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Improving sediment management in the reservoirs of the Lower Isère: a modelling-based approach

INTRODUCTION

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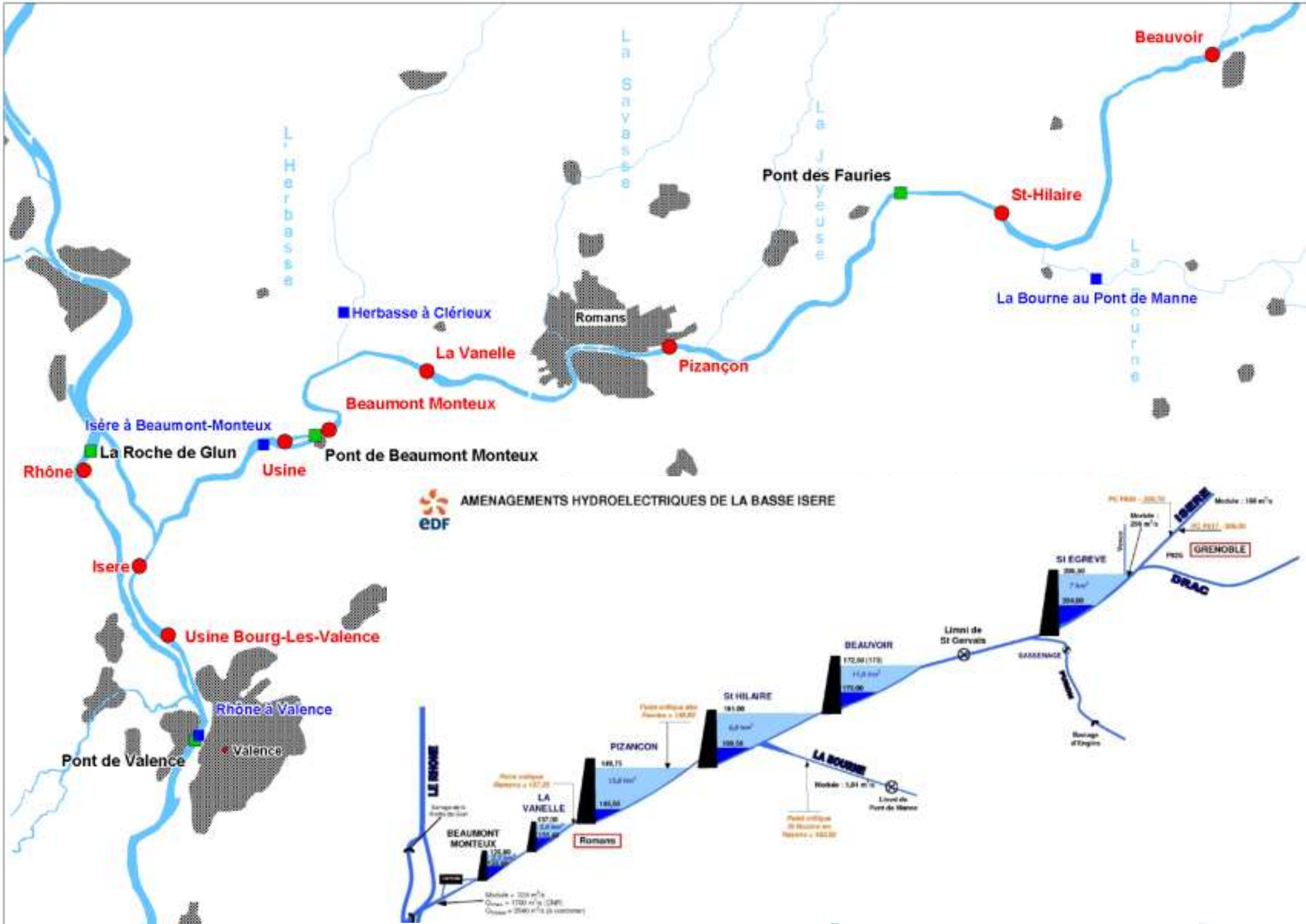

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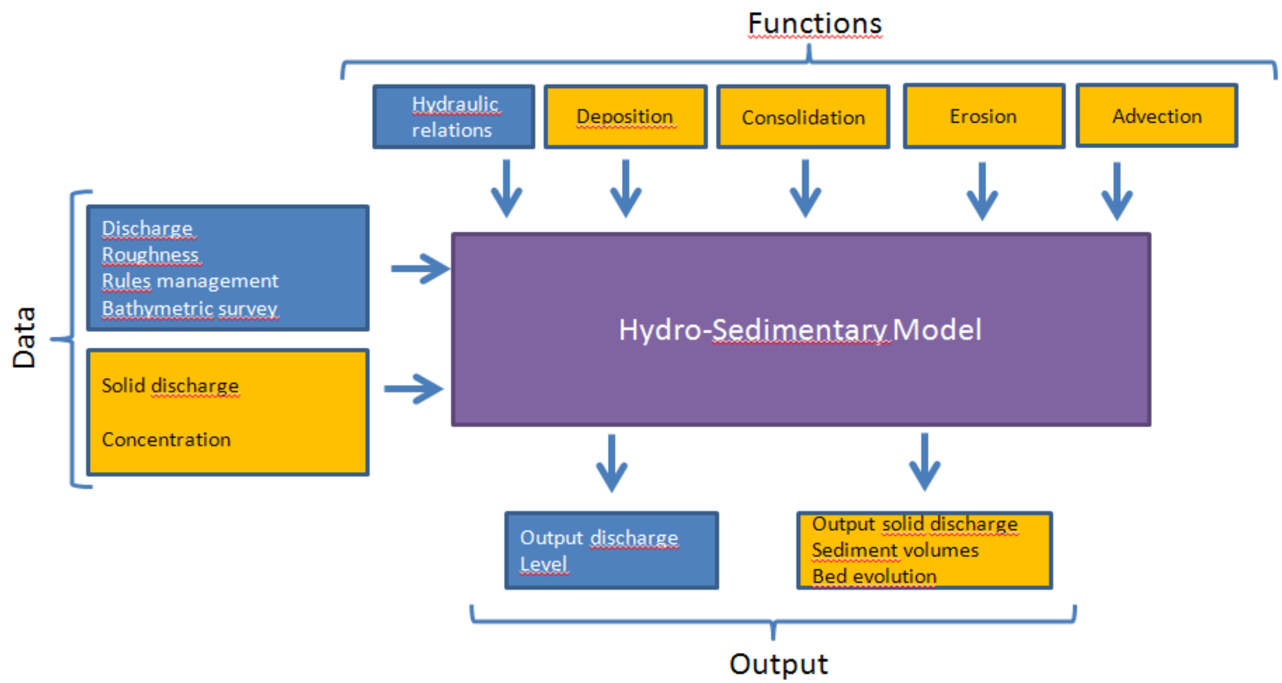
MODELLING

- Simplified and large-scale Hydro-Sedimentary Model
  - ✓ Conceptual model covering 80 km
  - ✓ Compute volume and sediment flows coherent with physical phenomena involved
  - ✓ Assess management of large quantities of sediment (washload) passing through the reservoirs and in relation to the level and flushing management rules



MODELLING

- 2 models :

✓ Mascaret model for hydraulic

✓ Specific (Sedimasc) model for sedimentary calculations (in fact simplified deterministic modeling):
- shear stress due to friction forces : $\tau = \rho_{water}\, g\, Rh\, J$
- Head slope : $J = Q^2 / D^2$, D being the discharge capacity

if $\tau < \tau_{cd}$ ➔ deposition

if $\tau_{cd} < \tau < \tau_{ce}$ ➔ simple transit

if $\tau > \tau_{ce}$ ➔ erosion

with: τ_{cd} = critical shear stress for deposition

τ_{ce} = critical shear stress for erosion

The deposition rate D (kg/m²/s) is expressed as follows: $D = W.C.(1 - \tau / \tau_{cd})$

with: W = sediment settling velocity (m/s)

C = concentration of suspended sediment transported in the water

The eroded sediment discharge E (kg/m²/s) is expressed by : $E = M.(\tau - \tau_{ce})$

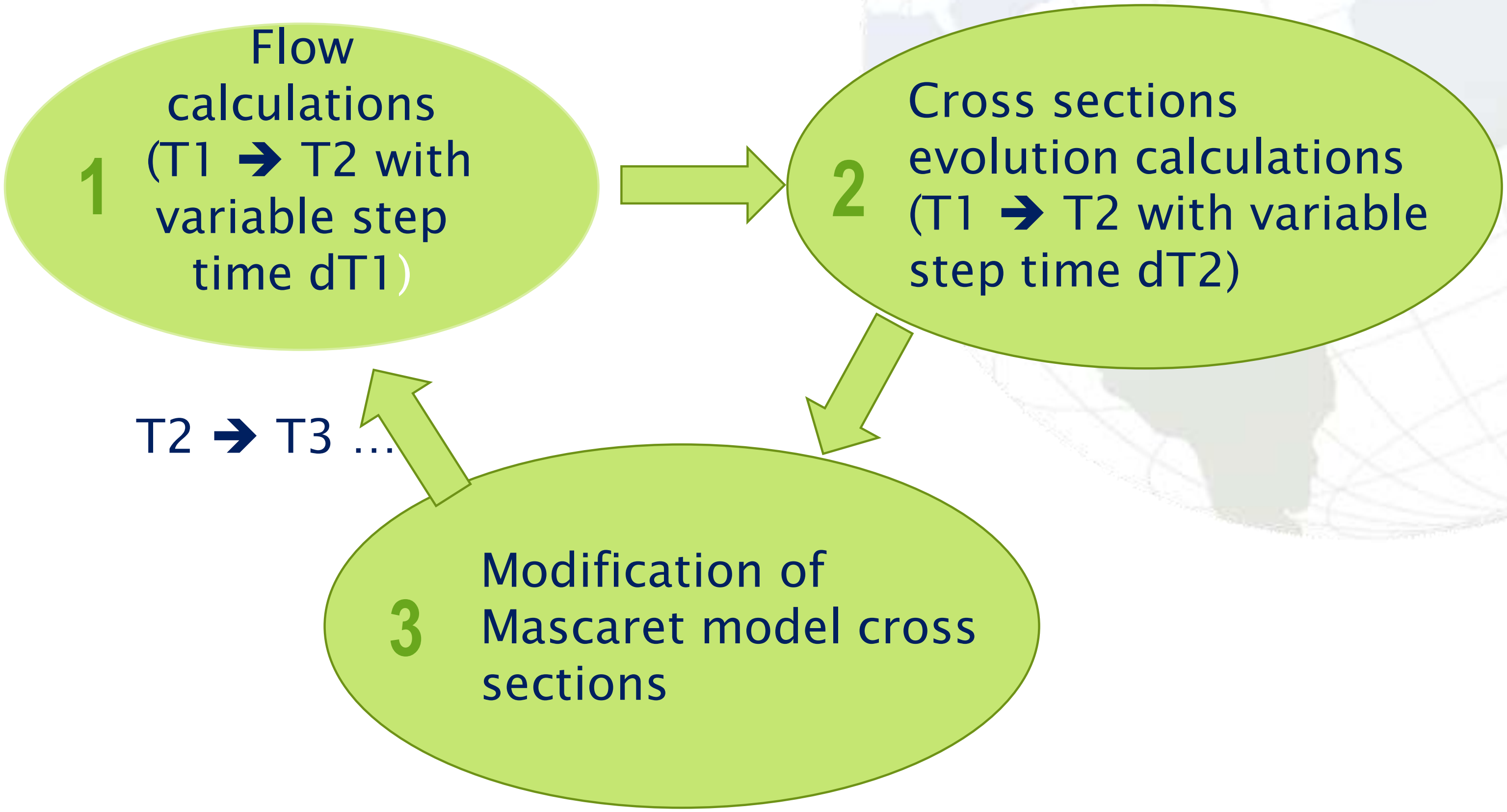
with: M = coefficient (s/m)

$\tau_{ce} = \tau_{eF}$ if fresh sediment

$\tau_{ce} = \tau_{eC}$ if consolidated sediment [➔Extreme bottom unerodable]

MODELLING PROCESS

MODELLING



CALIBRATION

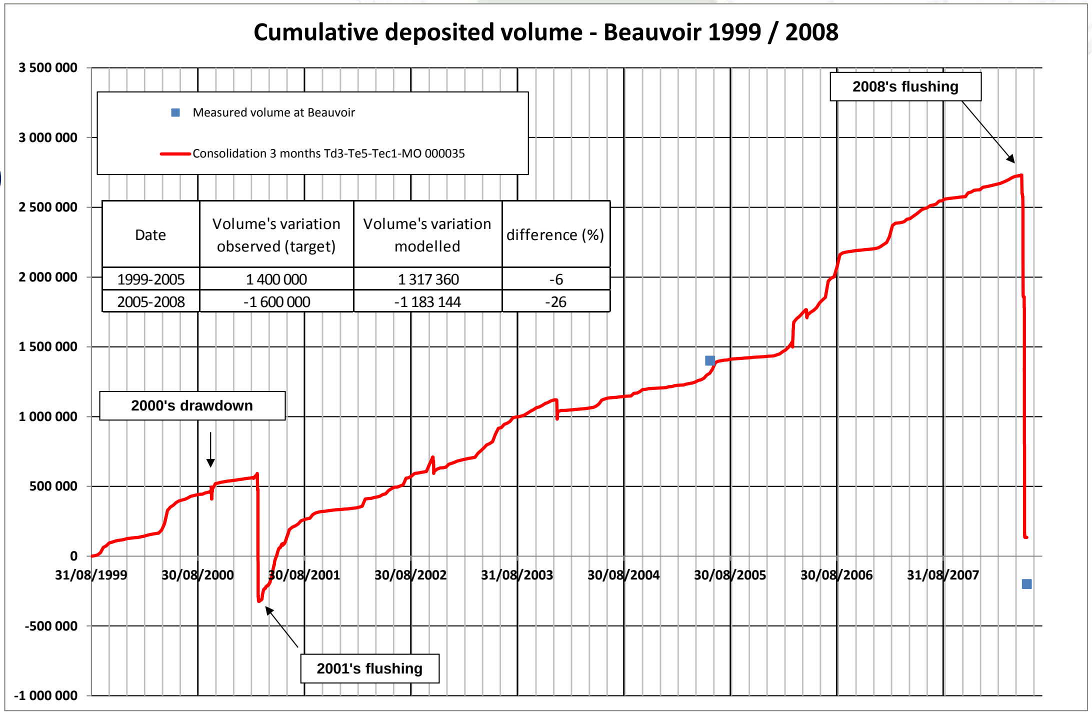
CALIBRATION

- to represent the following, as accurately as possible (from 1999 to 2008) :
  - ✓ Sediment volumes transiting through the reservoir during flushing
  - ✓ Sediment load variations over time
  - ✓ Changes reservoir bathymetry
- The results were satisfactory as the differences were between 0 and 26%
- Therefore tendancy for overestimation erosion at the start of flushing
- Does not take into account 2D and 3D phenomena and bank collapse (compensation of overestimation at the start)

τ_{cd}=3 Pa ■ W = 0.00035 m/s

τ_{ceF}=5 Pa ■ τ_{ceC}=11 Pa ■ M=0.0035

$T_{consolidation}$ = 3 months



Date	Volume's variation observed (target)	Volume's variation modelled	difference (%)
1999-2005	1 400 000	1 317 360	-6
2005-2008	-1 600 000	-1 183 144	-26

SCENARIOS

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SCENARIOS

- 6 management scenarios defined and simulated over 20 years (+ 10 years for running-in)
  1. Without flushing
  2. Without dams

  } = boundaries of the system

  3. Present situation (= reference)
  4. More frequent flushing (Thresholds decreased from 500 to 400 m3/s)
  5. Partial drawdowns
  6. Flushing during rising flood levels (instead of decreasing f.l.)
- Analyses :

  → Sediment volumes stored in the reservoirs

  → Solid discharge

  → concentration

SCENARIOS - RESULTS

SCENARIOS

- 1. Without flushing

  ➔ Huge storage and important destocking during floods

- 2. Without dams

  ➔ Deposition in the river Rhône increases

- 3. More frequent flushing

  ➔ Minimizes storage in reservoir

- 4. Partial drawdowns

  ➔ Not effective

- 5. Flushing during rising flood levels

  ➔ The best to reduce solid discharge and concentration

The solution is to mix the 2 scenarios 4 and 5

THANK YOU FOR ATTENTION

- SOME QUESTIONS ?….