

STONE 2.0		STONE
FAIRWAY partner: Peter Schipper (Wageningen University and Research, NL)		
Brief description		
The nutrient emission modelling system (STONE) is a process-based tool that quantifies nutrient losses to soil and water from rural areas. STONE is developed to analyse the impacts of fertilization scenarios on nutrient leaching to groundwater and surface water systems on the Dutch national scale. It has and is being used to evaluate the implementation of the EU Nitrate Directive (Nitrate Action Programmes) and Water Framework Directive (River basin Management Plan's). STONE consists of a chain of models, which are applied to 6405 spatial units that represent all biophysical conditions in the Netherlands. Key modelling components are 1) INITIATOR , that calculates the distribution (in space and time) and application of fertilizers on agricultural soils and emissions of N from stables and field to air, 2) SWAP , that calculates the soil water fluxes, inflow from precipitation and water losses by evapotranspiration, and 3) the model ANIMO , a complex one-dimensional process-oriented model for simulating the cycling of carbon and nutrients in soils and the resulting N and P runoff to surface waters and leaching to shallow groundwater.		
Contaminants covered (e.g. nitrate, pesticides etc.)	N, P	
Intended end users (e.g. farmer, water quality manager, policy maker)	Used by researchers to advise policy makers	
Level of expertise and/or training required	Expert users only	
Geographical resolution (e.g. field, catchment, national)	National and regional scale. Each of the 6405 calculation units differ with respect to hydrology (geohydrology, seepage, drainage), land use (grassland, maize, other arable crops, nature), soil physics, soil chemical characteristics (456 types that differ with respect to P fixation capacity, mineralization capacity and cation exchange capacity), and weather conditions (15 meteo regions).	
Temporal resolution (e.g. daily, annual, long-term).	Long-term	
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None	
Number and type of mitigation measures included	STONE can calculate the effects of various scenarios with regard to the intensity of the livestock, the use of animal manure and fertilizers and changes in land use. Subsequent, STONE is also used to quantify effects of changes on drainage systems and hydrology (f.i. tile drainage, control drainage, irrigation)	
Platform (e.g. paper-based tool, phone app, bespoke software).	Software tool used by researchers	
Frequency of updates	The latest update is STONE 2.4, developed and applied for the evaluation of the Dutch Fertilizer Act 2012. After that period, several other updates have been applied on parts of the modelling chain, especial with respect to the model INITIATOR (last update 2019)	
Cost/availability	STONE can only used by Wageningen University & Research	
Number of users or number of copies distributed/downloaded/purchased	4	
Links to demo material and other relevant information (e.g. user guides).		
Additional comments		

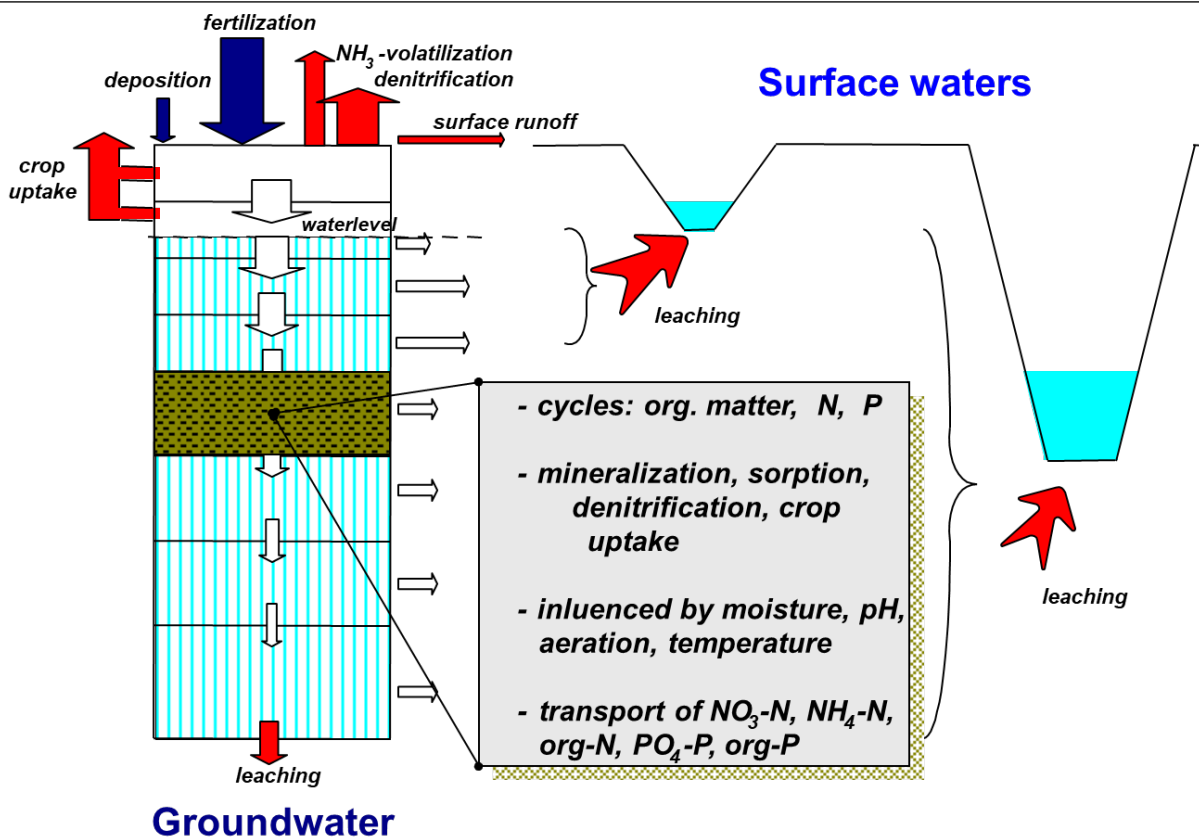
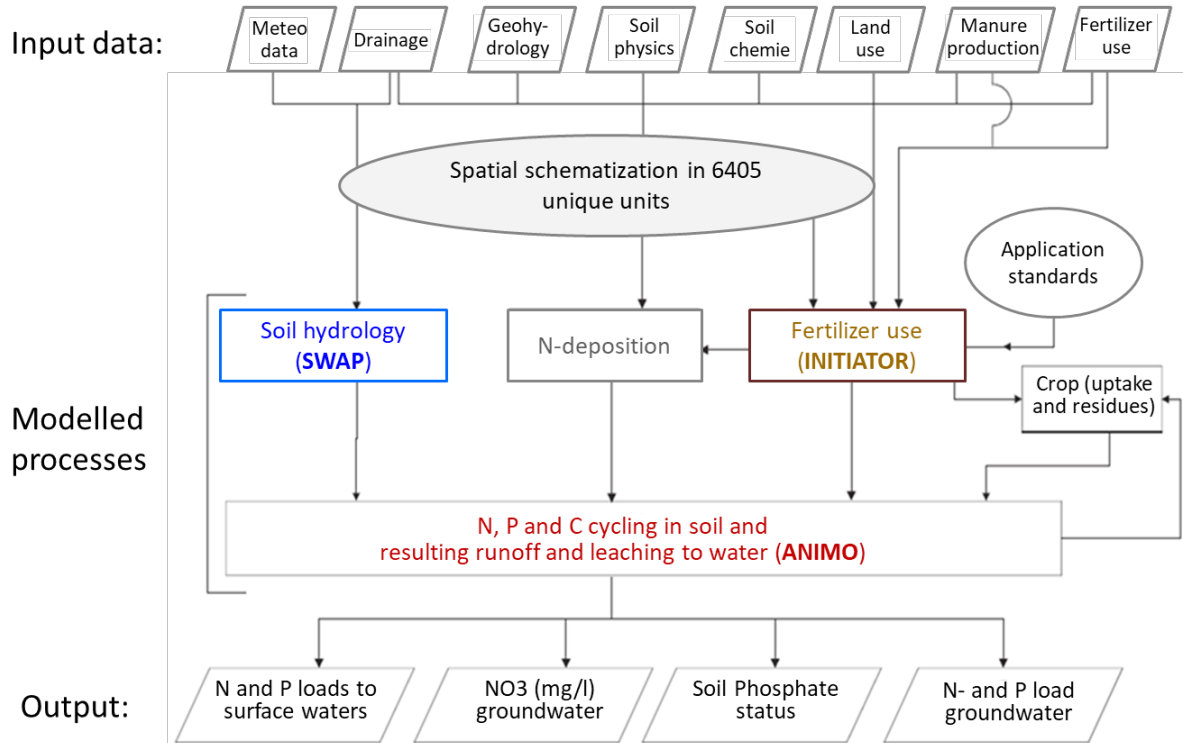
STONE FAIRWAY partner: Peter Schipper (Wageningen University and Research, NL)	
Input data required to run the DST	Extensive input information is required by each model component (see Wolf <i>et al</i> , 2003)
Outputs (including links to water quality and economic or financial aspects)	The main outputs are: (1) N and soil P surpluses to the soil (2) concentrations of P, N en carbon in the soil (3) Leaching and surface runoff fluxes of water, N and P to drainage systems and surface waters (4) leaching of P en N to groundwater All scenarios follow a simulation period of multitudes of 15 years. The hydrological data from SWAP are supplied on a 10-day basis, which is subsequently downscaled to daily data for use in the ANIMO system. The output can be given as yearly average or on 10-day basis. It is specified for the 6405 STONE plots covering the Netherlands as a whole.
Age/provenance of supporting data used to develop the DST	Details given in Wolf <i>et al</i> (2003)
Country-specific calibration or data requirements (including restrictions on use)	Nationally differentiated for soil type and geohydrology
Details of validation and testing	Details given in Wolf <i>et al</i> (2003)
Date developed/released (or planned release date)	2011 (latest update)
Author/developer names and affiliations	J. Wolf, A.H.W. Beusen, P. Groenendijk, T. Kroon, R. Rötter, H. van Zeijts (ALTErra and RIVM)
Member state(s) where developed	NL
Member State(s) where currently used	NL
Key publication references	Beusen, A.H.W., Boogaard, H.L., Finke, P.A., Gehrels, B., Groenendijk, P., Van Jaarsveld, J.A., Knol, O.M., 1998. User's guide STONE 1.0 (in Dutch). RIVM report. RIVM, Bilthoven, the Netherlands. Wolf <i>et al</i>. (2003). The integrated modeling system STONE for calculating nutrient emissions from agriculture in the Netherlands. <i>Environmental Modelling & Software</i>, 18, 597-617 https://www.sciencedirect.com/science/article/pii/S1364815203000367?via%3Dihub

STONE

FAIRWAY partner: Peter Schipper (Wageningen University and Research, NL)

Any other useful information (e.g. screenshots of DST input/outputs)

Overview of input data, modelled processes, and output of the STONE modeling system.



Schematic illustration of the model ANIMO