



# What is ECOBAS?

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4th August 2004

*Modelling and ...*

*ECOBAS and EMA ...*

*Simulation (SIMUL)*

*Simulation and Data*

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## 1. Modelling and documentation, basic concepts

In contrast to many other *simulation* or *modelling* systems, **ECOBAS** main focus is the creation and management of

- complete,
- correct and
- consistent

mathematical formulations of ecological processes.



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**ECOBAS** integrates the two working steps *modelling* and *documentation* into one step.



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**source code is not an ecological model!**



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*source code is not an ecological model!*

... but a technical document, which can be used to execute simulations.



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## *source code is not an ecological model!*

... but a technical document, which can be used to execute simulations.

From scientific understanding *a model is a hypothesis* about (functions, structure and) behaviour of a system. But the core element of a scientific hypothesis is its capability of being proven false (*falsification*)<sup>1</sup>.

Thus it is necessary that a scientific hypothesis is

- easy to access,
- as easy as possible to understand and
- the requirements above (complete, correct and consistent) are fulfilled.



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**An ecological model is more than a mathematical model!**

---

<sup>1</sup>For example, the hypothesis that “atoms move because they are pushed by small, invisible, immaterial demons” is pseudo-science since the existence of the demons cannot be proven false (i.e. cannot be tested at all).

[source: [http://zebu.uoregon.edu/~js/glossary/principle\\_of\\_falsification.html](http://zebu.uoregon.edu/~js/glossary/principle_of_falsification.html)]



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# *An ecological model is more than a mathematical model!*

... because we need not only

- the declaration of variables,
- the equations and the
- the definition of values.

(this is only sufficient for a mathematical model)



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... but also information about

- the units,
- the ranges of validity,
- the meaning of the variables,
- the used measuring methods and
- the ecological context as well.

to satisfy the scientific requirements of

- **reproducibility,**
- **falsification of hypothesis**

and the

- **assessment of the range of validity/application**

at the level of ecology.



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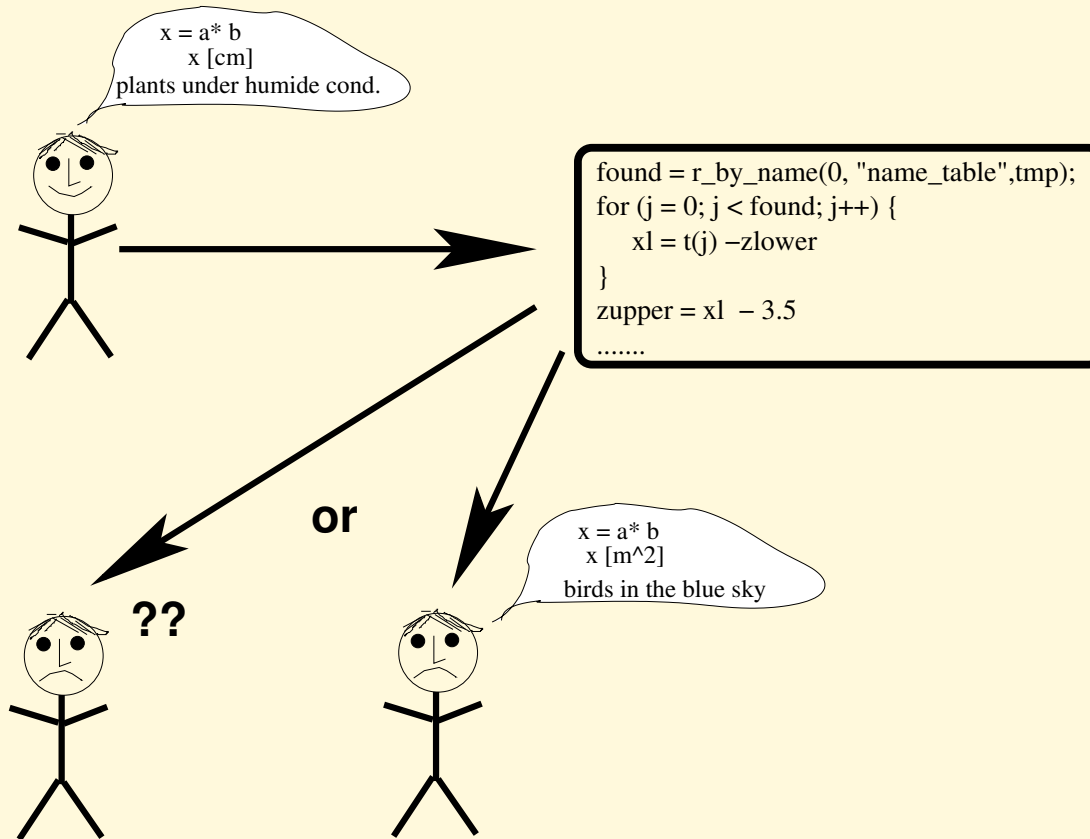
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practical situations are often like this:



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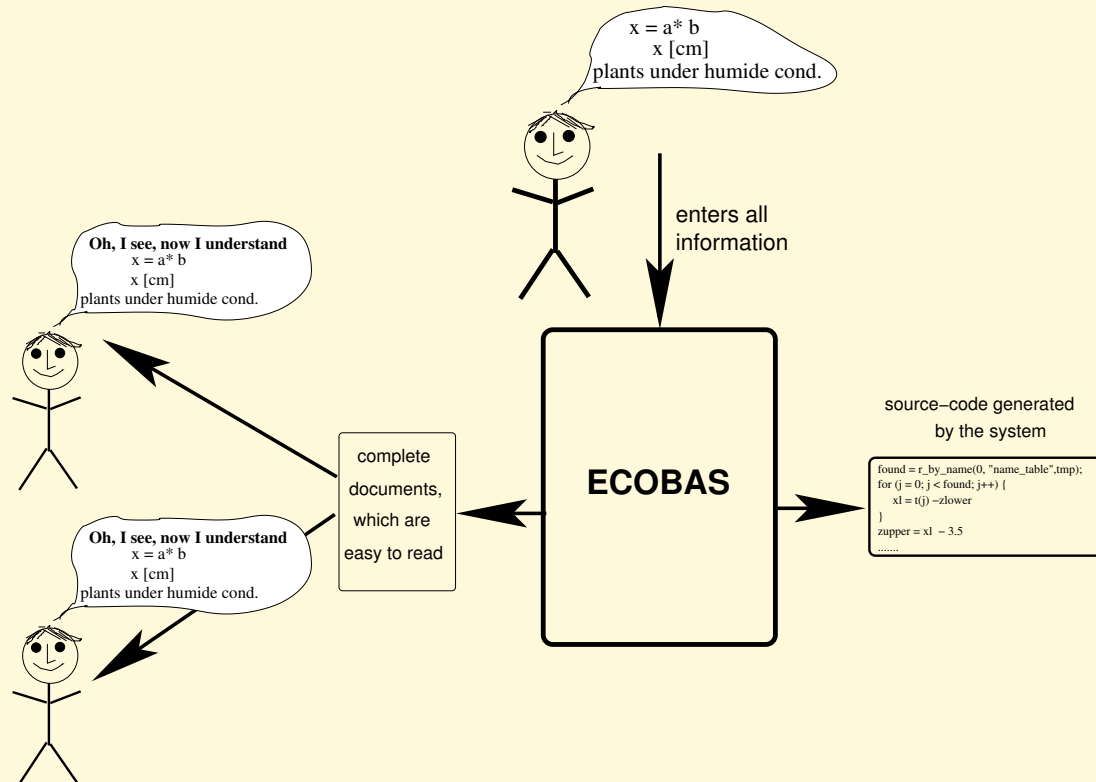
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an improvement of this situation can be achieved



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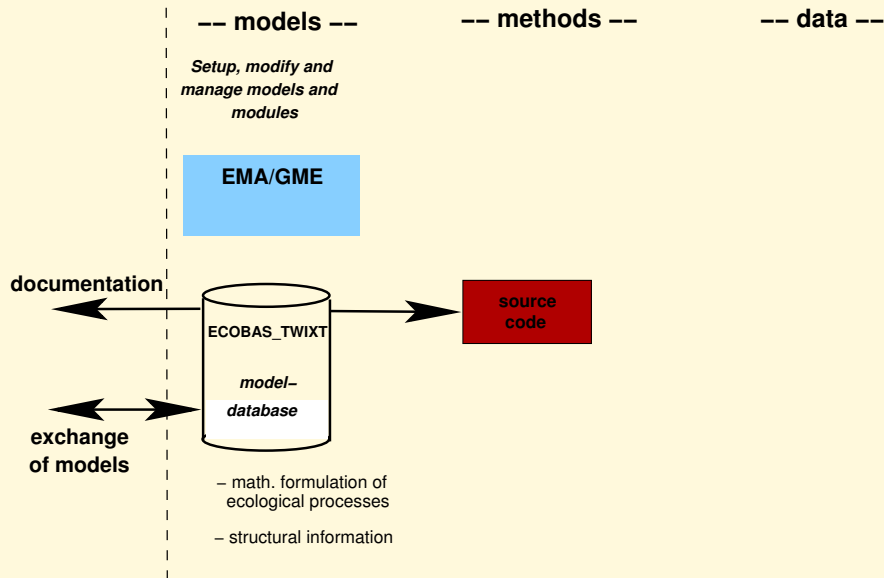
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## 2. ECOBAS and EMA (ECOBAS Modelling Assistant)

ECOBAS consists of

- a database (ECOBAS\_TWIXT) and
- an user interface (ECOBAS Modelling Assistant)



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the main tasks of EMA are:



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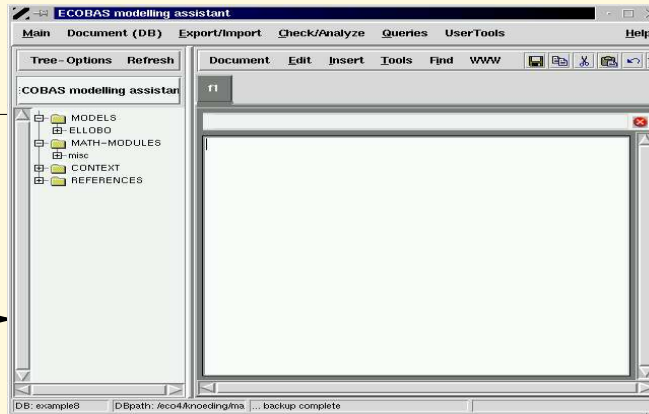
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**Presentation  
Text processing**

- TeX (postscript,pdf)
- HTML

**Export/Import  
Exchange**

- ECOBAS XML
- SQL



**Simulation**

- SIMUL

### Setup, modify and manage models and modules

#### Database

- Create, delete and select a database

#### Navigation in a database

#### Models/Modules

- Create, insert, delete and edit models/modules

#### Check/Analyze

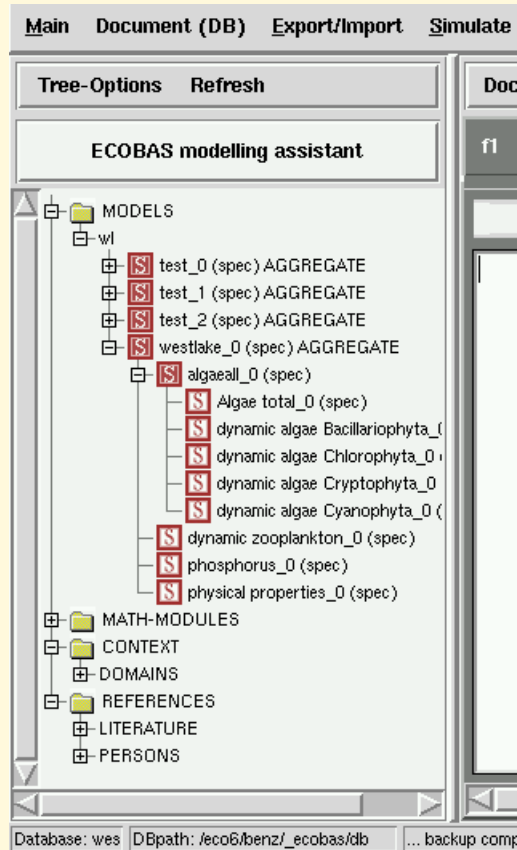
- Completeness, Syntax, Consistency
- *Compatibility, Modularization, ...*

#### Database queries

## 2.1. Navigation in the database

To specify models or sub-models (modules) 10 different document types in 3 main groups (Models, MATH-modules, Context and References) are defined in ECOBAS<sup>a</sup>. All documents are stored in ECOBAS model database. The user can navigate in the content of the database using the tree view in the left frame of EMA.

<sup>a</sup>more detailed information about modularization in ECOBAS can be found in: *Modularization of ecological models*



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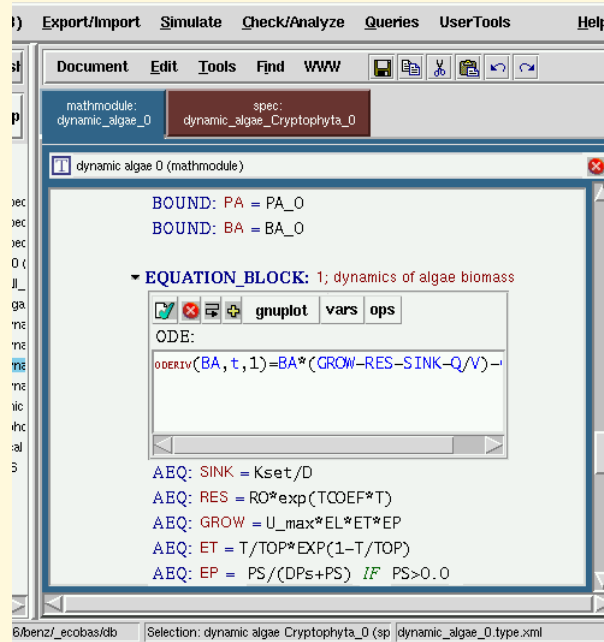
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## 2.2. Create or modify modules

To create or modify ECOBAS modules the right frame of EMA can be used. This is an easy-to-use and comfortable XML-Editor. The underlying format of all documents is ECOBAS\_XML<sup>a</sup>

<sup>a</sup>see: Document Type Definition of ECOBAS\_XML [http://eco.wiz.uni-kassel.de/ecobas/new\\_db/mif.dtd.txt](http://eco.wiz.uni-kassel.de/ecobas/new_db/mif.dtd.txt)



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the following mathematical concepts (types of equations) can be used in ECOBAS:

- algebraic equations  
(including piecewise defined functions)
- tabular functions
- ordinary differential equations
- time events
- state events
- *if then else* rules

( partial differential equations and coupled PDE-ODE systems are under development)



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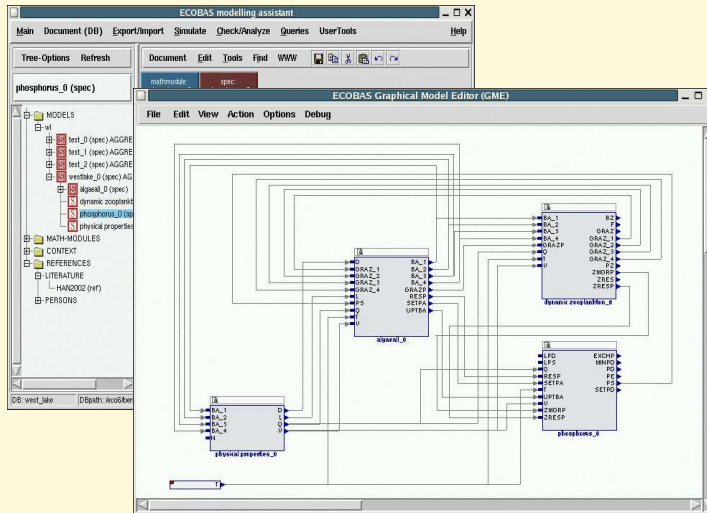
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### 2.3. Structural information (AGGREGATES)

So far we have dealt with ecological base-processes and how they can be entered into ECOBAS as generic modules. Meaningful ecological models or sub-models generally require that we connect several base-process modules to form more comprehensive systems. To enter or modify this *structural information*, the tool **ECOBAS Graphical Model Editor (GME)**, is applied. GME is started from the main menu of EMA and modules can be copied from the tree-view onto the GME canvas.



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Comprehensive checks are done to proof if a certain connection between two modules is valid or not.



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connection check result

Close

Connection analysis:  
 from: {algaeall\_0} {BA\_1}  
 to : {phosphorus\_0} {LPD}

-----

# INFO: Go backward from {algaeall\_0} {BA\_1}  
 to {dynamic algae Cyanophyta\_0} {BA}

# INFO: {phosphorus\_0} {LPD} has 1 sinks

Connection analysis:  
 from: {dynamic algae Cyanophyta\_0} {BA}  
 to : {phosphorus\_0} {LPD}

-----

check of units of time  
 end of check of units of time

-----

#ERROR: unequal prefactors at assign  
 $g/(n \times n \times n) = g/(n \times n \times n \times s)$   
 Prefactor of left hand side: 1.000000  
 Prefactor of right hand side: 0.000012

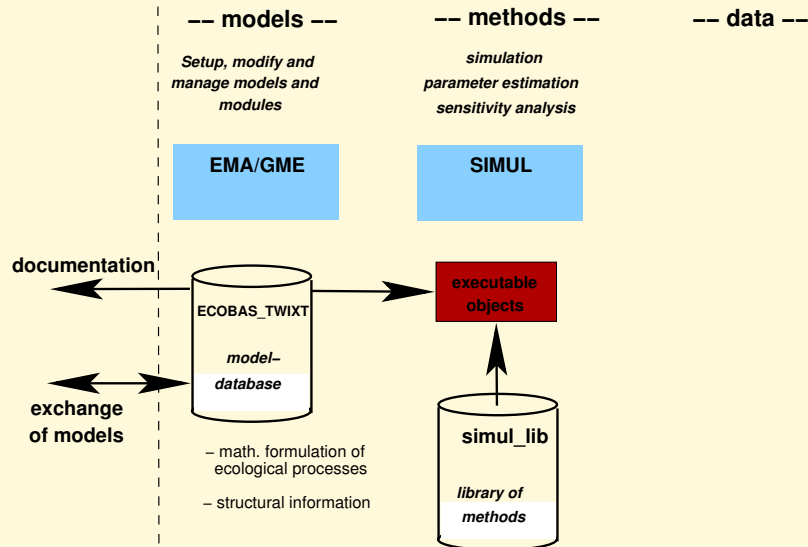
	source	sink	status
unit of time	d	d	consistent
range of time	0:365	-	unchecked
unit	$g/(n \times n \times n)$	$g/(n \times n \times n \times s)$	inconsistent
method	-	-	unchecked
Input->Output	Output	Input	consistent
dimension	SCALAR	SCALAR	consistent
variable types	float	float	consistent
scale	metric	metric	consistent
Domain(-> indomain)	Cyanophyta	-	unchecked, see(9)
(outdomain ->)Domain	-	West Lake	unchecked, see(10)
range	0:	0:	consistent, see(11)

ECOBAS Graphical Model Editor (GME)

File Edit View Action Options Debug

### 3. Simulation (SIMUL)

Finally the main aim of modelling is *simulation and analysis of systems behaviour*. For this task ECOBAS provides **ECOBAS SIMUL** (simulation system).



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Not only simulation can be done with SIMUL. Also functions are implemented to do *parameter analysis*, *parameter estimation* and *sensitivity analysis*.



The screenshot displays the SIMUL software interface. The main window, titled "ECOBAS\_SIMUL (version 0.0.3)", has a menu bar with "Main", "Set Value", "Execute", "Select Mode", "Show Result", "Remote processing", and "Help". It is divided into three panes: "Models" (listing streams and parameters like stream1, stream2, ..., zooplankton0), "Outputs" (listing biomass and soil-plant-flow outputs), and "selected Outputs (y)" (showing "3#biomass\_0:B:[kg/ha]").

A secondary window, "ECOBAS\_SIMUL: Parameter analysis of soilplantsystem0", is open in the foreground. It shows "Constants of soilplantsystem0" with a list of parameters and their values. Two constants are selected: "1. constant" (stepsize: 0.0002, upper value: 0.011, lower value: 0.009) and "2. constant" (stepsize: 0.02, upper value: 1.1, lower value: 0.9). The "time domain" is set to "off".

A 3D surface plot titled "Figure No. 1" is also visible, showing a surface with a color gradient from blue to red. The axes are labeled "biomass\_0:B [kg/ha]" and "biomass\_k\_1:[1/d]". The plot title includes the database path and date: "soil\_plant\_system\_0, database: /ecob6/benzf/\_ecobas/db/vorlesung, Tue Aug 3 09:17:24 CEST 2004".

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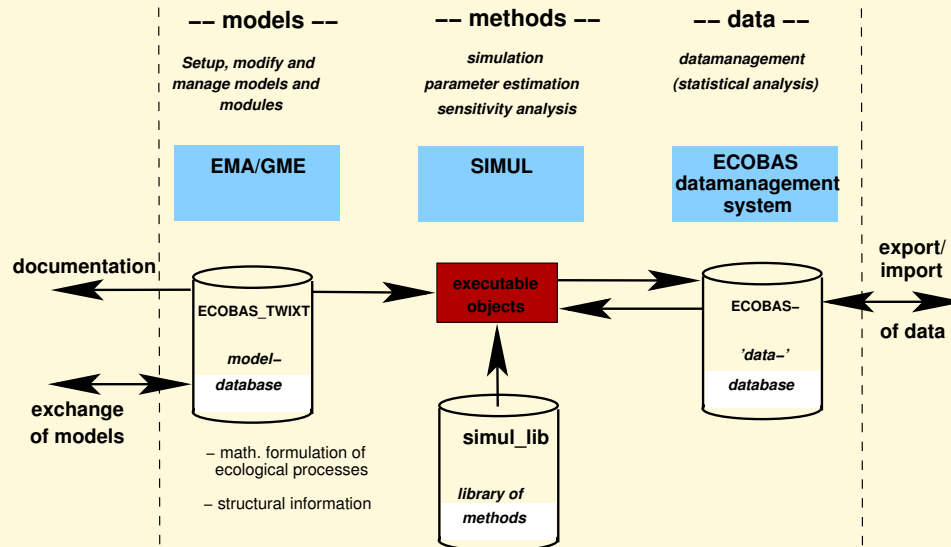
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## 4. Simulation and Data

In many cases we have to provide data (e.g. input time series). In particular if we want to do parameter estimation, verification or validation for certain boundary conditions, we have to provide time series of measured data. Also it is advantageous to store the results of simulations for analysis and presentation, which we will do later. Therefore ECOBAS provides a subsystem for data management.



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**ECOBAS data management system** is still under development and in an experimental state yet.



ECOBAS\_Data Editor (v0.1) – experimental –

Main Help

Refresh

selection:

selected series for export/statistics  
 (deselect with left button)

reset export statistics

SIMULATED  
 Algen+Gesamt\_0  
 Blaualgen\_1=PHYT  
 1  
 exponential\_0  
 X.everywhere.unkn  
 fish\_0  
 lake\_0  
 soil\_plant\_system\_0  
 stream\_2  
 stream\_5  
 CONTEXT  
 VARIABLE

Selected database: local@

Edit simulated:Algen Gesamt:0 Variable: Blaualgen\_1=PHYT:EMMO:unknown:0 R...  
 simulated: Algen Gesamt:0  
 Variable: Blaualgen\_1=PHYT:EMMO:unknown:0  
 Repetition: 1  
 start time: 2004:03:01:19:10:00, time unit: min  
 sigma: 0.0 weight: 1.0  
 space aggregation: none space scale:  
 time aggregation: none time scale:  
 longitude: 0 latitude: 0

time [min] (delete=double click)	value [kJm <sup>-3</sup> ]	sigma	weight
0.000000 (2004:03:01:19:10:00)	0.60000000000000E+01	0.0	1.0
86.383333 (2004:03:01:20:36:23)	0.497071003514E+01	0.0	1.0
172.800000 (2004:03:01:22:02:48)	0.494158743813E+01	0.0	1.0
259.200000 (2004:03:01:23:29:12)	0.491263124374E+01	0.0	1.0
345.600000 (2004:03:02:00:55:36)	0.488384049240E+01	0.0	1.0
432.000000 (2004:03:02:02:22:00)	0.485521423020E+01	0.0	1.0
518.383333 (2004:03:02:03:48:23)	0.482675150881E+01	0.0	1.0
604.783333 (2004:03:02:05:14:47)	0.479845138549E+01	0.0	1.0
691.183333 (2004:03:02:06:41:11)	0.477031292302E+01	0.0	1.0
777.583333 (2004:03:02:08:07:35)	0.474233518971E+01	0.0	1.0
864.000000 (2004:03:02:09:34:00)	0.471451725932E+01	0.0	1.0
950.400000 (2004:03:02:11:00:24)	0.468685821105E+01	0.0	1.0
1036.800000 (2004:03:02:12:26:48)	0.465935712949E+01	0.0	1.0
1123.183334 (2004:03:02:13:53:11)	0.463201310464E+01	0.0	1.0
1209.583333 (2004:03:02:15:19:35)	0.460482523180E+01	0.0	1.0

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0.0 1.0 new value

save change start time or time unit

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