

- ProdRisk and Fansi are closer to observed reservoir filling
- The three models are more similar in simple watersheds (Bardu, Røssåga etc.)
- Vansimtap still gives quite good results, especially for the watershed as a whole

| GLB | Prod,<br>[GWh] | Inntekt<br>[MNOK] |           |
|-----|----------------|-------------------|-----------|
|     | 11,705.54      | 3,134.13          | Vansimtap |
|     | 12,278.06      | 3,341.92          | FanSi     |
|     | 12,212.46      | 3,306.84          | Prodrisk  |

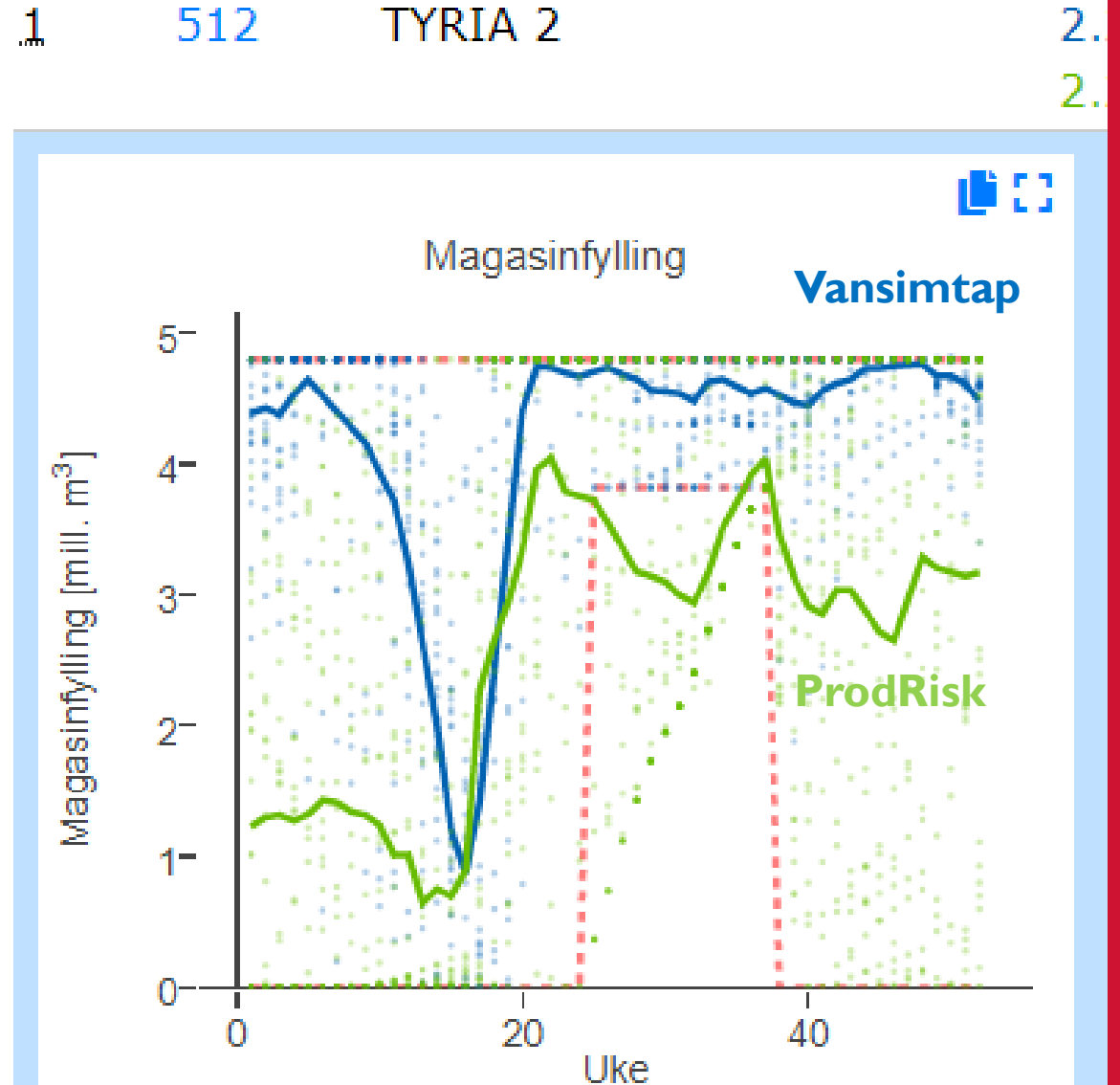


Reservoir filling of Flittig kraftverk in the Skien watershed. Average 1981-2010, observations 1998-2017

# Vansimtap is better at "soft" constraints for reservoirs

- Vansimtap:  
Rule-based constraints
- Prodrisk & Fansi:  
All constraints are the same,  
adjusts cost for violating  
constraints.

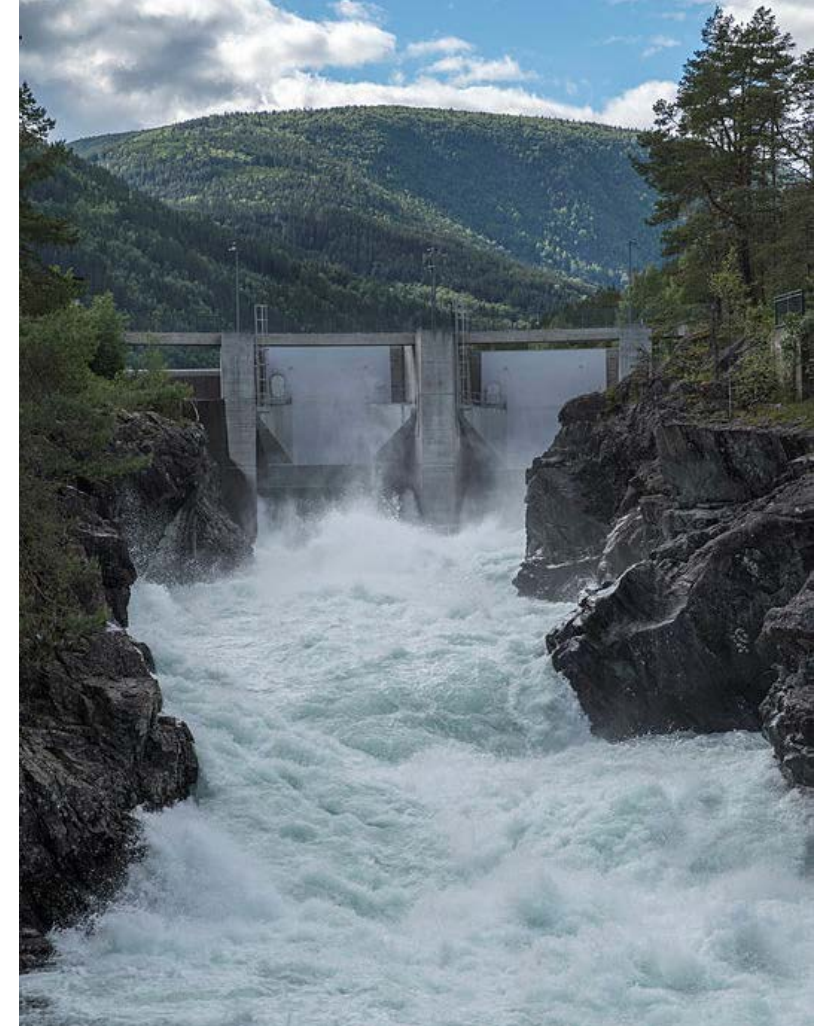
"After June 1<sup>st</sup>, all inflow should go towards filling the reservoir until it reaches level 474"





## Fansi was faster than Prodrisk in this test

- Run-times for Glomma and Lågen watershed:
  - Vansimtap: 20 seconds
  - Fansi: 60 minutes
  - ProdRisk: 12 hours
- Simulation parameters and hardware will affect time use a lot.
- Time use affects how you work with the models in practice.



Dam Eidefoss, Stig Storheil NVE



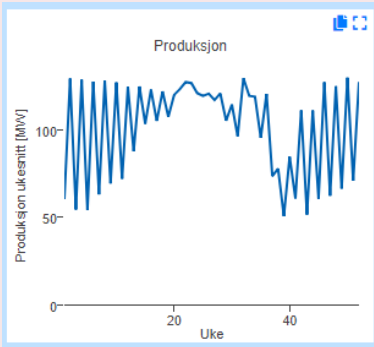
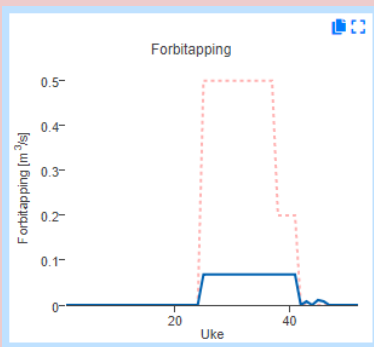
## Only ProdRisk uses daily inflow

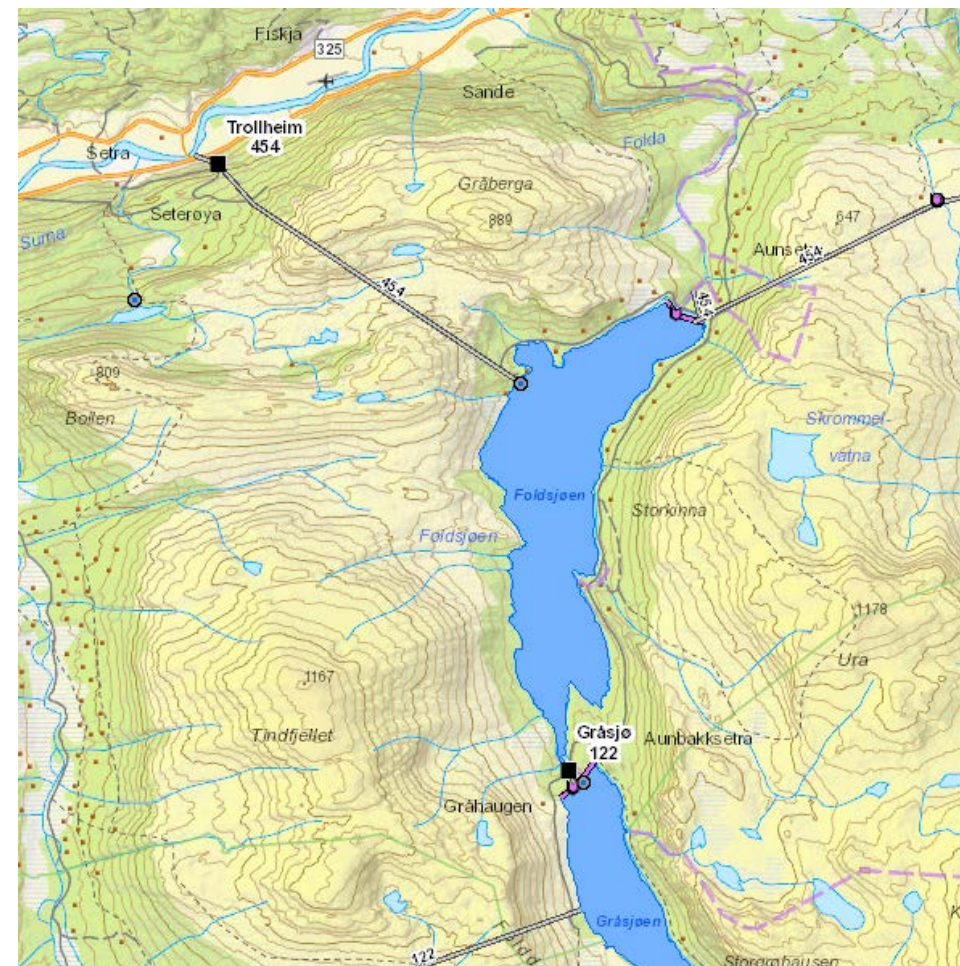
- Daily inflow resolution as opposed to weekly inflow is not important if the reservoirs are large.
- In watersheds with small reservoirs daily inflow resolution matters.



| Omr | Modul | Modulnavn | Ytelse<br>[MW] | MagLok<br>[Mm <sup>3</sup> ] | Vanntap<br>[Mm <sup>3</sup> ] |           |
|-----|-------|-----------|----------------|------------------------------|-------------------------------|-----------|
| 1   | 45902 | Grytdalen | 1.20           | 10.90 r                      | 1.27                          | FanSi     |
|     |       |           | 1.20           | 10.90 r                      | 5.25                          | ProdRisk  |
|     |       |           | 1.20           | 10.90 r                      | 1.64                          | Vansimtap |

# Fansi still has some possible bugs

| Incident               | # |   |
|------------------------|---|---|
| Crash                  | 1 | Bergsdalselva   |
| Oscillating production | 1 |   |
| Constraint violation   | 9 |  |



# We want to continue to explore the use of Fansi

- Fansi works quite well for modelling one watershed.
- Fansi can also model larger power systems and grid

