Effective Emulators for Flood Forecasting and Realtime Water Management

- **Detailed model**
  - State vector (observed)
  - Parameters
  - Knowledge driven
  - Data driven

- **Linear model**
  - State vector
  - Parameters

- **Covariance**
  - Mean
  - Conditioning

- **Gaussian Process Emulator**
  - Data

- **Adiswil**
  - Flow from 244 catchments and 460 conduits into a waste water treatment plant.
  - ~1'000 parameters.
  - Takes ~3 seconds per 100 min run.

- **Emulator**
  - Cost of emulation is proportional to design data size, i.e. Matrix-vector multiplication O(nN).
  - Generally constant but might depend on input size, e.g. NL FEM with Crank-Nicolson.

- **Quality of emulation?**
  - Conditioning the GP (matrix inversion) is generally O((nN)³).
  - Can be speeded up by giving structure to covariance matrix losing some control over the prior model.

- **References**:
  - Carlo Albert (2012)
  - David Machac, Peter Reichert, Jörg Rieckermann, and Carlo Albert (2016)
  - *Fast mechanism-based emulator of a slow urban hydrodynamic drainage simulator* in Environmental Modelling & Software, 78.