The value of hydrological ensemble predictions for reservoir inflow management

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- Reservoir management concerns...

I. operational hydrologists interested in forecasting hazardous events like floods for early warning and reservoir operation (safety & security)

II. planners searching to optimize the management of water resources systems (uses & conflicts) and to plan system’s evolution at different space-time scales (basin/national/regional planning)
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- **Objective**
  - to investigate the benefits of using hydrological ensemble predictions for reservoir inflow management in terms of potential gain to hydropower production

![Graph showing hydrological predictions](image)

*Photo: ENPC*

*Durance River @ Serre Ponçon May 2008 Photo: EDF*
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- **Data & methods**
  - ECMWF EPS as input to MORDOR hydrological model
  - Daily ensemble streamflow forecasts up to 7 days ahead
  - Heuristic model for reservoir operation
  - Hourly EU market energy prices (EPEX SPOT)
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- **Hourly EU Market Energy Price (€/MWh)**
  - Target/Objective function: best hours to produce energy (higher prices)

- **Q_{forecast} D to D+7**
  - Heuristic Model for reservoir operation

- **Constraints: Smax, Smin, Tmax**

- **Observation Day D**
  - Reservoir management rule

- **Constraints: Smax, Smin, Tmax**

- **Actual reservoir management**
  - Gain Day D (€)
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- Modelling of the power systems
  - Hydrological inflows: predictions over French catchments
  - Reservoirs: units of power production described by
    - Storage capacity coefficient (Smax, Smin): in days of mean daily flow of the catchment
    - Turbine capacity coefficient (Tmax): maximum flow capacity (also related to the mean daily flow of the catchment)

Constraints: Smax, Smin, Tmax

Heuristic Model for reservoir operation

Q_{\text{forecast}} \text{ D to D+7}
Results: illustration for one day of single forecast (1/3)

- Sep 5\textsuperscript{th} 2008: Predicted inflow to the Durance reservoir for the next 7 days

Q (m\textsuperscript{3}/s)
Results: illustration for one day of single forecast (1/3)

- Sep 5th 2008: Predicted inflow to the Durance reservoir for the next 7 days
- Energy prices for the week
- Turbine capacity = 3 * mean daily flow of the catchment
Results: illustration for one day of single forecast (1/3)

- Sep 5th 2008: Predicted inflow to the Durance reservoir for the next 7 days
- Energy prices for the week
- Turbine capacity = 3 * mean daily flow
- Reservoir capacity = 4 days of mean daily flow
Results: illustration for one day of single forecast (2/3)

- Sep 5th 2008: Predicted inflow to the Durance reservoir for the next 7 days
- Energy prices for the week
- Turbine capacity = 3 * mean daily flow
- Reservoir capacity = 4 days of mean daily flow

Results:
- $S_{max} = 0$
- $S_{min} = 0$
- $Q (m^3/s)$
Results: illustration for one day of single forecast (3/3)

- Sep 5th 2008: Predicted inflow to the Durance reservoir for the next 7 days
- Energy prices for the week
- Turbine capacity = 3 * mean daily flow
- Reservoir capacity = 4 days of mean daily flow
- Run the observed flows through the management rule (24h)
Results: sensitivity to system’s characteristics

Forecasts: Ensemble forecasts (2005 – 2008)

- Reservoir capacity in days of mean daily flow
- Turbine capacity (N * mean daily flow

Gain (MEuros)

Reservoir capacity in days of mean daily flow
Results: over a 4-year period

- Different types of forecasts:

  - Observed flows
  - Climatology (Q)
  - Ensemble mean
  - Deterministic forecast
  - Ensemble forecast (all members)

Turbine capacity (4* mean daily flow)

Gain (MEuros)

Reservoir capacity in days of mean daily flow
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• **Summary**
  • An adaptable tool: heuristic algorithm connected with simulation model for reservoir rules under constraints
    • Different inflow scenarios
    • Different characteristics of reservoir & power system
  • The relative economic gains of using hydrometeorological ensemble forecasts comparatively to no forecasts at all (i.e., only climatological information) can potentially result in an average gain of 5% (over hundreds of M€).
  • **Further studies**
    • Improve the use of the probabilistic information from ensembles,
    • Impact of post-processing on energy production (quality ⇔ usefulness)
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Category Archives: economic value

On the economic value of hydrological ensemble forecasts
Posted on January 31, 2014 by Marie-Amélie Boucher, Maria-Helena Ramos, and Ioanna Zalakoski

It is often assumed that probabilistic forecasts should lead to better water and risk management through increased benefits (economic or not) to users in their decision-making processes. Most often, this assumption arises from studies based on evaluations of forecast quality, ... Continue reading →

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