



# Improved Methods for Sustainable Hydropower Development



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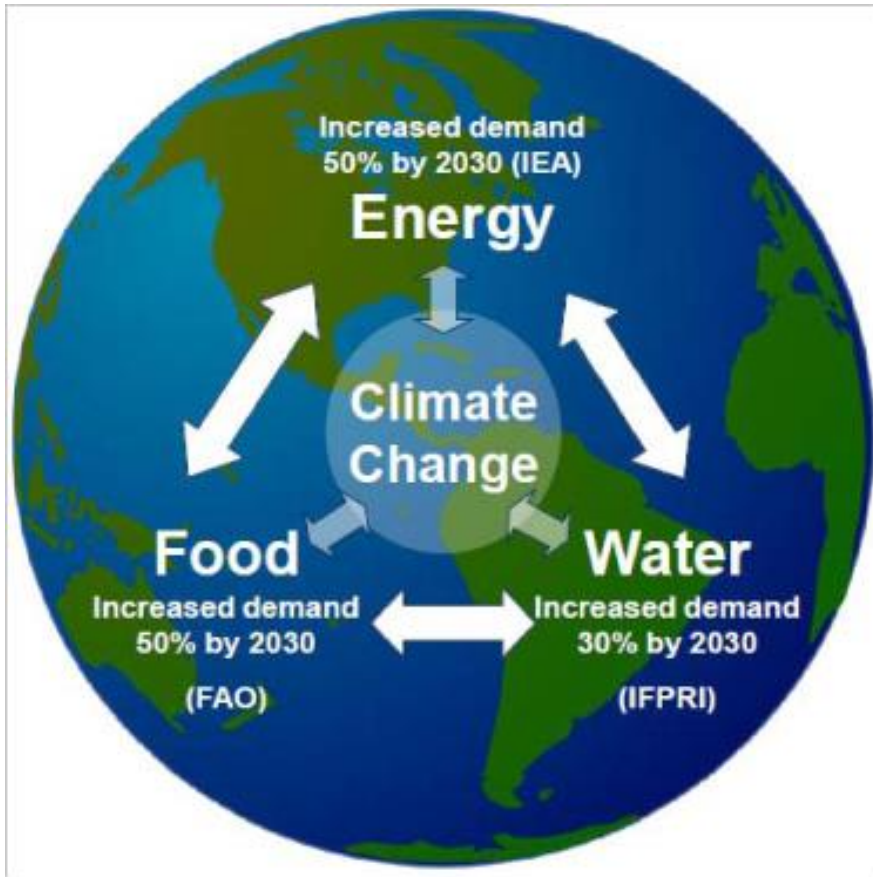


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# Energy-water-food nexus

## - development versus environment?



- Energy is vital for eradicating poverty, 2,5 billion without reliable access to electricity
- 2,8 billion live in areas with high water stress
- Use of resources, degradation of habitats, pollution and emissions
- Water for food production
- Climate change impacts on draughts, floods, water for energy and food



More reservoirs and potential impacts on rivers and lakes



Dams are barriers for fish and sediments



Degraded habitat in bypassed sections



Changed downstream flow regime



Greenhouse gas emissions and water consumption

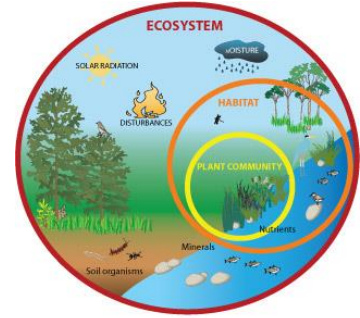


Landscape effect and impact on wildlife



Resettlement and social impacts

# How much water is needed?



# Handbook for environmental design in regulated salmon rivers

Editors:  
Torbjørn Forseth and Atle Harby

- Guidance developed for Atlantic salmon
- Methods suitable for other species and end users

- Download free copy:

**[www.cedren.no](http://www.cedren.no)**

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DATA COLLECTION AND TOOLS

Data collection and tools



CLASSIFICATION SYSTEMS

- The salmon population
- The hydropwer system



DIAGNOSIS

Diagnosis



DESIGN SOLUTIONS AND MEASURES

Design solutions



ASSISTING TOOLS

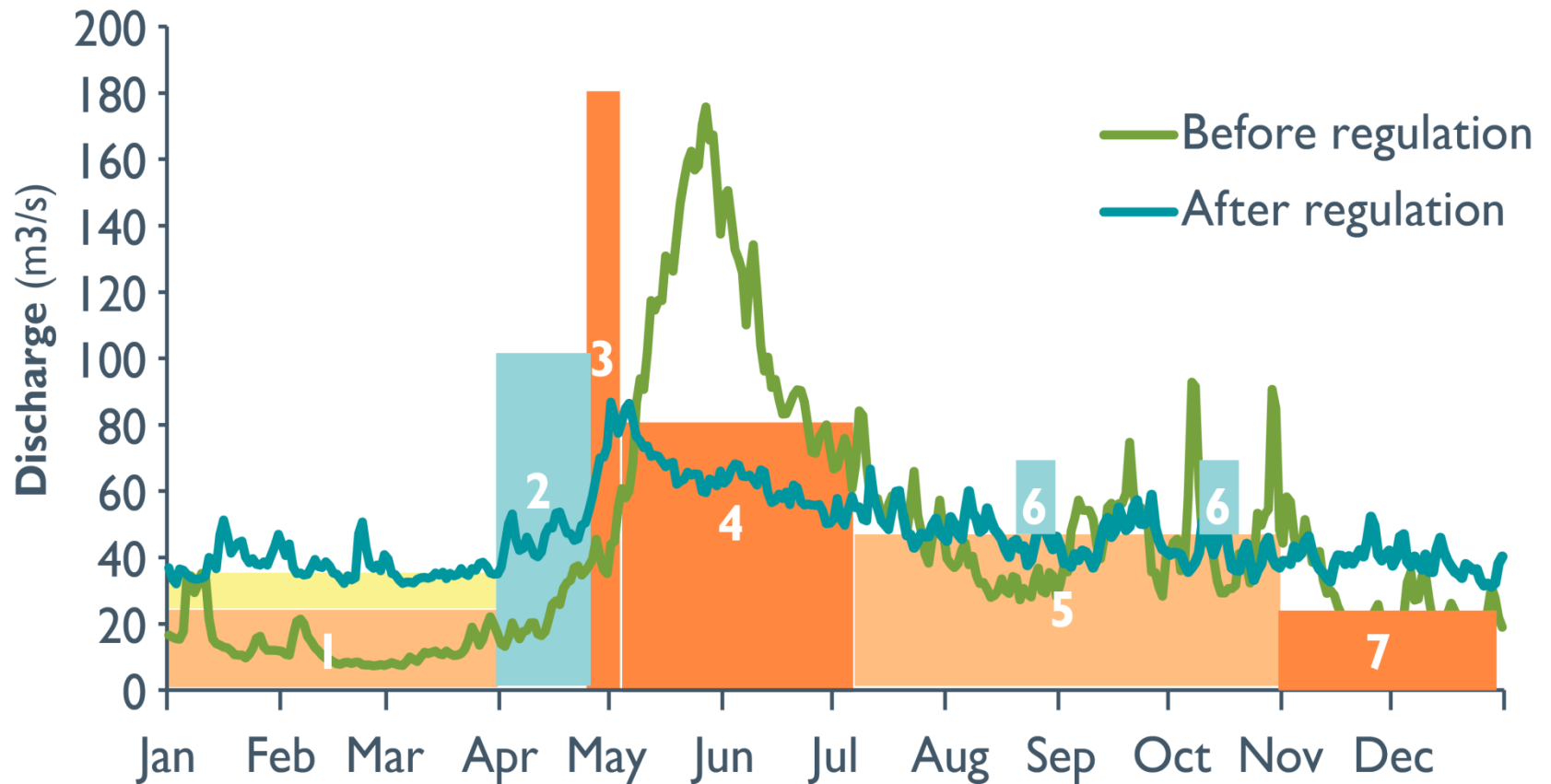
Tools

res

...take the river system to the doctor!



# Design solutions – use of water



# Design solutions





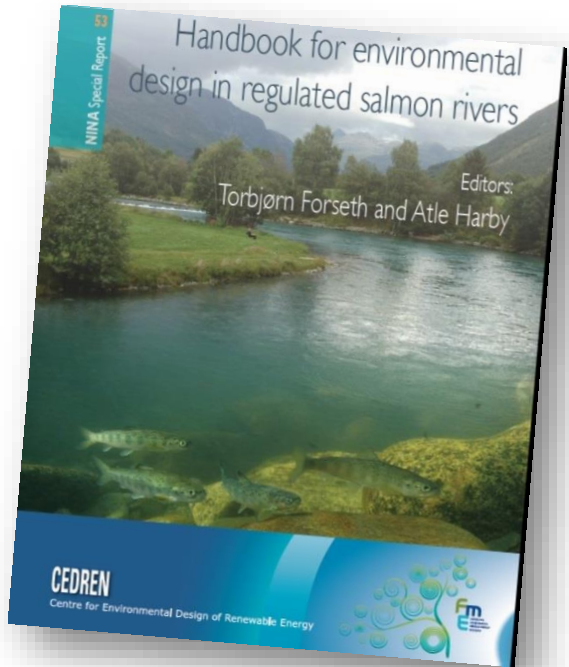
# The River Kvina case study

- 70 % of inflow transferred to neighbouring catchment
- Large reductions in flow
- Production capacity for salmon smolts reduced  $\sim 50$  % (20 000 smolts)



# Win-Win

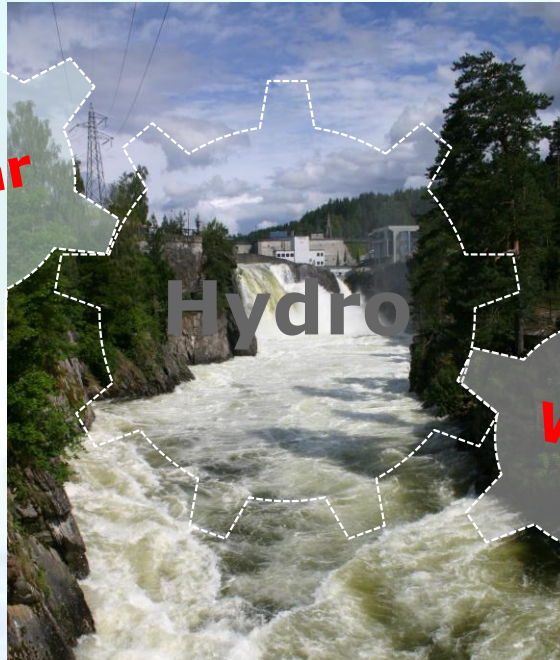
- 140 GWh renewable energy
- Salmon production and fisheries yield returning to pre-HP levels – doubling from present





**Solar**

Hydropower – supporting other renewables



**Hydro**



**Wind**



New role for hydropower - still need for environmental design!



social priorities in these plans.



Illustration by M. Friedrich for HarmoniCOP



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