Process-oriented pollutant transport modelling in rivers networks - Application in the Xizhijiang River in China (P3-01)

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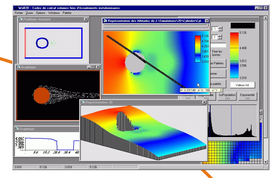
The WOLF package for free-surface flows computation



General scheme of the WOLF computation units

1D pollutant transport model

Equations

Mass conservation equation

$$\frac{\partial \omega}{\partial t} + \frac{\partial Q}{\partial x} = -q_L$$

Momentum conservation equation

$$\frac{\partial Q}{\partial t} + \frac{\partial uQ}{\partial x} + g\cos\theta \frac{\partial p_\omega}{\partial x} = -g\omega\cos\theta \frac{\partial z_b}{\partial x} + g\omega\cos\theta J + g\cos\theta\, p_x + g\omega\sin\theta$$

Pollutant *i* transport equation

$$\frac{\partial \omega C_i}{\partial t} + \frac{\partial QC_i}{\partial x} = \frac{\partial}{\partial x}\left(\omega E_{x,i}\frac{\partial C_i}{\partial x}\right) - K_i \omega C_i + S_i$$

Advective term — Diffusive term — Decay — Source term

ω = cross section
h = water depth
J = roughness slope
θ = mean channel bottom slope

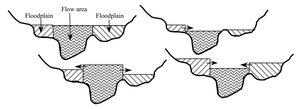
Q = discharge
q_L = lateral exchanges
l = channel width
C_i = concentration of pollutant I

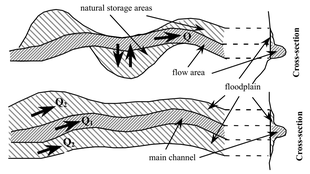
K_i = degradation coefficient
$E_{x,i}$ = longitudinal dispersion coefficient
z_b = bottom elevation
u = fluid velocity

$$p_\omega(h) = \int_0^h (h-\xi)\, l(x,\xi)\, d\xi$$

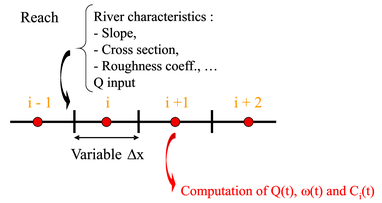
$$p_x(h) = \int_0^h (h-\xi)\frac{\partial l(x,\xi)}{\partial x} d\xi$$

Interaction between main channel and floodplain





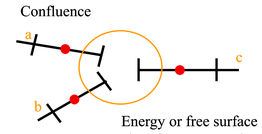
Discretization principles



Numerical model characteristics

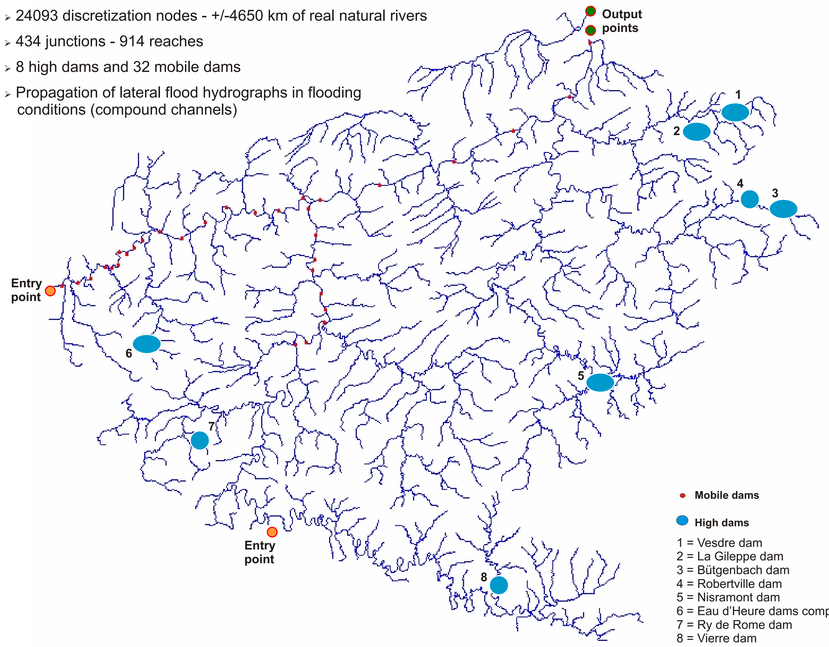
- 1D Saint Venant equations for hydrodynamics
- N advection-diffusion equations for pollutant transport
- Finite volume scheme - First or second order of precision
- Original Flux Vector Splitting to deal with any flow regimes (unsteady shocks)
- Explicit or implicit temporal integration
- Automatic computation of maximum time step
- Lagrange multipliers method to handle any natural network

Confluence



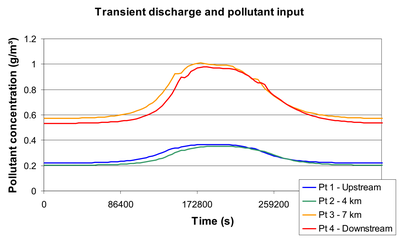
Meuse river network in the Walloon Region

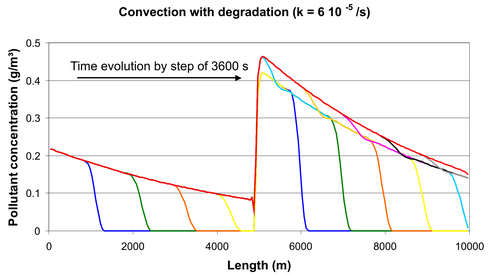
- 24093 discretization nodes - +/-4650 km of real natural rivers
- 434 junctions - 914 reaches
- 8 high dams and 32 mobile dams
- Propagation of lateral flood hydrographs in flooding conditions (compound channels)



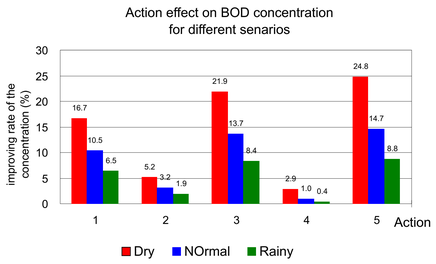
Xizhijiang River reach in China

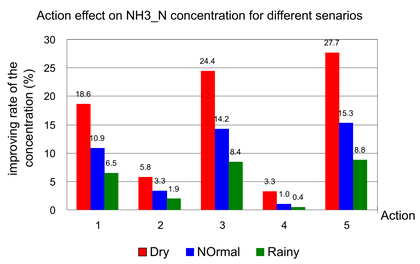
Model assessment : several pollutant sources, transient discharges





Test of 5 actions for pollution concentration mitigation with 3 weather scenarios





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