Integration of in-stream water quality concepts within SWAT

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Problem

Need for a policy to get good water quality

- ❑ What are the causes/sources?
- ❑What efforts are needed?
- ❑ Establish actions plans (pollution abatement, land use change)
- ❑ Scenario analysis (TMDL analysis)

⇒Need for integral water quality models

Integrated modelling tool

SWAT 98

- Catchment hydrology
- Agricultural pollution
- Constant point sources

ESWAT

- Hourly time step (land and river hydrology)
- River water quality processes
- Dynamic point sources
- Urban drainage system

River water quality processes

QUAL2E ⟷ RWQM1

Based on Activated Sludge Model concept

Effect based ↔ Cause based

No microbial masses modeled ↔ Microbial masses modeled

Simple ↔ Complex

Few parameters, variables ↔ Many parameters, variables

NOT closed mass balance ↔ closed mass balance

QUAL

River water quality processes

QUAL2E $\longleftrightarrow$ RWQM1

11 processes
9 variables
Stoechiometry: 9*11 Constants

24 processes
24 variables
Stoechiometry:
24*24 functions of 70 parameters and variables

$$
\begin{aligned}
&\frac{1}{32}\left(\alpha_{\mathrm{O},i} - (1 - f_{I,i})Y_{i,\mathrm{death}}\alpha_{\mathrm{O,XS}} - f_{I,i}Y_{i,\mathrm{death}}\alpha_{\mathrm{O,XI}}\right)\\
&-\frac{1}{4}\left(\alpha_{\mathrm{H},i} - (1 - f_{I,i})Y_{i,\mathrm{death}}\alpha_{\mathrm{H,XS}} - f_{I,i}Y_{i,\mathrm{death}}\alpha_{\mathrm{H,XI}}\right)\\
&-\frac{1}{12}\left(\alpha_{\mathrm{C},i} - (1 - f_{I,i})Y_{i,\mathrm{death}}\alpha_{\mathrm{C,XS}} - f_{I,i}Y_{i,\mathrm{death}}\alpha_{\mathrm{C,XI}}\right)\\
&+\frac{3}{56}\left(\alpha_{\mathrm{N},i} - (1 - f_{I,i})Y_{i,\mathrm{death}}\alpha_{\mathrm{N,XS}} - f_{I,i}Y_{i,\mathrm{death}}\alpha_{\mathrm{N,XI}}\right)\\
&-\frac{5}{124}\left(\alpha_{\mathrm{P},i} - (1 - f_{I,i})Y_{i,\mathrm{death}}\alpha_{\mathrm{P,XS}} - f_{I,i}Y_{i,\mathrm{death}}\alpha_{\mathrm{P,XI}}\right)\\
&-\frac{1}{4}\left(\beta_{+} - \beta_{\mathrm{H}} + \frac{\beta_{\mathrm{O}}}{8}\right)\left(\alpha_{\mathrm{X},i} - (1 - f_{I,i})Y_{i,\mathrm{death}}\alpha_{\mathrm{X,XS}} - f_{I,i}Y_{i,\mathrm{death}}\alpha_{\mathrm{X,XI}}\right)
\end{aligned}
$$

River water quality processes

Use concepts that have

- a closed mass balance
- applicable for integrated river water quality modelling
- include river bed processes

QUAL2E → VUB-QUAL

- Adaptation to close mass balance –processes and variables for river bed
- Add denitrification

RWQM1 → RWQM-integrated

- Adaptiation to be applicable for integrated modelling: variable composition for organic matter

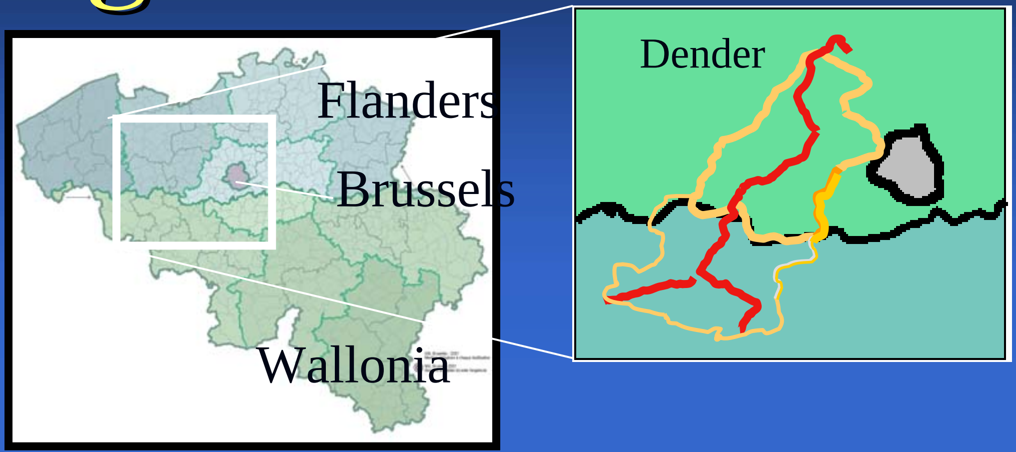
Belgian cases

Dender river basin

- 1400 km² catchment

Flemish part modelled

- heavily polluted
- 85% agriculture, 15% urban
- 300,000 inhabitants (400/km²)
- 50 km long



Dender basin model

MODEL: 700 km²

- 15 subbasins / 8 tributaries
- 80 HRU's (=combination land use and soil type)
- 10 point source locations
- 8 sluices

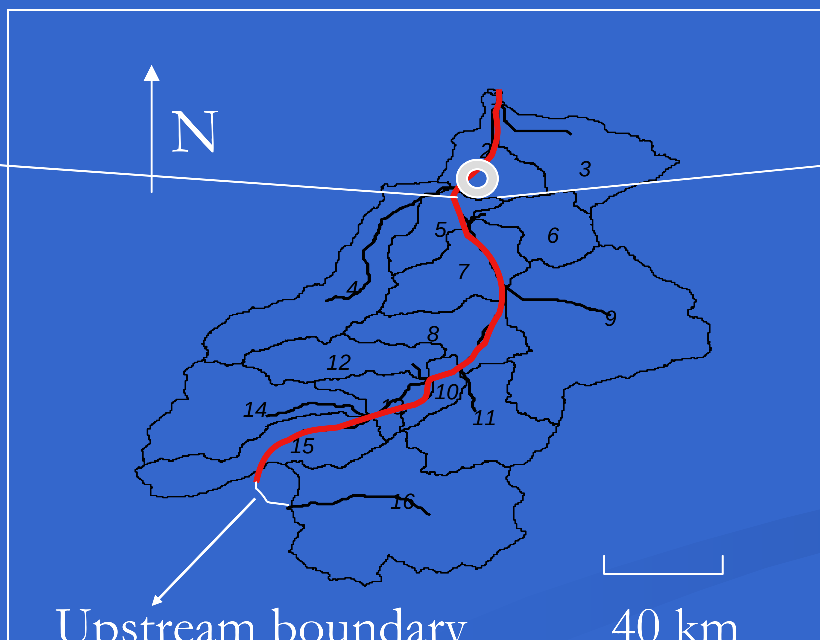
DO

BOD

HNO_3

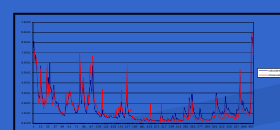
NH_4

HPO_4

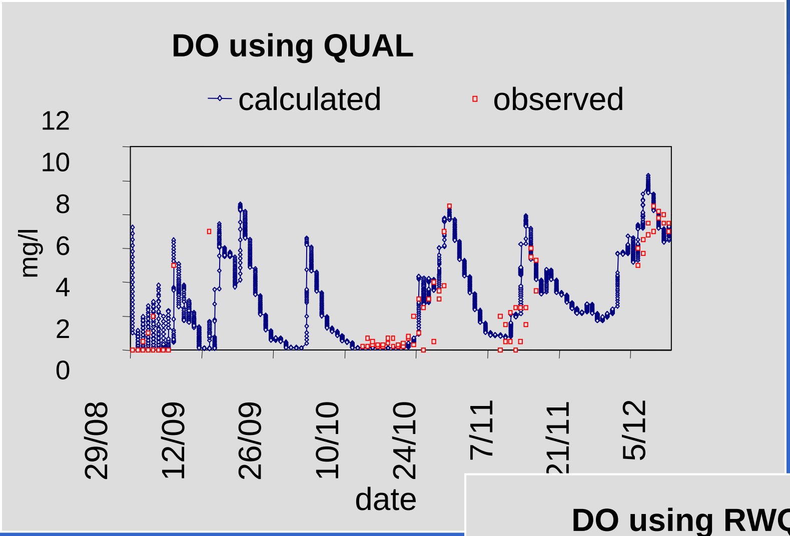


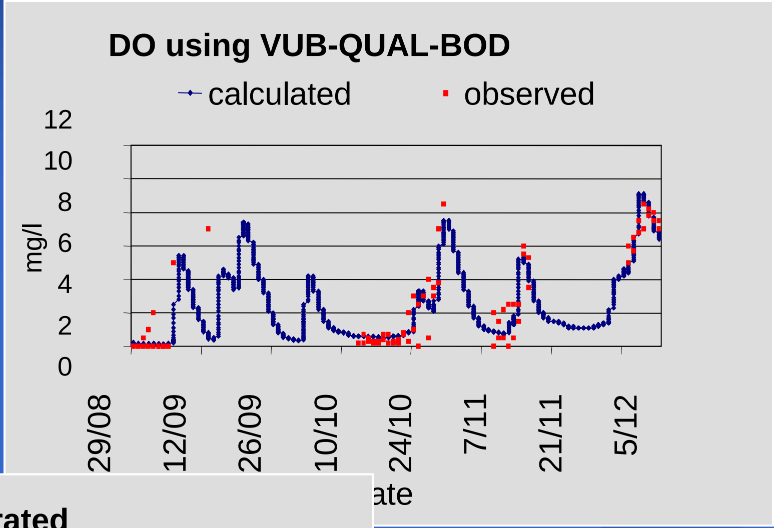
Flow

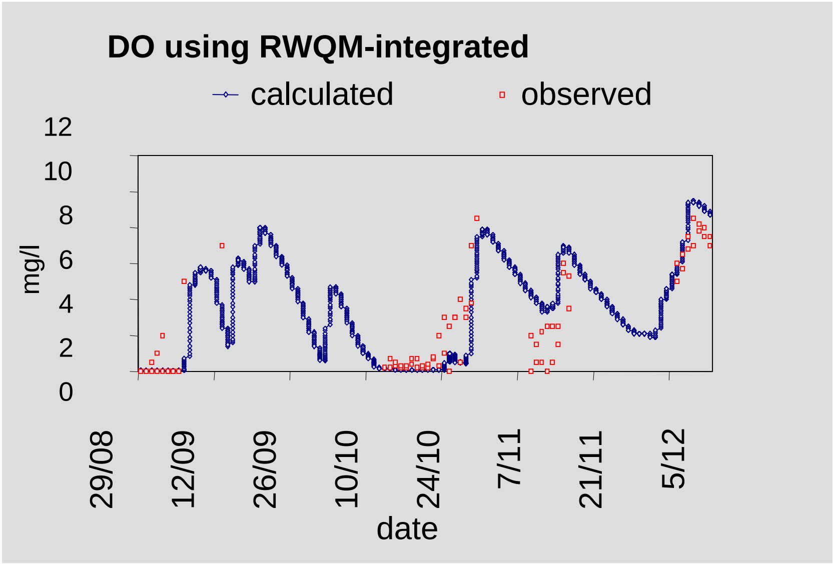
- time series
- ranked series



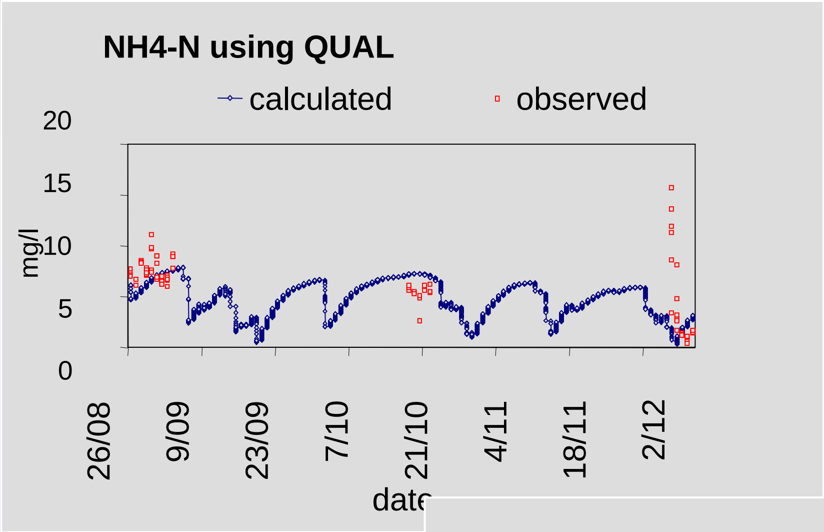
Results for oxygen

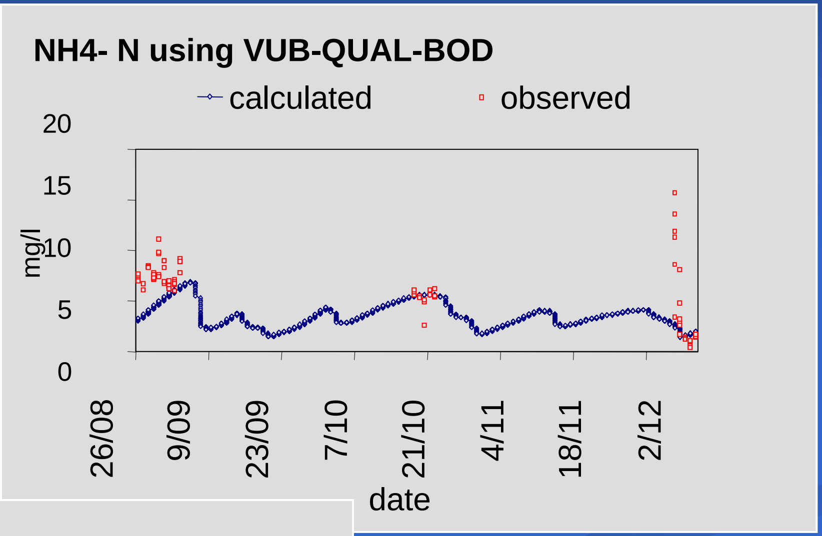


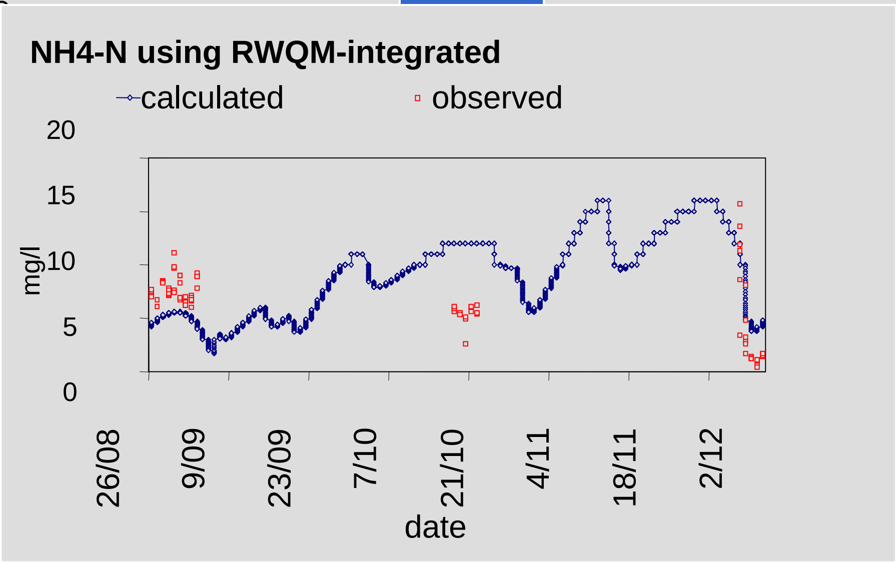




Results for ammonia







Conclusion

Both QUAL2E or RWQM1 can be adapted to be applicable for integrated water quality modelling

Thank you for your attention!