

Check Sediment Binding for Version 1.9

A sediment/water system consists of the amount of the chemical (A_{Tot}) in water and sediment. In a given surface area (SA), the volume of water (V_W) and amount of sediment (V_S) will be linearly related to the depth of the water (D_W) and sediment (D_S), respectively.

In the Version 1.8 and all earlier versions, the algorithm used in the pond for the amount in sediment (A_{Sed}) was:

$$A_{Sed} = \frac{A_{Tot} \times K_d \times V_S}{(K_d \times V_S) + V_W}$$

This algorithm is given on p. 58 of the Version 1.8, G-D documentation.

The new algorithm for both the pond and stream does not use the absolute volume of the water and sediment. Instead, it uses the sediment volume relative to the total volume of water (V_{SRel}). This is equivalent to using the sediment depth divided by the water depth.

$$A_{Sed} = \frac{A_{Tot} \times K_d \times V_{SRel}}{(K_d \times V_{SRel}) + 1}$$

This QA file checks these assumptions out. Demonstrates that the math is the same.

Below is the Version 1.8 approach.

$$\text{Orig}A_{Sed} = \frac{A_{Tot} \times K_d \times V_S}{(K_d \times V_S) + V_W}$$

$$\frac{A_{Tot} K_d V_S}{K_d V_S + V_W}$$

Now divide the numerator and denominator by the volume of water (V_W).

$$A_{Sed} = \frac{A_{Tot} \times K_d \times V_S \div V_W}{((K_d \times V_S) + V_W) \div V_W}$$

$$\frac{A_{Tot} K_d V_S}{K_d V_S + V_W}$$

$$\text{Orig}A_{Sed} = A_{Sed}$$

True

Now define the relative sediment volume -- i.e., relative to the water volume.

$$V_{SRel} = V_S \div V_W$$

$$\frac{V_S}{V_W}$$

Now define the new algorithm.

$$\mathbf{NewASed} = \frac{A_{Tot} \times K_d \times V_{SRe1}}{(K_d \times V_{SRe1}) + 1}$$

$$\frac{A_{Tot} K_d V_S}{(1 + \frac{K_d V_S}{V_W}) V_W}$$

Now simplify the equation.

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NewASedSimp = FullSimplify[NewASed]
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$$\frac{A_{Tot} K_d V_S}{K_d V_S + V_W}$$

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OrigASed == NewASedSimp
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True
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The Math is the same. OK.