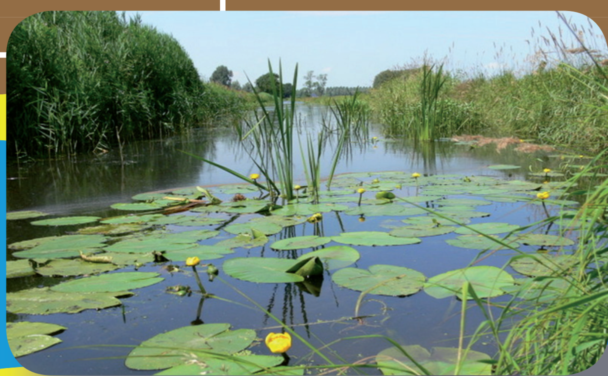
NUSWALITE

Manual Version 3.0

M.H.J.L. Jeuken
L.P.A. van Gerven

4



Alterra-Report 1226.4 ISSN 1566-7197

WAGENINGEN UR
For quality of life

NuswaLite

Manual version 3.0

NuswaLite

Manual version 3.0

M.H.J.L. Jeuken
L.P.A. van Gerven

Alterra Report 1226.4

Alterra, Wageningen, 2008

ABSTRACT

Jeuken, M.H.J.L., L.P.A. van Gerven, 2008. *NUSWALITE; Manual version 3.0*. Alterra Report 1226.4, Wageningen, Alterra, 63 blz.; 4 figs.; 21 tables.; 6 refs.

This report describes the input, execution and output of the NUSWALITE model, which simulates nutrient concentrations in surface waters. Example files are included of the application of the NUSWALITE model to the Vansjø-Hobøl catchment (Norway). A detailed description of the concepts behind the model is provided by the process description (Siderius et al., 2008).

Keywords: simulation model, user manual, NuswaLite, surface water quality, retention, nitrogen, phosphorus

ISSN 1566-7197

The pdf file is free of charge and can be downloaded via the website www.alterra.wur.nl (go to Alterra reports). Alterra does not deliver printed versions of the Alterra reports. Printed versions can be ordered via the external distributor. For ordering have a look at www.boomblad.nl/rapportenservice .

P.O. Box 47; 6700 AA Wageningen; The Netherlands
Phone: + 31 317 480700; fax: +31 317 419000; e-mail: info.alterra@wur.nl

Contents

Preface

This report describes the input, execution and output of the NUSWALITE model, which simulates nutrient concentrations in surface waters. Example files are included of the application of the NUSWALITE model to the Vansjø-Hobøl catchment (Norway). A detailed description of the concepts behind the model is provided by the process description (Siderius et al., 2008)

For questions about the contents of this report the reader is referred to the co-author mr. L. van Gerven (luuk.vangerven@wur.nl).

Wageningen, December 2008

Summary

This report describes the input, execution and output of the surface water quality model NUSWALITE (version 3.0) in detail. Example files are included of the application of the NUSWALITE model to the Vansjø-Hobøl catchment (Norway).

1 Introduction

Mathematical models predicting nitrogen and phosphorus concentrations in surface water can be useful tools to evaluate measures combating eutrophication. NUSWALITE is a water quality model to predict the nutrient concentration in catchments and 'polder areas'. Alterra Report 1226.2 (Siderius et al., 2008) describes the theoretical concepts behind the model. This report describes the input, execution and output of the current version of the model.

Chapter 2 gives an overview of the input for the model. The input comprises the network definition (schematization), the forcing of the network by water, nutrients and the environment (water temperature and cloudiness), the settings of the model parameters and some options regarding the IO, the model calculation settings and the management of the water courses. Instructions for the parameterization of the model processes can be found in the NUSWALITE process description (Siderius et al., 2008). There are however directions for the model settings (runtime options).

In chapter 3 the output of the model will be described in detail. The appendices include a description of the data model, an overview of the input and output files, an application to the Vansjø-Hobøl catchment (Norway) and a list of all error messages.

2 Input

This chapter gives an overview of the input data needed to run NUSWALITE, and the required format of the corresponding input files. The input files will be discussed thematically. A data model visualizing the structure of the data is presented in Appendix 1.

2.1 Input filenames

The NUSWALITE input is divided over different files (Table 1). These are the default filenames that NUSWALITE will be looking for. It is possible to use alternative file names (see paragraph 2.5.3).

Table 1 Overview of default input filenames

File	Description
NuswaLite_Waterbalance.bin	Water balance and network definition
NuswaLite_Param.ini	Parameters of the model
NuswaLite_LocalParam.csv*	Local parameters of the model
NuswaLite_Environment.csv	Environmental conditions for biomass growth
NuswaLite_DiffuseSource.csv*	Loads by nutrient leaching (e.g. ANIMO)
NuswaLite_Erosion.csv*	Loads by erosion (e.g. PUSLE)
NuswaLite_PointSource.csv*	Loads by point sources
NuswaLite_DischargeConcentrations.csv*	Concentrations for discharge boundary inflow
NuswaLite_LevelConcentrations.csv*	Concentrations for level boundary inflow
NuswaLite_LinkConcentrations.csv*	Concentrations for linked boundary inflow
NuswaLite_PrecipitationConcentrations.csv*	Concentrations for precipitation
NuswaLite_Initial.csv	Initial conditions
NuswaLite_NodeClusters.csv*	Clusters of nodes for aggregated output
NuswaLite.ini*	Alternative file names for input/output
NuswaLite_Management.csv*	Removal of biomass (e.g. mowing)

**optional*

2.2 Network definition and water balance

The network definition and the water balance provide the basis for the water quality calculations. The network is defined by the water course sections (nodes), their geometry and the way the nodes are connected. A single node can be connected to maximal ten other nodes. The water balance comprises for each time step the external water fluxes on the nodes (five different kinds), the internal water flow between the nodes and the water volume at the node.

The data on the network and the water balance, as well as the calculation period, have to be stored in the binary file NUSWALITE_WATERBALANCE.BIN, that consists of four sections. The file can also be supplied to NUSWALITE in ASCII format. The user decides which hydrological model is used to define the network and produce the water balance, as long as this information is given to NUSWALITE in the right format.

The hydrological model SWQN (Smit et al., 2009) contains an option to produce the NUSWALITE_WATERBALANCE.BIN file right away.

The first section of NUSWALITE_WATERBALANCE.BIN contains some calculation details (Table 2). This section contains only one record. In the first two fields the version ID and calculation ID can be defined. The following three columns comprise the start date of the calculation and the sixth column contains the number of days the calculation covers. In the last column the number of time steps per day have to be defined.

The total number of nodes is given in section 2 of NUSWALITE_WATERBALANCE.BIN (Table 3). This section contains only one record.

In section 3 of NUSWALITE_WATERBALANCE.BIN (Table 4) the network is defined. This section contains one record for every node. The first column contains the node ID. The node ID's do not have to be sorted or continuous. After that the bottom area and initial water volume of the node are given. The next column contains the number of nodes this node is connected to, followed by the ID's of the connected nodes. The number of connected nodes is limited to ten.

Table 2 Calculation details: section 1 of NUSWALITE_WATERBALANCE.BIN

Col	Name	Description	Unit	Type
1	VersionID	Version id for water balance file	-	C40
2	CalcID	Calculation identification message	-	C60
3	StartYear	Day for start of calculation	day	I4
4	StartMonth	Month for start of calculation	month	I4
5	StartDay	Year for start of calculation	year	I4
6	NrDays	Number of calculation days	day	I4
7	TimestepsPerDay	Time steps per day at which water balance is given	1/day	I4

Table 3 Number of nodes: section 2 of NUSWALITE_WATERBALANCE.BIN

Col	Name	Description	Unit	Type
1	NOfNodes	Number of nodes	-	I4

Table 4 Network layout: section 3 of NUSWALITE_WATERBALANCE.BIN

Col	Name	Description	Unit	Type
1	NodeID	Node ID	-	I4
2	BottomArea	Bottom area	m^2	R8
3	InitialVolume ($V_{w,t0}$)	Initial water volume	m^3	R8
4	NOfConNodes	Number of connected nodes (CN)	-	I4
5-N*	ConNodID	Connected node ID	-	I4

** NOfConNodes (CN) is limited to ten; $5 \leq N \leq 14$*

In section 4 of NUSWALITE_WATERBALANCE.BIN (Table 5) the water balance is given. NUSWALITE assumes that for a number of *EndTime* days a set of *NofNodes* records is given in the same order as the network layout is given. First the time averaged nodal water volume has to be defined. The second column contains the volume at the end of the time step, which is assumed to be equal to the volume at the beginning of the next time step. The next column contains five different flow boundary conditions, of which the first four can have different concentrations in case of inflow, defined by the user (see paragraph 2.4). In the last columns the internal flow is defined for each connected node. A positive flow means flow to the node; a negative flow means flow from the node.

NUSWALITE checks the water balance for all nodes, and expects the water balance errors to be below 0.01% of the average volume during the time step. NUSWALITE also checks if the flow from node A to B equals minus the flow from B to A with a tolerance of 0.01%. If these tolerances are exceeded warning messages are generated in the log file (NUSWALITE.LOG).

Table 5 Water balance: section 4 of NUSWALITE_WATERBALANCE.BIN

Col	Name	Description	Unit	Type
1	VolAddAvg ($\overline{V_w}$)	Time averaged nodal volume	m^3	R8
2	VolAddEnd ($V_{w,t0+\Delta t}$)	Nodal volume at end of time step	m^3	R8
3	DepthAvg	Averaged water depth per time step	m	R8
4	Vel	Flow velocity averaged over time step	$m.d^{-1}$	R8
5	FlwBndH ($Q_{external,1}$)	Level boundary flow**	$m^3\ d^{-1}$	R8
6	FlwBndQ ($Q_{external,2}$)	Discharge boundary flow**	$m^3\ d^{-1}$	R8
7	FlwBndL ($Q_{external,3}$)	Link boundary flow**	$m^3\ d^{-1}$	R8
8	FlwBndP ($Q_{external,4}$)	Precipitation boundary discharge**	$m^3\ d^{-1}$	R8
9	FlwBndE ($Q_{external,5}$)	Evaporation boundary discharge**	$m^3\ d^{-1}$	R8
10-N*	FlwNodID1-CN ($Q_{i,1-..}$)	Internal flow discharges**	$m^3\ d^{-1}$	R8

* *NOfConNodes (CN) is limited to ten; 10 ≤ N ≤ 19*

** *positive value = incoming flow, negative value = outgoing flow*

2.3 Parameterization and environmental conditions

The parameters for all model processes are defined in NUSWALITE_PARAM.INI. This file uses the Microsoft Windows INI-file format. The file is divided in the sections [LivBioPar], [Floating Biomass], [Rooting Biomass], [Reed], [Parameters] and [Options]. The parameters are set using the notation:

Name = [Value]   or   Name = [List]

A value is a real or integer, depending on the variable. List is a list of integers, separated by commas and placed on one line. Lists are only used in the [Options] section that will be discussed in paragraph 2.5.1.

For parameters in the [LivBioPar], [Floating Biomass], [Rooting Biomass], [Reed] and [Parameters] sections no default values are given or presumed by the program. The user has to provide values for all parameters (Tables 6 to 11), except the detailed mortality parameters (Table 10). These only need to be given when the option *UseDetailedMortality* is used (see section 2.5.1).

Suggestions for parameter values as well as information on the underlying processes can be found in the NUSWALITE Process Description (Siderius et al., 2008).

Table 6 Parameters of the [LivBioPar] section in NUSWALITE_PARAM.INI

Name	Description	Sym	Unit	Type
ConcNitrCritUpt	Minimum concentration for N uptake (all biomasses)	*cNupmin*	g/m^3	R8
ConcPhosCritUpt	Minimum concentration for P uptake (all biomasses)	*cPupmin*	g/m^3	R8

Table 7 Parameters of the [Floating Biomass] section in NUSWALITE_PARAM.INI

Name	Description	Sym	Unit	Type
NitrogenDMRatio	Nitrogen/dry matter ratio of floating biomass	$f_{N,FB}$	gN/g	R8
PhosphorusDMRatio	Phosphorus/dry matter ratio of floating biomass	$f_{N,FB}$	gP/g	R8
RespirationRate	Respiration loss during primary production	$a_{,FB}$	-	R8
MortalityRate	Mortality rate at 20°C	$k_{mor,FB}$	d^{-1}	R8
Q10MortalityRate	Temperature sensitivity for mortality	$\beta_{mor,FB}$	-	R8
ConcNitrMonod	50%-optimum concentration for N uptake	$c_{Nmonod,FB}$	g/m^3	R8
ConcPhosMonod	50%-optimum concentration for P uptake	$c_{Pmon,odFB}$	g/m^3	R8
InflowCFB	'background' inflow of floating biomass	-	g/m^3	R8
FBAdvectiveFraction	Fraction floating biomass subject to adv. transport	f_{adv}	-	R8
LightIntCoef	Light interception coefficient for floating biomass	α_{FB}	-	R8

Table 8 Parameters of the [Rooting Biomass] section in NUSWALITE_PARAM.INI

Name	Description	Sym	Unit	Type
NitrogenDMRatio	Nitrogen/dry matter ratio of rooting biomass	$f_{N,RB}$	gN/g	R8
PhosphorusDMRatio	Phosphorus/dry matter ratio of rooting biomass	$f_{N,RB}$	gP/g	R8
RespirationRate	Respiration loss during primary production	$a_{,RB}$	-	R8
MortalityRate	Mortality rate at 20°C	$k_{mor,RB}$	d^{-1}	R8
Q10MortalityRate	Temperature sensitivity for mortality	$\beta_{mor,RB}$	-	R8
ConcNitrMonod	50%-optimum concentration for N uptake	$c_{Nmonod,RB}$	g/m^3	R8
ConcPhosMonod	50%-optimum concentration for P uptake	$c_{Pmonod,RB}$	g/m^3	R8
LightIntCoef	Light interception coefficient for floating biomass	α_{FB}	-	R8

Table 9 Parameters of the [Reed] section in NUSWALITE_PARAM.INI

Name	Description	Sym	Unit	Type
NitrogenDMRatio	Nitrogen/dry matter ratio of reed	$f_{N,Reed}$	gN/g	R8
PhosphorusDMRatio	Phosphorus/dry matter ratio of reed	$f_{N,Reed}$	gP/g	R8
RespirationRate	Respiration loss during primary production	$a_{,Reed}$	-	R8
MortalityRate	Mortality rate at 20°C	$k_{mor,Reed}$	d^{-1}	R8
Q10MortalityRate	Temperature sensitivity for mortality	$\beta_{mor,Reed}$	-	R8
ConcNitrMonod	50%-optimum concentration for N uptake	$c_{Nmon,Reed}$	g/m^3	R8
ConcPhosMonod	50%-optimum concentration for P uptake	$c_{Pmon,Reed}$	g/m^3	R8
LightEffCoef	Light interception coefficient for reed	a_{int}	-	R8

Table 10 Optional detailed mortality parameters which can be implemented in the [Floating Biomass], [Rooting Biomass] and [Reed] section in NUSWALITE_PARAM.INI

Name	Description	Sym	Unit	Type
StartSeason	Day number in year for start of season	-	d	R8
EndSeason	Day number in year for end of season	-	d	R8
MortalityRateSeason	Season mortality rate at 20°C	$k_{mor,s}$	d^{-1}	R8
MortalityRateWinter	Winter mortality rate at 20°C	$k_{mor,w}$	d^{-1}	R8

Table 11 Parameters of the [Parameters] section in NUSWALITE_PARAM.INI

Name	Description	Sym	Unit	Type
Latitude	Latitude to determine maximum incoming radiation for primary production	ϕ	^{o}	R8
MineralizationRate	Mineralization rate of organic material	k_{mi}	d^{-1}	R8
Q10Mineralization	Temperature sensitivity for mineralization	β_{mi}	-	R8
DenitrificationRate	Removal rate of mineral N	k_{den}	d^{-1}	R8
Q10Denitrification	Temperature sensitivity for N removal	β_{den}	-	R8
BulkDensity	Dry bulk density of sediment	ρ_s	$g.m_s^{-3}$	R8
LinSorptionNMin	Minimum mineral N adsorption capacity	$k_{aN\text{min}}$	$m_{pores}^3.g_s^{-1}$	R8
LinSorptionNMax	Maximum mineral N adsorption capacity	$k_{aN\text{max}}$	$m_{pores}^3.g_s^{-1}$	R8
LinSorptionNDayMax	Day in year with highest N sorption capicity	$t_{kaN\text{max}}$	day	R8
LinSorptionPMin	Minimum mineral P adsorption capacity	$k_{aP\text{min}}$	$m_{pores}^3.g_s^{-1}$	R8
LinSorptionPMax	Maximum mineral P adsorption capacity	$k_{aP\text{max}}$	$m_{pores}^3.g_s^{-1}$	R8
LinSorptionPDayMax	Day in year with highest N sorption capicity	$t_{kaP\text{max}}$	day	R8
SedimentSinkSpeedMineral	Loss rate for mineral P	$w_{s(min)}$	$m.d^{-1}$	R8
SedimentSinkSpeedOrganic	Loss rate for organic N/P	$w_{s(org)}$	$m.d^{-1}$	R8
SedimentThickness	Virtual thickness of sediment layer	H_{sed}	m	R8

It is possible to overrule some of the parameters with local values. These can be specified in the file NUSWALITE_LOCALPARAM.CSV. Only parameters greater than or equal to zero will be modified for the specified nodes (e.g. the line '203, -1, 0.1, -1,-1' will only set the denitrification rate of node 203 to 0.1, but will keep the default values for the sediment thickness and sediment sink speed).

Important factors for the amount of primary production are water temperature and global radiation. The daily water temperature, which applies to all nodes, can be set in the NUSWALITE_ENVIRONMENT.CSV file. Global radiation is calculated with a function based on the latitude from the parameter file (Table 11) and a daily CloudinessFactor, which also applies to all nodes and is given in the NUSWALITE_ENVIRONMENT.CSV file. The cloudiness factor equals one minus the fraction of sunshine hours during daylight hours.

Table 12 NUSWALITE_LOCALPARAM.CSV

Col	Name	Description	Sym	Unit	Type
1	Node	Node ID		-	I4
2	SedimentThickness	Virtual thickness of sediment layer	H_{sed}	m	R8
3	DenitrificationRate	Removal rate of mineral N	k_{den}	d^{-1}	R8
4	SedimentSinkSpeedMineral	Loss rate for mineral P	$w_{s(min)}$	$m.d^{-1}$	R8
5	SedimentSinkSpeedOrganic	Loss rate for organic N/P	$w_{s(org)}$	$m.d^{-1}$	R8

Table 13 NUSWALITE_ENVIRONMENT.CSV

Col	Name	Description	Unit	Type
1	Date*	Date	-	C10
2	Temp	Water temperature	^oC	R8
3	CloudinessFactor	Clouded fraction of day (= 1–fraction of sunshine)	-	R8

** Date formats 'yyyy-m-d' and 'd-m-yyyy' are both accepted.*

2.4 Boundary and initial conditions

External nutrient loads can be provided to the model in two ways: directly as a load or indirectly as a concentration. Direct external loads are submitted to NUSWALITE through three files which represent three different nutrient sources. It concerns nutrient leaching by the soil system (for example derived by the ANIMO model Groenendijk et al., 2005), nutrients coming from point sources en nutrients associated with the erosion of the soil surface by run-off.

The three files with the direct external input loads have the same format (Table 14). The first two columns define the time and location at which the loads (column three to six) are applied. Values at a node are sustained in time until a new value is given for the same node. Values for the same date and node within a file are summed up. For each time step the external loads defined by these files are added to the indirect loads to determine the total external loads to the nodal water volumes.

Indirect external loads in the form of concentrations can be provided through four different files. Each file is coupled to a specific discharge from the water balance (Table 5). The actual load is calculated by multiplying the actual inflow with the given concentration. In case of boundary outflow the outgoing load is calculated by multiplying the outflow with the concentration of the nodal water volumes.

These files also share the same format (Table 15). The first column contains the date, followed by the node ID to set the time and place a concentration applies to. The third till sixth column contain the concentrations of organic and mineral nitrogen and phosphorus. Values at a node are sustained in time until a new value is given for the same node. Values for the same date and node within a file are replaced by the latter. For each time step the resulting indirect external loads are added to the direct external loads to determine the total external loads to the nodal water volumes.

Table 14 NUSWALITE_DIFFUSESOURCE/POINTSOURCE/EROSION.CSV

Col	Name	Description	Unit	Type
1	Date*	Date for change of setting	Date	C10
2	Node	ID used in node definition	-	I4
3	LoadOrgN	Load of organic nitrogen	$g.d^{-1}$	R8
4	LoadMinN	Load of mineral nitrogen	$g.d^{-1}$	R8
5	LoadOrgP	Load of organic phosphorus	$g.d^{-1}$	R8
6	LoadMinP	Load of mineral phosphorus	$g.d^{-1}$	R8

** Date formats 'yyyy-m-d' and 'd-m-yyyy' are both accepted*

Table 15 NUSWALITE_DISCHARGE/LEVEL/LINK/PRECIPITATIONCONCENTRATIONS.CSV

Col	Name	Description	Sym	Unit	Type
1	Date*	Date for change of setting		Date	C10
2	Node	ID used in node definition		-	I4
3	ConOrgN	Concentration of organic nitrogen	$c_{oN,in}$	$g.m^{-3}$	R8
4	ConMinN	Concentration of mineral nitrogen	$c_{mN,in}$	$g.m^{-3}$	R8
5	ConOrgP	Concentration of organic phosphorus	$c_{oP,in}$	$g.m^{-3}$	R8
6	ConMinP	Concentration of mineral phosphorus	$c_{mP,in}$	$g.m^{-3}$	R8

** Date formats 'yyyy-m-d' and 'd-m-yyyy' are both accepted*

The initial condition of the system is determined on basis of the initial nutrient and biomass concentrations which have to be specified for every node (Table 16). The biomass 'concentrations' have to be entered as a density per bottom area (g/m2). Initial nutrient loads can be calculated by using the initial nodal volume (Table 4).

It is important to make realistic estimates of the initial concentrations to prevent that the water system is unrealistically overloaded or depleted with nutrients. To reduce the influence of wrongly chosen initial conditions it is recommended to make one model run in advance (over a considerable number of time steps) of which the output concentrations can be used as initial concentrations (paragraph 3.6).

Table 16 NUSWALITE_INITIAL.CSV

Col	Name	Description	Unit	Type
1	Node	Node ID	-	I4
2	BiomassRoot	Initial rooting biomass	$g.m^{-2}$	R8
3	BiomassReed	Initial reed biomass	$g.m^{-2}$	R8
4	BiomassFloat	Initial floating biomass	$g.m^{-2}$	R8
5	ConOrgN	Initial concentration of organic nitrogen	$g.m^{-3}$	R8
6	ConMinN	Initial concentration of mineral nitrogen	$g.m^{-3}$	R8
7	ConOrgP	Initial concentration of organic phosphorus	$g.m^{-3}$	R8
8	ConMinP	Initial concentration of mineral phosphorus	$g.m^{-3}$	R8

2.5 User options

NUSWALITE offers several options for the user:

- Runtime options considering input, output and model processes can be set by the user (NUSWALITE_PARAM.INI)
- Clusters of nodes can be defined for which aggregated output is produced (NUSWALITE_NODECLUSTERS.CSV). In this way nutrient balances are given on subcatchment scale
- Alternative names for the input and output files can be defined (NUSWALITE.INI)
- The amount, time and location of biomass removal (e.g. mowing, dredging) can be specified by the user (NUSWALITE_MANAGEMENT.CSV)

These options will be successively discussed in the next paragraphs.

2.5.1 Runtime options

The runtime options must be set in the [Options] section of nuswalite_param.ini. An overview of all options is given by Table 17. If an option is not set, NUSWALITE uses the default value as specified in the table.

Table 17 Runtime options from NUSWALITE_PARAM.INI

Name	Description	Def	Unit	Type
StartTimeNuswaLite	Day number after first day in NUSWALITE _WATERBALANCE.BIN to start calculation	-	day	I4
StartDayNuswaLite		-	day	I4
StartMonthNuswaLite	Alternative date to start the calculation	-	month	I4
StartYearNuswaLite		-	year	I4
EndTimeNuswaLite	Day number after first day in NUSWALITE _WATERBALANCE.BIN to end calculation	-	day	I4
EndDayNuswaLite		-	day	I4
EndMonthNuswaLite	Alternative date to end the calculation	-	month	I4
EndYearNuswaLite		-	year	I4
HBotAdd	Work-around parameter for negative or near zero volumes and water depths.	0.0	m	R8
DiffuseSourceFactorN	Correction factor for diffuse N loads	1.0	-	R8
DiffuseSourceFactorP	Correction factor for diffuse P loads	1.0	-	R8
PointSourceFactor	Correction factor for point source loads	1.0	-	R8
ErosionFactor	Correction factor for erosion loads	1.0	-	R8
MergeNodes	List* of nodes that will be merged			C9999
UseDetailedMortalityRoot	Option to give detailed mortality parameters for submerged rooting biomass	0	1/0^	I4
UseDetailedMortalityReed	Option to give detailed reed mortality parameters	0	1/0^	I4
UseDetailedMortalityFloat	Option to give detailed mortality parameters for floating biomass	0	1/0^	I4
UseSedimentation	Use sedimentation rate only at listed nodes	0	1/0^	I4
SedimentationNodes	List* of nodes where sedimentation occurs (A = all)	A	-	C9999
FloatingBiomassOutflowNodes	List* of nodes where floating biomass can leave the system with boundary flow	None	-	C9999
EchoLoads	Write all external loads (per node per time) to NUSWALITE_OUTECHOLOADS.CSV and to a yearly sum (NUSWALITE_OUTECHOLOADSYEARLY.CSV)	0	1/0^	I4
WriteLoad	Write daily loads per node associated with incoming internal flows to NUSWALITE _OUTLOADS.CSV	0	1/0^	I4
WriteCon	Write daily nodal biomass and nutrient concentrations to NUSWALITE_OUTCON.CSV	0	1/0^	I4
WriteBiomass	Write daily nodal biomass characteristics to NUSWALITE_OUTBIOMASS.CSV	0	1/0^	I4
WriteBalN	Write daily nodal mass balance for nitrogen to NUSWALITE_OUTBALN.CSV and yearly aggregates to NUSWALITE_OUTBALYEARLYN.CSV	0	1/0^	I4
WriteBalP	Write daily nodal mass balance for phosphorus to NUSWALITE_OUTBALP.CSV and yearly aggregates to NUSWALITE_OUTBALYEARLYP.CSV	0	1/0^	I4
WriteBalBin	Write to daily nodal binary balance file for N and P	0	1/0^	I4
OutBalanceAll	Write daily balances for all (selected) nodes (=1) or write balances only for days when (selected) nodes have significant balance errors (=0)	0	1/0^	I4
OutputNode	List* of nodes for output of detailed results (A = all; yearly totals are always for all nodes)	A	-	C9999
RetentionSubbasinNode1, RetentionSubbasinNode2, ….. RetentionSubbasinNode9	Up to nine lists* of nodes for which retention results are written to NUSWALITE_ OUTRETENTIONSYEARLYSUBCATCHMENT1-9.CSV	-	-	C9999
RetentionScientific	If set to 1 the N and P loads carried by floating biomass are taken into account for calculating retention	0	1/0^	I4

*All variables are optional , * Lists are comma separated , ^1=Yes; 0=No*

StartTimeNuswaLite or StartDayNuswaLite, StartMonthNuswaLite and StartYearNuswaLite
EndTimeNuswaLite or EndDayNuswaLite, EndMonthNuswaLite and EndYearNuswaLite
By default the calculation period of NUSWALITE is set in NUSWALITE_ WATERBALANCE.BIN. By setting an alternate start time and/or end time the calculation period can be shortened. When a -Time- (= day number after the first day of the water balance) is given the -Day-, -Month- and -Year- values are ignored.

HBotAdd
HBotAdd is a workaround parameter to deal with negative (and zero) water volumes in the water balance supplied to NUSWALITE. Although physically not correct, some hydrological models produce negative water volumes in their water balance. This is mainly due to inaccurate dealing with dry fall situations, instability or the chosen numerical solution. Though these problems should be resolved in the hydrological model, it is possible to use a work-around implemented in NUSWALITE.

The easiest way to correct a water balance with negative volumes is to add a constant extra volume per node during the whole calculation period that is big enough to make the lowest volume positive. With this method the volume changes per time step are not affected, and no correction of water flows is needed. A drawback of this method is that it can influence the results because the residence time goes up, which leads to less dynamic results and possibly increased retention.

There are two ways to define how much extra volume is added. Both methods are expressed in terms of extra depth added to the node (Figure 1). Extra depth is a relative factor, and the extra volume added to a node is determined as extra depth multiplied with the bottom area. The two methods are:

- A constant value for the whole system (given as *HBotAdd*>0)
- A value per node based on the actual water balance (given as *HBotAdd*<0)

The extra depth is also added to the water depth taken from the water balance.

The first method is chosen by giving a positive value for *HBotAdd*. This leads to a constant extra depth for al nodes. The advantage of this method is that it is independent of the scenario that is simulated. A disadvantage is the correction factor needs to be set to the 'worst-case' in the model to work. It is not recommended to set this parameter to >0.10m.

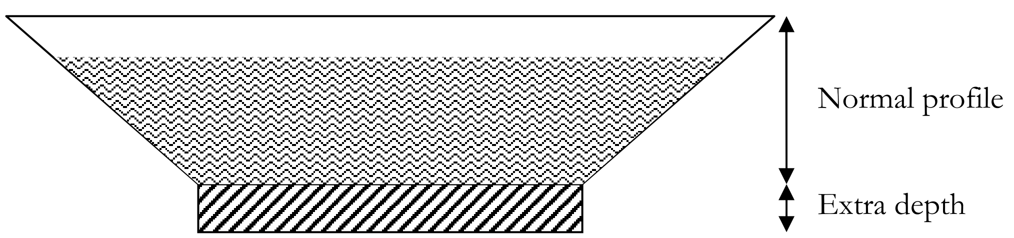


Figure 1 Scheme showing how extra volume is created using HBotAdd

The second method is chosen by giving a negative value for *HBotAdd*. In this situation the extra depth is appointed per node and is constant during the calculation period. This is done by determining the lowest water volume per node, and thus the extra depth needed for this node to get positive water volumes. The extra depth is then raised with (the absolute value of) *HBotAdd* to prevent zero water volumes. The advantage of this method is that it will always work. The disadvantages are that automatic extra depth could become very high, and could also change significantly when the water balance is recalculated (extreme negative volumes tend to change more rapidly than the over all water balance). So when simulating scenarios and presenting results relative to other scenarios this option should not be used. The actual depth corrections are written to the NUSWALITE_OUTHBOTADD.CSV file, and the user should take notice of these values. It is not recommended to set this parameter to < -0.02m.

In all cases the user should be aware of the fact that the use of *HBotAdd* can have great effects on the results.

DiffuseSourceFactorN, DiffuseSourceFactorP, PointSourceFactor, ErosionFactor
These factors can be used to manipulate the boundary conditions. All values of a specific boundary file can be multiplied with a given factor. For the NUSWALITE_DIFFUSESOURCE file there can be differentiated between nitrogen and phosphorus. There are various reasons to use this factor:

- Unit conversions
- Sensitivity analysis
- Scenario calculations
- Anticipate on expected changes in the results of a supplying model

Especially in the latter case one must not forget to set back this parameter when new results from the model are used. Always look at the warnings in the NUSWALITE.LOG file.

MergeNodes
This option makes it possible to merge the listed nodes to one node. Make sure that the listed nodes are connected to each other.

UseDetailedMortalityRoot, UseDetailedMortalityReed, UseDetailedMortalityFloat
These options make it possible to differentiate between seasonal and winter biomass mortality, for the selected biomass. When set to 1, the user must provide all detailed mortality parameters (Table 10) in respectively the [Rooting Biomass], [Reed] and [Floating Biomass] section. These parameters include the duration of the 'seasonal' period.

UseSedimention, SedimentationNodes
With the *UseSedimention* option sedimentation only occurs in the nodes that are listed in *SedimentationNodes*.

FloatingBiomassOutflowNodes
Normally biomass flows out of the system with every negative boundary flow (discharge boundary, link boundary and level boundary flow). This is however an unwanted situation for negative flow boundaries due to infiltration. Because NUSWALITE can not distinguish between infiltration outflow and catchment outflow, we made it possible to limit the outflow of biomass to the nodes selected with *FloatingBiomassOutflowNode*. It is recommended to define only the node(s) at the outlet(s) as a floating biomass outflow node, since its outgoing flux is defined as a negative flow boundary. Make sure there is no infiltration flux at such an outlet node.

EchoLoads, WriteLoad, WriteCon, WriteBiomass, WriteBalN, WriteBalP, WriteBalBin
These switches can be used to produce extra output files (see Table 17). When using the *EchoLoads* switch all external incoming and outgoings loads are registered, which can be a useful check on the input delivered by external models. The *WriteLoad* switch can be useful when comparing loads associated with flow-proportional water samples (field measurements) to model results. The generated output file gives the daily loads per node associated with internal inflow.

More info about the extra output files is given in Chapter 3. To improve performance it is recommended only to produce the extra output if needed. Especially the production of the detailed balance files (by setting *WriteBalN* and *WriteBalP* to 1) and the file with the incoming and outgoing loads (by setting *EchoLoads* to 1) can be time consuming.

OutBalanceAll, OutputNode
The detailed balance files do not only slow down the calculation itself. They can also be time consuming during post processing. When *OutBalanceAll* is set to 0, results are only written to the detailed mass balance files NUSWALITE_OUTBALP.CSV and NUSWALITE_OUTBALN.CSV when the overall mass balance error for a certain node on a certain day is greater than 10^{-3} g.
If a list is provided for *OutputNode*, results of only the selected nodes will be written to:

- NUSWALITE_OUTBALN.CSV
- NUSWALITE_OUTBALP.CSV
- NUSWALITE_OUTCON.CSV
- NUSWALITE_OUTBIOMASS.CSV
- NUSWALITE_OUTECHOLOADS.CSV
- NUSWALITE_OUTLOADS.CSV

Yearly balances will still be written for all nodes (NUSWALITE_OUTBALYEARLYN.CSV, NUSWALITE_OUTBALYEARLYP.CSV and NUSWALITE_OUTECHOLOADSYEARLY.CSV.
When combining *OutputNode* with *OutBalanceAll* set to 0, only mass balance errors in the selected nodes will be written to the detailed balance files.

RetentionSubbasinNode1 - RetentionSubbasinNode9, RetentionScientific
By default the calculation of the retention (= the amount of nutrients that are stored or removed in the water system) is made for the whole network. It is also possible to make retention calculations for parts of the modeled network. Therefore up to 9 different subbasins can be specified by providing a list of nodes to *RetentionSubbasinNode1* to *RetentionSubbasinNode9*. It is important that these nodes form a complete basin with preferably one outlet point; otherwise the retention calculation will give false results.

By default the incoming and outgoing N and P loads of floating biomass flow are not included in the calculation of retention. When *RetentionScientific* is set to 1 there will be accounted for floating biomass outflow. More details on how the retention is calculated can be found in paragraph 3.5.

2.5.2 Clustering of results

Initially it was thought that NUSWALITE should only produce plain results per node per day, and that it was up to the user to process these detailed results. This practice however becomes awkward in calculations with longer periods and bigger networks because it results in big unmanageable files that makes processing the results very slow. Besides the option to produce results for a selection of nodes, and files with the total results per year for every node, and per day for all nodes, the need emerged to have results for groups of nodes. In this way results can be produced for subcatchments (subbasins), provided that the clustered nodes are connected to each other and have one common outlet point. Clustering only takes place when the NUSWALITE_NODECLUSTERS.CSV file is provided. The file has a very simple layout with the node ID in the first column, and the cluster ID in the second. When a node is not included, or is given a cluster ID less or equal to zero, then this node is excluded in the clustered results.

Table 18 NUSWALITE_NODECLUSTERS.CSV

Col	Name	Description	Unit	Type
1	Node	Node ID	-	I4
2	ClusterID	ID to cluster node by	-	I4

2.5.3 Alternative file names

It is possible to use alternative file names for (almost) all input and output files of NUSWALITE. They can be specified in the NUSWALITE.INI file using the same INI-file format as used for the parameter file. The file contains the sections [Input] and [Output]. To change the name of a file from this document, just put filename (with an underscore ('_') instead of the dot) = new filename (with dot). For example: NuswaLite_Param_ini = MyPar.txt. Omission leads to the use of default names. An alternative name for the nuswalite.ini file can be specified at program execution (see paragraph 3.1).

2.5.4 Biomass management

In NUSWALITE it is possible to define management strategies (e.g. mowing) by entering the biomass fraction (between zero and one) that will be removed for a certain node and date in the NUSWALITE_MANAGEMENT.CSV file. For mowing of reed it is recommended not to use removal fractions greater than 0.75, since at least 25 % of the biomass cannot be removed by mowing (roots and reed parts under water). Applying a removal fraction of 1 means that the rooting biomass in that section is removed for ever. Unlike the date interpretation in the load and concentration files, values for a certain date will only be applied on that specific date, and will not be sustained after the date. When a Node ID of -99 is used, the management settings will be applied to all nodes.

Table 19 NUSWALITE_MANAGEMENT.CSV

Col	Name	Description	Unit	Type
1	Date*	Date	-	C10
2	NodeID	Node ID	-	I4
3	RootRemove	Rooting biomass removal fraction	-	R8
4	ReedRemove	Reed removal fraction	-	R8
5	FloatRemove	Floating biomass removal fraction	-	R8

** Date formats 'yyyy-m-d' and 'd-m-yyyy' are both accepted.*

3 Execution and output

3.1 Program execution

NUSWALITE is a Win32 Fortran Console Application with no direct interaction with the user. It can be run from a file browser, but also from a command prompt, command file or batch file. In the latter situations it is possible to pass on an argument. The argument can contain an alternative working directory and an alternative name for nuswalite.ini. If only an alternative working directory is given it should end with a backslash (\).

Examples:

NuswaLite	looks for NuswaLite.ini in exe-work dir
NuswaLite MyIni.txt	looks for MyIni.txt in exe-work dir
NuswaLite D:\MyDir\MyIni.txt	looks for MyIni.txt in 'D:\MyDir'
NuswaLite D:\MyDir\	looks for NuswaLite.ini in 'D:\MyDir'
NuswaLite D:\MyDir	looks for MyDir (as a file!) in 'D:\'

When no alternative name for NUSWALITE.INI is given, and NUSWALITE.INI is not found, it will use default filenames.
During execution NUSWALITE writes warnings, errors and messages to the screen, and to the NUSWALITE.LOG file, one of the file names that can not be changed. It is advised to check the log-file after each run, because it can contain important information.

3.2 Output filenames

Table 20 gives an overview of all output files. The majority of these files is optional. In the next paragraphs the output files will be successively discussed. The format of the output files is given in Appendix 3.

Table 20 Overview of output filenames

File	Description
NuswaLite_OutCon.csv*	Daily concentrations per (selected) nodes
NuswaLite_OutLoads.csv*	Daily incoming N and P loads associated with internal flow per selected node
NuswaLite_OutEchoLoads.csv*	Daily external loads of N and P per selected node
NuswaLite_OutEchoLoadsYearly.csv*	Yearly external input loads of N and P for all nodes
NuswaLite_OutBalN.csv/bin*	Daily N balance per (selected) nodes
NuswaLite_OutBalP.csv/bin*	Daily P balance per (selected) nodes
NuswaLite_OutBalTotN.csv	Daily total N balance
NuswaLite_OutBalTotP.csv	Daily total P balance
NuswaLite_OutBalClusterN.csv**	Daily N balance per cluster of nodes (subcatchment)
NuswaLite_OutBalClusterP.csv**	Daily P balance per cluster of nodes (subcatchment)
NuswaLite_OutBalYearlyN.csv*	Yearly N balance per (selected) nodes
NuswaLite_OutBalYearlyP.csv*	Yearly P balance per (selected) nodes
NuswaLite_OutBalTotYearlyN.csv	Yearly N balance for whole system (catchment)
NuswaLite_OutBalTotYearlyP.csv	Yearly P balance for whole system (catchment)
NuswaLite_OutBalClusterYearlyN.csv**	Yearly N balance per cluster of nodes (subcatchment)
NuswaLite_OutBalClusterYearlyP.csv**	Yearly P balance per cluster of nodes (subcatchment)
NuswaLite_OutRetentionsYearly.csv	Yearly retention of N and P for whole catchment
NuswaLite_OutRetentionsYearly Subcatchment1-9.csv*	Yearly retention of N and P in defined subcatchments
NuswaLite_OutHBotAdd.csv***	Added water depth per node to prevent negative volumes
NuswaLite_OutBiomass.csv*	Daily biomass densities (g/m^2) per (selected) nodes + specification of reduction factors on growth
NuswaLite_OutInitial.csv	Concentrations at the end of the calculation period

* *optional: generated by setting switches to 1 (see Table 17)*

** *optional: generated by defining NUSWALITE_NODECLUSTERS.CSV*

*** *optional: generated when HBotAdd (see Table 17) has a negative value*

3.3 Concentrations and loads

NUSWALITE_OUTCON.CSV

Concentrations are the most direct output of the model to compare with measured data. To limit the size of the file, it is possible to select the nodes for which output is generated. After a date and a node ID the concentrations of the 9 state variables are given (Appendix 3).

NUSWALITE_OUTLOADS.CSV

This output file can be useful when comparing loads associated with flow-proportional water samples (field measurements) to model results. It contains the daily loads per node associated with internal inflow.

NUSWALITE_OUTECHOLOADS.CSV , NUSWALITE_OUTECHOLOADSYEARLY.CSV
These files contain the loads of mineral and organic nitrogen and phosphorus entering or leaving the model via the different flow boundaries, respectively per selected node per day and for all nodes per year. These files can be used to check if the external input has entered the model correctly.

3.4 Nutrient mass balances

The most accurate overview of what happens in the system can be derived from the nutrient mass balances. NUSWALITE provides detailed daily and yearly balances on nodal, subcatchment and catchment scale (Table 21).

The balance files give information on:

- Water balance (daily/yearly)
- Situation of the state variables at the begin and at the end of the day/year (in grams)
- Incoming and outgoing nutrient loads (both external and internal) per day/year
- Daily/yearly loads associated with internal processes (e.g. sedimentation, denitrification and sorption)
- Mass balance errors for the nutrients

A detailed description is given in Appendix 3.

Table 21 Overview of the balance files produced by NuswaLite

	per (selected / clustered) node	for total system
daily	NuswaLite_OutBalN.csv NuswaLite_OutBalP.csv NuswaLite_OutBalClusterN.csv NuswaLite_OutBalClusterP.csv	NuswaLite_OutBalTotN.csv NuswaLite_OutBalTotP.csv
yearly	NuswaLite_OutBalYearlyN.csv NuswaLite_OutBalYearlyP.csv NuswaLite_OutBalClusterYearlyN.csv NuswaLite_OutBalClusterYearlyP.csv	NuswaLite_OutBalTotYearlyN.csv NuswaLite_OutBalTotYearlyP.csv

NUSWALITE_OUTBALN.BIN , NUSWALITE_OUTBALP.BIN
Detailed nutrient balances per node for every time step are also available in binary format when the switch *WriteBalBin* is set to 1. Compared to the csv files these files do not contain the water balance and mass balance errors. Contrarily, the network definition is given. The binary files are indifferent to *OutBalanceAll* and *OutputNode* settings. A detailed description is given in Appendix 3.

3.5 Retention

NUSWALITE_OUTRETENTIONSYEARLY.CSV
In this file the nutrient retention in the whole system or catchment is calculated. It is important to know how these retentions are calculated, because different methods or definitions of retention exist.

Retention is determined on a yearly basis. First the sum of all incoming mineral and organic nutrients is determined. This is the combined load from all boundary conditions. Then the sum of all outgoing mineral and organic nutrients is determined. These fluxes are the result of all negative flow boundaries and all level boundaries resulting in negative boundary flow. The difference between the incoming and outgoing nutrient loads is called retention. A certain part of the incoming nutrients will not leave the water system. This can be explained by removal processes (e.g. denitrification and sedimentation) or the seasonal variation in storage over the different state variables. When computing the retention on an annual basis these seasonal effects level out to a large extent.

The outgoing loads used to calculate retention do not include the outflow of floating biomass, which leads to an overestimation of the retention. This is done because usually measured outflow of nutrients is based on total nitrogen and phosphorus in filtered samples that do not include biomass. As discussed in section 2.5.1 the loads associated with floating biomass can be taken into account when the *RetentionScientific* switch is set to 1.

The absolute retention is calculated as incoming nutrients minus outgoing nutrients. The relative retention is calculated as absolute retention divided by incoming nutrients. Retention can be negative. This happens when the storage change in the surface water is negative (for example during high flow conditions when sedimentated nutrients are partly released to the water), and bigger than the loss of nutrients within the surface water.

Loads associated with for example infiltration and drink water inlet are also regarded as retention since NUSWALITE can not distinguish between these kind of boundary outflows and boundary outflow at the outlets.

NUSWALITE_OUTRETENTIONSYEARLYSUBCATCHMENT1-9.CSV
Optionally the nutrient retention in parts of the system or subcatchments can be calculated based on the subcatchments defined in the NUSWALITE_PARAM.INI file (Table 17). For subcatchments it is important that the selected nodes form a closed unit.

3.6 Other output files

NUSWALITE_OUTHBOTADD.CSV

The actual depth corrections per node associated with a negative *HBotAdd* workaround (paragraph 2.5.1) are written to the NUSWALITE_OUTHBOTADD.CSV file. The user should take notice of these values keeping in mind that large depth corrections imply large extra nodal volumes. This leads to increased residence times resulting in less dynamic results and possibly increased retention.

NUSWALITE_OUTBIOMASS.CSV

This file contains detailed information on biomass development. The biomass densities (in g/m2) are given for each day on every selected node. In addition the factors reducing the growth are stored for each biomass separately: the nutrient reduction, growth reduction by light and the temperature influence on the growth.

NUSWALITE_OUTINITIAL.CSV

The NUSWALITE_OUTINITIAL.CSV file contains the biomass and nutrient concentrations at the end of the calculated period, in the same format as the initial input file (NUSWALITE_INITIAL.CSV). It can be used as a new initial input file for a succeeding period or for the same period again. In the latter situation the first calculation period serves as an initial calculation to the second calculation. This can be done to reduce the influence of wrongly chosen initial conditions.

Literature

Dik, P.E., M.H.J.L. Jeuken & L.P.A. van Gerven, 2009. SWQN, Manual version 3.0. Alterra Report 1226.3, Alterra, Wageningen.

Groenendijk, P., L.V. Renaud & J. Roelsma, 2005. Prediction of nitrogen and phosphorus leaching to groundwater and surface waters; process descriptions of the ANIMO 4.0 model. Alterra Report 983, Alterra, Wageningen.

Schoumans O.F., C. Siderius & P. Groenendijk, 2008. NL-CAT application to six European catchments. Alterra Report 1205, Alterra, Wageningen.

Siderius C., P. Groenendijk, L.P.A. van Gerven, M.H.J.L. Jeuken, A.A.M.F.R Smit, 2008. Process description of NUSWALITE; a simplified model for the fate of nutrients in surface waters. Alterra Report 1226.2, Alterra, Wageningen.

Smit A.A.M.F.R, C. Siderius, L.P.A. van Gerven, 2009. Process description of SWQN; A simplified hydraulic model. Alterra Report 1226.1, Alterra, Wageningen.

Walvoort, D.J.J., 2008. Implementation of USLE in NL-CAT. In: Schoumans *et al.* (Ed.). NL-CAT aplication to six European catchments. Pag 294, Alterra Report 1205, Alterra, Wageningen

Appendix 1 Data structure

As can be seen in Figure 2, the data model for NUSWALITE is very simple. All data shown is coupled to the schematization in WATERBALANCE_BIN_TABLE3 (see Table 4) by NodeID. Not shown in this data model are environmental data, process parameters and runtime options that apply to the model as a whole. There is also a relationship in time, coupled by dates, but this could not be visualized.

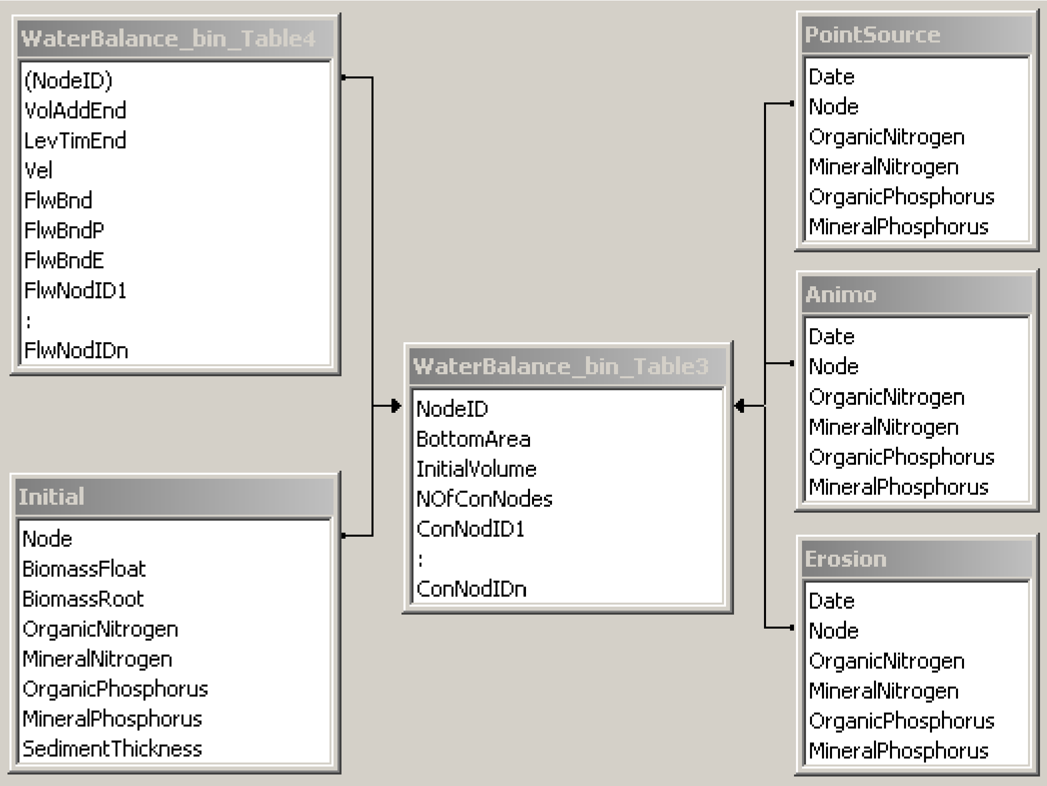


Figure 2 Data model of NUSWALITE

Appendix 2 Input files

NuswaLite.ini

[Input]

File	Default name
NuswaLite_Param_ini	NuswaLite_Param.ini
NuswaLite_LocalParam_csv	NuswaLite_LocalParam.csv
NuswaLite_Waterbalance_bin	NuswaLite_Waterbalance.bin
NuswaLite_Initial_csv	NuswaLite_Initial.csv
NuswaLite_Environment_csv	NuswaLite_Environment.csv
NuswaLite_DischargeConcentrations_csv	NuswaLite_DischargeConcentrations.csv
NuswaLite_LevelConcentrations_csv	NuswaLite_LevelConcentrations.csv
NuswaLite_LinkConcentrations_csv	NuswaLite_LinkConcentrations.csv
NuswaLite_PrecipitationConcentrations_csv	NuswaLite_PrecipitationConcentrations.csv
NuswaLite_DiffuseSource_csv	NuswaLite_DiffuseSource.csv
NuswaLite_Erosion_csv	NuswaLite_Erosion.csv
NuswaLite_PointSource_csv	NuswaLite_PointSource.csv
NuswaLite_NodeClusters_csv	NuswaLite_NodeClusters.csv
NuswaLite_Management_csv	NuswaLite_Management.csv

[Output]

File	Default name
NuswaLite_OutCon_csv	NuswaLite_OutCon.csv
NuswaLite_OutLoads_csv	NuswaLite_OutLoads.csv
NuswaLite_OutEchoLoads_csv	NuswaLite_OutEchoLoads.csv
NuswaLite_OutBiomass_csv	NuswaLite_OutBiomass.csv
NuswaLite_OutBalN_csv	NuswaLite_OutBalN.csv
NuswaLite_OutBalP_csv	NuswaLite_OutBalP.csv
NuswaLite_OutBalTotN_csv	NuswaLite_OutBalTotN.csv
NuswaLite_OutBalTotP_csv	NuswaLite_OutBalTotP.csv
NuswaLite_OutBalYearlyN_csv	NuswaLite_OutBalYearlyN.csv
NuswaLite_OutBalYearlyP_csv	NuswaLite_OutBalYearlyP.csv
NuswaLite_OutBalTotYearlyN_csv	NuswaLite_OutBalTotYearlyN.csv
NuswaLite_OutBalTotYearlyP_csv	NuswaLite_OutBalTotYearlyP.csv
NuswaLite_OutRetentionsYearly_csv	NuswaLite_OutRetentionsYearly.csv
NuswaLite_OutInitial_csv	NuswaLite_OutInitial.csv
NuswaLite_HBotAdd_csv	NuswaLite_HBotAdd.csv

NuswaLite_Param.ini

[LivBioPar]

Name	Description	Sym	Unit	Type
ConcNitrCritUpt	Minimum concentration for N uptake for all biomasses	$cNupmin$	g/m^3	R8
ConcPhosCritUpt	Minimum concentration for P uptake for all biomasses	$cPupmin$	g/m^3	R8

[Floating Biomass]

Name	Description	Sym	Unit	Type
NitrogenDMRatio	Nitrogen/dry matter ratio of floating biomass	$f_{N,FB}$	gN.g^{-1}	R8
PhosphorusDMRatio	Phosphorus/dry matter ratio of floating biomass	$f_{N,FB}$	gP.g^{-1}	R8
RespirationRate	Respiration loss during primary production	$a_{,FB}$	-	R8
MortalityRate	Mortality rate at 20^{o}C	$k_{mor,FB}$	d^{-1}	R8
Q10MortalityRate	Temperature sensitivity for mortality	$\beta_{mor,FB}$	-	R8
ConcNitrMonod	50%-optimum concentration for N uptake	$c_{Nmonod,FB}$	g/m^3	R8
ConcPhosMonod	50%-optimum concentration for P uptake	$c_{Pmon,odFB}$	g/m^3	R8
InflowCFB	'background' inflow of floating biomass	-	g/m^3	R8
FBAdvectiveFraction	Fraction floating biomass subject to adv. transport	f_{adv}	-	R8
LightIntCoef	Light interception coefficient for floating biomass	α_{FB}	-	R8

[Rooting Biomass]

Name	Description	Sym	Unit	Type
NitrogenDMRatio	Nitrogen/dry matter ratio of rooting biomass	$f_{N,RB}$	gN.g^{-1}	R8
PhosphorusDMRatio	Phosphorus/dry matter ratio of rooting biomass	$f_{N,RB}$	gP.g^{-1}	R8
RespirationRate	Respiration loss during primary production	$a_{,RB}$	-	R8
MortalityRate	Mortality rate at 20^{o}C	$k_{mor,RB}$	d^{-1}	R8
Q10MortalityRate	Temperature sensitivity for mortality	$\beta_{mor,RB}$	-	R8
ConcNitrMonod	50%-optimum concentration for N uptake	$c_{Nmonod,RB}$	g/m^3	R8
ConcPhosMonod	50%-optimum concentration for P uptake	$c_{Pmonod,RB}$	g/m^3	R8
LightIntCoef	Light interception coefficient for floating biomass	α_{FB}	-	R8

[Reed]

Name	Description	Sym	Unit	Type
NitrogenDMRatio	Nitrogen/dry matter ratio of reed	$f_{N,Reed}$	gN.g^{-1}	R8
PhosphorusDMRatio	Phosphorus/dry matter ratio of reed	$f_{N,Reed}$	gP.g^{-1}	R8
RespirationRate	Respiration loss during primary production	$a_{,Reed}$	-	R8
MortalityRate	Mortality rate at 20^{o}C	$k_{mor,Reed}$	d^{-1}	R8
Q10MortalityRate	Temperature sensitivity for mortality	$\beta_{mor,Reed}$	-	R8
ConcNitrMonod	50%-optimum concentration for N uptake	$c_{Nmon,Reed}$	g/m^3	R8
ConcPhosMonod	50%-optimum concentration for P uptake	$c_{Pmon,Reed}$	g/m^3	R8
LightEffCoef	Light interception coefficient for reed	a_{int}	-	R8

[Optional detailed mortality parameters]

Name	Description	Sym	Unit	Type
StartSeason	Day number in year for start of season	-	d	R8
EndSeason	Day number in year for end of season	-	d	R8
MortalityRateSeason	Season mortality rate at 20^{o}C	$k_{mor,s}$	d^{-1}	R8
MortalityRateWinter	Winter mortality rate at 20^{o}C	$k_{mor,w}$	d^{-1}	R8

[Parameters]

Name	Description	Sym	Unit	Type
Latitude	Latitude to determine maximum incoming radiation for primary production	ϕ	o	R8
MineralizationRate	Mineralization rate of organic material	k_{mi}	d^{-1}	R8
Q10Mineralization	Temperature sensitivity for mineralization	β_{mi}	-	R8
DenitrificationRate	Removal rate of mineral N	k_{den}	d^{-1}	R8
Q10Denitrification	Temperature sensitivity for N removal	β_{den}	-	R8
BulkDensity	Dry bulk density of sediment	ϱ_s	$g.m_s^{-3}$	R8
LinSorptionNMin	Minimum mineral N adsorption capacity	$k_{aN\min}$	$m_{pores}^3.g_s^{-1}$	R8
LinSorptionNMax	Maximum mineral N adsorption capacity	$k_{aN\max}$	$m_{pores}^3.g_s^{-1}$	R8
LinSorptionNDayMax	Day in year of maximum N sorption capacity	$t_{kaN\max}$	day	R8
LinSorptionPMin	Minimum mineral P adsorption capacity	$k_{aP\min}$	$m_{pores}^3.g_s^{-1}$	R8
LinSorptionPMax	Maximum mineral P adsorption capacity	$k_{aP\max}$	$m_{pores}^3.g_s^{-1}$	R8
LinSorptionPDayMax	Day in year of maximum P sorption capacity	$t_{kaP\max}$	day	R8
SedimentSinkSpeedMineral	Loss rate for mineral P	$w_{s(min)}$	$m.d^{-1}$	R8
SedimentSinkSpeedOrganic	Loss rate for organic N/P	$w_{s(org)}$	$m.d^{-1}$	R8
SedimentThickness	Virtual thickness of sediment layer	H_{sed}	m	R8

[Options]

Name	Description	Def	Unit	Type
StartTimeNuswaLite	Day number after first day in NUSWALITE_WATERBALANCE.BIN to start calculation	-	day	I4
StartDayNuswaLite		-	day	I4
StartMonthNuswaLite	Alternative date to start the calculation	-	month	I4
StartYearNuswaLite		-	year	I4
EndTimeNuswaLite	Day number after first day in NUSWALITE_WATERBALANCE.BIN to end calculation	-	day	I4
EndDayNuswaLite		-	day	I4
EndMonthNuswaLite	Alternative date to end the calculation	-	month	I4
EndYearNuswaLite		-	year	I4
HBotAdd	Work-around parameter for negative or near zero volumes and water depths.	0.0	m	R8
DiffuseSourceFactorN	Correction factor for diffuse N loads	1.0	-	R8
DiffuseSourceFactorP	Correction factor for diffuse P loads	1.0	-	R8
PointSourceFactor	Correction factor for point source loads	1.0	-	R8
ErosionFactor	Correction factor for erosion loads	1.0	-	R8
MergeNodes	List* of nodes that will be merged			C9999
UseDetailedMortalityRoot	Option to give detailed mortality parameters for submerged rooting biomass	0	1/0^	I4
UseDetailedMortalityReed	Option to give detailed reed mortality parameters	0	1/0^	I4
UseDetailedMortalityFloat	Option to give detailed mortality parameters for floating biomass	0	1/0^	I4
UseSedimentation	Use sedimentation rate only at listed nodes	0	1/0^	I4
SedimentationNodes	List* of nodes where sedimentation is applied (A = all)	A	-	C9999
FloatingBiomassOutflowNodes	List* of nodes where floating biomass can leave the system with boundary flow	None	-	C9999
EchoLoads	Write all external loads (per node per time) to NUSWALITE_OUTECHOLOADS.CSV and to a yearly aggregated file (NUSWALITE_OUTECHOLOADSYEARLY.CSV)	0	1/0^	I4

WriteLoad	Write daily loads per node associated with incoming internal flows to NUSWALITE_OUTLOADS.CSV	0	1/0^	I4
WriteCon	Write daily nodal biomass and nutrient concentrations to NUSWALITE_OUTCON.CSV	0	1/0^	I4
WriteBiomass	Write daily nodal biomass characteristics to NUSWALITE_OUTBIOMASS.CSV	0	1/0^	I4
WriteBalN	Write daily nodal mass balance for nitrogen to NUSWALITE_OUTBALN.CSV and yearly aggregates to NUSWALITE_OUTBALYEARLYN.CSV	0	1/0^	I4
WriteBalP	Write daily nodal mass balance for phosphorus to NUSWALITE_OUTBALP.CSV and yearly aggregates to NUSWALITE_OUTBALYEARLYP.CSV	0	1/0^	I4
WriteBalBin	Write to daily nodal binary balance file for N and P	0	1/0^	I4
OutBalanceAll	Write daily balances for all (selected) nodes (=1) or write balances only for days when (selected) nodes have significant balance errors (=0)	0	1/0^	I4
OutputNode	List* of nodes for output of detailed results (A = all; yearly totals are always for all nodes)	A	-	C9999
RetentionSubbasinNode1, RetentionSubbasinNode2, ….. RetentionSubbasinNode9	Up to nine lists* of nodes for which retention results are written to NUSWALITE_OUTRETENTIONSYEARLYSUBCATCHMENT1-9.CSV	-	-	C9999
RetentionScientific	If set to 1 the N and P loads carried by floating biomass are taken into account for calculating retention	0	1/0^	I4

*All variables are optional , * Lists are comma separated , ^1=Yes; 0=No*

NuswaLite_LocalParam.csv

Col	Name	Description	Sym	Unit	Type
1	Node	Node ID		-	I4
2	SedimentThickness	Virtual thickness of sediment layer	H_{sed}	m	R8
3	DenitrificationRate	Removal rate of mineral N	k_{den}	d^{-1}	R8
4	SedimentSinkSpeedMineral	Loss rate for mineral P	$w_{s(min)}$	$m.d^{-1}$	R8
5	SedimentSinkSpeedOrganic	Loss rate for organic N/P	$w_{s(org)}$	$m.d^{-1}$	R8

NuswaLite_DiffuseSource.csv
NuswaLite_PointSource.csv
NuswaLite_Erosion.csv

Col	Name	Description	Unit	Type
1	Date*	Date for change of setting	Date	C10
2	Node	ID used in node definition	-	I4
3	LoadOrgN	Load of organic nitrogen	$g.d^{-1}$	R8
4	LoadMinN	Load of mineral nitrogen	$g.d^{-1}$	R8
5	LoadOrgP	Load of organic phosphorus	$g.d^{-1}$	R8
6	LoadMinP	Load of mineral phosphorus	$g.d^{-1}$	R8

** Date formats 'yyyy-m-d' and 'd-m-yyyy' are both accepted; values are sustained until a new value is given in the same file at the same node.*

NuswaLite_Waterbalance.bin

Table	Col	Name	Description	Unit	Type
1	1	VersionID	Version ID for water balance file	-	C40
	2	CalcID	Calculation identification message	-	C60
	3	StartYear	Day for start of calculation	day	I4
	4	StartMonth	Month for start of calculation	month	I4
	5	StartDay	Year for start of calculation	year	I4
	6	NrDays	Number of calculation days	day	I4
	7	TimestepsPerDay	Time steps per day at which water balance is given	1/day	I4
2	1	NOfNodes	Number of nodes	-	I4
3*	1	NodeID	Node ID	-	I4
	2	BottomArea	Bottom area	m^2	R8
	3	InitialVolume	Initial water volume	m^3	R8
	4	NOfConNodes	Number of connected nodes (CN)	-	I4
	5-CN	ConNodID1-CN	Connected node ID	-	I4
4**	1	VolAddAvg ($\overline{V_w}$)	Average water volume per time step	m^3	R8
	2	VolAddEnd ($V_{w,to+\Delta t}$)	Volume at end of time step	m^3	R8
	3	DepthAvg	Averaged water depth per time step	m	R8
	4	Vel	Flow velocity averaged over time step	$m\ d^{-1}$	R8
	5	FlwBndH ($Q_{external,1}$)	Level boundary discharge***	$m^3\ d^{-1}$	R8
	6	FlwBndQ ($Q_{external,2}$)	Flow boundary discharge***	$m^3\ d^{-1}$	R8
	7	FlwBndL ($Q_{external,3}$)	Link boundary discharge***	$m^3\ d^{-1}$	R8
	8	FlwBndP ($Q_{external,4}$)	Precipitation boundary discharge***	$m^3\ d^{-1}$	R8
	9	FlwBndE ($Q_{external,5}$)	Evaporation boundary discharge***	$m^3\ d^{-1}$	R8
	10-CN	FlwNodID1-CN ($Q_{i,1-..}$)	Internal flow discharges***	$m^3\ d^{-1}$	R8

** One record for every node*
*** One record for every node and then repeated for every time step*
**** positive value = incoming flow, negative value = outgoing flow*

NuswaLite_Initial.csv

Col	Name	Description	Unit	Type
1	Node	Node ID	-	I4
2	BiomassRoot	Initial rooting biomass	$g.m^{-2}$	R8
3	BiomassReed	Initial reed biomass	$g.m^{-2}$	R8
4	BiomassFloat	Initial floating biomass	$g.m^{-2}$	R8
5	ConOrgN	Initial concentration of organic nitrogen	$g.m^{-3}$	R8
6	ConMinN	Initial concentration of mineral nitrogen	$g.m^{-3}$	R8
7	ConOrgP	Initial concentration of organic phosphorus	$g.m^{-3}$	R8
8	ConMinP	Initial concentration of mineral phosphorus	$g.m^{-3}$	R8

NuswaLite_Environment.csv

Col	Name	Description	Unit	Type
1	Date*	Date	-	C10
2	Temp	Water temperature	^oC	R8
3	CloudinessFactor	Clouded fraction of day (= 1–fraction of sunshine)	-	R8

** Date formats 'yyyy-m-d' and 'd-m-yyyy' are both accepted.*

Appendix 3 Output files

NuswaLite_OutCon.csv

Col	Name	Description	Unit	Type
1	Date	Date	date	Y-m-d
2	Node	Node ID	-	I4
3	Rooting	Density of submerged rooting biomass	$g.m^{-2}$	R8
4	Reed	Reed density	$g.m^{-2}$	R8
5	Floating	Density of floating biomass	$g.m^{-2}$	R8
6	N Floating	Concentration of nitrogen in floating biomass	$g.m^{-3}$	R8
7	N Organic	Concentration of organic nitrogen	$g.m^{-3}$	R8
8	N Mineral	Concentration of mineral nitrogen	$g.m^{-3}$	R8
9	P Floating	Concentration of phosphorus in floating biomass	$g.m^{-3}$	R8
10	P Organic	Concentration of organic phosphorus	$g.m^{-3}$	R8
11	P Mineral	Concentration of mineral phosphorus	$g.m^{-3}$	R8

NuswaLite_OutBiomass.csv

Col	Name	Description	Unit	Type
1	Date	Date	date	Y-m-d
2	Node	Node ID	-	I4
3	Production	Standard biomass production (P_{st})	$g.m^{-2}$	R8
4	fT	Influence of temperature on biomass growth (F_T)	-	R8
5	Rooting	Submerged rooting biomass density	$g.m^{-2}$	R8
6	Lightint Root.	Growth reduction on rooting biomass by light extinction ($f_{lightinterception}$)	-	R8
7	NutRed Root.	Nutrient reduction on rooting biomass growth ($f_{reduction}$)	-	R8
8	Reed	Reed biomass density	$g.m^{-2}$	R8
9	Lightint Reed	Growth reduction on reed biomass by light extinction	-	R8
10	NutRed Reed	Nutrient reduction on reed biomass growth ($f_{reduction}$)	-	R8
11	Floating	Floating biomass density	$g.m^{-2}$	R8
12	Lightint Float.	Growth reduction on floating biomass by light extinction	-	R8
13	NutRed Float.	Nutrient reduction on floating biomass growth ($f_{reduction}$)	-	R8

NuswaLite_OutInitial.csv

Col	Name	Description	Unit	Type
1	Node	Node ID	-	I4
2	BiomassRoot	Rooting biomass at the end of calculation period	$g.m^{-2}$	R8
3	BiomassReed	Reed biomass at the end of calculation period	$g.m^{-2}$	R8
4	BiomassFloat	Floating biomass at the end of calculation period	$g.m^{-2}$	R8
5	ConOrgN	Concentration of organic nitrogen at the end	$g.m^{-3}$	R8
6	ConMinN	Concentration of mineral nitrogen at the end	$g.m^{-3}$	R8
7	ConOrgP	Concentration of organic phosphorus at the end	$g.m^{-3}$	R8
8	ConMinP	Concentration of mineral phosphorus at the end	$g.m^{-3}$	R8

NuswaLite_OutBalN.csv, NuswaLite_OutBalP.csv
NuswaLite_OutBalClusterN.csv, NuswaLite_OutBalClusterP.csv
NuswaLite_OutBalTotN.csv, NuswaLite_OutBalTotP.csv
NuswaLite_OutBalYearlyN.csv, NuswaLite_OutBalYearlyP.csv
NuswaLite_OutBalClusterYearlyN.csv,NuswaLite_OutBalClusterYearlyP.csv
NuswaLite_OutBalTotYearlyN.csv, NuswaLite_OutBalTotYearlyP.csv

All files contain the same balance terms, only with N replaced by P when applicable, the yearly balances contain a year instead of a date (all outcomes are per year) and the total balance files do not contain the node column. The flow velocity and water height (column 15 and 16) are only displayed in the NUSWALITE_OUTBALN.CSV and NUSWALITE_OUTBALP.CSV files. The daily and yearly totals are summed over all nodes and thus do not contain Node ID's.

Col	Name	Description	Unit	Type
1	Date/Year	Date or year	-	Y-m-d
2	Node/ Cluster	Node ID/ Cluster ID	-	I4
3	VolumeAt0	Water volume at start of day	m^3	R8
4	VolumeAtt	Water volume at end of day	m^3	R8
5	QHIn	Level boundary water inflow	m^3d^{-1}	R8
6	QQIn	Discharge boundary water inflow	m^3d^{-1}	R8
7	QLIn	Link boundary water inflow	m^3d^{-1}	R8
8	QPIn	Precepitation	m^3d^{-1}	R8
9	QCIn	Connected nodes inflow	m^3d^{-1}	R8
10	QHOut	Level boundary water outflow	m^3d^{-1}	R8
11	QQOut	Discharge boundary water outflow	m^3d^{-1}	R8
12	QLOut	Link boundary water outflow	m^3d^{-1}	R8
13	QEOut	Evaporation	m^3d^{-1}	R8
14	QCOut	Connected nodes outflow	m^3d^{-1}	R8
15	QVel	Flow velocity	m/d	R8
16	Height	Water height	m	R8
17	VCRBNAt0	N/P in rooting biomass at start of day	g	R8
18	VCReedBNAt0	N/P in reed at start of day	g	R8
19	VCFBNAt0	N/P in floating biomass at start of day	g	R8
20	VCONAt0	Organic N/P at start of day	g	R8
21	VCMNAt0	Dissolved mineral N/P at start of day	g	R8
22	VCMNAAt0	Adsorbed mineral N/P at start of day	g	R8
23	VCRBNAtt	N/P in rooting biomass at end of day	g	R8
24	VCReedBNAtt	N/P in reed at end of day	g	R8
25	VCFBNAtt	N/P in floating biomass at end of day	g	R8
26	VCONAtt	Organic N/P at end of day	g	R8
27	VCMNAtt	Dissolved mineral N/P at end of day	g	R8
28	VCMNAAtt	Adsorbed mineral N/P at end of day	g	R8
29	LFBNHIn	External input of floating biomass in N/P	$g.d^{-1}$	R8
30	LONHIn	Level boundary input of organic N/P	$g.d^{-1}$	R8
31	LMNHIn	Level boundary input of mineral N/P	$g.d^{-1}$	R8
32	LONQIn	Discharge boundary input of organic N/P + input from Diffuse Sources, Erosion and Point Sources	$g.d^{-1}$	R8
33	LMNQIn	Discharge boundary input of mineral N/P + input from Diffuse Sources, Erosion and Point Sources	$g.d^{-1}$	R8
34	LONLIn	Link boundary input of organic N/P	$g.d^{-1}$	R8
35	LMNLIn	Link boundary input of mineral N/P	$g.d^{-1}$	R8
36	LONPIn	Precepitation boundary input of organic N/P	$g.d^{-1}$	R8
37	LMNPIn	Precepitation boundary input of mineral N/P	$g.d^{-1}$	R8

38	LFBNCIn	Internal input of floating biomass in N/P	$g.d^{-1}$	R8
39	LONCIn	Internal input of organic N/P	$g.d^{-1}$	R8
40	LMNCIn	Internal input of mineral N/P	$g.d^{-1}$	R8
41	LFBNHOut	Level boundary output of floating biomass in N/P	$g.d^{-1}$	R8
42	LONHOut	Level boundary output of organic N/P	$g.d^{-1}$	R8
43	LMNHOut	Level boundary output of mineral N/P	$g.d^{-1}$	R8
44	LFBNQOut	Discharge boundary output of floating biomass N/P	$g.d^{-1}$	R8
45	LONQOut	Discharge boundary output of organic N/P	$g.d^{-1}$	R8
46	LMNQOut	Discharge boundary output of mineral N/P	$g.d^{-1}$	R8
47	LFBNLOut	Link boundary output of floating biomass in N/P	$g.d^{-1}$	R8
48	LONLOut	Link boundary output of organic N/P	$g.d^{-1}$	R8
49	LMNLOut	Link boundary output of mineral N/P	$g.d^{-1}$	R8
50	LFBNCOut	Internal output of floating biomass in N/P	$g.d^{-1}$	R8
51	LONCOut	Internal output of organic N/P	$g.d^{-1}$	R8
52	LMNCOut	Internal output of mineral N/P	$g.d^{-1}$	R8
53	GrowthRBN	Growth of rooting biomass in N/P	$g.d^{-1}$	R8
54	GrowthReedBN	Growth of reed in N/P	$g.d^{-1}$	R8
55	GrowthFBN	Growth of floating biomass in N/P	$g.d^{-1}$	R8
56	MortRBN	Mortality of rooting biomass in N/P	$g.d^{-1}$	R8
57	MortReedBN	Mortality of reed in N/P	$g.d^{-1}$	R8
58	MortFBN	Mortality of floating biomass in N/P	$g.d^{-1}$	R8
59	MinerMN	Mineralisation of organic N/P	$g.d^{-1}$	R8
60	DenitrMN	Denitrification of mineral N	$g.d^{-1}$	R8
61	SedFBN	Sedimentation of floating biomass N/P	$g.d^{-1}$	R8
62	SedON	Sedimentation of organic N/P	$g.d^{-1}$	R8
63	SedMN	Sedimentation of mineral N/P	$g.d^{-1}$	R8
64	ManRBN	N/P Removal by management of rooting biomass	$g.d^{-1}$	R8
65	ManReedBN	N/P Removal by reed management	$g.d^{-1}$	R8
66	ManFBN	N/P Removal by management of floating biomass	$g.d^{-1}$	R8
67	ErrorRBN	Mass balance error for rooting biomass N/P	$g.d^{-1}$	R8
68	ErrorReedBN	Mass balance error for reed N/P	$g.d^{-1}$	R8
69	ErrorFBN	Mass balance error for floating biomass N/P	$g.d^{-1}$	R8
70	ErrorON	Mass balance error for organic N/P	$g.d^{-1}$	R8
71	ErrorMN	Mass balance error for mineral N/P	$g.d^{-1}$	R8
72	ErrorTotN	Total mass balance error	$g.d^{-1}$	R8

NuswaLite_OutBalN.bin, NuswaLite_OutBalP.bin

Note: these are binary files

Table	Col	Name	Description	Unit	Type
1	1	CalcID	Calculation identification message	-	C60
	2	StartYear	Day for start of calculation	day	I4
	3	StartMonth	Month for start of calculation	month	I4
	4	StartDay	Year for start of calculation	year	I4
	5	EndTime	Calculation length in days	day	I4
2	1	NOfNodes (N)	Number of nodes	-	I4
3*	1	NodeID	Node ID	-	I4
	2	NOfConNodes (CN)	Number of connected nodes	-	I4
	3+CN-1	ConNodID	Connected node ID	-	I4
	3+CN	IniRooting	N/P rooting biomass at start of calculation	g	R8
	4+CN	IniReed	N/P reed at start of calculation	g	R8
	5+CN	IniFloating	N/P floating biomass at start of calculation	g	R8
	6+CN	IniOrganic	Organic N/P at start of calculation	g	R8
	7+CN	IniDis.Mineral	Diss. mineral N/P at start of calculation	g	R8
	8+CN	IniAds.Mineral	Ads. mineral N/P at start of calculation	g	R8
4**	1	Rooting(t)	N/P in rooting biomass at end of day	g	R8
	2	Reed(t)	N/P in reed at end of day	g	R8
	3	Floating(t)	N/P in floating biomass at end of day	g	R8
	4	Organic(t)	Organic N/P at end of day	g	R8
	5	Dis.Mineral(t)	Dissolved mineral N/P at end of day	g	R8
	6	Ads.Mineral(t)	Adsorbed mineral N/P at end of day	g	R8
	7	InExtFloating	External input of floating biomass in N/P	g/d	R8
	8	InExtOrganic	External input of organic N/P	g/d	R8
	9	InExtMineral	External input of mineral N/P	g/d	R8
	10	OutExtFloat	External output of floating biomass in N/P	g/d	R8
	11	OutExtOrganic	External output of organic N/P	g/d	R8
	12	OutExtMineral	External output of mineral N/P	g/d	R8
	12+Cn	IntFloat	Internal output of floating biomass in N/P specified per connected node	g/d	R8
	12+CN+Cn	IntOrganic	Internal output of organic N/P specified per connected node	g/d	R8
	12+2CN+Cn	IntMineral	Internal output of mineral N/P specified per connected node	g/d	R8
	13+3CN	GrowthRooting	Growth of rooting biomass in N/P	g/d	R8
	14+3CN	GrowthReed	Growth of reed in N/P	g/d	R8
	15+3CN	GrowthFloating	Growth of floating biomass in N/P	g/d	R8
	16+3CN	MortRooting	Mortality of rooting biomass in N/P	g/d	R8
	17+3CN	MortReed	Mortality of rooting biomass in N/P	g/d	R8
	18+3CN	MortFloating	Mortality of floating biomass in N/P	g/d	R8
	19+3CN	Mineralisation	Mineralisation of organic N/P	g/d	R8
	20+3CN	Denitrification	Denitrification of mineral N	g/d	R8
	21+3CN	SedFloat	Sedimentation of floating biomass N/P	g/d	R8
	22+3CN	SedOrganic	Sedimentation of organic N/P	g/d	R8
	23+3CN	SedMineral	Sedimentation of mineral N/P	g/d	R8

** One record for every node ** One record for every node and then repeated for every calculation day*

NuswaLite_OutRetentionsYearly.csv

Col	Name	Description	Unit	Type
1	Year	Year	-	I4
2	TotalNLoadIn	Total nitrogen input from boundary conditions	$g.y^{-1}$	R8
3	TotalNLoadOut	Total nitrogen outflow associated with boundary fluxes	$g.y^{-1}$	R8
4	RetentionN	Nitrogen losses in the entire system (2 minus 3)	$g.y^{-1}$	R8
5	RetentionN	Nitrogen loss fraction (4 divided by 2)	-	R8
6	TotalPLoadIn	Total phosphorus input from boundary conditions	$g.y^{-1}$	R8
7	TotalPLoadOut	Total phosphorus outflow associated with boundary fluxes	$g.y^{-1}$	R8
8	RetentionP	Phosphorus losses in the network (6 minus 7)	$g.y^{-1}$	R8
9	RetentionP	Phosphorus loss fraction (8 divided by 6)	-	R8

NuswaLite_OutRetentionsYearlySubcatchment1-9.csv

Col	Name	Description	Unit	Type
1	Year	Year	-	I4
2	TotalNLoadIn	Total nitrogen input from subcatchment boundaries	$g.y^{-1}$	R8
3	TotalNLoadOut	Total nitrogen outflow at subcatchment boundaries	$g.y^{-1}$	R8
4	RetentionN	Nitrogen losses in the subcatchment (2 minus 3)	$g.y^{-1}$	R8
5	RetentionN	Nitrogen loss fraction (4 divided by 2)	-	R8
6	TotalPLoadIn	Total phosphorus input from subcatchment boundaries	$g.y^{-1}$	R8
7	TotalPLoadOut	Total phosphorus outflow at subcatchment boundaries	$g.y^{-1}$	R8
8	RetentionP	Phosphorus losses in the subcatchment (6 minus 7)	$g.y^{-1}$	R8
9	RetentionP	Phosphorus loss fraction (8 divided by 6)	-	R8

NuswaLite_OutLoads.csv

Col	Name	Description	Unit	Type
1	Date	Date	date	Y-m-d
2	Node	Node ID	-	I
3	Floating	Load of floating biomass	$g.d^{-1}$	R
4	N Floating	Load of nitrogen in floating biomass	$g.d^{-1}$	R
5	N Organic	Load of organic nitrogen	$g.d^{-1}$	R
6	N Mineral	Load of mineral nitrogen	$g.d^{-1}$	R
7	TotalN	Total abiotic load of nitrogen	$g.d^{-1}$	R
8	P Floating	Load of phosphorus in floating biomass	$g.d^{-1}$	R
9	P Organic	Load of organic phosphorus	$g.d^{-1}$	R
10	P Mineral	Load of mineral phosphorus	$g.d^{-1}$	R
11	TotalP	Total abiotic load of phosphorus	$g.d^{-1}$	R

NuswaLite_OutEchoLoads.csv

Col	Name	Description	Unit	Type
1	Date	Date	date	Y-m-d
2	Node	Node ID	-	I4
3	LBndHNorg	Level boundary input load of organic nitrogen	$g.d^{-1}$	R8
4	LBndHNmin	Level boundary input load of mineral nitrogen	$g.d^{-1}$	R8
5	LBndHPorg	Level boundary input load of organic phosphorus	$g.d^{-1}$	R8
6	LBndHPmin	Level boundary input load of mineral phosphorus	$g.d^{-1}$	R8
7	LBndQAnimoNorg	Diffuse input load of organic nitrogen	$g.d^{-1}$	R8
8	LBndQAnimoNmin	Diffuse input load of mineral nitrogen	$g.d^{-1}$	R8
9	LBndQAnimoPorg	Diffuse input load of organic phosphorus	$g.d^{-1}$	R8
10	LBndQAnimoPmin	Diffuse input load of mineral phosphorus	$g.d^{-1}$	R8
11	LBndQPntNorg	PointSource input load of organic nitrogen	$g.d^{-1}$	R8
12	LBndQPntNmin	PointSource inputload of mineral nitrogen	$g.d^{-1}$	R8
13	LBndQPntPorg	PointSource input load of organic phosphorus	$g.d^{-1}$	R8
14	LBndQPntPmin	PointSource input load of mineral phosphorus	$g.d^{-1}$	R8
15	LBndQErosionNorg	Erosion input load of organic nitrogen	$g.d^{-1}$	R8
16	LBndQErosionNmin	Erosion input load of mineral nitrogen	$g.d^{-1}$	R8
17	LBndQErosionPorg	Erosion input load organic phosphorus	$g.d^{-1}$	R8
18	LBndQErosionPmin	Erosion input load mineral phosphorus	$g.d^{-1}$	R8
19	LBndQLnkNorg	Link boundary input load of organic nitrogen	$g.d^{-1}$	R8
20	LBndQLnkNmin	Link boundary input load of mineral nitrogen	$g.d^{-1}$	R8
21	LBndQLnkPorg	Link boundary Erosion input load organic phosphorus	$g.d^{-1}$	R8
22	LBndQLnkPmin	Link boundary Erosion input load mineral phosphorus	$g.d^{-1}$	R8
23	LBndPNorg	Precipitation boundary input load of organic nitrogen	$g.d^{-1}$	R8
24	LBndPNmin	Precipitation boundary input load of mineral nitrogen	$g.d^{-1}$	R8
25	LBndPPorg	Precipitation boundary input load organic phosphorus	$g.d^{-1}$	R8
26	LBndPPmin	Precipitation boundary input load mineral phosphorus	$g.d^{-1}$	R8
27	LBndQDisConcNorg	Flow boundary input load of organic nitrogen	$g.d^{-1}$	R8
28	LBndQDisConcNmin	Flow boundary input load of mineral nitrogen	$g.d^{-1}$	R8
29	LBndQDisConcPorg	Flow boundary input load organic phosphorus	$g.d^{-1}$	R8
30	LBndQDisConcPmin	Flow boundary input load mineral phosphorus	$g.d^{-1}$	R8

NuswaLite_OutEchoLoadsYearly.csv

Col	Name	Description	Unit	Type
1	Year	Year	Year	Y
2	Node	Node ID	-	I4
3	LBndHNorg	Level boundary input load of organic nitrogen	$g.y^{-1}$	R8
4	LBndHNmin	Level boundary input load of mineral nitrogen	$g.y^{-1}$	R8
5	LBndHPorg	Level boundary input load of organic phosphorus	$g.y^{-1}$	R8
6	LBndHPmin	Level boundary input load of mineral phosphorus	$g.y^{-1}$	R8
7	LBndQAnimoNorg	Diffuse input load of organic nitrogen	$g.y^{-1}$	R8
8	LBndQAnimoNmin	Diffuse input load of mineral nitrogen	$g.y^{-1}$	R8
9	LBndQAnimoPorg	Diffuse input load of organic phosphorus	$g.y^{-1}$	R8
10	LBndQAnimoPmin	Diffuse input load of mineral phosphorus	$g.y^{-1}$	R8
11	LBndQPntNorg	PointSource input load of organic nitrogen	$g.y^{-1}$	R8
12	LBndQPntNmin	PointSource inputload of mineral nitrogen	$g.y^{-1}$	R8
13	LBndQPntPorg	PointSource input load of organic phosphorus	$g.y^{-1}$	R8
14	LBndQPntPmin	PointSource input load of mineral phosphorus	$g.y^{-1}$	R8
15	LBndQErosionNorg	Erosion input load of organic nitrogen	$g.y^{-1}$	R8
16	LBndQErosionNmin	Erosion input load of mineral nitrogen	$g.y^{-1}$	R8
17	LBndQErosionPorg	Erosion input load organic phosphorus	$g.y^{-1}$	R8
18	LBndQErosionPmin	Erosion input load mineral phosphorus	$g.y^{-1}$	R8
19	LBndQLnkNorg	Link boundary input load of organic nitrogen	$g.y^{-1}$	R8
20	LBndQLnkNmin	Link boundary input load of mineral nitrogen	$g.y^{-1}$	R8
21	LBndQLnkPorg	Link boundary Erosion input load organic phosphorus	$g.y^{-1}$	R8
22	LBndQLnkPmin	Link boundary Erosion input load mineral phosphorus	$g.y^{-1}$	R8
23	LBndPNorg	Precipitation boundary input load of organic nitrogen	$g.y^{-1}$	R8
24	LBndPNmin	Precipitation boundary input load of mineral nitrogen	$g.y^{-1}$	R8
25	LBndPPorg	Precipitation boundary input load organic phosphorus	$g.y^{-1}$	R8
26	LBndPPmin	Precipitation boundary input load mineral phosphorus	$g.y^{-1}$	R8
27	LBndQDisConcNorg	Flow boundary input load of organic nitrogen	$g.y^{-1}$	R8
28	LBndQDisConcNmin	Flow boundary input load of mineral nitrogen	$g.y^{-1}$	R8
29	LBndQDisConcPorg	Flow boundary input load organic phosphorus	$g.y^{-1}$	R8
30	LBndQDisConcPmin	Flow boundary input load mineral phosphorus	$g.y^{-1}$	R8

Appendix 4 Example: Vansjø-Hobøl catchment (Norway)

Introduction

This example appends to the case in the SWQN-manual (Dik et al., 2009) where a general description can be found.

NUSWALITE_PARAM.INI

The used parameterization of the Norwegian catchment was derived from the original NUSWA parameter settings, combined with expert knowledge and manual calibration. Mainly due to calibration it deviates from the recommended parameter settings in the NUSWALITE process description (Siderius et al., 2008). For the biomass parameters are assumed to be equal for all biomass species. However it is recommended to use the parameterization described in the NUSWALITE process description (Siderius et al., 2008).

[LivBioPar]

Name	Description	Value	Unit
ConcNitrCritUpt	Minimum concentration for N uptake for all biomasses	0.00001	g/m^3
ConcPhosCritUpt	Minimum concentration for P uptake for all biomasses	0.00001	g/m^3

[Floating Biomass]

Name	Description	Value	Unit
NitrogenDMRatio	Nitrogen/dry matter ratio of floating biomass	0.1	$gN.g^{-1}$
PhosphorusDMRatio	Phosphorus/dry matter ratio of floating biomass	0.005	$gP.g^{-1}$
RespirationRate	Respiration loss during primary production	0.15	-
MortalityRate	Mortality rate at 20°C	0.05	d^{-1}
Q10MortalityRate	Temperature sensitivity for mortality	0.0	-
ConcNitrMonod	50%-optimum concentration for N uptake	1	g/m^3
ConcPhosMonod	50%-optimum concentration for P uptake	0.0000001	g/m^3
InflowCFB	'background' inflow of floating biomass	0.0	g/m^3
FBAdvectiveFraction	Fraction floating biomass subject to adv. transport	1.0	-
LightIntCoef	Light interception coefficient for floating biomass	0.02	-

[Rooting Biomass]

Name	Description	Value	Unit
NitrogenDMRatio	Nitrogen/dry matter ratio of rooting biomass	0.1	$gN.g^{-1}$
PhosphorusDMRatio	Phosphorus/dry matter ratio of rooting biomass	0.005	$gP.g^{-1}$
RespirationRate	Respiration loss during primary production	0.15	-
MortalityRate	Mortality rate at 20°C	0.05	d^{-1}
Q10MortalityRate	Temperature sensitivity for mortality	0.0	-
ConcNitrMonod	50%-optimum concentration for N uptake	1	g/m^3
ConcPhosMonod	50%-optimum concentration for P uptake	0.0000001	g/m^3
LightIntCoef	Light interception coefficient for rooting biomass	0.02	-

[Reed]

Name	Description	Value	Unit
NitrogenDMRatio	Nitrogen/dry matter ratio of reed	0.1	$gN.g^{-1}$
PhosphorusDMRatio	Phosphorus/dry matter ratio of reed	0.005	$gP.g^{-1}$
RespirationRate	Respiration loss during primary production	0.15	-
MortalityRate	Mortality rate at 20^{o}C	0.05	d^{-1}
Q10MortalityRate	Temperature sensitivity for mortality	0.0	-
ConcNitrMonod	50%-optimum concentration for N uptake	1	g/m^3
ConcPhosMonod	50%-optimum concentration for P uptake	0.0000001	g/m^3
LightEffCoef	Light interception coefficient for reed	0.02	-

[Parameters]

Name	Description	Value	Unit
Latitude	Latitude to determine maximum incoming radiation and primary production	53.0	^{o}
MineralizationRate	Mineralization rate of organic material	0.25	d^{-1}
Q10Mineralization	Temperature sensitivity for mineralization	0.047	-
DenitrificationRate	Denitrification rate of mineral N	0.002	d^{-1}
Q10Denitrification	Temperature sensitivity for denitrification	0.045	-
SedimentThickness	Default sediment thickness for all nodes	0.01	m
BulkDensity	Dry bulk density of sediment	400000	$g.m^{-3}$
LinSorptionNMin	Minimum mineral N adsorption capacity	0.0001	$m^3.g^{-1}$
LinSorptionNMax	Maximum mineral N adsorption capacity	0.0001	$m^3.g$
LinSorptionNDayMax	Day in year of maximum N sorption capacity	240	day
LinSorptionPMin	Minimum mineral P adsorption capacity	0.00125	$m^3.g$
LinSorptionPMax	Maximum mineral P adsorption capacity	0.004	$m^3.g$
LinSorptionPDayMax	Day in year of maximum P sorption capacity	330	day
SedimentSinkSpeedMineral	Loss rate for mineral P	0.03	$m.d^{-1}$
SedimentSinkSpeedOrganic	Loss rate for organic N/P	0	$m.d^{-1}$
SedimentThickness	Virtual thickness of sediment layer	0.1	m

[Options]

Name	Description	Value	Unit
HBotAdd	Work-around parameter for negative or near zero volumes and water depths.	-0.02	m
DiffuseSourceFactorN	Correction factor for diffuse N loads	1.0	-
DiffuseSourceFactorP	Correction factor for diffuse P loads	1.0	-
PointSourceFactor	Correction factor for point source loads	1.0	-
ErosionFactor	Correction factor for erosion loads	0.2	-
UseSedimention	Use sedimentation rate only at listed nodes	1	1/0^
SedimentationNodes	List* of nodes where sedimentation is applied (A = all)	All	-
FloatingBiomassOutflowNodes	List* of nodes where floating biomass can leave the system with boundary flow (A = all)	All	-
WriteCon	Write to concentrations file	1	1/0^
WriteBalN	Write to detailed balance file for N	1	1/0^
WriteBalP	Write to detailed balance file for P	1	1/0^
WriteBalBin	Write to detailed binary balance file for N and P	1	1/0^
OutBalanceAll	No means only write days and nodes with significant balance errors to detailed files	1	1/0^
OutputNode	List* of nodes for output of detailed results (A = all; yearly totals are always for all nodes)	All	-

NUSWALITE_LOCALPARAM.INI

It is assumed that in lakes a more substantial part of the sediment layer influences the water column, so sediment thickness was set higher in the lakes (0.10 m) than in the other parts of the schematization (0.01 m). The other parameters in this input file are not varied locally.

NUSWALITE_WATERBALANCE.BIN

The waterbalance is provided by the SWQN example (Dik et al., 2009).

NUSWALITE_INITIAL.CSV

The initial conditions are based on the average concentrations found in the area. An initial calculation of one year is used to decrease the influence of the chosen values. Results for this first year (1990) are therefore not shown.

Node	Biomass Root	Biomass Reed	Biomass Float	ConOrgN	ConMinN	ConOrgP	ConMinP
1	1.0	0.0	1.0	0.1	1.2	0.005	0.015
2	1.0	0.0	1.0	0.1	1.2	0.005	0.015
3	1.0	0.0	1.0	0.1	1.2	0.005	0.015
4	1.0	0.0	1.0	0.1	1.2	0.005	0.015
5	1.0	0.0	1.0	0.1	1.2	0.005	0.015
6	1.0	0.0	1.0	0.1	1.2	0.005	0.015
7	1.0	0.0	1.0	0.1	1.2	0.005	0.015
8	1.0	0.0	1.0	0.1	1.2	0.005	0.015
9	1.0	0.0	1.0	0.1	1.2	0.005	0.015
10	1.0	0.0	1.0	0.1	1.2	0.005	0.015
11	1.0	0.0	1.0	0.1	1.2	0.005	0.015
12	1.0	0.0	1.0	0.1	1.2	0.005	0.015
13	1.0	0.0	1.0	0.1	1.2	0.005	0.015
14	1.0	0.0	1.0	0.1	1.2	0.005	0.015
15	1.0	0.0	1.0	0.1	1.2	0.005	0.015
16	1.0	0.0	1.0	0.1	1.2	0.005	0.015
17	1.0	0.0	1.0	0.1	1.2	0.005	0.015
18	1.0	0.0	1.0	0.1	1.2	0.005	0.015
19	1.0	0.0	1.0	0.1	1.2	0.005	0.015
20	1.0	0.0	1.0	0.1	1.2	0.005	0.015
21	1.0	0.0	1.0	0.1	1.2	0.005	0.015
22	1.0	0.0	1.0	0.1	1.2	0.005	0.015
23	1.0	0.0	1.0	0.1	1.2	0.005	0.015
24	1.0	0.0	1.0	0.1	1.2	0.005	0.015
25	1.0	0.0	1.0	0.1	1.2	0.005	0.015
26	1.0	0.0	1.0	0.1	1.2	0.005	0.015
27	1.0	0.0	1.0	0.1	1.2	0.005	0.015
28	1.0	0.0	1.0	0.1	1.2	0.005	0.015
29	1.0	0.0	1.0	0.1	1.2	0.005	0.015
30	1.0	0.0	1.0	0.1	1.2	0.005	0.015
31	1.0	0.0	1.0	0.1	1.2	0.005	0.015
32	1.0	0.0	1.0	0.1	1.2	0.005	0.015
33	1.0	0.0	1.0	0.1	1.2	0.005	0.015
34	1.0	0.0	1.0	0.1	1.2	0.005	0.015
35	1.0	0.0	1.0	0.1	1.2	0.005	0.015

Node	Biomass Root	Biomass Reed	Biomass Float	ConOrgN	ConMinN	ConOrgP	ConMinP
36	1.0	0.0	1.0	0.1	1.2	0.005	0.015
37	1.0	0.0	1.0	0.1	1.2	0.005	0.015
38	1.0	0.0	1.0	0.1	1.2	0.005	0.015
39	1.0	0.0	1.0	0.1	1.2	0.005	0.015
40	1.0	0.0	1.0	0.1	1.2	0.005	0.015
41	1.0	0.0	1.0	0.1	1.2	0.005	0.015
42	1.0	0.0	1.0	0.1	1.2	0.005	0.015
43	1.0	0.0	1.0	0.1	1.2	0.005	0.015

NUSWALITE_ENVIRONMENT.CSV

Water temperatures were not available for the catchment, only daily minimum and maximum air temperature. The average temperature is taken as water temperature. Cloudiness factor was derived from global radiation compared with a theoretical maximum global radiation sine curve.

Date	Temperature	Cloudiness Factor
1990-01-01	-6.25	0.597511943
1990-01-02	-5.65	0.515972076
1990-01-03	-5.15	0.502029549
1990-01-04	-2.10	0.487378701
1990-01-05	-2.15	0.144040788
1990-01-06	-2.55	0.201078255
1990-01-07	2.20	0.308385066
1990-01-08	2.30	0.737949594
1990-01-09	3.20	0.655391106
1990-01-10	3.00	0.269388932
:	:	:
:	:	:
:	:	:
1992-12-29	-7.85	0.205733259
1992-12-30	-6.10	0.202231663
1992-12-31	-3.25	0.198194271

NUSWALITE_DIFFUSESOURCE.CSV

The loads in NUSWALITE_DIFFUSESOURCE.CSV are aggregated from the results of the SWAP/ANIMO-calculations for the different plot in the catchments. For more details on these calculations see the Euroharp report (Schoumans et al., 2008).

Date	NodeID	LON	LMN	LOP	LMP
1990-01-01	1	208.65	4558.79	29.18	484.31
1990-01-02	1	209.54	5069.78	29.44	506.36
1990-01-03	1	198.91	4781.02	27.91	488.99
1990-01-04	1	181.05	4247.99	25.33	453.87
1990-01-05	1	177.89	4224.54	24.92	453.29
1990-01-06	1	518.70	4757.36	76.59	522.51
1990-01-07	1	4143.79	810486.68	553.62	31932.53
1990-01-08	1	11837.05	1023369.11	1500.04	46610.45
1990-01-09	1	15606.61	1416164.82	1983.43	61367.77
1990-01-10	1	16925.40	1479775.11	2198.90	65100.37
:	:	:	:	:	:
:	:	:	:	:	:
:	:	:	:	:	:
1992-12-29	34	3.14	1838.30	0.49	36.14
1992-12-30	34	1.61	1072.19	0.25	26.22
1992-12-31	34	0.82	688.28	0.13	19.28

NUSWALITE_POINTSOURCE.CSV

The loads in NUSWALITE_POINTSOURCE.CSV are estimates based on information about WWTP's and scattered dwellings in the catchment.

Date	Node	LON	LMN	LOP	LMP
1990-01-01	1	0.00	51526.52	0.00	1967.59
1990-01-01	7	0.00	12355.07	0.00	718.52
1990-01-01	11	0.00	23335.22	0.00	1874.23
1990-01-01	15	0.00	2465.00	0.00	334.00
1990-01-01	18	0.00	2481.21	0.00	322.21
1990-01-01	22	0.00	9041.34	0.00	632.66
1990-01-01	29	0.00	329.00	0.00	49.00
1990-01-01	32	0.00	5878.66	0.00	821.92
1990-01-01	34	0.00	335.00	0.00	59.00
1990-01-01	3	0.00	115.00	0.00	16.00
1990-01-01	17	0.00	88.00	0.00	23.00

NUSWALITE_EROSION.CSV

The loads in NUSWALITE_EROSION.CSV are the results of a simplified application of the PUSLE (Walvoort, 2008). For more details on these calculations see the Euroharp report (Schoumans et al., 2008).

Date	Node	LON	LMN	LOP	LMP
1990-01-01	1	0.00	0.00	0.00	0.00
1990-01-01	7	0.00	0.00	0.00	0.00
1990-01-01	11	0.00	0.00	0.00	0.00
1990-01-01	15	0.00	0.00	0.00	0.00
1990-01-01	18	0.00	0.00	0.00	0.00
1990-01-01	22	0.00	0.00	0.00	0.00
1990-01-01	29	0.00	0.00	0.00	0.00
1990-01-01	32	0.00	0.00	0.00	0.00
1990-01-01	34	0.00	0.00	0.00	0.00
:	:	:	:	:	:
:	:	:	:	:	:
:	:	:	:	:	:
1990-01-23	1	0.00	135087.53	0.00	44343.77
1990-01-23	7	0.00	2120113.55	0.00	864602.18
1990-01-23	11	0.00	1666821.06	0.00	707983.84
1990-01-23	15	0.00	49205.41	0.00	14156.41
1990-01-23	18	0.00	139885.66	0.00	49314.08
1990-01-23	22	0.00	97805.19	0.00	29492.72
1990-01-23	29	0.00	10189.07	0.00	2955.48
1990-01-23	32	0.00	167822.15	0.00	58918.83
1990-01-23	34	0.00	7732.23	0.00	2950.82
:	:	:	:	:	:
:	:	:	:	:	:
:	:	:	:	:	:
1992-12-31	1	0.00	0.00	0.00	0.00
1992-12-31	7	0.00	0.00	0.00	0.00
1992-12-31	11	0.00	0.00	0.00	0.00
1992-12-31	15	0.00	0.00	0.00	0.00
1992-12-31	18	0.00	0.00	0.00	0.00
1992-12-31	22	0.00	0.00	0.00	0.00
1992-12-31	29	0.00	0.00	0.00	0.00

Results

The results of NUSWALITE are presented here in graphs of the concentration and loads of N and P, and as a yearly mass balance.

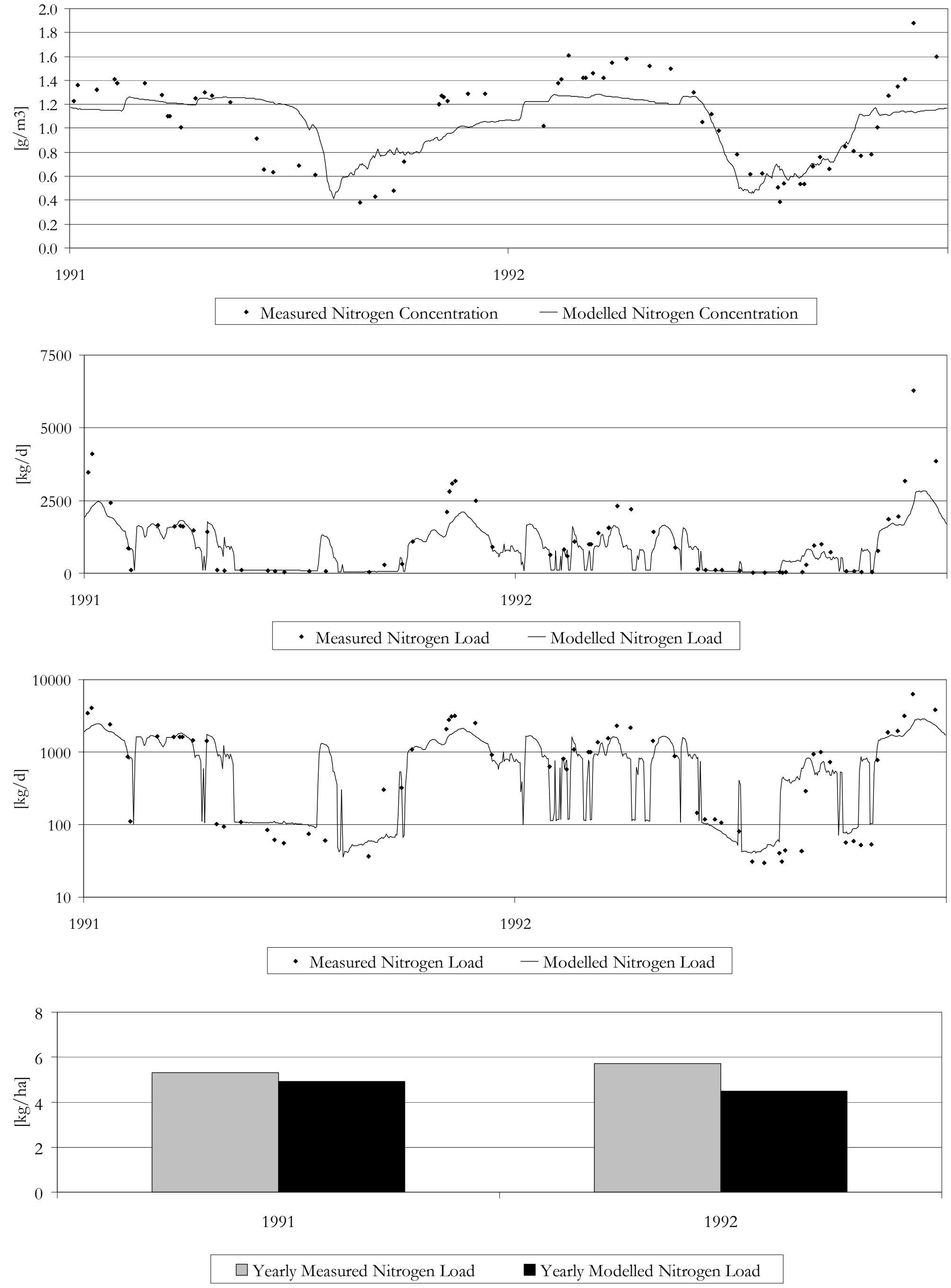


Figure 3: modeled nitrogen concentrations and loads at the outflow point of the catchment

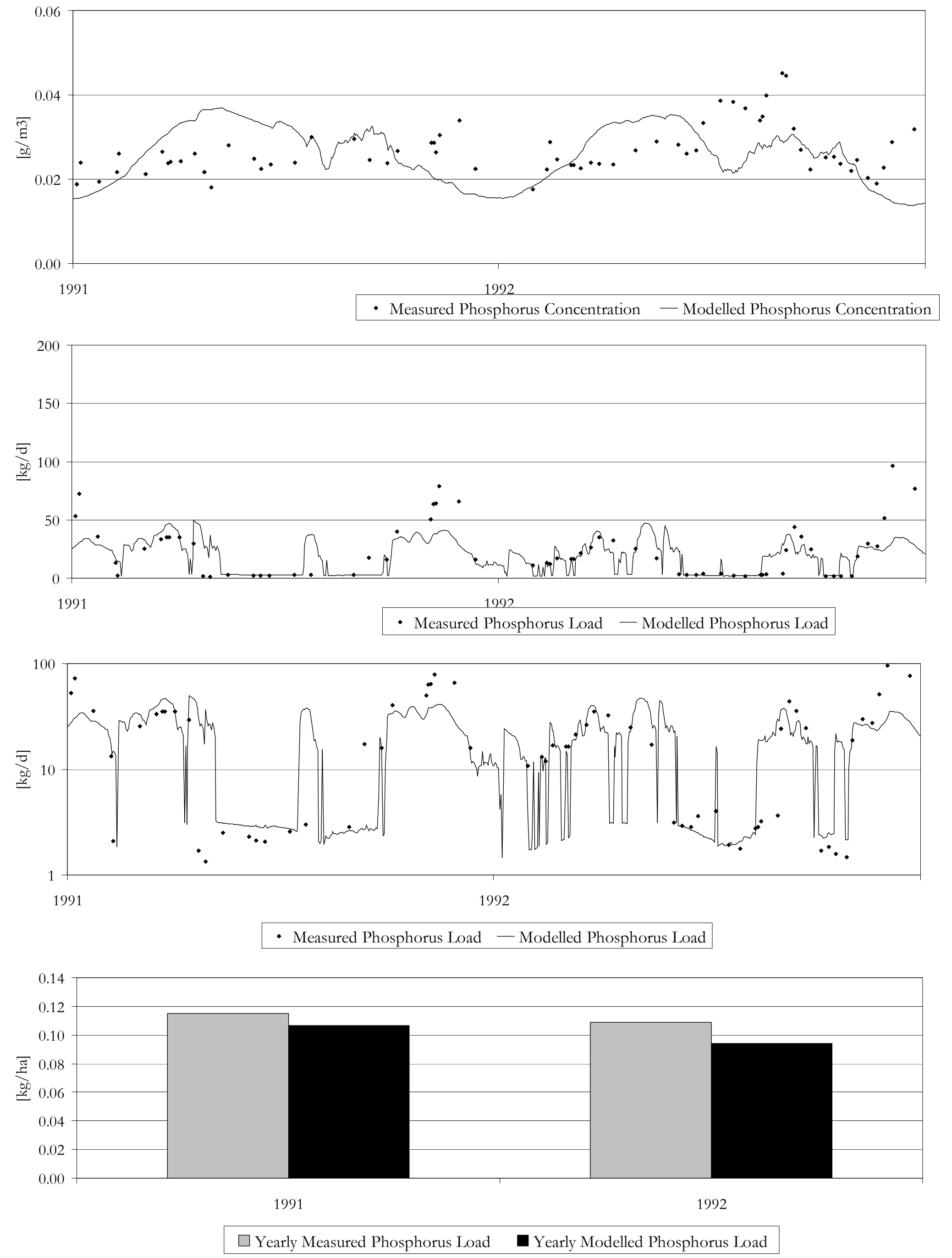


Figure 4: modeled phosphorus concentrations and loads at the outflow point of the catchment

Surface water balance for 1991

Water balance — *10^6 m^3*

Input		Output	
Runoff	285.2	Outflow	323.7
Precipitation	63.5	Evaporation	31.1
Storage change	6.2		
	354.8		354.8

Nitrogen balance — *ton*

Input		Output	
Runoff	674.8	Outflow	344.9
Pointsources	39.4	Biomass loss	56.0
Erosion	38.9	Denitrification loss	268.0
		Storage Change	84.2
Total	753.2	Total	753.2

Phosporus balance — *ton*

Input		Output	
Runoff	19.3	Outflow	7.5
Pointsources	2.5	Biomass loss	2.8
Erosion	13.8	Sedimentation loss	30.6
Storage Change			
Total	41.0	Total	41.0

Surface water balance for 1992

Water balance — *10^6 m^3*

Input		Output	
Runoff	267.8	Outflow	281.2
Precipitation	68.0	Evaporation	31.0
		Storage change	23.7
	335.8		335.8

Nitrogen balance — *ton*

Input		Output	
Runoff	696.7	Outflow	308.8
Pointsources	39.5	Biomass loss	59.2
Erosion	29.2	Denitrification loss	278.0
		Storage Change	119.4
Total	765.4	Total	765.4

Phosporus balance — *ton*

Input		Output	
Runoff	19.2	Outflow	6.4
Pointsources	2.5	Biomass loss	3.0
Erosion	10.9	Sedimentation loss	28.1
Storage Change	4.8		
Total	37.5	Total	37.5

Appendix 5 Error messages in alphabetic order

Message	Type	Explanation
A fatal error occurred	E	The problem mentioned before this message is fatal, and the calculation could not be finished!
Calculation ended without errors	M	The calculation was ended successfully!
Deviation in water balance <Value> m3 (<Value> %) in node <ID> at time = <Day>	E	The relative water balance deviation found at the specified node and time was higher than 0.1% of the averaged volume that day.
Didn't find <Parameter> in <Section> A fatal error occurred	E	The specified parameter was not found in the parameter file. Because there is no default value for this parameter, the calculation stops.
Didn't find <Parameter> in <Section> Using default option <Value>	M	The specified parameter was not found in the parameter file. Because there is a default value for this parameter, the calculation could continue.
Error reading line <LineNr> in file: <File>	E	There was a problem reading the specified line. Header lines are not included in the line number count.
Error reading list <Parameter>	E	The list specified for the mentioned parameter could not be read. A list a row of comma separated integers.
Unable to repair circular flow! (IMSL: <Message>)	E	A problem with circular flow could not be solved, and the calculation could not finish. The IMSL message is for debug purposes.
Inconsistency of internal flows for node <ID> connected to <ID> greater than <Value>% discharge node <ID>: <Value> m3 discharge node <ID>: <Value> m3	E	The flow from A to B should be equal to minus the flow from B to A. However, NUSWALITE discovered a difference of more than 0.1% between the flows.
Lowest depth in Waterbalance: <Value> m Negative or near zero waterdepths and volumes in waterbalance. Set HBotAdd or recalculate waterbalance!	E	There are negative volumes in the water balance, see section 2.5.1 about this problem and the use of HBotAdd.
Lowest depth in Waterbalance: <Value> m HBotAdd is not high enough to prevent negative or near zero waterdepths and volumes in waterbalance. Increase HBotAdd or recalculate waterbalance!	E	There are negative volumes in the water balance, see section 2.5.1 about this problem and the use of HBotAdd.
Maximum N balance error <Value> g Maximum P balance error <Value> g	M	Summarizes the maximum balance deviations during the calculation. Not zero because even double precision calculations have limitations, but it should usually be lower than 10^{-5}.
Missing file: <File>	W / E	The mentioned file was not found. For required files this is a fatal error. For optional files this is only a warning. If NUSWALITE should read the mentioned file, please check if it has the correct (default) file name on the disk, are the correct alternative filename was specified in the NUSWALITE.INI file.

More than 100 date warnings! Logging stopped	W	Detailed date warnings slow down the model performance. Therefore the number of warnings was limited to 100.
More than 20 linked circuits detected! Unable to sort the nodes!	E	A problem with circular flow could not be solved, and the calculation could not finish.
No <Type> value for <Parameter> in <Section>	E	NUSWALITE could not find a value of the correct type for the specified parameter
No floating biomass outflow nodes defined! Using default option All.	M	When FloatingBiomassOutflowNodes is not set, floating biomass will be transported over the systems boundaries with every outflow
No sedimentation nodes defined!	W	UseSedimentation was set to 1, but node selection of nodes was made at SedimentationNodes
Node <ID> in <File> is not defined!	E	Non-existing ID used, the information can not be used.
Node <Value> does not exist	W	Non-existing ID used, the information can not be used.
Number of nodes is bigger than maximum allowed: <Value>	E	Unfortunately the number of allowed nodes in the calculation is not flexible yet. If you want to include more nodes than allowed, you need a recompiled version of the program
Read invalid date: <Date>	W	Unable to read the date, use either yyyy-mm-dd or dd-mm-yyyy.
Reading file: <File>	M	Currently the mentioned file is read.
Replacing <File> with <File>	M	In the NuswaLite.ini file an alternative filename was specified for the mentioned file.
Specified EndTimeNuswaLite is lower than in water balance. New calculation end time will be used!	W	The calculation period for NUSWALITE will be shorter than the spam of the water balance because EndTimeNuswaLite was set.
Using default end time from waterbalance file	M	No EndTimeNuswaLite was found in the parameter file, NUSWALITE calculate for the whole period of the waterbalance.
Using default filenames	M	Since no NuswaLite.ini file was found in the working directory and no alternative name for this file was specified, NUSWALITE will use the default filenames.
Warning: <Date> in this file is not in calculation range, and will not be used!	W	The values connected with this date will be ignored. Note that values before the start of the calculation are not interpolated to the start itself!
WARNING: <Factor> is not equal to one! A factor of <Value> will be applied on all <Load type>	W	This factor usually set intentionally, but because it has a great effect on the results it was thought that a warning should be in place.
WARNING: Circular flow circuit(s) detected! Unable to sort the nodes Work-around by correcting lowest flow in the circuit At year/day number: <Year>/<DayNr> etc…	W	NUSWALITE is not able to deal with circular flow directly. Circular flow occurs between three or more nodes when water flows from node A to B, from B to C, and back from C to A during the same day. NUSWALITE tries to find a solution by correcting the flows with the lowest flow in the circuit. In more complex situations however, a solution can not always be found.
Waterbalance file not complete, end at day <DayNr>	E	The water balance file was not complete. Probably the water balance calculation finished with errors.
WaterbalanceID: <Text>	M	Optional informative text derived from the water

		balance file.
Work-around with negative HBotAdd used! HBotAdd = <Value> m NodeID Area HBotAdd <ID> <Value>m <Value>m	W	See section 2.5.1 about HBotAdd.
Work-around with positive HBotAdd used! HBotAdd = <Value> m	W	See section 2.5.1 about HBotAdd.