

Ecolego

Overview

Rodolfo Avila

Workshop on Performance Assessments of Near-Surface Disposal Facilities: FEPs Analysis, Scenario and Conceptual Model Development, and Code Selection

August 29 –30, 2012 , US NRC

Outline

- Short introduction to Ecolego
- New features in latest version – Ecolego 6
- Future development
- Examples of applications for LLW disposal facilities

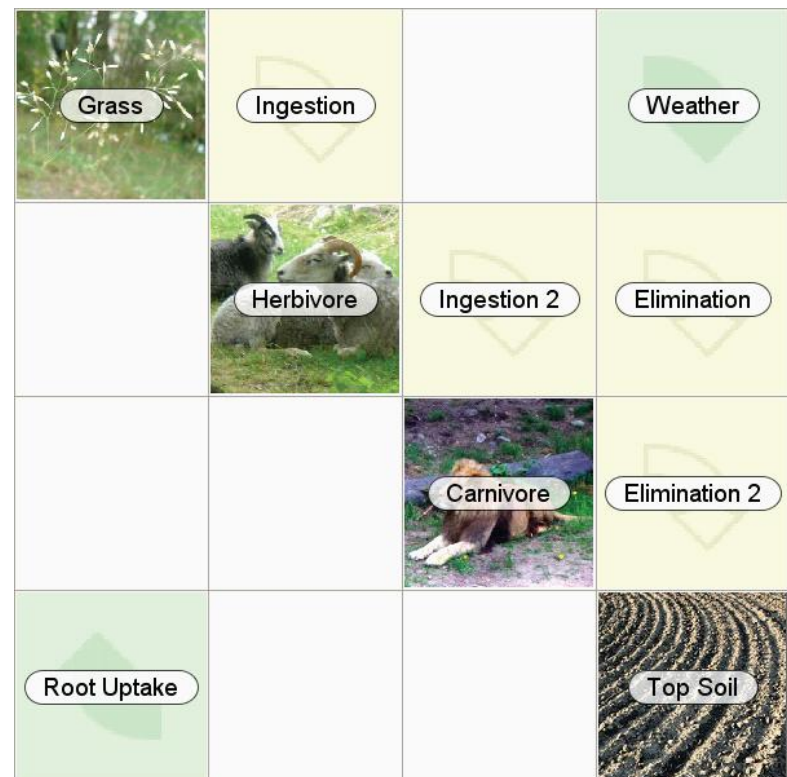


Ecolego - Simulation Modeling and Risk Assessment Software

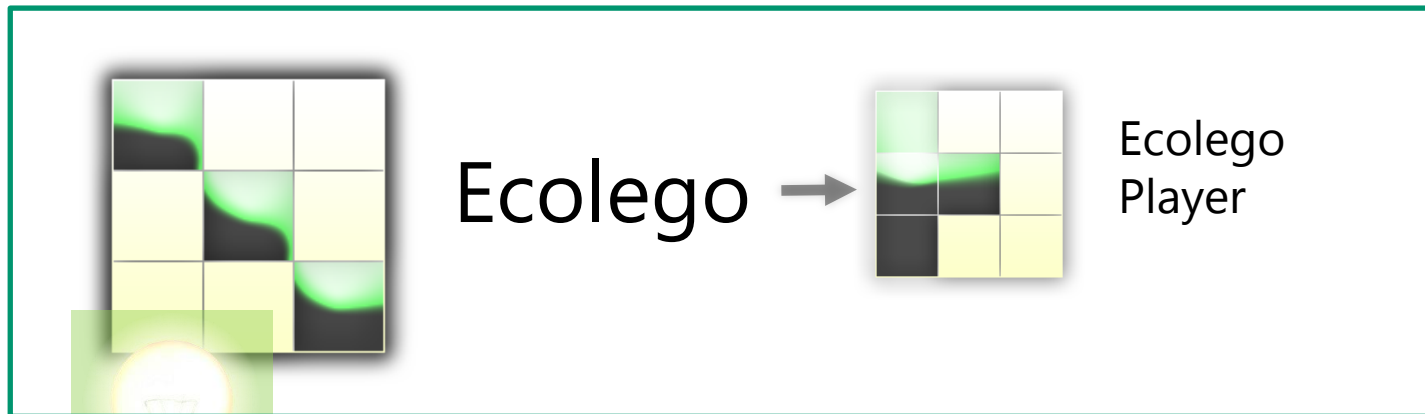
Flexible software tool for creating dynamic models and performing deterministic or probabilistic simulations.

Can be used for conducting risk and safety assessments of complex dynamic systems evolving over time with any number of species.

www.ecolego.facilia.se



Ecolego components



ODE solver



Parameter
Database

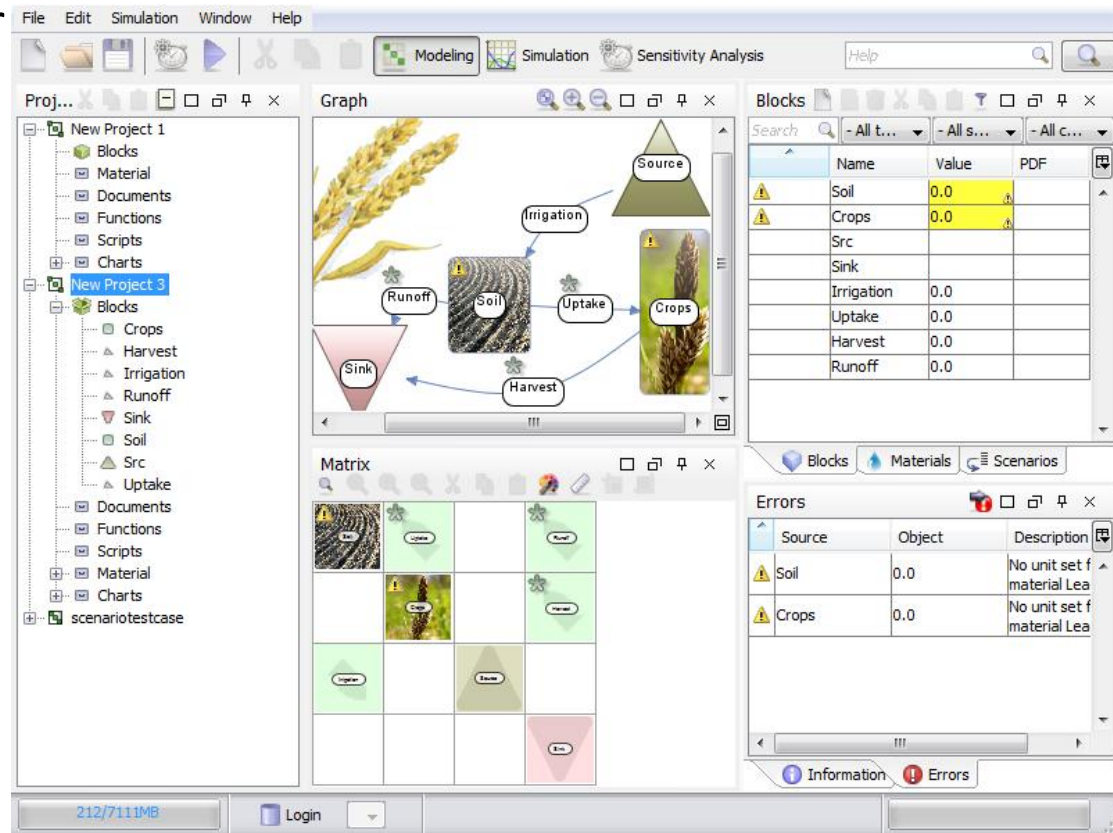


Sensitivity
Analyses

Toolboxes

User interface

- Ecolego has a modern user interface, where the latest techniques for customization and user-friendliness have been applied. A wide array of windows is available to support the many different tasks in modeling.
- Mathematical models are built graphically with different types of generic blocks





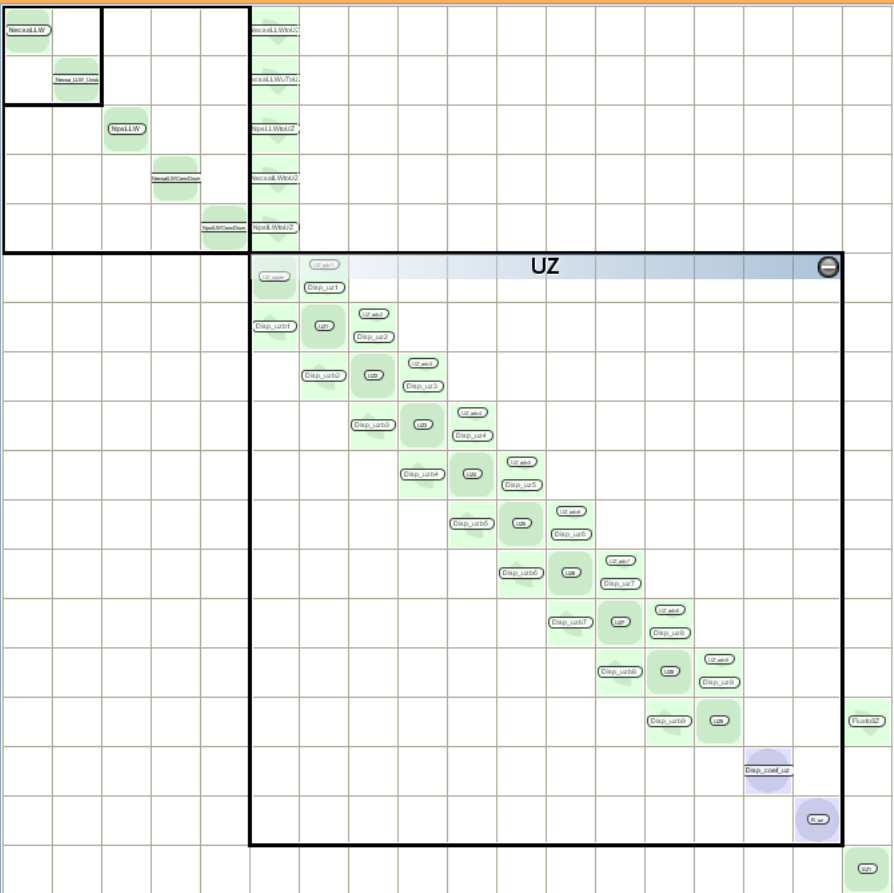
Hierarchical models

Ecolego - VaalputsRepositoryFinaladv - Repository*

File Edit Simulation Window Debug Help

Conceptual Modeling Simulation Database

Model



Materials

Name	Enabled	Comment	Half life	Unit
Ac-227	<input checked="" type="checkbox"/>		2,2E1	yr
Am-241	<input checked="" type="checkbox"/>		4,3E2	yr
Am-243	<input checked="" type="checkbox"/>		7,4E3	yr
C-14	<input checked="" type="checkbox"/>		5,7E3	yr
Cl-36	<input checked="" type="checkbox"/>		3,0E5	yr
Cm-243	<input checked="" type="checkbox"/>		2,9E1	yr
Cm-245	<input checked="" type="checkbox"/>		8,5E3	yr
I-129	<input checked="" type="checkbox"/>		1,6E7	yr
Np-237	<input checked="" type="checkbox"/>		2,1E6	yr
Pa-231	<input checked="" type="checkbox"/>		3,3E4	yr
Pu-239	<input checked="" type="checkbox"/>		2,4E4	yr
Pu-241	<input checked="" type="checkbox"/>		1,4E1	yr
Ra-226	<input checked="" type="checkbox"/>		1,6E3	yr
Tc-99	<input checked="" type="checkbox"/>		2,1E5	yr
Th-229	<input checked="" type="checkbox"/>		7,3E3	yr

Parameters Blocks Materials Post-processing

Radionuclide Decay

Parent	Daughter	Ratio	Comment
U-234	Th-230	1,0E0	
U-238	U-234	1,0E0	
Th-230	Ra-226	1,0E0	
Am-241	Np-237	1,0E0	
U-233	Th-229	1,0E0	
Np-237	U-233	1,0E0	
Cm-245	Am-241	1,0E0	
Pu-241	Am-241	1,0E0	
Pu-239	U-235	1,0E0	
Pa-231	Ac-227	1,0E0	
Am-243	Pu-239	1,0E0	

Using several conceptual models

- Possibility to create modules and libraries - LEGO
- Possible to activate-deactivate modules
- Possibility to create index lists
- General Variable – several expressions can be used for the same process
- Scenarios – simulations with different parameter sets and simulation settings (Version 6)
- Possibility to **create** functions that can even run external codes



Simulations

Ecolego can integrate systems of ODE, from simple systems to large, stiff problems.

Monte Carlo simulations

List of probability density functions (PDFs)

Monte Carlo sampling

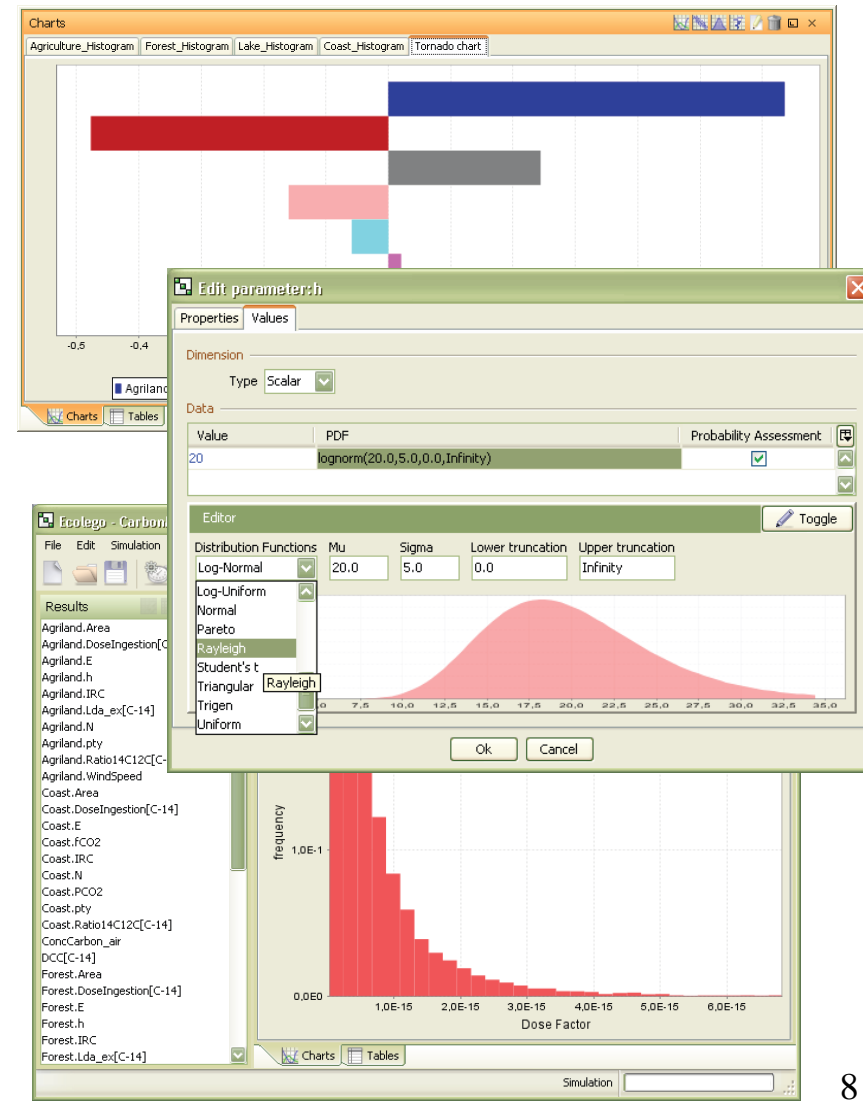
Latin Hypercube sampling

parameter correlation settings,

Sensitivity analysis

Rank correlation coefficients are available for tornado plots or correlation tables.

More advance SA methods in the Eikos Toolbox



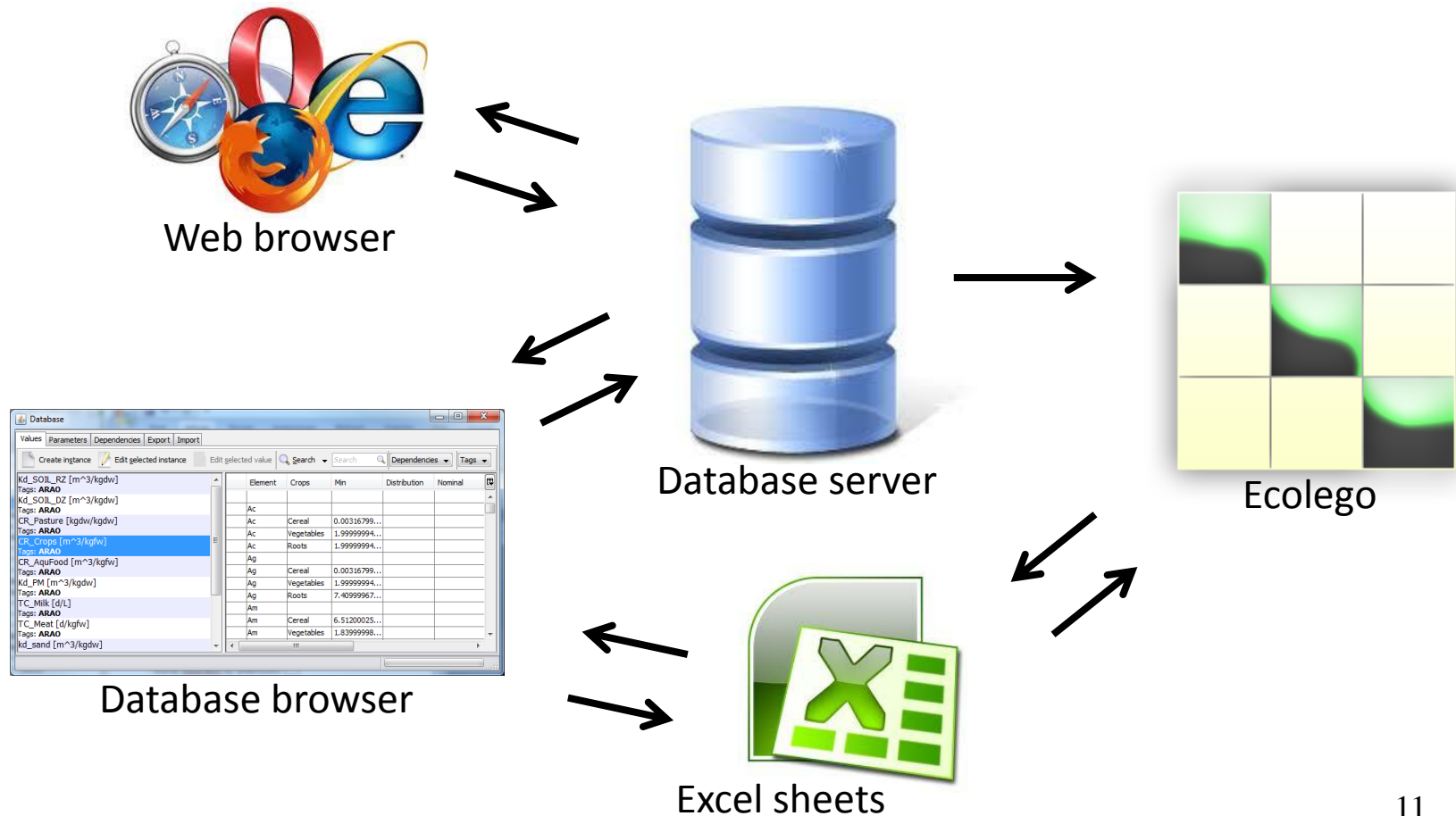
Eikos, SA-toolbox

- Sensitivity analysis
 - The study of how input factors impact a model output
- Toolbox integrated with Ecolego
- State-of-the-art methods
- Stepwise workflow
- Specialized tables and graphs illustrating input-output-relationships

Sensitivity Analysis methods

- Screening methods – for initial analysis to identify inputs that can be fixed (**Morris**)
- Graphical methods – to discover e.g. linearity or monotonicity
- Correlation and regression analysis (for **linear models**)
- Correlation and regression on ranked outputs (for **monotonic functions**)
- Variance based methods – **model free (FAST, EFAST, Sobol)**

Parameter database



Parameter Database Q/A

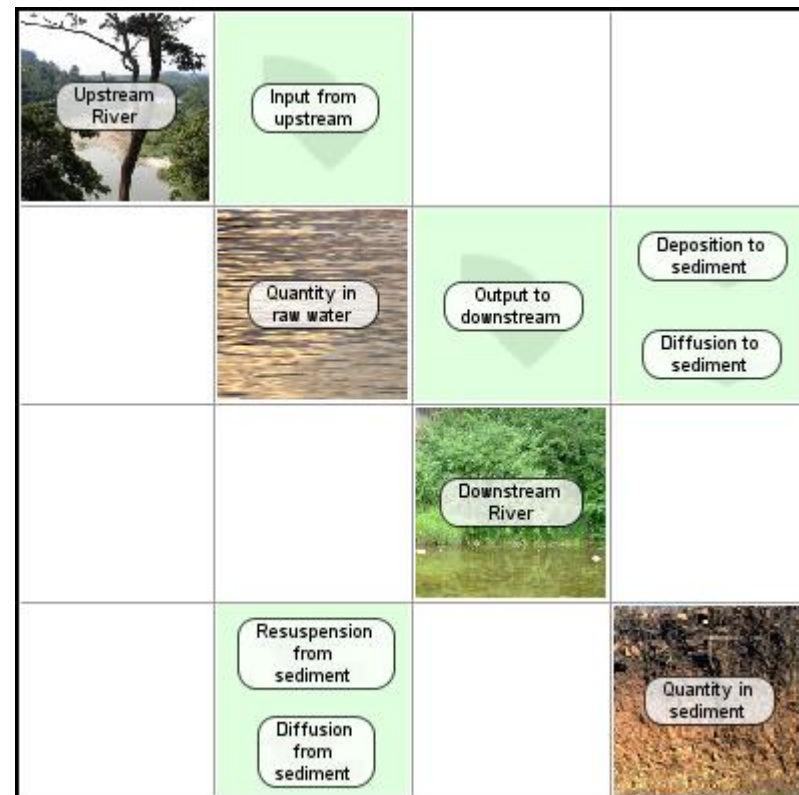
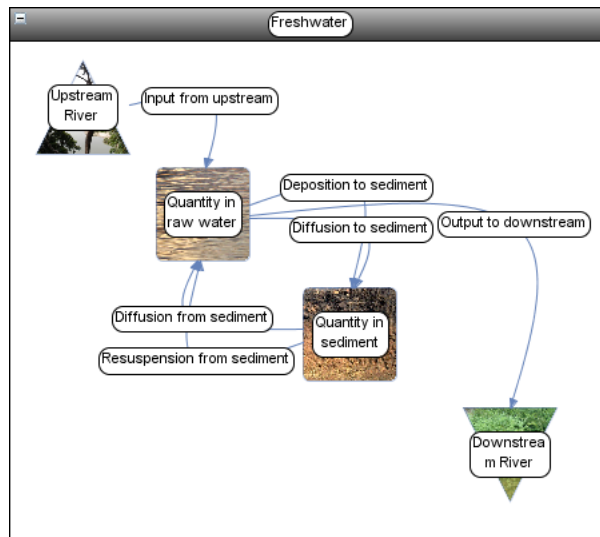
- Instance has usability status
 - Draft, Reviewed, Accepted
- Data review
- Different levels of permissions, user roles
 - Administrator, Operator, Reviewer



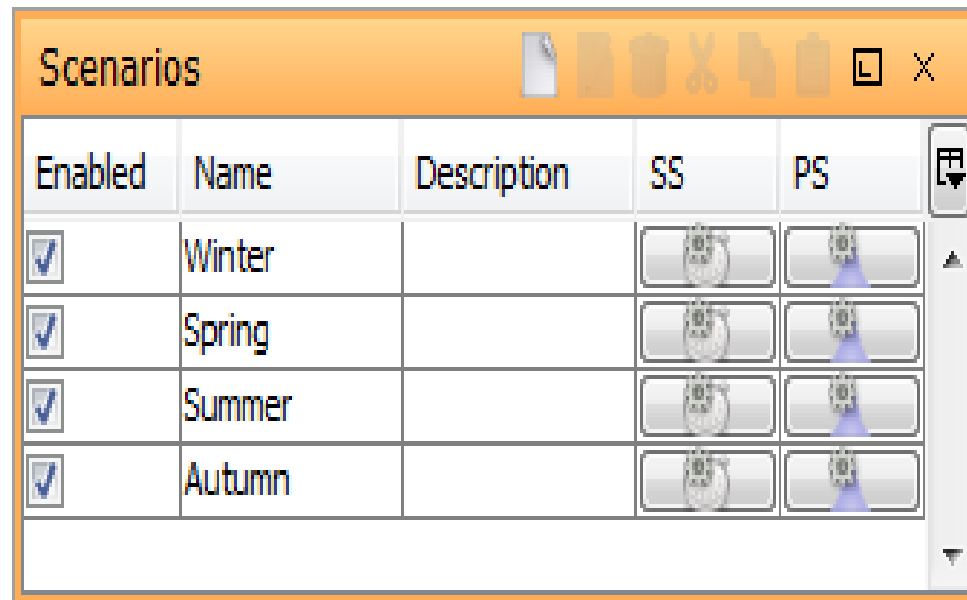
New in Ecolego 6

- Change in internal architecture – toolboxes
- Flow diagrams
- Scenarios
- Possibility to buy subscriptions instead of perpetual licenses

Ecolego 6 supports flow diagrams and interaction matrices



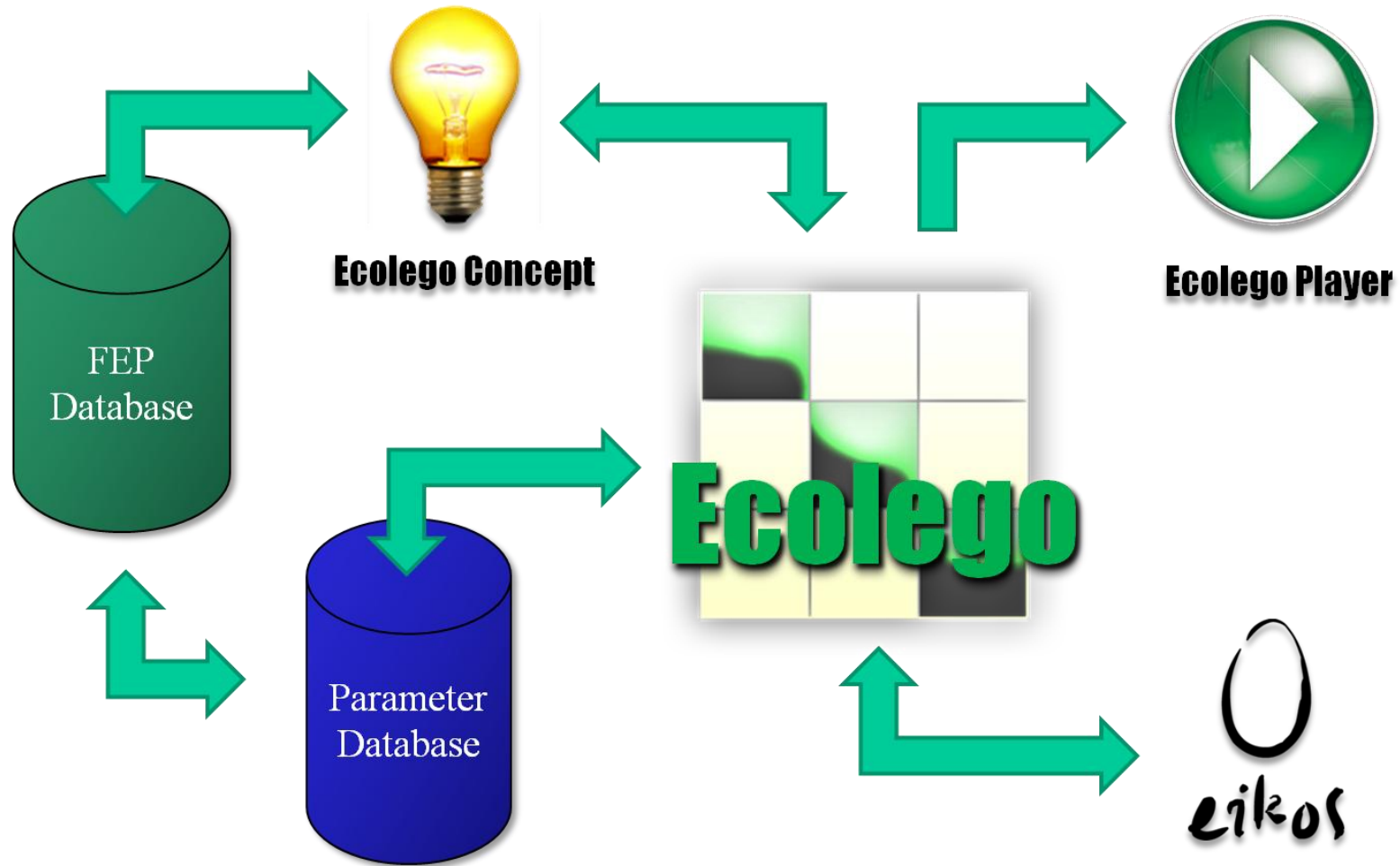
Ecolego 6 support performing parallel simulations for several scenarios



The image shows a software window titled "Scenarios" with a toolbar containing icons for file operations (new, open, save, delete, copy, paste) and window management (maximize, close). Below the toolbar is a table with five columns: "Enabled", "Name", "Description", "SS", and "PS". The table contains four rows representing seasons: Winter, Spring, Summer, and Autumn. Each row has a checked checkbox in the "Enabled" column, an empty "Description" field, and two numeric input fields in the "SS" and "PS" columns. The "SS" column contains the value "0.0" and the "PS" column contains the value "0.0". A vertical scrollbar is visible on the right side of the table.

Enabled	Name	Description	SS	PS
<input checked="" type="checkbox"/>	Winter		0.0	0.0
<input checked="" type="checkbox"/>	Spring		0.0	0.0
<input checked="" type="checkbox"/>	Summer		0.0	0.0
<input checked="" type="checkbox"/>	Autumn		0.0	0.0

Next version – focus on integration of tools and
QA/QC



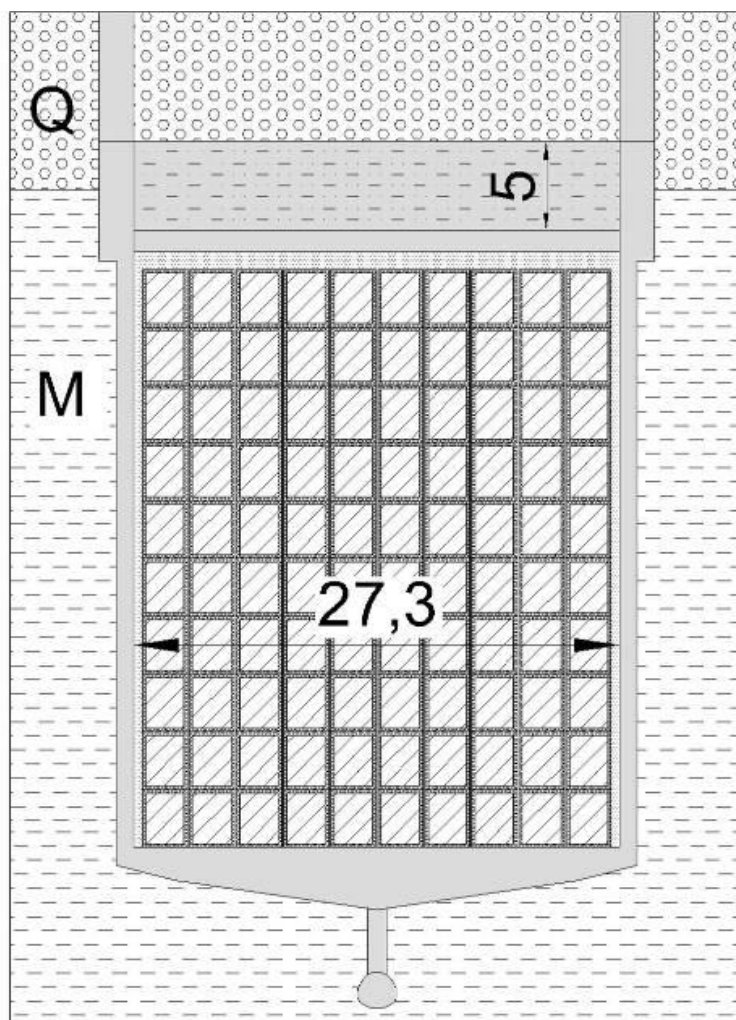
Functionalities adding QC/QA

- System for error tracking during model development, including units checking (Available).
- Sub-version handling for models (Available)
- Import/export of data from quality assured database (Available)
- Report generator (Available)
- System for review of models and assessments (Next version)








Examples of application

- SFR repository, Sweden – near field-geosphere-biosphere
- HLW repositories in Sweden and Finland
- Radon type repositories in Russia and Ukraine
- LILW repository in Slovenia
- Vaalputs disposal facility, South Africa
- Wolsong repository, South Korea
- Borehole disposal concept, IAEA

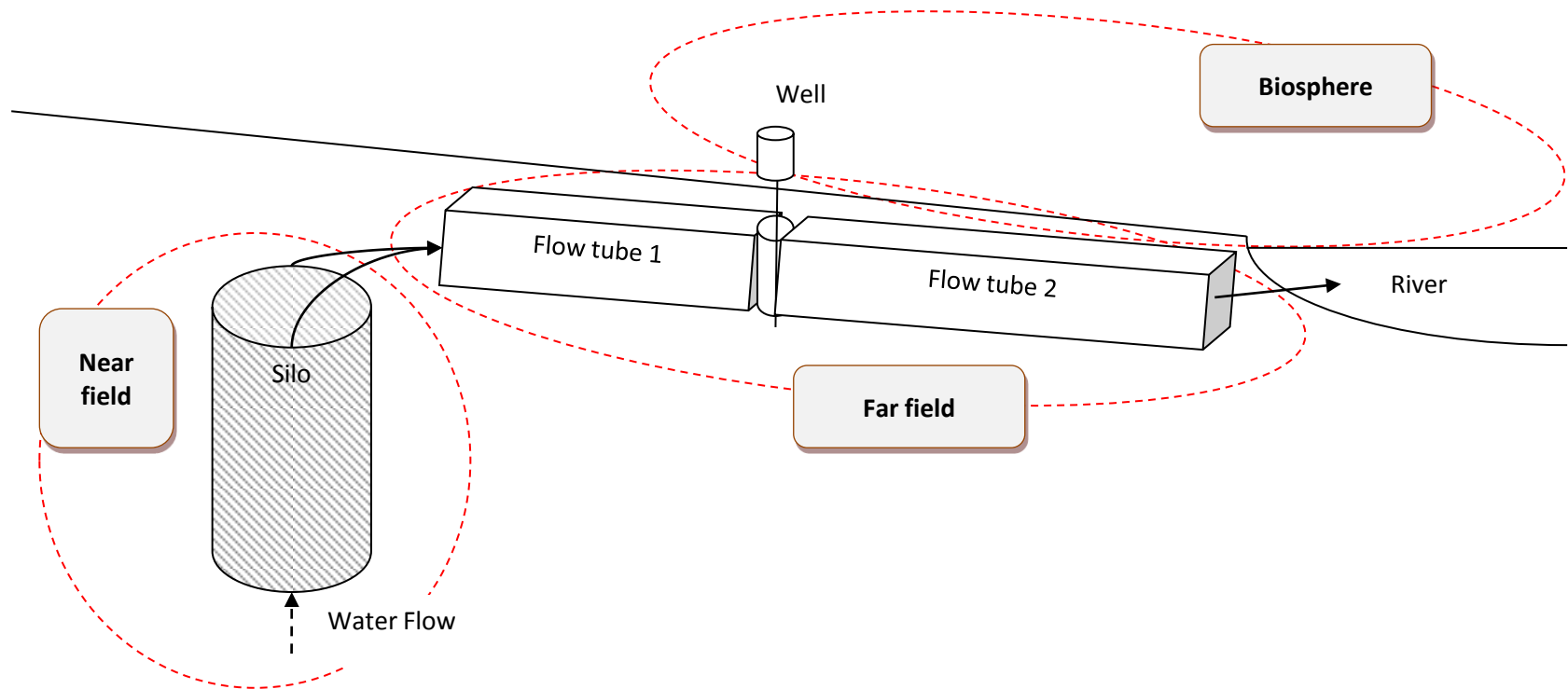
Vrbina LILW repository, Slovenia



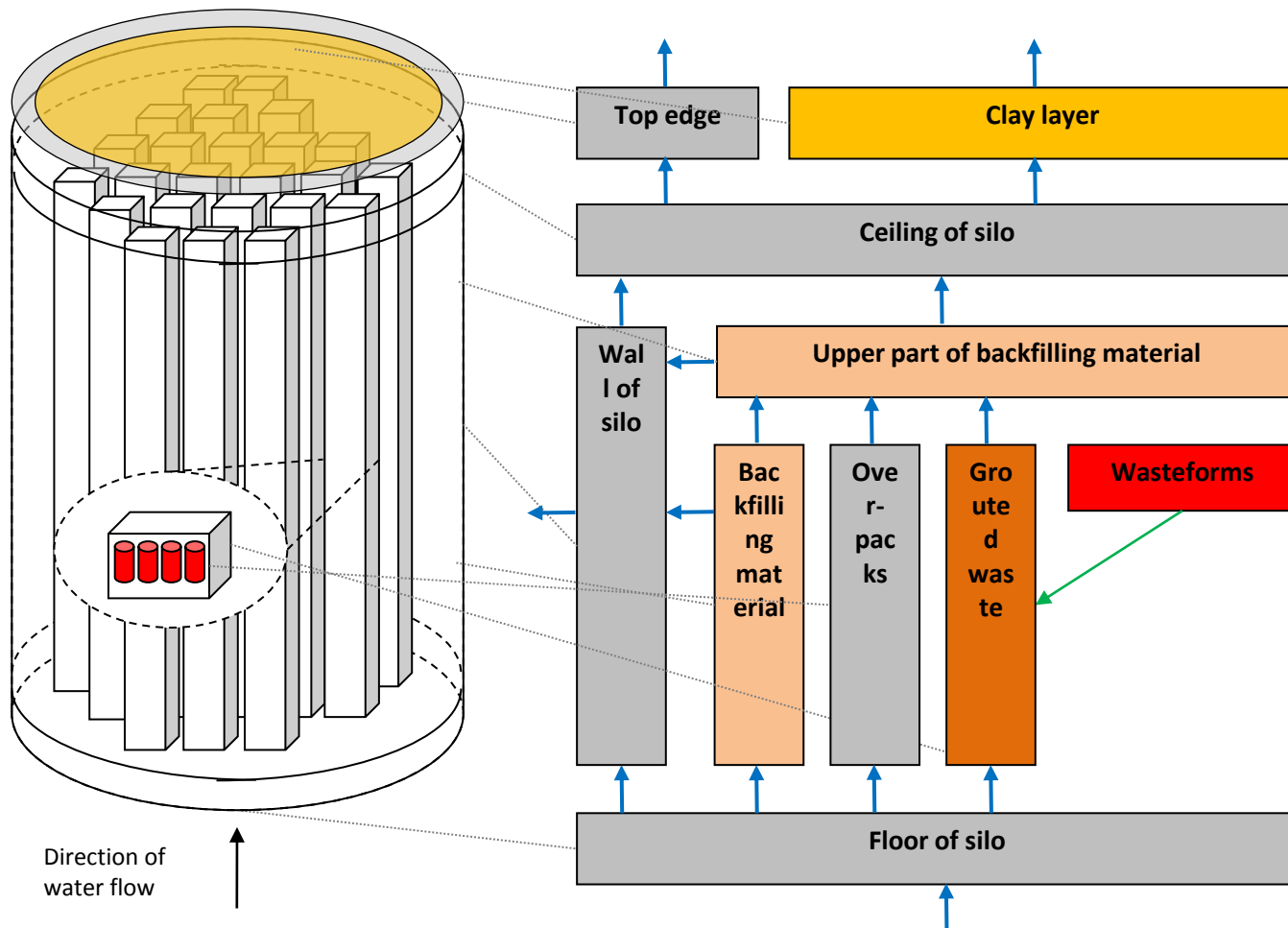
Legend

	Quaternary gravel ($K=5E-3$ m/s)
	Clay top
	Sand backfill
	Silo concrete
	Overpacks
	Grouted waste
	Miocene ($K=5E-7 - 6.4E-8$ m/s)

Scope of the System Level Model



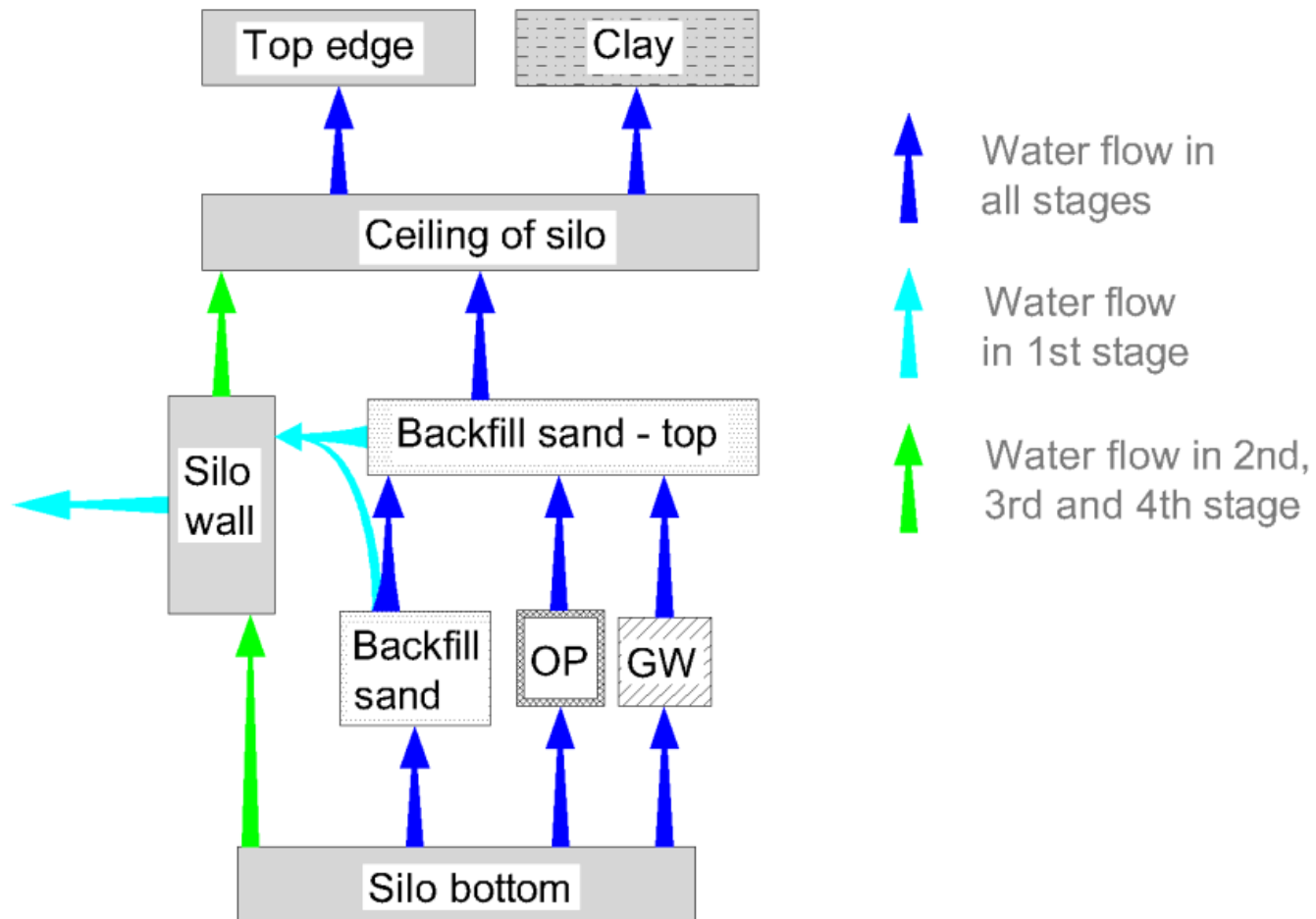
Conceptual model of the near field



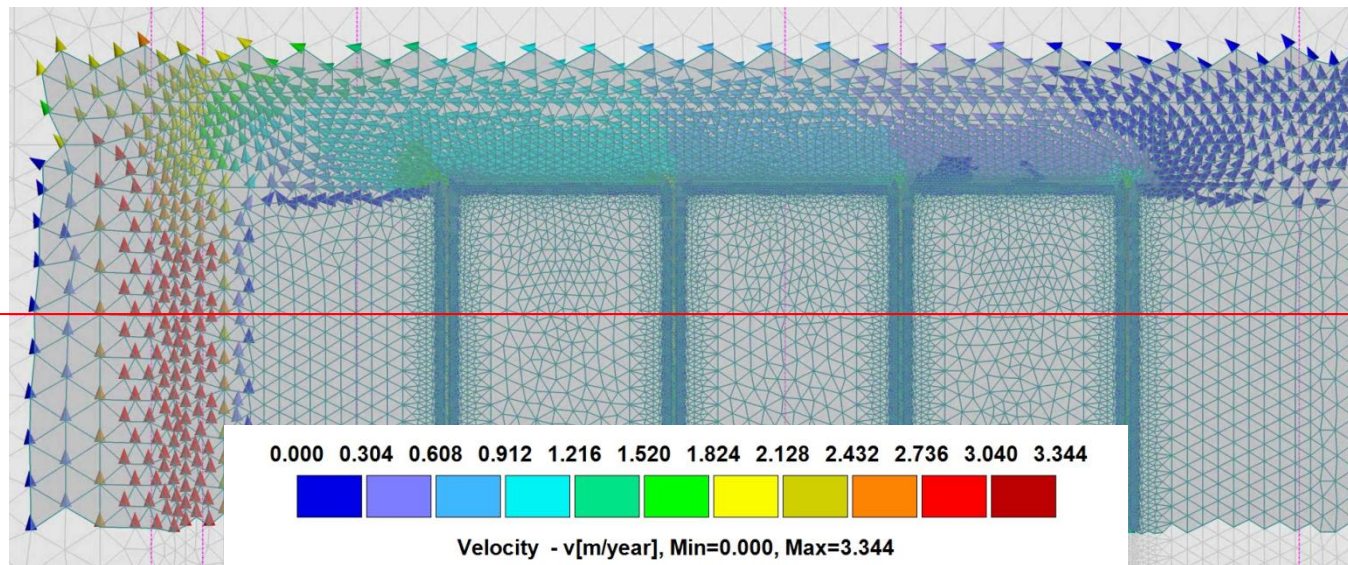
Farfield												
Advection	Silo edge	Diffusion										
Diffusion												
Advection	Diffusion	Clay	Diffusion									
Diffusion												
	Advection	Advection	Silo ceiling		Diffusion							
		Diffusion										
Advection			Advection	Silo wall	Diffusion	Diffusion						
Diffusion												
			Advection	Advection	Backfill top	Diffusion	Diffusion	Diffusion				
			Diffusion	Diffusion								
				Advection	Advection	Backfill	Diffusion					Diffusion
				Diffusion	Diffusion							
					Advection	Overpack	Diffusion	Diffusion				Diffusion
					Diffusion							
					Advection		Diffusion	Waste grout				Diffusion
					Diffusion							
								Leaching	Waste uc			
								Leaching		Waste ss		
								Leaching			Waste cs	
Diffusion				Advection		Advection	Advection	Advection				Silo floor
					Diffusion	Diffusion	Diffusion					

Implementation
of near field
model in
Ecolego

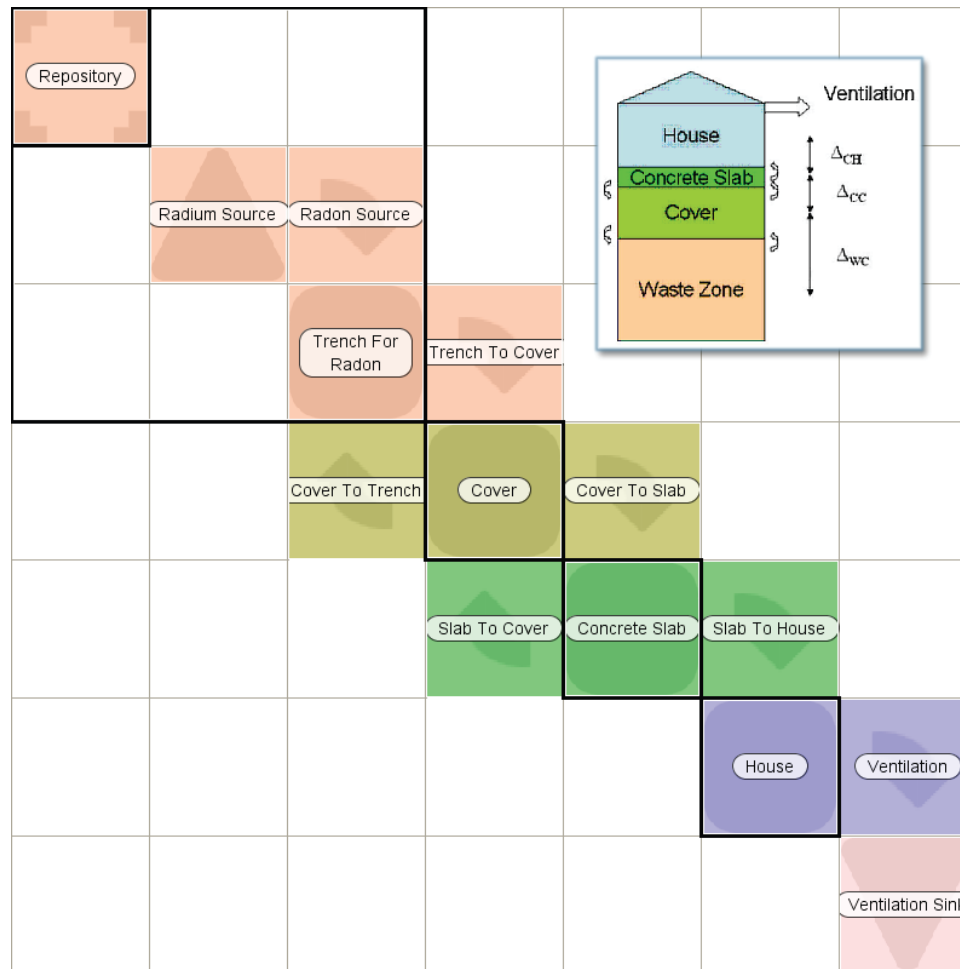
Groundwater flow model



Calculation of water fluxes using Hydrus



Vaalputs, South Africa



Wolsong, South Korea

