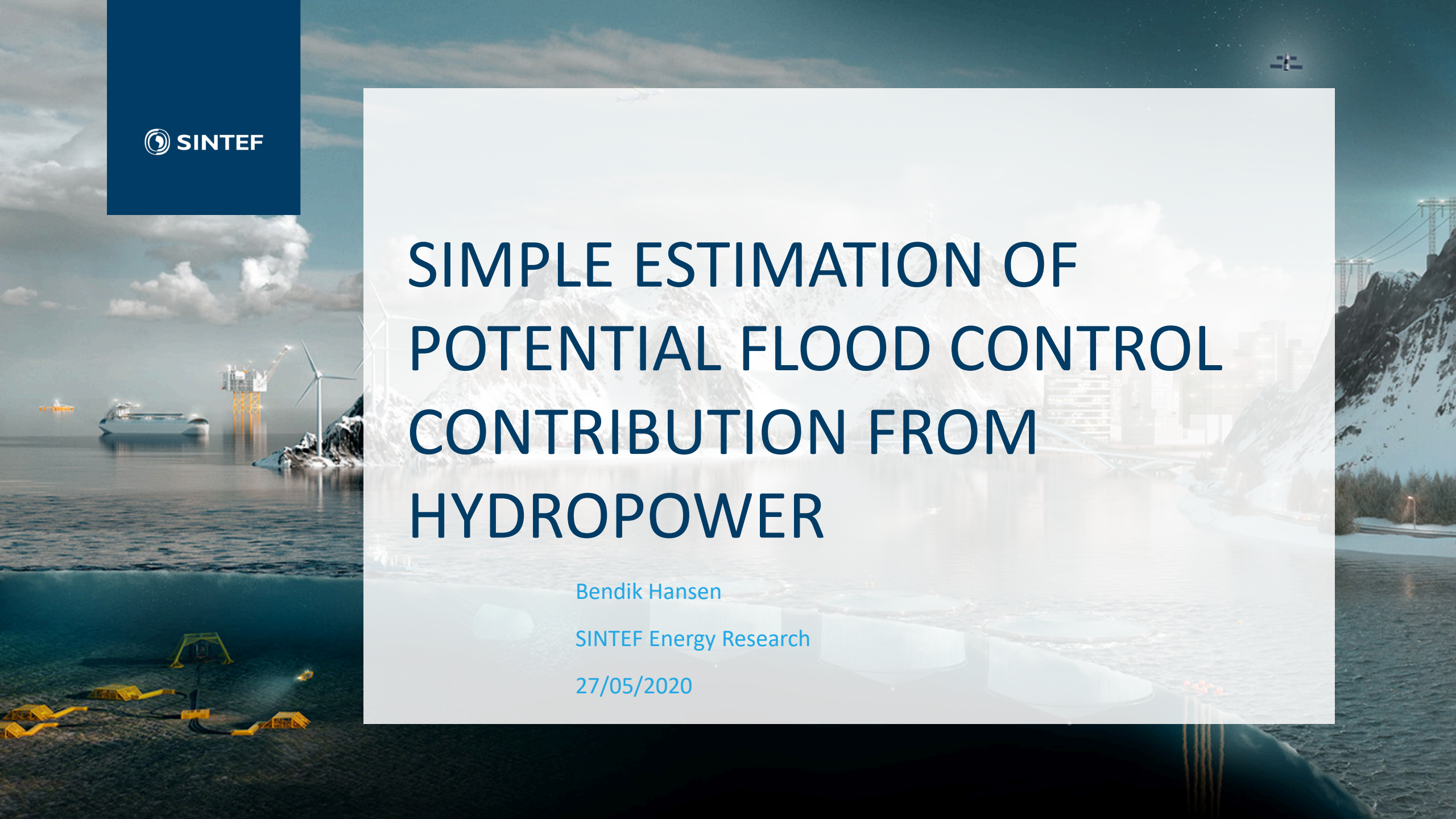

# SIMPLE ESTIMATION OF POTENTIAL FLOOD CONTROL CONTRIBUTION FROM HYDROPOWER

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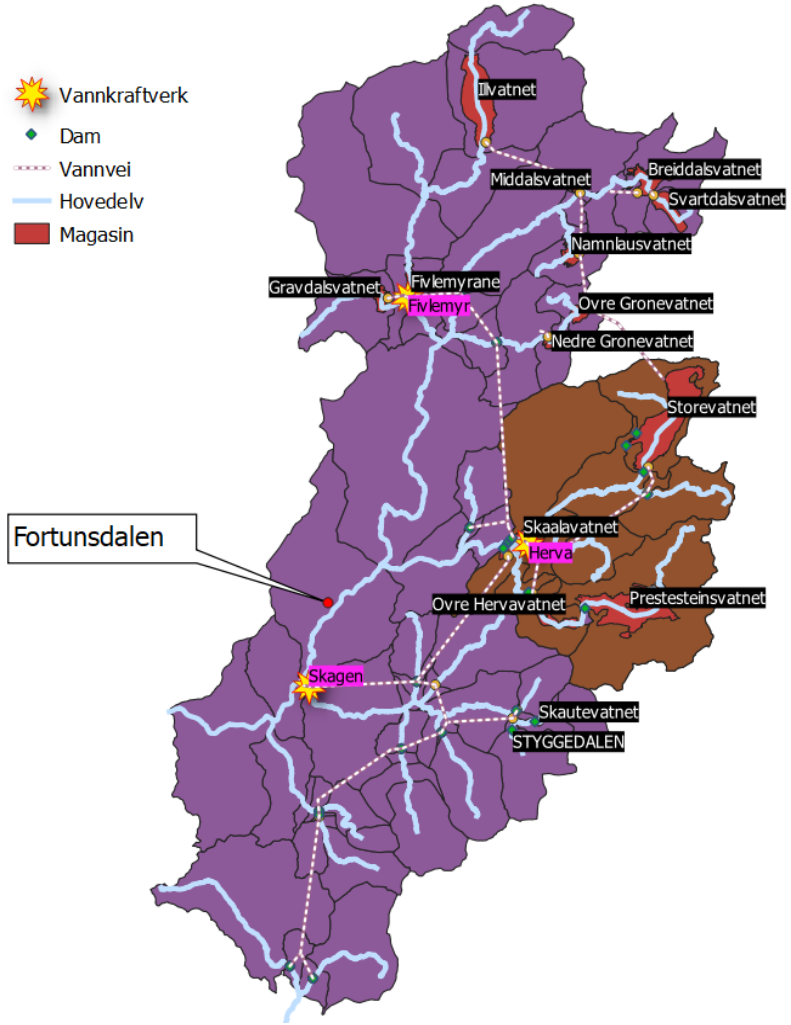
# Background

- Part of ongoing work on extending *Environmental Design* in the research center *Hydrocen*
- Describe hydropower reservoirs' ability to mitigate flood for a point downstream
  - Both one single reservoir in a larger system and the system as a whole
  - Intended for systems with multiple reservoirs
- Based on readily available data
  - Reservoir capacity
  - Drawdown capacity
  - Typical reservoir filling throughout the year
  - Yearly runoff
  - Curves for the relationship between degree of regulation and flood dampening*

# Example of output




| | Flood dampening potential of individual reservoir in the system | | |
|---|---|---|---|
| | 1/5 | 1/7 | 1/9 |
| Gravdalsvatnet | None | None | None |
| Fivlemyrane | None | None | None |
| Illvatnet | Low | Low | None |
| Middalsvatnet | None | None | None |
| Breiddalsvatnet | Low | None | None |
| Svartdalsvatnet | None | None | None |
| Namslausvatnet | None | None | None |
| Øvre Grønevatnet | None | None | None |
| Nedre Grønevatnet | None | None | None |
| Storevatnet | Low | Low | None |
| Skålavatnet | Low | None | Low |
| Øvre Hervavatnet | None | None | None |
| Prestensteinsvatnet | Moderate | Moderate | None |
| | Total flood dampening potential | | |
| | 1/5 | 1/7 | 1/9 |
| Flood peak reduction | 0.34 | 0.25 | 0.50 |
| Classification | Major | High | Major |

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# METHOD

# Method (1)

For each reservoir in the system:

1. Gather data (typical filling, capacity, drawdown capacity, yearly runoff)
2. Find typical available reservoir capacity for the relevant days of the year
3. Calculate available capacity assuming 7 and 3 days of drawdown (spring/autumn, Norway)
4. Calculate **available** degree of regulation when flood typically arrives
5. Use flood dampening curves to find local and total flood dampening from each reservoir
   - The reservoir's contribution towards the total is dependent on the area/runoff of the total catchment it covers

# Method (2)

6. Limit "total flood dampening" from a reservoir to "significant dampening"
   - Sum up the contributions from all the reservoirs and see what % the total is
   - 100% reduction of flood peak does not serve a purpose. We have assumed that the upper limit for what is "significant dampening" is 40% flood peak reduction.
   - If a reservoir's contribution towards the total does not contribute to the significant dampening, it is not counted as a flood dampening potential
   - Ex:
     - Total dampening with reservoir=25%, without=15% -> reservoir contributes 10%p significant dampening
     - Total dampening with reservoir=45%, without=35% -> reservoir contributes 5%p significant dampening

# Method (3)

7. Classify each individual reservoir based on contribution towards significant dampening
8. Classify the system as a whole based on the total dampening (sum of all reservoir, not reduced to "significant dampening")

# Class boundaries

| Total system flood reduction potential | | | | | |
|---|---|---|---|---|---|
| Potential flood peak dampening | <5% | 5-10% | 10-15% | 15-30% | >30% |
| Flood reduction potential | None | Low | Moderate | High | Major |

| Individual reservoir flood reduction potential | | | | | |
|---|---|---|---|---|---|
| Potential contribution to significant total flood peak dampening (percentage points) | <3% | 3-7% | 7-14% | 14-20% | >20% |
| Flood reduction potential | None | Low | Moderate | High | Major |

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# EXAMPLES OF TEST CASES

Preliminary results, still require discussion and confirmation from the operators

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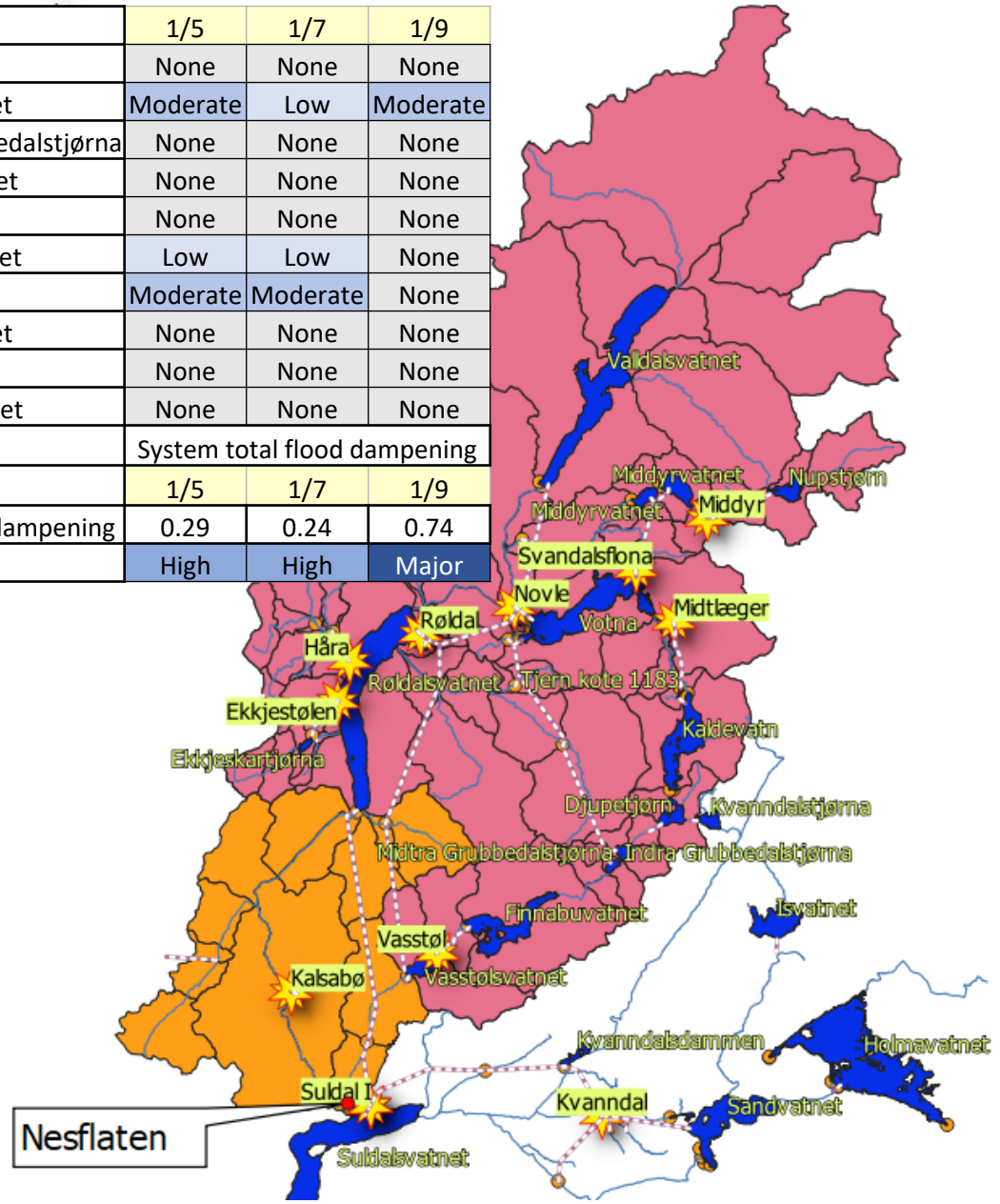
Remove Valldalsvatnet →

# Suldalsvassdraget

| | Flood dampening potential of individual reservoir in the system | | |
|---|---|---|---|
| | 1/5 | 1/7 | 1/9 |
| Djupetjørn | None | None | None |
| Røldalsvatnet | None | None | None |
| Indra Grubbedalstjørna | None | None | None |
| Valldalsvatnet | Moderate | High | None |
| Nupstjørn | None | None | None |
| Finnabuvatnet | None | None | None |
| Votna | None | None | None |
| Middyrvatnet | None | None | None |
| Kaldevatn | None | None | None |
| Vasstølsvatnet | None | None | None |
| | Total flood dampening potential | | |
| | 1/5 | 1/7 | 1/9 |
| Flood peak reduction | 0.59 | 0.47 | 0.83 |
| Classification | Major | Major | Major |

| | 1/5 | 1/7 | 1/9 |
|---|---|---|---|
| Djupetjørn | None | None | None |
| Røldalsvatnet | Moderate | Low | Moderate |
| Indra Grubbedalstjørna | None | None | None |
| Valldalsvatnet | None | None | None |
| Nupstjørn | None | None | None |
| Finnabuvatnet | Low | Low | None |
| Votna | Moderate | Moderate | None |
| Middyrvatnet | None | None | None |
| Kaldevatn | None | None | None |
| Vasstølsvatnet | None | None | None |
| | System total flood dampening | | |
| | 1/5 | 1/7 | 1/9 |
| Flood peak dampening | 0.29 | 0.24 | 0.74 |
| Score | High | High | Major |

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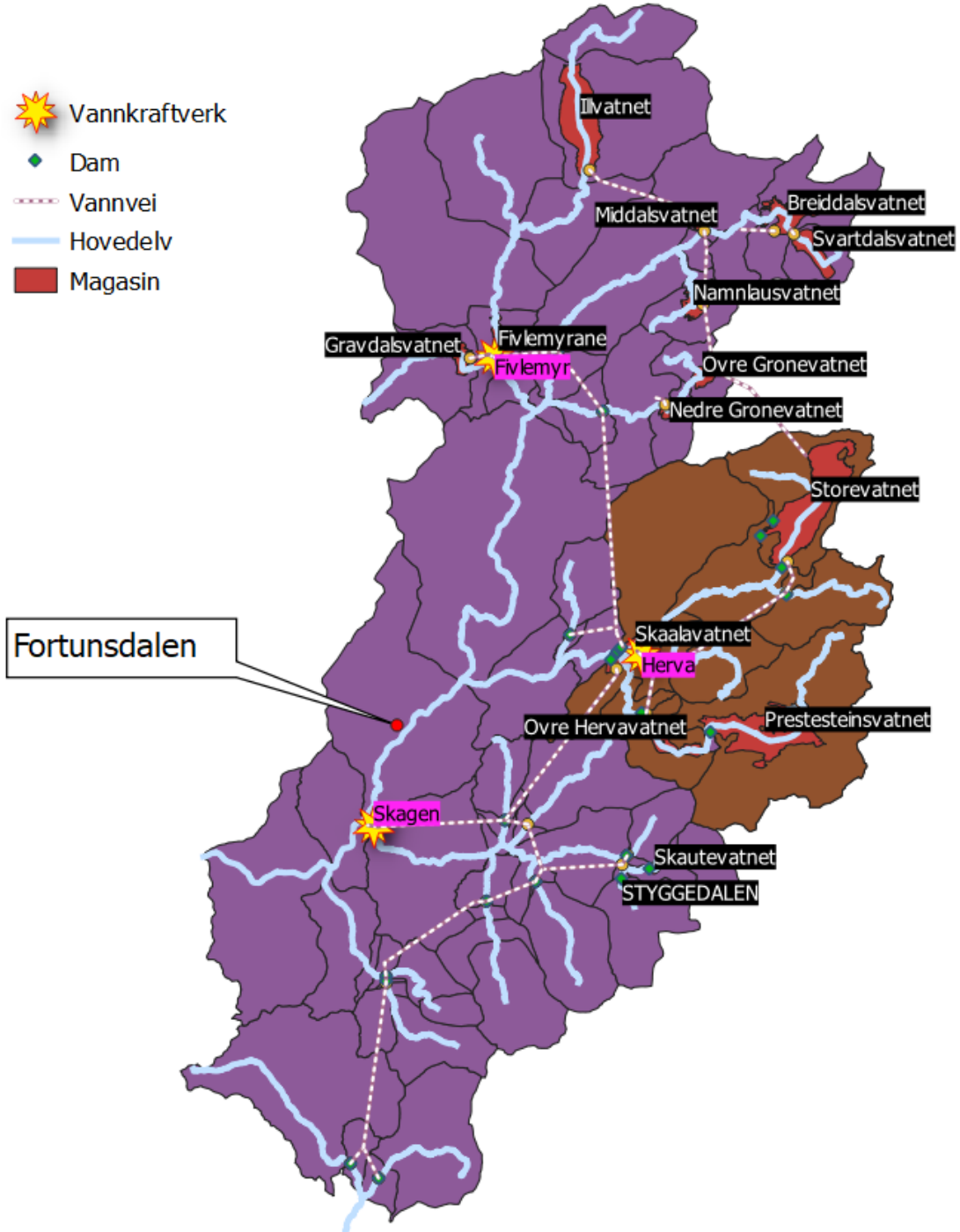
# Fortunvassdraget

| | Flood dampening potential of individual reservoir in the system | | |
|---|---|---|---|
| | 1/5 | 1/7 | 1/9 |
| Gravdalsvatnet | None | None | None |
| Fivlemyrane | None | None | None |
| Illvatnet | Low | Low | None |
| Middalsvatnet | None | None | None |
| Breiddalsvatnet | Low | None | None |
| Svartdalsvatnet | None | None | None |
| Namslausvatnet | None | None | None |
| Øvre Grønevatnet | None | None | None |
| Nedre Grønevatnet | None | None | None |
| Storevatnet | Low | Low | None |
| Skålavatnet | Low | None | Low |
| Øvre Hervavatnet | None | None | None |
| Prestensteinsvatnet | Moderate | Moderate | None |
| | Total flood dampening potential | | |
| | 1/5 | 1/7 | 1/9 |
| Flood peak reduction | 0.34 | 0.25 | 0.50 |
| Classification | Major | High | Major |



# Application and limitations

Possible applications:

- Concessions (which reservoirs are important for floods)
- Optimal operation and configuration of a system (first sorting)
- Flood protection in a changing climate

Limitations:

- Underlying curves for degree of regulation vs. flood dampening
- Very simplified, many assumptions
- Flood dampening potential for one point, not whole river reach

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