HEC-RAS Water Quality Test Data Sets

HEC-RAS Water Quality User's Manual

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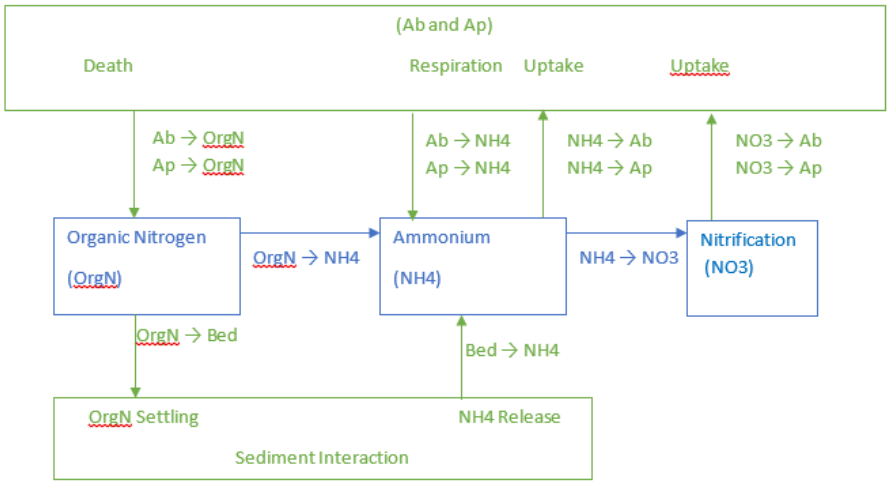
Table of Contents

Placeholder

1 Example: Nutrient Simulation Module - OrgN->NH4->NO3

1.1 Organic N (OrgN) → Ammonia Nitrogen NH_4(NH4) → Nitrate NO_3 (NO3)

NSMI simulates the transformations of organic nitrogen (OrgN), ammonium (NH_4), and nitrate (NO3). There is a stepwise transformation form OrgN to NH4, and on to NO3. Release of nutrients from (and settling of nitrogen to) the bed may also be important. Algae interact with both organic and inorganic forms of nitrogen through algal death, respiration and uptake of nutrients. The block diagram below shows sources and sinks for Organic Nitrogen (OrgN) to Ammonium Nitrogen (NH4) to Nitrate (NO3). The pathway for this test is shown in blue.



1.2 Parameters and Initial Conditions

Symbol	Description	Units	Value
$OrgN$	Organic Nitrogen	$\mathrm{mg/L}$	State variable
$NH4$	NH_4 Nitrogen	$\mathrm{mg/L}$	State variable
$NH4$	NO_3 Nitrogen	$\mathrm{mg/L}$	State variable

Symbol	Description	Units	Value
$OrgN_0$	Organic Nitrogen (initial concentration)	mg/L	8
$NH4_0$	NH_4 Nitrogen (initial concentration)	mg/L	1
$NO3_0$	NO_3 Nitrogen (initial concentration)	mg/L	0
$k_{on}(T)$	Organic N hydrolysis rate *OrgN → NH_4*	1/day	0.3
$\theta_{k_{on}}$	k_{on} Temperature correction factor	unitless	1.047
$k_{nit}(T)$	Nitrification rate *NH_4 → NO_3*	1/day	1
$\theta_{k_{nit}}$	k_{nit} Temperature correction factor	unitless	1.083
$k_{dnit}(T)$	Denitrification rate *NO_3 → atm*	1/day	0
$k_{dp}(T)$	Phytoplankton algae mortality rate *Ap → OrgN*	1/day	0
$k_{db}(T)$	Benthic algae mortality rate *Ab → OrgN*	1/day	0
$k_{rp}(T)$	Phytoplankton algae respiration rate *Ap → NH4*	1/day	0
$k_{rb}(T)$	Benthic algae base respiration rate *Ab → NH4*	1/day	0
μ_p	Growth rate for phytoplankton algae *NH4 → Ap*	1/day	0

Symbol	Description	Units	Value
μ_b	Growth rate for benthic algae *NH4 → Ab*	$1/\text{day}$	0
$r_{nb}(T)$	Benthic algae uptake rate *NH4 → Ab*	$1/\text{day}$	0
r_{nh4}	Sediment release rate of NH4 *Bed ↔ NH4*	$\text{g}-\text{N}/\text{m}^2/\text{day}$	0
v_{son}	Organic N settling velocity *OrgN → Bed*	m/day	0
T	Water Temperature	C	25
u	Stream velocity	m/s	1
D	Dispersion coefficient	m^2/s	0

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1.2.1 Analytic Solutions for OrgN→NH4

1.3 Analytic Solutions

$$OrgN = OrgN_o\, e^{-k_{on}t}$$

$$NH4(t) = NH4_o\, e^{-k_{nit}t} + \frac{k_{on} OrgN_o}{(k_{nit} - k_{on})}\left(e^{-k_{on}t} - e^{k_{nit}t}\right)$$

1.4 Settings and Parameters

Symbol	Description	Units	Value
$OrgN$	Concentration of Organic N	mg/L	State variable
$NH4$	Concentration of NH_4	mg/L	State variable
$NO3$	Concentration of NO_3	mg/L	State variable
$OrgN_o$	Initial concentration of organic nitrogen	mg/L	8
$NH4_o$	Initial concentration of NH_4	mg/L	1
$NO3_o$	Initial concentration of NO_3	mg/L	0
v_{son}	Organic N settling rate	m/day	0
k_{on}	Organic N hydrolysis rate	1/day	0.3
k_{nit}	Nitrification rate	1/day	1
r_{nh4}	Sediment release rate of NH4	m/day	0
k_{dnit}	Denitrification rate	1/day	0
v_{son}	Sediment denitrification velocity	m/day	0
θ_{kon}	Temperature correction factor	unitless	1.047
θ_{knit}	Temperature correction factor	unitless	1.083
T	Water temperature	C	25
u	Stream velocity	m/s	1

Symbol	Description	Units	Value
D	Dispersion coefficient	m^2/s	0

1.5 Comparison of Model and Analytic Solution

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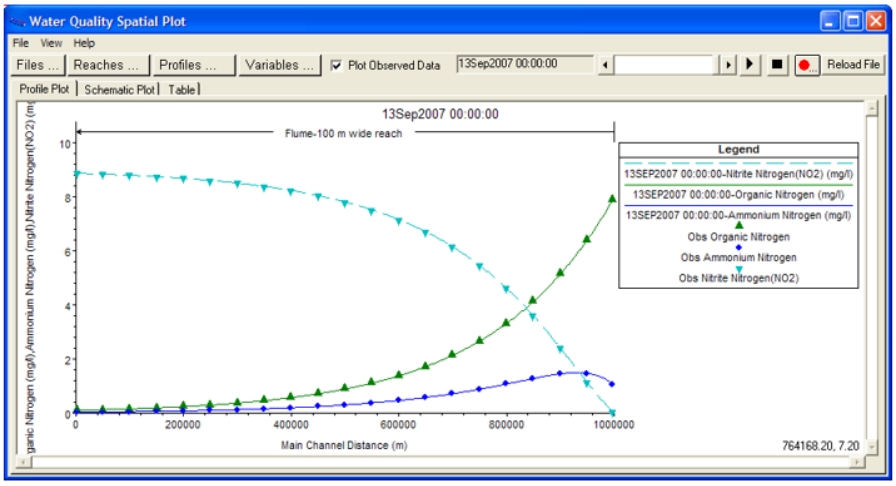

2 Example: Nutrient Simulation Module - Atmospheric Reaeration to Organics with Dissolved Oxygen

A block diagram is shown below. There are only two rate rate constants, the oxygen re-aeration rate (k_{ah}) and the BOD decay rate (k_{bod}).