Integration of the erosion and sediment transport model WaTEM/SeDEM in the nutrient emmision model NEMO used to support nutrient management in Flanders

Daan Renders¹, Sacha Gobeyn¹, Niels De Vleeschouwer¹, Rob Laethem² and Jan Coppens²

¹Fluves NV, Kerkstraat 106, 9050 Ghent, Belgium

²Vlaamse Milieumaatschappij, Dokter De Moorstraat 24-26, 9300 Aalst, Belgium

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Introduction

WaTEM-SEDEM is a raster-based soil erosion and sediment transport model (Van Oost et al., 2000; Van Rompaey et al., 2001; Verstraeten et al., 2003) that is used as a submodule in two simulation models used by the Flemish Government. On the one hand it is used in CN-WS, a coupled hydrological-sediment transport model, and on the other hand it is used in NEMO, a nutrient transport model. The aim of the current presented project is to integrate the version of WS in CN-WS in NEMO. This integration has several advantages:

- Only one WaTEM-SEDEM code has to be maintained
- Easy to update
- Results are comparable

WaTEM-SEDEM (Soil erosion by water and tillage and sediment deposition and transport model)

- Spatially distributed model
- Developed at KU Leuven
- Multiple flow algorithm
- Based on RUSLE (Renard et al., 1997)
- Erosion = R*K*LS*C*P
- Transporting sediment through landscape
 TC = kTC*R*K*LS
- If amount of sediment < TC: Erosion</p>
- If amount of sediment > TC: Sedimentation

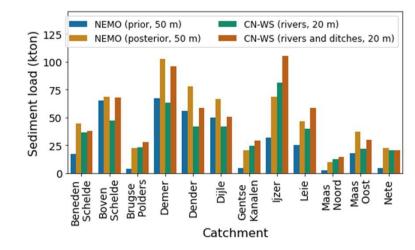
Methods and results

a. Preparation

- Re-implementing sediment module in NEMO:
 - Create inputdata for CN-WS, run CN-WS, read results CN-WS
 - Distribute nutrients and calculate nutrient fluxes towards rivers according to calculated routing and sediment fluxes in CN-WS
 - Compare and align (sediment related) input data of NEMO and the data used for the Flemish application of CN-WS
 - R and K and LS-factors are now calculated in the same way
 - Update landuse data and digital elevation model
 - Calibrate CN-WS for spatial resolution NEMO (50m)

b. Modelling

- Sediment load in Flanders was calculated with the original Sediment module in NEMO (prior) and the updated sediment module (with CN-WS, posterior) both on a spatial resolution of 50 m (see fig 1).
- The sediment load to rivers and ditches was also calculated with CN-WS on a resolution of 20m (see fig 1).
- Despite differences in resolution and, thus, details in land use and routing, results are comparable



NEMO (Nutrient Emission Model)

- Modelling N (Nitrogen) and P (Phosphorus) emissions from agriculture to surface water
- Spatially distributed model (resolution 50*50m)
- Developed at KU Leuven (Van Opstal et al., 2014).
- Used at Flemish environmental agency for nutrient management in Flanders
- Sediment transport creates important flux of nutrients towards surface water
- Coded in python, modular-setup
- Sediment fluxes are calculated with simplified and static python version of WaTEM-SEDEM in the 'sediment' module (slow)

CN-WS

- Combination of Curve-Number model and WaTEM-SEDEM
- Most developed version of WaTEM-SEDEM at the moment
- Active development @Fluves and @KULeuven, funded by Flemish government
- Code reviewed and debugged (Deproost et al., 2018)
- Code optimized for speed
 - Good documentation available (lot's of tutorials, detailed explanations about the model) see figure
 - SOON: open-source! Everyone can use it and can contribute to the code

https://cn-ws.github.io/

4.1.0-497-gf19e6fe	* Model Description * Erosion/sediment model: WaTEM/SEDEM View page source	
Search docs		
CONTENTS:	Erosion/sediment model: WaTEM/SEDEM	
Model Description	Concept	
Erodor/sediment model: WaTEM/SEDEM Concept Mean annual soll erosion rate Transport capacity calculation Tillage erosion EUSE factors	WaTEM/SEDEM is a spatially distributed model that was created at the Laboratry for Experimental Geomorphology (KU Leuven, Belgium). WaTEM stands for Water and Tillage erosion model (Van Oost et al., 2000) and SEDEM is the abbreviation of Sediment Delivery Model (Van Rompaey et al., 2001). In WaTEM/SEDEM, the mean annual soil erosion rate <i>B</i> and transport capacity <i>TC</i> are calculated for every pixel in the model domain. Next, the model iterates over all pixels according to the order	
References Run-off model: Curve Number Routing	determined by the routing algorithm. During the iteration, the outgoing sediment for every pixel is calculated by comparing the the total available sediment in the cell S_A (incoming sediment, $S_t + E$) with the transport capacity.	
CN-WS	Two cases exist:	
Overview of formulas and units Model Usage Installation Tutorial Frequently Asked Questions Contributing Changelog	• $S_A \leq TC$: the pixel can transport the total available sediment S_a , so erosion will occur at the mean annual soil erosion rate. The outgoing sediment S_a is set equal to the available sediment S_A . • $S_A > TC$; the total available sediment S_A is higher than the amount of sediment that can be transported. The outgoing sediment (S_A) equals the transport capacity TC . The net erosion rate is lower than the mean annual erosion rate E and equals $TC - S_a$. If the incoming sediment S_i is higher than the transport capacity TC , net sediment deposition will occur and equals $S_i - TC$.	

Figure 2: screenshot of documentation website cn_ws, soon available on github

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Figure 1: Sediment load in Flanders calculated with the original sediment module (prior, 50m), the new module (posterior, 50m) and CN-WS (20m)

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Contact information: info@fluves.com – Kerkstraat 106, 9050 Gent, Belgium



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