Four decades of hindsight into a complex hydropower system

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1 The KWO system, in Switzerland

- The Kraftwerke Oberhasli AG (KWO) hydropower system (Fig. 1): a) 10 power plants, b) 29 turbines, c) 1368 MW, d) 4 main reservoirs.

2 Data

A wealth of data was used:
- Daily series of all water fluxes in the system (since 1980).
- Daily series of reservoir levels (since 2008).
- Hourly series of SPOT market prices (since 2008).

3 Visualization

Sankey plots provide an appealing way of visualizing and interpreting system operation states:
- The width of each arrow is proportional to the magnitude of the flux (in this case discharge).
- These plots can be produced automatically, enabling a practical view of the system.

4 Clustering techniques

Mean behaviors of the KWO system (1980 to 2014).

5 Seasonal operations

Seasonal clusters of daily operations can be found using the K-means algorithm. Significant changes since the 1980s (pumped storage).

6 Outlier operation modes

Using DBSCAN clustering one can quickly identify rare operation modes.

7 Conclusions

- Sankey plots are effective tools to visualize the operation of complex hydropower systems.
- Clustering can be used to reduce the dimensionality and facilitate the interpretation of the operations of a complex hydropower system.
- KWO has undergone significant changes in its operation that can mostly be explained by energy market conditions (stable hydrology on average terms).

8 References and acknowledgements

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