Design Project - SIE 2013

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

KWO GRIMSELSTROM

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MANAGEMENT OF A RETENTION BASIN TO MITIGATE EFFECTS OF HYDROPEAKING

1. Problematic

Who: KWO (Kraftwerke Oberhasli AG) hydropowerplant in the Berner Oberland

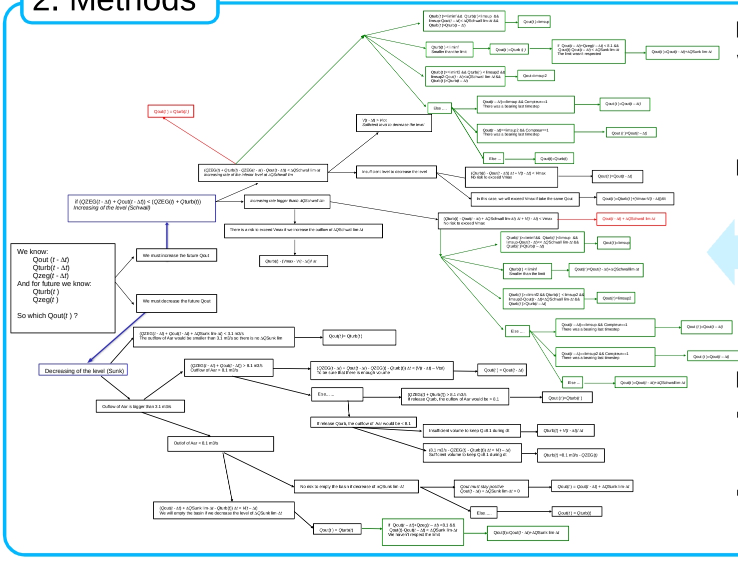
What: Releases its turbined water in the river Aare in Innertkirchen, creating hydropeaking

Problem: In order to lower the impact of the hydro power plants on the river and to respect the federal prescriptions: plan to construct a retention basin and a tunnel (initially 80'000m^3, expectation 94'000m^3) to mitigate the effects of hydropeaking

Constraints:
- Increasing rate (to limit the macrozoobenthos drifting)
- Decreasing rate (to avoid fish stranding on the gravel banks)

3 cases studied:
A) Simulation from 2009 to 2012 for two volumes: **A1:** 80'000 m^3
A2: 94'000 m^3 with different increasing rates.
B) Simulation for November only, with a constraint of a maximal outflow (20 m^3/s) for fish spawning.
C) Algorithm with a bearing (German: Vorschwall) for both volumes (80'000 and 94'000 m^3) to create a "warning" effect when the flow increases.

2. Methods



I) Datasets and data treatment

Why: To perform the simulation: need of the data of the water released by the turbines (Qturb) and the residual Aare from 2009 to 2012.

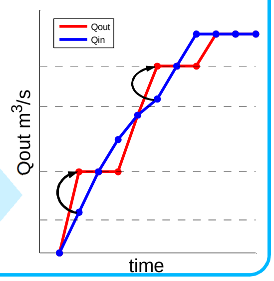
How: Values were missing from March to November: extrapolation from downstream.

II) Design of the algorithm

- Starting from the algorithm developed by Martin Bieri during his thesis at EPFL
- Respect the environmental constraints
- Manage to keep a minimal stored water volume (Vtot = 12'000m^3)
- Addition of specific constraints in November
- Addition of constraints for the bearings

III) Choice of the bearing parameters

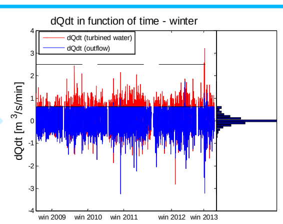
- Determine the optimal parameters corresponding to 4 different bearing's limits : 2 in summer, 2 in winter.
- By iterations, we looked for the parameters allowing the highest number of bearings to happen.

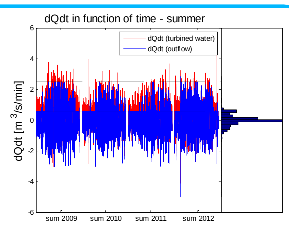


3. Results

A) First case : 2009 to 2012

Volume max	**A1:** 80'000 m^3	**A2:** 94'000 m^3
Increasing rate Decreasing rate	0.7 m^3/s/min 0.14 m^3/s/min	0.5 to 0.7 m^3/s/min 0.14 m^3/s/min
Respect of the constraints	all the constraints respected at 95%	all the constraints respected at 95%

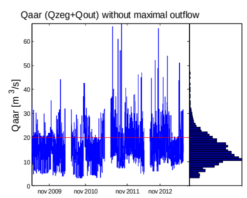


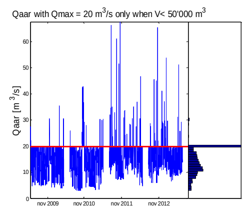


B) Second case : November

Volume = 94'000 m3	without constraint	with Qmax = 20 m^3/s
Q = 20 m^3/s excess ratio	92 %	37%
Ratio of events with Q<20 m^3/s for 12 hr	37.5%	91.4 %

The algorithm is able to increase significantly the number of events where Qout < 20 m^3/s during 12 hours, respecting the other constraints at 95%.

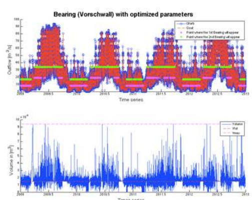


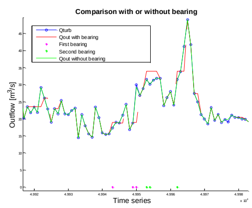


C) Third case : bearing (Vorschwall)

Vmax: 94'000 m^3 Vtot: 12'000 m^3	95% increasing rate**: 0.7** m^3/s/min	95% decreasing rate: **-0.24** m^3/s/min
Optimized parameters	Winter: 5 m^3/s -> 8 m^3/s, 14 m^3/s -> 17 m^3/s. Summer: 16 m^3/s -> 19 m^3/s, 29 m^3/s -> 34 m^3/s.	

The problem of the decreasing rate could be avoided by using a Vtot volume of 15'000 m^3, and we would have a decreasing rate at 95% of -0.14 m^3/s/min.





4. Take Home Message

Algorithm → Evaluate the outflow of the retention basin / Based on the next 15-minutes value / Using 20 different possibilities / Depending on several constraints → The results are quite good and promising for the future retention basin management with these 3 different scenarios → Doesn't take several technical difficulties that could be encountered into account. / Retention basin: great potential to reduce the impact of the hydropeaking on the environment