Development of Integrated SWAT-VFSMOD model

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- The muddy water is not that simple problem.
- To prevent and management this, there are some methods.
- The **VFS** is deemed as one of the good methods against this sediment-laden water problem.
How does it work??

The sediment is being trapped by the VFS, like this.
Limitation of Current SWAT..
What does VFSMOD – w model need..??

**Source Area**
- Rainfall event and Runoff
  - (Rainfall, Storm Duration, Curve Number, Storm Type)
- Source Area
  - (Length along slope, Slope as a fraction, Area)
- Erosion Parameters
  - (Soil Erodibility, Soil Type, Percent organic matter, Particle Class Diameter, Crop Factor, Practice Factor)

**Filter Strip**
- Overland Flow Inputs
  - (Buffer Length, Width of the Strip)
- Soil Properties
  - (Vertical Saturated K, Initial Water Content, Saturated Water Content)
- Buffer Vegetation Properties
  - (Spacing for grass stems, Height of Grass, Roughness)
Improvement of SWAT model – Old Study

• SWAT source code:

  subroutine trapeff_vfsmod (added new subroutine)

  Trapping Efficiency
  =
  (-0.00007345046 \times L^3 + 0.001558 \times L^2 - 0.006376 \times L - 0.001189)
  \times (\log(V))^3 +
  (0.0009688469 \times L^3 - 0.020779 \times L^2 + 0.095153 \times L + 0.019348)
  \times (\log(V))^2 +
  (-0.004274 \times L^3 + 0.092846 \times L^2 -0.487355 \times L - 0.10563)
  \times (\log(V)) +
  (0.006381 \times L^3 - 0.140713 \times L^2 + 0.869293 \times L + 0.19386)

  …

  Park et al., 2008. Improvement of Sediment Trapping Efficiency Module in SWAT using

  http://www.envsys.co.kr/~vfsmod
Improvement of SWAT model – Old Study

**READMGT**
- Read: FILTERW
- Calculate: Sediment Trapping Efficiency using Equation (1)

**FILTER**
- Calculate: Reduced Water and Non-Point Source Pollutants

**READMGT**
- Read: FILTERW
- Calculate: Sediment Trapping Efficiency using Equation (1)

**FILTER**
- Calculate: Reduced Water and Non-Point Source Pollutants

**TRAPEFF_VFSMOD**
- Calculate: Sediment Trapping Efficiency using Equation (2)
To Simulate VFS effect..

• **VFS** needs to be simulated before it’s installation to fields.

• There are many factors, that **VFS** has, affecting sediment trapping efficiency.

• Moreover, the condition of source area is also important.

• The current **SWAT** model considers only filter strip width.

• Not only **VFS** width, but various **VFS** conditions need to be considered.

• Thus, the VFSMOD model has been integrated to **SWAT** model.
Subroutine Filter
... 
"call VFSMOD"
...

Subroutine VFSMOD
Prepare Input Parameters for VFSMOD-w model

vfsmoddb1.knu : sol_clay(1,i), silt(1,i)

vfsmoddb2.knu : usle_c

vfsmoddb3.knu : usle_p(i)

vfsmoddb4.knu : cnday(j)

vfsmoddb5.knu: filterw(ihru), hru_ha(ihru), hru_slp(ihru)

vfsmoddb6.knu : precipday

Calculation sediment trapping efficiency

VFSMOD model

TE.txt

vfsmod.cio

precipitation ranges,
Ratio of width and length of HRU
Storm type
Application of Integrated SWAT to Small Watershed

- Jaun-ri, Gangwon province, South-Korea
- Forest: 23.83 ha, 96.17%
- Agricultural Area: 1.06 ha, 3.83%

Sediment trapping Efficiency (fraction)

Precipitation (mm)

Precipitation

Integrated SWAT

Current SWAT

1-Jan-02 11-Apr-02 20-Jul-02 28-Oct-02 5-Feb-03 16-May-03 24-Aug-03 2-Dec-03

3.00

2.50

2.00

1.50

1.00

0.50

0.00

0

50

100

150

200

250

300
Comparison of Flow (2000. 01. – 2007. 08.)

Average Flow in each year

<table>
<thead>
<tr>
<th>Year</th>
<th>Non-VFS</th>
<th>Current SWAT</th>
<th>Integrated SWAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0.0085</td>
<td>0.0085</td>
<td>0.0085</td>
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<tr>
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<td>2002</td>
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<td>0.0099</td>
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<tr>
<td>2003</td>
<td>0.0142</td>
<td>0.0142</td>
<td>0.0142</td>
</tr>
<tr>
<td>2004</td>
<td>0.0126</td>
<td>0.0126</td>
<td>0.0126</td>
</tr>
<tr>
<td>2005</td>
<td>0.0109</td>
<td>0.0109</td>
<td>0.0109</td>
</tr>
<tr>
<td>2006</td>
<td>0.0145</td>
<td>0.0145</td>
<td>0.0145</td>
</tr>
</tbody>
</table>

Min. : 0.0000 (Feb. 2000)
Max. : 0.1086 (Jul. 2006)
Comparison of Sediment (2000. 01. – 2007. 08.)

Average Sediment in each year

<table>
<thead>
<tr>
<th>Year</th>
<th>Non-VFS</th>
<th>Current SWAT</th>
<th>Integrated SWAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0.4911</td>
<td>0.2104</td>
<td>0.3157</td>
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<td>2001</td>
<td>0.3735</td>
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<td>0.2905</td>
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<td>2002</td>
<td>0.8266</td>
<td>0.4221</td>
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<td>2003</td>
<td>0.9245</td>
<td>0.3724</td>
<td>0.6124</td>
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<tr>
<td>2004</td>
<td>0.9215</td>
<td>0.4513</td>
<td>0.7010</td>
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<tr>
<td>2005</td>
<td>0.6878</td>
<td>0.3027</td>
<td>0.4329</td>
</tr>
<tr>
<td>2006</td>
<td>1.2671</td>
<td>0.5521</td>
<td>1.0898</td>
</tr>
</tbody>
</table>

Min. (Feb. 2000) : 0.0000
Max. (Jul. 2006) : 12.47 (Non-VFS)
5.54 (Current SWAT)
11.22 (Integrated SWAT)
• The **SWAT** model is deemed as the one of good watershed model.

• The model, however, has limitation to simulate **VFS**.

• Although the VFSMOD model is available to **VFS** simulation effectively, the model is field scale model.

• Thus, the VFSMOD model has been integrated to **SWAT** model.

• The integrated model shows non-constant sediment trapping efficiency, reflecting time-variant conditions.

• The integrated model is expected as a useful model for **VFS** simulations.
Welcome to any Question..

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