

# Appendix C: The Knowledge Base in MoST - Glossary

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[www.grundvandskortlægning.dk](http://www.grundvandskortlægning.dk) eller  
[www.vandmodel.dk](http://www.vandmodel.dk)

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## Absorption

Sorption is the process in which a compound is bound to a sorbing material. Sorption is differentiated into adsorption where the compound is bound onto the sorbing material and absorption where the compound is bound into the internal structure of the sorbing material. Desorption is the process by which the compound is released from the sorbing material. The quantity of the bound compound is dependent on the aqueous phase concentration and described by a linear or non-linear sorption isotherm. If the sorption/desorption process is fast compared to the advective velocity sorption may be assumed to be instantaneous (Local Equilibrium Assumption, LEA). Otherwise, the sorption process is kinetically controlled or a rate-limited process.

**Synonym of:** *Sorption*

## Accuracy

Closeness of computations, estimates or measurements to the exact or true values.

### References

International Glossary of Hydrology, UNESCO, WMO.URL: <http://www.cig.ensmp.fr/~hubert/glu/aglo.htm>.

## Activity

Each task in MoST is decomposed into a number of activities comprising descriptions of things to be done within the specific tasks.

### Footnotes

MoST term

## Adsorption

Sorption is the process in which a compound is bound to a sorbing material. Sorption is differentiated into adsorption where the compound is bound onto the sorbing material and absorption where the compound is bound into the internal structure of the sorbing material. Desorption is the process by which the compound is released from the sorbing material. The quantity of the bound compound is dependent on the aqueous phase concentration and described by a linear or non-linear sorption isotherm. If the sorption/desorption process is fast compared to the advective velocity sorption may be assumed to be instantaneous (Local Equilibrium Assumption, LEA). Otherwise, the sorption process is kinetically controlled or a rate-limited process.

**Synonym of:** *Sorption*

## **Advection**

The process by which the solutes are transported by motion of the flowing groundwater

### **References**

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## **Agrochemicals**

All chemicals used in agriculture (pesticides, herbicides, etc.).

### **References**

International Navigation Association (2000) Glossary of Selected Environmental Terms, Report of Working Group No. 3 of the Permanent Environmental Commission, Supplement to Bulletin No. 104.

## **Algorithm**

A precise rule (or set of rules) for solving a problem.

### **References**

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## **Alluvium**

Sediments (clays, silts, sands, gravels and other materials) deposited by flowing water. Deposits can be made by streams on river beds, floodplains and alluvial fans.

### **References**

Murray-Darling Basin Commision (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Analytical model**

A models that can be solved mathematically in closed form. For example, some model algorithms that are based on relatively simple differential equations can be solved analytically to provide a single solution.

### **References**

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## **Anisotropy**

The condition under which one or more hydraulic properties at any point within the groundwater flow system vary with the direction of measurement.

### **References**

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## **Anoxic**

Deficient in or lacking oxygen.

### **References**

International Navigation Association (2000) Glossary of Selected Environmental Terms, Report of Working Group No. 3 of the Permanent Environmental Commission, Supplement to Bulletin No. 104.

## **Anthropogenic**

Refers to the influence of human activities on natural systems.

### **References**

International Navigation Association (2000) Glossary of Selected Environmental Terms, Report of Working Group No. 3 of the Permanent Environmental Commission, Supplement to Bulletin No. 104.

## **Aquiclude**

A saturated geological unit that is incapable of transmitting significant quantities of water under ordinary hydraulic gradients.

### **References**

Freeze RA and Cherry JA (1979) Groundwater. Prentice Hall, New Jersey.

## **Aquifer**

A saturated permeable geological unit that can transmit significant quantities of water under ordinary hydraulic gradients.

### **References**

Freeze RA and Cherry JA (1979) Groundwater. Prentice Hall, New Jersey.

## **Aquifer, confined**

An aquifer that is overlain by a low permeability layer.

### **Aquifer, perched**

A saturated lense that is bounded (overlain and underlain) by unsaturated conditions. This is a special type of an unconfined aquifer.

#### **References**

Freeze RA and Cherry JA (1979) *Groundwater*. Prentice Hall, New Jersey.

### **Aquifer, unconfined**

An aquifer that contains the water table and is normally exposed to the ground surface. There may be a low permeability layer overlying the aquifer protecting it from the surface.

#### **References**

Murray-Darling Basin Commision (2000) *Groundwater Flow Modelling Guideline*. Aquaterra Consulting Pty Ltd, South Perth, Australia.

### **Aquitard**

A relatively low-permeable layer or bed in a stratigraphic sequence. These layers may be permeable enough to transmit water in quantities that are significant in the study of regional groundwater flow, but their permeability is not sufficient to allow the completion of production wells within them.

#### **References**

Freeze RA and Cherry JA (1979) *Groundwater*. Prentice Hall, New Jersey.

### **Artesian bores**

Bores having a static water level (head) above the top of the aquifer being tapped. If the head is above the ground surface, the bore is free flowing, unless capped.

#### **References**

Murray-Darling Basin Commision (2000) *Groundwater Flow Modelling Guideline*. Aquaterra Consulting Pty Ltd, South Perth, Australia.

### **Artesian conditions**

Conditions where the hydraulic head in a confined aquifer rises above the top of the aquifer.

#### **References**

Freeze RA and Cherry JA (1979) *Groundwater*. Prentice Hall, New Jersey.

## Auditor

A person that is conducting some kind of review of a modelling study. The review may be more or less comprehensive depending on the requirements of the particular case. The auditor is typically appointed by the water manager to support the water manager to match the modelling capability of the modeller. The auditor may belong to the water manager's organisation or to an independent organisation. The task of the auditor should be distinguished from internal reviews which the modeller's organisation often carry out as part of its internal quality assurance procedure. The reviews performed by the auditor are done over and above any internal reviews that the modeller may carry out.

### Synonyms

Reviewer

### Footnotes

MoST term – User type

## Automatic calibration

Parameter values are often optimised through inverse modelling. This is also denoted as automatic calibration (Duan et al, 1994; Hill, 1998; Doherty, 2003). An optimal parameter set is sought "automatically" by minimising an objective function, often defined as the summed squared deviation between the calibration targets (field data) and their simulated counterparts.

**Synonym of:** *Inverse modelling*

### References

Doherty J (2003) Ground water model calibration using pilot points and regularization. *Ground Water*, 41(2), 170-177. (See also <http://www.sspa.com/pest> for further information/download of PEST)

Duan Q, Sorooshian S and Gupta VK (1994) Optimal use of the SCE-UA global optimization method for calibrating watershed models. *Journal of Hydrology* 158, 265-284.

## Average lineary velocity

The average linear velocity ( $v$ ) takes into account that flow occurs only in the voids, and is the Darcy velocity divided by the effective porosity  $v = v_f / n = -K_i / n$  where  $v_f$  is the Darcy velocity,  $n$  the effective porosity,  $K$  is the hydraulic conductance, and  $i$  is the hydraulic gradient

### References

Freeze RA and Cherry JA (1979) *Groundwater*. Prentice Hall, New Jersey.

## **Background level**

The level of pollutants present in ambient air, water, soil or any other medium from natural sources.  
Also called Background concentration.

### **References**

International Navigation Association (2000) Glossary of Selected Environmental Terms, Report of Working Group No. 3 of the Permanent Environmental Commission, Supplement to Bulletin No. 104.

## **Balance**

Comparing of masses of a specific substance or liquid, involved in the supply and drainage and changes in storage over a certain period and within a certain area.

## **Baseflow**

Part of the discharge which enters a stream channel mainly from groundwater, but also from lakes and glaciers during long periods when no precipitation or snowmelt occurs. Complementary to quickflow.

### **References**

International Glossary of Hydrology, UNESCO, WMO.URL: <http://www.cig.ensmp.fr/~hubert/glu/aglo.htm>.

### **Footnotes**

Baseflow is often assessed by different methods in the groundwater and precipitation-runoff domains. The amount of discharge characterised as baseflow may therefore differ significantly depending on the estimation method.

## **Baseline**

Reference used as starting point for making comparisons.

## **Baseline study**

An inventory of a natural community or environment to provide a measure of its condition at a moment in time - often done to describe the status of diversity and environmental condition against which future change can be gauged (usually development drive)

### **References**

International Navigation Association (2000) Glossary of Selected Environmental Terms, Report of Working Group No. 3 of the Permanent Environmental Commission, Supplement to Bulletin No. 104.

## Basic job complexity

A project is characterised as having a basic job complexity when relatively small efforts and resources are required to carry out the modelling study. Studies in preliminary phases of a planning study aiming at a pre-screening of alternatives for subsequent more detailed study later on could e.g. be characterised as belonging to this category. The HarmoniQuA guidelines for basic job complexity is the simplest version of the guidelines, and it includes less tasks activities than e.g. the 'comprehensive' category.

### Footnotes

MoST term – User type

## Basin

An area of land, bounded by a divide, in which water flowing across the surface will drain into a stream or river and flow out of the area through a specified point on that stream or river. Synonymous terms are catchment and watershed. Generally a basin is defined at a regional scale whereas a catchment or a watershed can be of smaller area. The term catchment is mostly used in Europe, while watershed is a preferred term in USA.

### Synonyms

Catchment; Watershed; Hydrological Basin; Drainage Basin

## Benchmark

This word may have different meanings: 1. A surveyor's mark on a permanent object of predetermined position and elevation used as a reference point. 2. A point of reference for the purpose of comparison. Different uses in this regard include: (2a) the best, (2b) a standard against which a comparison can be made, or (2c) a method of comparison.

### References

<http://www.rbm-toolbox.net/>

Wordnet lexical database for English language: <http://www.cogsci.princeton.edu/~wn/>

## **Bias**

Systematic deviation between a measured (i.e., observed) or computed value and its “true” value. Bias is affected by faulty instrument calibration and other measurement errors, systematic errors during data collection, and sampling errors such as incomplete spatial randomization during the design of sampling programs

### **References**

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## **Biota domain**

The biota (ecological) modelling domain comprises water quality processes in all surface water elements such as:- River systems including flood plain, lakes and reservoirs- Estuaries and coastal waters  
The biota (ecological) domain in MoST corresponds to the ecological aspects in 'river' 'lake' 'transitional water' and 'coastal water' as these terms are defined in the Water Framework Directive.

### **Footnotes**

MoST term - Modelling domain

## **Black Box Model**

A model where the structure is derived, not from from knowledge on the physical, biological or ecological processes, but from analyses of relationship among observed data.

**Synonym of:** *Empirical Model*

### **References**

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.  
Refsgaard JC (1996) Terminology, modelling protocol and classification of hydrological model codes. In: Abbot MB and Refsgaard JC (Eds): Distributed Hydrological Modelling, 17-39. Kluwer Academics Publishers.

## **Bore (well)**

A structure drilled or dug below the surface to obtain water from an aquifer system.

### **References**

Murray-Darling Basin Commision (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.



### **Boundary condition - First Type Boundary: Constant Head**

A boundary condition for a groundwater model where the head is known and specified at the boundary of the flow field, and the model computes the associated groundwater flow. Also known as a Specified, Fixed, Constant Head or First Type boundary condition.

**Synonym of:** *Dirichlet condition*

#### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

### **Boundary condition - Second Type Boundary: Specified Flow**

The boundary condition for a groundwater model where the flux across the boundary of the flow region is known and specified, and the model computes the associated aquifer head. Also known as a Constant Flux or Second Type boundary condition.

**Synonym of:** *Neumann condition*

#### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

### **Boundary condition - Third Type Boundary: Head Dependent Flow**

A boundary condition for a groundwater model where the relationship between the head and the flow at a boundary is specified, and the model computes the groundwater flux for the head conditions applied. Also known as a Head-Dependent, mixed or Third Type

**Synonym of:** *Cauchy condition*

#### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

### **Boundary conditions**

Conditions put to the (spatial) boundaries of a model in order to make the solution of a differential equation unambiguous.

## Calibration

The procedure of adjustment of model parameter values to reproduce the response of reality within the range of accuracy specified in the performance criteria.

**Synonym of:** *Model Calibration*

### References

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

## Calibration, Initial Conditions

The initial hydrologic conditions for a flow system that are represented by its aquifer head distribution at some particular time corresponding to the antecedent hydrologic conditions in that system. Initial conditions provide a starting point for transient simulations.

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Calibration, Steady State

The calibration of a model to a set of hydrologic conditions that represent (approximately) an equilibrium condition that does not account for changes in storage.

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Calibration, Transient or Dynamic

The calibration of a model to hydrologic conditions that vary dynamically with time, including changes in aquifer storage.

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Catchment

An area of land, bounded by a divide, in which water flowing across the surface will drain into a stream or river and flow out of the area through a specified point on that stream or river. Synonymous terms are catchment and watershed. Generally a basin is defined at a regional scale whereas a catchment or a watershed can be of smaller area. The term catchment is mostly used in Europe, while watershed is a preferred term in USA.

**Synonym of:** *Basin*

## Cauchy condition

A boundary condition for a groundwater model where the relationship between the head and the flow at a boundary is specified, and the model computes the groundwater flux for the head conditions applied. Also known as a Head-Dependent, mixed or Third Type

### Synonyms

Boundary condition - Third Type Boundary: Head Dependent Flow

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Chained model

Model that includes several domains with a forward coupling, so that output of one domain is used as input to another domain without any feedback.

**Synonym of:** *Integrated model, uncoupled*

## Client

A water manager is the person or organisation responsible for the management or protection of the water resource, and thus of the modelling study and its outcome (the problem owner). The water manager is the counterpart of the modeller. If the water manager and the modeller belong to different organisations their roles will typically be denoted client and consultant, respectively

**Synonym of:** *Water Manager*

### Footnotes

MoST term – User type

## Code

A mathematical formulation in the form of a computer program that is so generic that it, without program changes, can be used to establish a model with the same basic type of equations (but allowing different input variables and parameter values) for different study areas.

**Synonym of:** *Model Code*

### References

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

### Footnotes

Model code versus model Many authors and many guidelines use the term model both in the meaning of a model code and as a site-specific model.

## Code Verification

Substantiation that a model code is in some sense a true representation of a conceptual model within certain specified limits or ranges of application and corresponding ranges of accuracy.

### Synonyms

Verification

### Footnotes

Validation versus verification The terms validation and verification are controversial in the scientific community, because there is no consensus on the fundamental question concerning whether a water resources model can be validated or verified, and whether it as such can be claimed to be suitable or valid for particular applications. Examples of such discussion is given in Hassanizadeh and Carrera (1992) Konikow and Bredehoeft (1992) De Marsily et al. (1992) Oreskes et al. (1994). An overview is provided by Refsgaard and Henriksen (2002). All existing guidelines use either the term validation and/or the term verification. However, the two terms are used with different, and some times interchangeable, meaning in different guidelines. Almost all guidelines use the term verification about demonstration of the adequacy of the numerical algorithms of the computer code. The term dealing with the adequacy of the site-specific model is denoted validation in guidelines from The Netherlands (Van Waveren et al., 2000)

## Coefficient

See parameter or constant.

## Comparison to other models

The output of one model can be compared to that of another model.

### Synonyms

Model Comparison

### References

Rykiel, E.J. (1996) Testing ecological models: the meaning of validation. *Ecological Modelling*, 90, 229-244.

### Footnotes

Taken from the cited reference.

## Comprehensive job complexity

A project is characterised as having a comprehensive job complexity when significant efforts and resources are required to carry out the modelling study. The HarmoniQuA guidelines for comprehensive job complexity is the most comprehensive version of the guidelines.

### Footnotes

MoST term – User type

## Computer Program

A mathematical formulation in the form of a computer program that is so generic that it, without program changes, can be used to establish a model with the same basic type of equations (but allowing different input variables and parameter values) for different study areas.

**Synonym of:** *Model Code*

### References

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

### Footnotes

Model code versus model Many authors and many guidelines use the term model both in the meaning of a model code and as a site-specific model.

## Conceptual Model

A description of reality in terms of verbal descriptions, equations, governing relationships or 'natural laws' that purport to describe reality. This is the user's perception of the key hydrological and ecological processes in the study area and the corresponding simplifications and numerical accuracy limits that are assumed acceptable in order to achieve the purpose of the modelling.

### References

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

### Footnotes

Conceptual model This term is often used with a different meaning in the precipitation runoff domain. Here, hydrological models are often classified according to the complexity of their process descriptions as empirical, conceptual or physically-based (e.g. Refsgaard, 1996). Examples of conceptual models in this context are the Stanford Watershed Model, the Sacramento, the HBV and the NAM.

## Confining layer

A body of material of low hydraulic conductivity that is stratigraphically adjacent to one or more aquifers. It may lie above or below the aquifer.

### References

Fetter CW (1980) *Applied Hydrogeology*. Merril Publishing Co.

## Confirmation

Determination of adequacy of the conceptual model to provide an acceptable level of agreement for the domain of intended application. This is in other words the scientific confirmation of the theories/hypotheses included in the conceptual model.

**Synonym of:** *Model Confirmation*

### References

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

## Conjunctive use

The combined use of surface water and groundwater storage to optimise available water resources.

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Constant

A quantity with a fixed value (e.g. the speed of light or gravitational force) representing known physical, biological or ecological activities.

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## Consultant

A specialist who undertakes the technical modelling activity. A modeller should have expert knowledge of both the issue and the sound model modelling approaches. The modeller should present and interpret the model outputs to the water manager and to the stakeholders. The modeller is the counterpart of the water manager. If the modeller and the water manager belong to different organisations their roles will typically be denoted consultant and client, respectively.

**Synonym of:** *Modeller*

### Footnotes

MoST term – User type

## Darcy velocity

An apparent velocity calculated from Darcy's law as the volumetric flow rate divided by the cross-sectional area over which the flux occur. It represents the flow rate at which water would flow in an aquifer if the aquifer was an open conduit. The velocity ( $v_f$ ) is thus an imaginary velocity, because it assumes that the flow takes places over the entire cross-sectional area and not only in the voids  $v_f = Q/A = -Ki$  where  $Q$  is the flow rate  $A$  the cross sectional area, and  $i$  the hydraulic gradient

**Synonym of:** *Specific discharge*

### References

Murray-Darling Basin Commision (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Darcy's law

An empirical equation developed to compute the quantity of water flowing through an aquifer. Usually expressed as  $Q=KiA$  or  $Q=Tiw$ , where  $Q$ = flow,  $K$ = hydraulic conductivity,  $i$ =hydraulic gradient,  $A$ =aquifer cross-sectional area,  $T$ =transmissivity, and  $w$ =width

### References

Murray-Darling Basin Commision (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Data Assimilation

Approach in which observed data are integrated in a model simulation in a way that the information content of both data and model result are made explicit and weighted. Data assimilation is a feed back process where the model simulation is updated as a response to field observations. This is in certain domains denoted updating.

### Synonyms

Updating



## Data bank

Comprehensive set of related data files for a specific application, usually on a direct access storage device.

### Synonyms

Database

### References

International Glossary of Hydrology, UNESCO, WMO.URL: <http://www.cig.ensmp.fr/~hubert/glu/aglo.htm>.

## Data processing

Handling of raw observational data until they are in a form ready to be used for a specific purpose.

### References

International Glossary of Hydrology, UNESCO, WMO.URL: <http://www.cig.ensmp.fr/~hubert/glu/aglo.htm>.

## Data Uncertainty

Uncertainty that is caused by measurement errors, analytical imprecision and limited sample sizes during collection and treatment of data.

### Synonyms

Parameter Uncertainty

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## Database

Comprehensive set of related data files for a specific application, usually on a direct access storage device.

**Synonym of:** *Data bank*

### References

International Glossary of Hydrology, UNESCO, WMO.URL: <http://www.cig.ensmp.fr/~hubert/glu/aglo.htm>.

## Decision maker

See Manager

### Footnotes

MoST term - User type

## Degradable

That can be reduced, broken down or chemically separated.

### References

International Navigation Association (2000) Glossary of Selected Environmental Terms, Report of Working Group No. 3 of the Permanent Environmental Commission, Supplement to Bulletin No. 104.

## Degradation

Bio-chemical process of transformation of pollutants (e.g. nitrogen, phosphorus...), organic matter or bacteria.

## Design

A project that involves modelling studies for design purposes. A design study is typically preceded by a planning study, and typically puts higher requirements to model performance than the preceding planning study.

### Footnotes

MoST term - User type

## Desorption

Sorption is the process in which a compound is bound to a sorbing material. Sorption is differentiated into adsorption where the compound is bound onto the sorbing material and absorption where the compound is bound into the internal structure of the sorbing material. Desorption is the process by which the compound is released from the sorbing material. The quantity of the bound compound is dependent on the aqueous phase concentration and described by a linear or non-linear sorption isotherm. If the sorption/desorption process is fast compared to the advective velocity sorption may be assumed to be instantaneous (Local Equilibrium Assumption, LEA). Otherwise, the sorption process is kinetically controlled or a rate-limited process.

**Synonym of:** *Sorption*

## Deterministic Model

A model is said to be deterministic if it does not contain any random component, and its response due to a given input therefore is uniquely determined. The opposite to a deterministic model is a stochastic model.

## Diffuse pollution

Cause of water pollution that is not associated with point sources. Examples include (i) agriculturally related, including runoff from manure disposal areas and from land used for livestock and crop production; (ii) forest related; (iii) mine-related, including new, current, and abandoned surface and underground mine runoff; (iv) construction-activity-related sources of pollution; (v) waste disposal on land, in wells, or in subsurface excavations that affect groundwater and surface water quality; (vi) saltwater intrusion into rivers, lakes, estuaries, and groundwater; and (vii) hydrologic modifications, including those caused by changes in the movement, flow, or circulation of waters due to construction and operation of dams, levees, channels, or flow diversion facilities.

**Synonym of:** *Non-point source*

### References

Frick GW (1984) Environmental Glossary. Rockville: Government Institutes. 325 pp. (Terms extracted from "Development of Environmental Statistics", Glossary of Environmental Terms).

## Diffusion

Molecular diffusion is the movement of solutes due to concentration gradients, and described by Fick's first law. Molecular diffusion exists as long as a concentration gradient is maintained, and is especially important when flow velocities becomes low or zero. In advective dominated systems, molecular diffusion may be of only little importance, as the mechanical dispersion will be of much greater importance.

**Synonym of:** *Molecular diffusion*

### References

Freeze RA and Cherry JA (1979) Groundwater. Prentice Hall, New Jersey.

## **Direchlet condition**

A boundary condition for a groundwater model where the head is known and specified at the boundary of the flow field, and the model computes the associated groundwater flow. Also known as a Specified, Fixed, Constant Head or First Type boundary condition.

### **Synonyms**

Boundary condition - First Type Boundary: Constant Head

### **References**

Murray-Darling Basin Commision (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Discharge**

The volume of water flowing in a stream or aquifer past a specific point in a given period of time.

### **References**

Murray-Darling Basin Commision (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Discharge area**

An area where there are upward components of hydraulic head in the groundwater system resulting in the flow of water to springs, seeps or surface water bodies, or by evaporation and transpiration.

### **References**

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## **Discretisation**

Spatial distribution of a model area in model specific calculational units or temporal distribution of a simulation period in temporal steps.

## Dispersion

Mechanical dispersion is due to variations in the advective velocity at different scales. The solute particles move hereby at different velocities resulting in mixing and dilution of the solute. Dispersion occurs both in the direction of the bulk flow (longitudinal dispersion) and perpendicular to this direction (transversal dispersion). Longitudinal dispersion is most often the dominant dispersion. Dispersion is computed as the linear average velocity ( $v$ ) times a media specific constant, termed the longitudinal/transversal dispersivity

**Synonym of:** *Mechanical dispersion*

### References

Freeze RA and Cherry JA (1979) Groundwater. Prentice Hall, New Jersey.

## Domain

In MoST the description of the modelling process is decomposed into seven different domain:- groundwater (including solute transport and geochemistry)-precipitation runoff (including non-point pollution)- hydrodynamics (flows in pipes, rivers, estuaries, coastal water and associated sediment transport and morphology)- flood forecasting- surface water quality- biota (ecology)- socio-economics

### Footnotes

MoST term - Modelling domain

## Domain of Applicability (of Conceptual Model)

Prescribed conditions in space, time and types of applications, for which the conceptual model has been tested, i.e. compared with reality to the extent possible and judged suitable for use (by model confirmation).

### References

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. Advances in Water Resources, 27, 71-82.

### Footnotes

Domain of applicabilityThe limitations of the statements model confirmation, code verification and model validation in time, space, type of application etc. implies that these statements in a Popperian sense are confined to be numerically universal and not strictly universal statements (Popper, 1959).

### **Domain of Applicability (of Model Code)**

Prescribed conditions in space, time and types of applications, for which the model code has been tested, i.e. compared with analytical solutions, other model codes or similar to the extent possible and judged suitable for use (by code verification).

#### **References**

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

#### **Footnotes**

Domain of applicability The limitations of the statements model confirmation, code verification and model validation in time, space, type of application etc. implies that these statements in a Popperian sense are confined to be numerically universal and not strictly universal statements (Popper, 1959).

### **Domain of Applicability (of Model)**

Prescribed conditions in space, time and types of applications, for which the site-specific model has been tested, i.e. compared with reality to the extent possible and judged suitable for use (by model validation).

#### **References**

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

#### **Footnotes**

Domain of applicability The limitations of the statements model confirmation, code verification and model validation in time, space, type of application etc. implies that these statements in a Popperian sense are confined to be numerically universal and not strictly universal statements (Popper, 1959).

### **DPSIR**

DPSIR is a general framework for organising information about state of the environment. DPSIR is an abbreviation of - Driving forces, - Pressures, - States, - Impacts, and- Responses.

## Drainage Basin

An area of land, bounded by a divide, in which water flowing across the surface will drain into a stream or river and flow out of the area through a specified point on that stream or river. Synonymous terms are catchment and watershed. Generally a basin is defined at a regional scale whereas a catchment or a watershed can be of smaller area. The term catchment is mostly used in Europe, while watershed is a preferred term in USA.

**Synonym of:** *Basin*

## Drawdown

The lowering of the water table in an unconfined aquifer/aquitard or the potentiometric surface in a confined aquifer/aquitard due to pumping of groundwater from wells.

### References

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## Dupuit assumptions

The following assumptions for flow in an unconfined aquifer: (a) the hydraulic gradient is equal to the slope of the water table, (b) streamlines are horizontal and (c) equipotential lines are vertical.

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Dynamic Equilibrium

A condition in which the amount of recharge to a flow system equals the amount of natural discharge.

### References

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## Dynamic model

Model in which time is an independent variable.

### Synonyms

Non-stationary model; Transient model

## Ecological domain

See Biota domain

### Footnotes

MoST term - User type

## Effective Porosity

The amount of interconnected pore space through which fluids can pass, expressed as a percent of bulk volume. Part of the total porosity will be occupied by static fluid being held to the mineral surface tension, so effective porosity will be less than total porosity.

### References

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## Empirical Model

A model where the structure is derived, not from knowledge on the physical, biological or ecological processes, but from analyses of relationship among observed data.

### Synonyms

Black Box Model; Empirically-based Model

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

Refsgaard JC (1996) Terminology, modelling protocol and classification of hydrological model codes. In: Abbot MB and Refsgaard JC (Eds): Distributed Hydrological Modelling, 17-39. Kluwer Academics Publishers.

## Empirically-based Model

A model where the structure is derived, not from knowledge on the physical, biological or ecological processes, but from analyses of relationship among observed data.

**Synonym of:** *Empirical Model*

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

Refsgaard JC (1996) Terminology, modelling protocol and classification of hydrological model codes. In: Abbot MB and Refsgaard JC (Eds): Distributed Hydrological Modelling, 17-39. Kluwer Academics Publishers.



## **Equipotential Line**

A line in a two-dimensional groundwater flow field such that the total hydraulic head is the same for all points along the line.

### **References**

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## **Equipotential Surface**

A surface in a three-dimensional groundwater flow field such that the total hydraulic head is the same everywhere on the surface.

### **References**

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## **Evapotranspiration**

The combination of the processes of evaporation and transpiration.

### **References**

National Weather Forecast Service Office, NOAA, Glossary of Select Meteorological, Climatological and Hydrological Terms. URL: <http://www.crh.noaa.gov/dvn/ScienceandEducation/glossary.htm>.

## **Expert Elicitation**

A process for obtaining expert beliefs about subjective quantities and probabilities. Typically, structured interviews and/or questionnaires are used to elicit the necessary knowledge. Expert elicitation may also include “coaching” techniques to help the expert conceptualize, visualize, and quantify the knowledge being sought

### **References**

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## Extreme-condition tests

The model structure and output should be plausible for extreme or unlikely combinations of factors in the system.

### References

Rykiel, E.J. (1996) Testing ecological models: the meaning of validation. *Ecological Modelling*, 90, 229-244.

### Footnotes

Taken from the cited reference.

## False Negative

Also known as false acceptance decision errors. False negatives occur when the null hypothesis or baseline condition cannot be rejected based on the available sample data. The decision is made assuming the baseline condition is true when in reality it is false.

### Synonyms

Type 2 Error

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## False Positive

Also known as false rejection decision errors. False positives occur when the null-hypothesis or baseline condition is incorrectly rejected based on the sample data. The decision is made assuming the alternate condition or hypothesis to be true when in reality it is false.

### Synonyms

Type 1 Error

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## Finite difference method

Method to solve (partial) differential equations using structured grids, in which Taylor expansion series are used to approximate derivatives.

## **Finite element method**

Method to solve (partial) differential equations using unstructured grids, in which shape functions are used to approximate derivatives.

## **Flood forecasting domain**

The flood forecasting modelling domain comprises all modelling activities related to operational, real-time forecasting of floods in rivers and coastal waters. The flood forecasting domain in MoST is applicable to the 'river', 'transitional water' and 'coastal water' as these terms are defined in the Water Framework Directive.

### **Footnotes**

MoST term - Modelling domain

## **Flux**

The volumetric flow rate per unit area through which flow occurs. See also Discharge.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Fractured rock aquifer**

Occur in igneous, metamorphic and sedimentary rocks that have been subjected to disturbance, deformation or weathering, and which allow water to move through joints, bedding planes and faults. Typically, fractured rock aquifers contain much less available water than unconsolidated and consolidated sedimentary aquifers.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## General public

The public is composed of partners that are not directly involved (as modeller, manager or auditor) in a modelling study but that have a legitimate interest in the modelling results. The public may typically be either interest groups/stakeholders or the general public.

**Synonym of:** *Public*

### Footnotes

MoST term - User type

## Generic

When a modelling project in MoST is composed of more than one domain it is denoted as a multi-domain project

### Footnotes

MoST term - Modelling domain

## Ghyben-Herzberg principle

An equation that relates the depth of a saline interface in a coastal aquifer to the height of the freshwater table.

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Goodness of fit criterion

See objective function.

## Grid

To solve a model consisting of (partial) differential equations in order to apply it in a specific area, one needs a spatial schematisation (discretisation). This schematisation is called a grid (or, sometimes mesh, raster or network). A grid has to be seen as a set of grid points spanning up a set of grid cells.

### Synonyms

Mesh; Raster; Network

## **Groundwater**

The water present in interconnected pores located below the water table.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Groundwater divide**

The boundary between two adjacent groundwater basins. The divide is represented by a high in the water table surface.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Groundwater domain**

The groundwater modelling domain comprises modelling activities related to groundwater, i.e.:- Groundwater flow (heads and flows)- Solute transport (advection, diffusion and hydrodynamic dispersion)- Geochemistry (ad/absorption, ion exchange, complexation, degradation, etc.)The groundwater domain in MoST corresponds to the term 'groundwater' as this term is defined in the Water Framework Directive.

### **Footnotes**

MoST term - Modelling domain

## **Groundwater flow model**

The application of a mathematical model to represent a site-specific groundwater flow system.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Heterogeneous**

The condition under which one or more hydraulic properties of the groundwater flow system vary spatially.

### **References**

Freeze RA and Cherry JA (1979) Groundwater. Prentice Hall, New Jersey.

## **Homogeneous**

The condition under which the hydraulic properties of the groundwater flow system are independent of the position within the geological formation.

### **References**

Freeze RA and Cherry JA (1979) Groundwater. Prentice Hall, New Jersey.

## **Hydraulic conductance**

A term that incorporates model geometry and hydraulic conductivity into a single value for simplification purposes. It controls the flow rate to or from a given model cell, river reach, etc.

### **References**

Murray-Darling Basin Commision (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Hydraulic conductivity**

A coefficient of proportionality that describes the rate at which water can move through a permeable medium. It is dependent upon properties of both the fluid (viscosity and density) and the medium.

### **References**

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## **Hydraulic diffusivity**

A property of an aquifer or confining layer defined as the ration of the transmissivity to the storativity or alternatively as the ratio of the hydraulic conductivity to the specific storage.

### **References**

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## Hydraulic dispersion

Mechanical dispersion is due to variations in the advective velocity at different scales. The solute particles move hereby at different velocities resulting in mixing and dilution of the solute. Dispersion occurs both in the direction of the bulk flow (longitudinal dispersion) and perpendicular to this direction (transversal dispersion). Longitudinal dispersion is most often the dominant dispersion. Dispersion is computed as the linear average velocity ( $v$ ) times a media specific constant, termed the longitudinal/transversal dispersivity

**Synonym of:** *Mechanical dispersion*

### References

Freeze RA and Cherry JA (1979) Groundwater. Prentice Hall, New Jersey.

## Hydraulic gradient

The change in total head with a change in distance in a given direction. The direction is that which yields a maximum rate of decrease in head. See also Energy gradient.

### References

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## Hydrodynamic dispersion

The process of mechanical mixing during fluid advection and molecular diffusion. It causes a spread and dilution of the solute.

### References

Freeze RA and Cherry JA (1979) Groundwater. Prentice Hall, New Jersey.

## Hydrodynamic domain

The hydrodynamic modelling domain comprises flows of water, sediment transport and morphological aspects in all surface water elements such as:- Water supply systems- Sewer drainage systems- River systems including flood plain, lakes and reservoirs- Estuaries and coastal waters The hydrodynamic domain in MoST corresponds to the water flow and sediment aspects in 'river' 'lake' 'transitional water' and 'coastal water' as these terms are defined in the Water Framework Directive.

### Footnotes

MoST term - Modelling domain

## Hydrograph

A graph that shows some property of groundwater or surface water as a function of time.

### References

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## Hydrological Basin

An area of land, bounded by a divide, in which water flowing across the surface will drain into a stream or river and flow out of the area through a specified point on that stream or river. Synonymous terms are catchment and watershed. Generally a basin is defined at a regional scale whereas a catchment or a watershed can be of smaller area. The term catchment is mostly used in Europe, while watershed is a preferred term in USA.

**Synonym of:** *Basin*

## Hydrostratigraphic unit

A formation, part of a formation or group of formations possessing similar hydrologic characteristics allowing for grouping into aquifers or confining layers.

### References

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## Infiltration

Movement of water through the soil surface into the soil. The infiltration rate is a function of surface wetness, soil texture, surface residue cover, irrigation application or precipitation rate, surface topography and other factors.

### References

NOAA Glossary (Jetstream Online Weather School) URL:

[http://www.srh.weather.gov/jetstream/append/glossary\\_a.htm](http://www.srh.weather.gov/jetstream/append/glossary_a.htm)

## Input variable

A quantity that varies in time. Variables may be divided into state variables (or internal variables), input variables and output variables.

**Synonym of:** *Variable*



## **Integrated model**

Model that includes several domains, e.g. groundwater-surface water or hydrodynamic-water quality.

## **Integrated model, fully coupled**

Model that includes several domains with full couplings, so that feedback between domains is accounted for within each time step, typically in an iterative scheme.

## **Integrated model, uncoupled**

Model that includes several domains with a forward coupling, so that output of one domain is used as input to another domain without any feedback.

### **Synonyms**

Chained model

## **Interflow**

The lateral movement of water in the unsaturated zone during and immediately after a precipitation event. The water moving as interflow discharges directly into a stream or lake.

### **References**

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

### **Footnotes**

Interflow Different from use in Precipitation-Runoff domain modelling domain.

## **Intermediate job complexity**

A project is characterised as having an intermediate job complexity when relatively moderate efforts and resources are required to carry out the modelling study. The HarmoniQuA guidelines for intermediate job complexity is the medium version of the guidelines, as it includes more tasks and activities than the 'basic' category, but less than the 'comprehensive' category.

### **Footnotes**

MoST term - User type

## Inverse modelling

Parameter values are often optimised through inverse modelling. This is also denoted as automatic calibration (Duan et al, 1994; Hill, 1998; Doherty, 2003). An optimal parameter set is sought "automatically" by minimising an objective function, often defined as the summed squared deviation between the calibration targets (field data) and their simulated counterparts.

### Synonyms

Automatic calibration

### References

Doherty J (2003) Ground water model calibration using pilot points and regularization. *Ground Water*, 41(2), 170-177. (See also <http://www.sspa.com/pest> for further information/download of PEST)

Duan Q, Sorooshian S and Gupta VK (1994) Optimal use of the SCE-UA global optimization method for calibrating watershed models. *Journal of Hydrology* 158, 265–284.

## Isotropy

The condition under which hydraulic properties of the aquifer are equal in all directions.

### References

Fetter CW (1980) *Applied Hydrogeology*. Merrill Publishing Co.

## Journal

A record of which activities have been carried out and which decisions have been made in a specific project.

**Synonym of:** *Model Journal*

### Footnotes

MoST term - User type

## Karst

The type of geologic terrain underlain by carbonate rocks where significant solution of the rock has occurred due to flowing groundwater. Karst terrain is frequently characterised by sinkholes, caves and underground drainage.

### References

Murray-Darling Basin Commission (2000) *Groundwater Flow Modelling Guideline*. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Leakance

Controls vertical flow in a model between cells in adjacent layers. Equivalent to the effective vertical hydraulic conductivity divided by the vertical distance between layer midpoints.

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Leaky confining layer

A low-permeability layer that can transmit water at sufficient rates to provide some recharge to a well pumping from an underlying aquifer. Also called an aquitard.

### References

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## Local groundwater system

Aquifers which respond rapidly to recharge due to a shallow water table elevation and/or close proximity to recharge and discharge areas. These types of flow systems occur almost exclusively in unconfined aquifers.

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Manager

A water manager is the person or organisation responsible for the management or protection of the water resource, and thus of the modelling study and its outcome (the problem owner). The water manager is the counterpart of the modeller. If the water manager and the modeller belong to different organisations their roles will typically be denoted client and consultant, respectively

**Synonym of:** *Water Manager*

### Footnotes

MoST term - User type

## **Mass balance**

Balance of material flows, see balance.

## **Measurement Error**

Errors in the observed data that are a function of human or instrumental errors during collection.

### **Synonyms**

Observation Error

### **References**

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## **Mechanical dispersion**

Mechanical dispersion is due to variations in the advective velocity at different scales. The solute particles move hereby at different velocities resulting in mixing and dilution of the solute. Dispersion occurs both in the direction of the bulk flow (longitudinal dispersion) and perpendicular to this direction (transversal dispersion). Longitudinal dispersion is most often the dominant dispersion. Dispersion is computed as the linear average velocity ( $v$ ) times a media specific constant, termed the longitudinal/transversal dispersivity

### **Synonyms**

Hydraulic dispersion; Dispersion

### **References**

Freeze RA and Cherry JA (1979) Groundwater. Prentice Hall, New Jersey.

## Mechanistic Model

A model that has a structure that explicitly represents an understanding of physical, chemical, biological and/or ecological processes. Mechanistic models quantitatively describe the relationship between phenomenon and underlying principles of cause., often through partial differential equations.

### Synonyms

Physically-based Model

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

Refsgaard JC (1996) Terminology, modelling protocol and classification of hydrological model codes. In: Abbot MB and Refsgaard JC (Eds): Distributed Hydrological Modelling, 17-39. Kluwer Academics Publishers.

## Mesh

To solve a model consisting of (partial) differential equations in order to apply it in a specific area, one needs a spatial schematisation (discretisation). This schematisation is called a grid (or, sometimes mesh, raster or network). A grid has to be seen as a set of grid points spanning up a set of grid cells.

**Synonym of:** *Grid*

## Method

A description of a methodology for carrying out an activity, possibly with links to supporting tools.

### Footnotes

MoST term

## **Model**

A site-specific model established for a particular study area, including input data and parameter values.

### **References**

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

### **Footnotes**

Model code versus model Many authors and many guidelines use the term model both in the meaning of a model code and as a site-specific model.

## **Model Archive**

A set of model journals

### **Footnotes**

MoST term - User type

## **Model Calibration**

The procedure of adjustment of model parameter values to reproduce the response of reality within the range of accuracy specified in the performance criteria.

### **Synonyms**

Calibration

### **References**

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

## Model Code

A mathematical formulation in the form of a computer program that is so generic that it, without program changes, can be used to establish a model with the same basic type of equations (but allowing different input variables and parameter values) for different study areas.

### Synonyms

Code; Computer Program; Software Package

### References

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

### Footnotes

Model code versus model Many authors and many guidelines use the term model both in the meaning of a model code and as a site-specific model.

## Model Comparison

The output of one model can be compared to that of another model.

**Synonym of:** *Comparison to other models*

### References

Rykiel, E.J. (1996) Testing ecological models: the meaning of validation. *Ecological Modelling*, 90, 229-244.

### Footnotes

Taken from the cited reference.

## Model Confirmation

Determination of adequacy of the conceptual model to provide an acceptable level of agreement for the domain of intended application. This is in other words the scientific confirmation of the theories/hypotheses included in the conceptual model.

### Synonyms

Confirmation

### References

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

## Model Construction

Establishment of a site-specific model using a model code. This requires, among other things, the definition of boundary and initial conditions and parameter assessment from field and laboratory data.

**Synonym of:** *Model Set-up*

### References

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

## Model Error

Difference between observed and simulated variables; can be cumulative, absolute, quadratic, etc.

## Model Journal

A record of which activities have been carried out and which decisions have been made in a specific project.

### Synonyms

Journal

### Footnotes

MoST term - User type

## Model Pedigree

A qualitative or quantitative determination of the rigor with which a model has been developed and evaluated. In some cases, a model's pedigree may be represented as a quantitative score that reflects the quality of a model's development and evaluation. Model pedigree is concerned with the source of data used in model development, the conceptual model, the model code, and the extent of performed model validation tests.

### Synonyms

Pedigree

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.



## **Model Set-up**

Establishment of a site-specific model using a model code. This requires, among other things, the definition of boundary and initial conditions and parameter assessment from field and laboratory data.

### **Synonyms**

Model Construction

### **References**

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

## **Model Study Plan**

A document that describes the structure and elements of a modelling study. It should contain information on project background and problem, data availability, objectives and expected outputs of modelling job, scope of work (methodologies and activities), expected accuracy of model performance, time schedule, resources allocated, reporting requirements and management procedures.

## Model Validation

Substantiation that a model within its domain of applicability possesses a satisfactory range of accuracy consistent with the intended application of the model.

### Synonyms

Validation

### References

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

### Footnotes

Validation versus verification  
The terms validation and verification are controversial in the scientific community, because there is no consensus on the fundamental question concerning whether a water resources model can be validated or verified, and whether it as such can be claimed to be suitable or valid for particular applications. Examples of such discussion is given in Hassanizadeh and Carrera (1992) Konikow and Bredehoeft (1992) De Marsily et al. (1992) Oreskes et al. (1994). An overview is provided by Refsgaard and Henriksen (2002). All existing guidelines use either the term validation and/or the term verification. However, the two terms are used with different, and some times interchangeable, meaning in different guidelines. Almost all guidelines use the term verification about demonstration of the adequacy of the numerical algorithms of the computer code. The term dealing with the adequacy of the site-specific model is denoted validation in guidelines from The Netherlands (Van Waveren et al., 2000)

## Modeller

A specialist who undertakes the technical modelling activity. A modeller should have expert knowledge of both the issue and the sound model modelling approaches. The modeller should present and interpret the model outputs to the water manager and to the stakeholders. The modeller is the counterpart of the water manager. If the modeller and the water manager belong to different organisations their roles will typically be denoted consultant and client, respectively.

### Synonyms

Consultant

### Footnotes

MoST term - User type

## Modelling Process

All steps that have to be or can be passed in the establishment and application of models.

## **Molecular diffusion**

Molecular diffusion is the movement of solutes due to concentration gradients, and described by Fick's first law. Molecular diffusion exists as long as a concentration gradient is maintained, and is especially important when flow velocities becomes low or zero. In advective dominated systems, molecular diffusion may be of only little importance, as the mechanical dispersion will be of much greater importance.

### **Synonyms**

Diffusion

### **References**

Freeze RA and Cherry JA (1979) Groundwater. Prentice Hall, New Jersey.

## **Monitoring**

Periodic or continuous sampling to determine the status of an environmental variable or parameter.

### **Footnotes**

Adapted

## **Monte-Carlo simulation**

A problem solving technique used to approximate the probability of certain outcomes by running multiple trial runs, called simulations, using random variables

## **Multi-domain**

When a modelling project in MoST is composed of more than one domain it is denoted as a multi-domain project

### **Footnotes**

MoST term - Modelling domain

## Network

To solve a model consisting of (partial) differential equations in order to apply it in a specific area, one needs a spatial schematisation (discretisation). This schematisation is called a grid (or, sometimes mesh, raster or network). A grid has to be seen as a set of grid points spanning up a set of grid cells.

**Synonym of:** *Grid*

## Neumann condition

The boundary condition for a groundwater model where the flux across the boundary of the flow region is known and specified, and the model computes the associated aquifer head. Also known as a Constant Flux or Second Type boundary condition.

### Synonyms

Boundary condition - Second Type Boundary: Specified Flow

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Non-point pollution

Cause of water pollution that is not associated with point sources. Examples include (i) agriculturally related, including runoff from manure disposal areas and from land used for livestock and crop production; (ii) forest related; (iii) mine-related, including new, current, and abandoned surface and underground mine runoff; (iv) construction-activity-related sources of pollution; (v) waste disposal on land, in wells, or in subsurface excavations that affect groundwater and surface water quality; (vi) saltwater intrusion into rivers, lakes, estuaries, and groundwater; and (vii) hydrologic modifications, including those caused by changes in the movement, flow, or circulation of waters due to construction and operation of dams, levees, channels, or flow diversion facilities.

**Synonym of:** *Non-point source*

### References

Frick GW (1984) Environmental Glossary. Rockville: Government Institutes. 325 pp. (Terms extracted from "Development of Environmental Statistics", Glossary of Environmental Terms).

## Non-point source

Cause of water pollution that is not associated with point sources. Examples include (i) agriculturally related, including runoff from manure disposal areas and from land used for livestock and crop production; (ii) forest related; (iii) mine-related, including new, current, and abandoned surface and underground mine runoff; (iv) construction-activity-related sources of pollution; (v) waste disposal on land, in wells, or in subsurface excavations that affect groundwater and surface water quality; (vi) saltwater intrusion into rivers, lakes, estuaries, and groundwater; and (vii) hydrologic modifications, including those caused by changes in the movement, flow, or circulation of waters due to construction and operation of dams, levees, channels, or flow diversion facilities.

### Synonyms

Diffuse pollution; Non-point pollution

### References

Frick GW (1984) Environmental Glossary. Rockville: Government Institutes. 325 pp. (Terms extracted from "Development of Environmental Statistics", Glossary of Environmental Terms).

## Non-stationary model

Model in which time is an independent variable.

Synonym of: *Dynamic model*

## Non-uniqueness

The principle that different sets of model parameter values can produce nearly identical model results.

## Nutrient

A substance, element or compound, organic or inorganic, necessary for the growth and development of plants and animals. Carbon, oxygen, nitrogen, potassium and phosphorus are important examples of nutrients needed by living things.

### Footnotes

Adapted

## Objective function

A function to quantify the deviations between model variables and observations. Also sometimes denoted cost function.

## Observation

A measurement of a variable in reality.

## Observation Error

Errors in the observed data that are a function of human or instrumental errors during collection.

**Synonym of:** *Measurement Error*

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## Observation well

A non-pumping well used to observe the elevation of the water table or the potentiometric surface. An observation wells is generally of larger diameter than a piezometer and typically screened or slotted throughout the entire thickness of the aquifer.

### References

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## Operational management

A project that involves real-time operation, e.g. flood forecasting.

### Footnotes

MoST term - User type

## Optimisation

Numerical procedure which is concerned with finding the maxima and minima of functions, possibly subject to constraints. This term is used in different contexts, e.g.- optimisation of parameter values in calibration- optimisation of objective functions in economic analysis (e.g. cost-effectiveness of alternative measures, least cost strategies, maximisation of the benefit-cost ratio)

## Output variable

A quantity that varies in time. Variables may be divided into state variables (or internal variables), input variables and output variables.

Synonym of: *Variable*

## Parameter

A quantity that is assumed constant in time. A parameter is most often a representation of a physical, chemical or ecological characteristic of reality.

## Parameter Uncertainty

Uncertainty that is caused by measurement errors, analytical imprecision and limited sample sizes during collection and treatment of data.

Synonym of: *Data Uncertainty*

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## Parameterisation

Activities to transform system characteristics into model parameters. This includes to determine the spatial patterns of the parameter values so that a given parameter only reflects the significant and systematic variation described in the available field data, as exemplified by using representative values for individual soil types, vegetation classes, or geological layers. An important aim in the parameterisation process is to limit the number of free parameters to be assessed in model calibration.

## Parsimony

The parsimony principle implies that a conceptual model has been simplified as much as possible, yet it retains enough complexity so that it adequately represents the physical system and its behaviour.

## Partial Differential Equation

Differential equations with more than one independent variable.

## **Pedigree**

A qualitative or quantitative determination of the rigor with which a model has been developed and evaluated. In some cases, a model's pedigree may be represented as a quantitative score that reflects the quality of a model's development and evaluation. Model pedigree is concerned with the source of data used in model development, the conceptual model, the model code, and the extent of performed model validation tests.

**Synonym of:** *Model Pedigree*

### **References**

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## **Percolation**

The flow of water downward from the landsurface into a certain geological layer.

## **Performance Criteria**

Level of acceptable agreement between model and reality. The performance criteria apply both for model calibration and model validation. The performance criteria are usually formulated so that a number of objective functions have to be better than specified numerical values.

### **References**

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

## **Permeable strata**

Layers of rock or sediment through which water can flow.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.



## Pesticide

Any substance used to control pests ranging from rats, weeds, and insects to algae and fungi.  
Pesticides can accumulate in the food chain and contaminate the environment if misused.

### References

International Navigation Association (2000) Glossary of Selected Environmental Terms, Report of Working Group No. 3 of the Permanent Environmental Commission, Supplement to Bulletin No. 104.

## Physically-based Model

A model that has a structure that explicitly represents an understanding of physical, chemical, biological and/or ecological processes. Mechanistic models quantitatively describe the relationship between phenomenon and underlying principles of cause., often through partial differential equations.

**Synonym of:** *Mechanistic Model*

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.  
Refsgaard JC (1996) Terminology, modelling protocol and classification of hydrological model codes. In: Abbot MB and Refsgaard JC (Eds): Distributed Hydrological Modelling, 17-39. Kluwer Academics Publishers.

## Piezometer

A non-pumping well, generally of small diameter, which is used to measure the elevation of the water table or the potentiometric surface. A piezometer generally has a short well screen through which water can enter.

### References

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## Planning

A project that involves modelling studies as part of a planning process

### Footnotes

MoST term - User type

## **Point source**

A stationary location where pollutants are discharged, usually from an industry. Any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock,

### **References**

Frick GW (1984) Environmental Glossary. Rockville: Government Institutes. 325 pp. (Terms extracted from "Development of Environmental Statistics", Glossary of Environmental Terms).

## **Pollutant**

A contaminant at a concentration high enough to endanger the environment or the public health.

### **References**

International Navigation Association (2000) Glossary of Selected Environmental Terms, Report of Working Group No. 3 of the Permanent Environmental Commission, Supplement to Bulletin No. 104.

## **Porosity**

The ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment.

### **References**

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## **Porosity – effective**

The volume of the inter-connected void spaces through which water or other fluids can travel in a rock or sediment divided by the total volume of the rock or sediment.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Porosity – primary**

The porosity that represents the original pore openings when the rock or sediments formed.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Porosity – secondary**

The porosity that has been caused by fracturing or weathering in a rock or sediment after it has been formed.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Post audit**

Comparison of model predictions with what actually happened.

## **Potentiometric surface**

A surface that represents the level to which water will rise in a tightly cased well. The water table is a particular potentiometric surface of an unconfined well.

### **References**

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## **Precipitation-runoff domain**

The precipitation-runoff domain comprises modelling activities related to precipitation-runoff processes, i.e.:- Flow processes (precipitation, evapotranspiration, runoff etc., typically at catchment scale)- Non-point pollution (e.g. nitrate, pesticides originating from agricultural practise)The precipitation-runoff domain in MoST corresponds more or less to the term 'surface water' related to 'river basin' as these terms are defined in the Water Framework Directive.

### **Footnotes**

MoST term - Modelling domain

## **Precision**

The quality of being reproducible in amount of performance. With models and other forms of quantitative information, precision refers specifically to the number of decimal places to which a number is computed as a measure of the "preciseness" or "exactness" with which a number is computed.

### **References**

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## **Problem definition**

A clear, precise (not necessarily quantitative) specification of what is known on the problem and what has to be computed.

## **Programmer**

A person that develops or adapts model code.

## **Project**

A model study.

### **Footnotes**

MoST term - User type

## **Public**

The public is composed of partners that are not directly involved (as modeller, manager or auditor) in a modelling study but that have a legitimate interest in the modelling results. The public may typically be either interest groups/stakeholders or the general public.

### **Synonyms**

General public

### **Footnotes**

MoST term - User type

## **Pumping test**

A test made by pumping a well for a period of time and observing the change in hydraulic head in the aquifer or adjacent aquitard(s). A pumping test may be used to determine the capacity of a well and the hydraulic properties of the aquifer and adjacent aquitard(s).

### **References**

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## Quality Assurance

Quality assurance (QA) is the procedural and operational framework used by an organisation managing the modelling study to build consensus among the organisations concerned in its implementation, to assure technically and scientifically adequate execution of all tasks included in the study, and to assure that all modelling-based analysis is reproducible and justifiable

## Quality Control

Part of quality management focussing on fulfilling quality requirements

### References

EN ISO 9000:2000 E, Quality management systems - fundamentals and vocabulary. European Committee for Standardization, ICS 00.004.03.

## Quality Management

Co-ordinated activities to direct and control an organisation (e.g. a project) with respect to quality of work.

### References

EN ISO 9000:2000 E, Quality management systems - fundamentals and vocabulary. European Committee for Standardization, ICS 00.004.03.

## Quality Requirements

Need or expectations to quality of work that is stated, generally implied or obligatory.

### References

EN ISO 9000:2000 E, Quality management systems - fundamentals and vocabulary. European Committee for Standardization, ICS 00.004.03.

## Raster

To solve a model consisting of (partial) differential equations in order to apply it in a specific area, one needs a spatial schematisation (discretisation). This schematisation is called a grid (or, sometimes mesh, raster or network). A grid has to be seen as a set of grid points spanning up a set of grid cells.

**Synonym of:** *Grid*

## **Reality**

The natural system, understood here as the study area.

### **References**

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

## **Recharge**

The process which replenishes groundwater, usually by rainfall infiltrating from the ground surface to the water table and/or by surface water entering the water table or exposed aquifers. The addition of water to an aquifer.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Regional groundwater system**

Extensive aquifer which take longer than local and intermediate systems to respond to increased groundwater recharge because their recharge and discharge areas are separated by large distances, and/or they have a deep water table. Unconfined aquifers with deep water tables that are part of regional flow systems may become, in effect, local or intermediate flow systems if there is sufficient recharge to cause the water table to rise close to the surface.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Reliability**

The confidence that (potential) users have in a model and in the information derived from the model such that they are willing to use the model and the derived information.

### **References**

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## Residual

Deviation between the model prediction and the field measurement. Residuals form the basis for establishment of objective functions.

## Reviewer

A person that is conducting some kind of review of a modelling study. The review may be more or less comprehensive depending on the requirements of the particular case. The auditor is typically appointed by the water manager to support the water manager to match the modelling capability of the modeller. The auditor may belong to the water manager's organisation or to an independent organisation. The task of the auditor should be distinguished from internal reviews which the modeller's organisation often carry out as part of its internal quality assurance procedure. The reviews performed by the auditor are done over and above any internal reviews that the modeller may carry out.

**Synonym of:** *Auditor*

### Footnotes

MoST term - User type

## River basin management

The river basin planning process is followed by implementation of the programme of measures. The planning process together with the implementation of the programme is often referred to as river basin management

### References

<http://forum.europa.eu.int/Public/irc/env/wfd/library>

European Communities (2003) Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance Document No 11, Planning Process.

## River basin planning

The process of collecting and analysing river basin data and evaluating management measures in order to achieve the objectives of the Water Framework Directive within prescribed timescales

### References

<http://forum.europa.eu.int/Public/irc/env/wfd/library>

European Communities (2003) Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance Document No 11, Planning Process.

## **Rock - igneous**

A rock formed by the cooling and crystallisation of a molten rock mass called magma.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Rock - metamorphic**

A rock formed by the application of relatively high heat and pressure to existing rocks or sediments.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Rock - sedimentary**

A layered rock formed from the consolidation of sediments. These include clastic rocks (such as sandstone), rocks formed by chemical precipitation in water (such as some limestones), or rocks formed from organic material (such as coal).

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Rock - volcanic**

An igneous rock that forms when molten rock called lava cools on the earth's surface.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Salinity**

The concentration of sodium chloride or dissolved salts in water, usually expressed in EC units or milligrams of total dissolved solids per liter (mg/L TDS).

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.



## Saltwater intrusion

A movement of salt water inland through soils into freshwater aquifers.

### References

Glossary from unknown source A.

## Saturated zone

The zone in which voids in rock or soil are filled with water at a pressure greater than atmospheric.

The water table defines the top of the saturated zone in unconfined aquifers.

### References

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## Scaling

Upscaling means that the process equations and the associated parameter values that constitute a model in principle are modified or substituted when moving the scale of interest from smaller scale to the larger scale.

**Synonym of:** *Upscaling*

## Schematisation

Simplified representation of the spatial and/or temporal distribution of variables and parameters. See also grid.

## Sedimentary aquifer

Aquifers comprised of consolidated and unconsolidated sediments such as sands or sandstones, in which water is stored in the intergranular pores, and limestone, in which water is stored in solution cavities and joints.

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Seepage velocity**

The actual rate of movement of fluid particles in permeable medium. Also known as the pore water velocity

### **References**

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## **Sensitivity**

The degree to which the model outputs are affected by changes in selected model input.

## **Sensitivity Analysis**

Analysis of the sensitivity of the model results to changes in parameter values or other assumptions (e.g. input data). In a sensitivity analysis the various sources of uncertainty are analysed individually.

## **Set-up**

See model set-up.

## **Simulation**

Use of a validated model to gain insight into reality and obtain predictions that can be used by water managers. This includes insight into how reality can be expected to respond to human interventions.

### **References**

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

## **Socio-economic domain**

The socio-economic modelling domain comprises all modelling activities related to human interventions and evaluations. The model elements include the driving socio-economic factors and impacts of water use, the costs and benefits of water management, the socio-economic optimisation procedures, and the water policies.

## **Footnotes**

MoST term - Modelling domain

## Software Package

A mathematical formulation in the form of a computer program that is so generic that it, without program changes, can be used to establish a model with the same basic type of equations (but allowing different input variables and parameter values) for different study areas.

**Synonym of:** *Model Code*

### References

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

### Footnotes

Model code versus model Many authors and many guidelines use the term model both in the meaning of a model code and as a site-specific model.

## Solute

A substance dissolved in a solution. Salts are the solute in saltwater.

### Footnotes

Adapted

## Solute transport

Migration of dissolved pollutants by convective and/or diffusive-dispersive processes

### Synonyms

Transport

## Solution

This word may have different meanings: 1. A state in which a solute is homogeneously mixed with a liquid solvent. Water is the solvent for the solution that is ocean water. 2. Solution of a problem

### References

Modified from glossary from unknown source B.

## Sorption

Sorption is the process in which a compound is bound to a sorbing material. Sorption is differentiated into adsorption where the compound is bound onto the sorbing material and absorption where the compound is bound into the internal structure of the sorbing material. Desorption is the process by which the compound is released from the sorbing material. The quantity of the bound compound is dependent on the aqueous phase concentration and described by a linear or non-linear sorption isotherm. If the sorption/desorption process is fast compared to the advective velocity sorption may be assumed to be instantaneous (Local Equilibrium Assumption, LEA). Otherwise, the sorption process is kinetically controlled or a rate-limited process.

### Synonyms

Adsorption; Absorption; Desorption

## Specific capacity

An expression of the productivity of a well, obtained by dividing the rate of discharge of water from the well by the drawdown of water in the well. Specific capacity should be described on the basis of the number of hours of pumping prior to the time the drawdown measurement is made.

### References

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## Specific discharge

An apparent velocity calculated from Darcy's law as the volumetric flow rate divided by the cross-sectional area over which the flux occur. It represents the flow rate at which water would flow in an aquifer if the aquifer was an open conduit. The velocity ( $v_f$ ) is thus an imaginary velocity, because it assumes that the flow takes place over the entire cross-sectional area and not only in the voids  $v_f = Q/A = -K_i$  where  $Q$  is the flow rate  $A$  the cross sectional area, and  $i$  the hydraulic gradient

### Synonyms

Darcy velocity

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Specific retention**

The ratio of the volume of water that the rock or sediment will retain against the pull of gravity to the total volume of the rock or sediment.

### **References**

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## **Specific storage**

The volume of water released from or taken into storage per unit volume of a permeable medium per unit change in head.

### **References**

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## **Specific yield**

The ratio of the volume of water that a permeable medium will yield by gravity drainage to the volume of the permeable medium.

### **References**

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## **Stability**

Property of a numerical method for which the solution errors converge to a finite limit as the number of time steps or iterations goes to infinity.

## **Stakeholder**

The interested parties, i.e. those with a stake in the water management issue, either their interest is in exploiting or protecting the resource. Stakeholders include the following different groups: (i) competent water resource authority; (ii) interest groups; and (iii) general public. The water manager typically belongs to one of the first two groups.

### **Footnotes**

MoST term - User type

## State variable

A quantity that varies in time. Variables may be divided into state variables (or internal variables), input variables and output variables.

Synonym of: *Variable*

## Stationary model

A model that is not dynamic, i.e. a model where everything is considered stationary in time.

### Synonyms

Steady-state model

## Statistical Model

A model based on statistical techniques, such as probabilistic laws or regression equations.

## Steady-state model

A model that is not dynamic, i.e. a model where everything is considered stationary in time.

Synonym of: *Stationary model*

## Step

MoST decomposes the modelling process into five major steps and 48 tasks. The five steps are: 1. Model Study Plan 2. Data and Conceptualisation 3. Model Set-up 4. Calibration and Validation 5. Simulation and Evaluation

### Footnotes

MoST term

## Stochastic Model

A model that includes variability in model parameters and variables. The solutions obtained by the model is therefore a function of both the deterministic input and model structure and the random variability.

## Stochasticity

Fluctuations in physical, chemical, biological and ecological processes that are due to natural variability and inherent randomness

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## Storage

This word is used in different contexts with different meanings: 1. Impounding of water in surface or underground reservoirs, for future use. 2. Volume of water stored. 3. Data stored

## Storage coefficient (storativity)

The volume of water released or taken into storage per unit surface area of the permeable medium per unit change in head. It is equal to the product of the specific storage and saturated thickness. In an unconfined aquifer, the storativity is equal to the the specific yield.

### References

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## Streamline

A line (commonly transverse to groundwater level contours) that represents the flow path for a particle of water.

### References

Murray-Darling Basin Commision (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Surface water quality domain

The surface water quality modelling domain comprises water quality processes in all surface water elements such as:- River systems including flood plain, lakes and reservoirs- Estuaries and coastal waters  
The surface water quality domain in MoST corresponds to the water quality aspects in 'river' 'lake' 'transitional water' and 'coastal water' as these terms are defined in the Water Framework Directive.

### Footnotes

MoST term - Modelling domain

## **Task**

Action to perform with a clear purpose, e.g. defining objectives or model calibration. A task belongs to a step. A task consists of one or more activities. Tasks can be the responsibility of one or more roles (water manager, modeller, auditor, stakeholder, public). There are 3 types of tasks in MoST: - (normal) task: task without a decision - decision task: an authorized team member should decide whether to continue in the process or to re-do one or more tasks - review task: a decision task in which team members with different roles have to discuss what is done in the step and how to continue in the next step

### **Footnotes**

MoST term

## **Theis equation**

An equation describing the unsteady flow of groundwater in a fully confined aquifer in response to pumping.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Time series**

Temporal sequence of consecutive data.

## **Time step (of a given model)**

Unit interval of time used by discrete model for time series simulations.

## **Total dissolved solids**

A measure of the salinity of water, usually expressed in milligrams per litre (mg/L).

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.



## Traces

The behaviour of specific variables is traced through the model and through simulations to determine if the behaviour is correct and if necessary accuracy is obtained.

### References

Rykiel, E.J. (1996) Testing ecological models: the meaning of validation. *Ecological Modelling*, 90, 229-244.

### Footnotes

Taken from the cited reference.

## Transient model

Model in which time is an independent variable.

**Synonym of:** *Dynamic model*

## Transmissivity

The rate at which water at a prevailing density and viscosity is transmitted through a unit width of an aquifer or confining unit under a unit hydraulic gradient. It is a function of the properties of the media, fluid and thickness of the media.

### References

Fetter CW (1980) *Applied Hydrogeology*. Merril Publishing Co.

## Transport

Migration of dissolved pollutants by convective and/or diffusive-dispersive processes

**Synonym of:** *Solute transport*

## Turing tests

Knowledgeable individuals are asked if they can discriminate between system and model outputs.

### References

Rykiel, E.J. (1996) Testing ecological models: the meaning of validation. *Ecological Modelling*, 90, 229-244.

### Footnotes

Taken from the cited reference.

## Turtosity

The actual length of a groundwater flow path, which is sinuous in form, divided by the straight-line distance between the ends of the flow path.

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Type 1 Error

Also known as false rejection decision errors. False positives occur when the null-hypothesis or baseline condition is incorrectly rejected based on the sample data. The decision is made assuming the alternate condition or hypothesis to be true when in reality it is false.

**Synonym of:** *False Positive*

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## Type 2 Error

Also known as false acceptance decision errors. False negatives occur when the null hypothesis or baseline condition cannot be rejected based on the available sample data. The decision is made assuming the baseline condition is true when in reality it is false.

**Synonym of:** *False Negative*

### References

Pasqual P, Stiber N and Sunderland E (2003) Draft guidance on the development, evaluation and application of regulatory environmental models. The Council for Regulatory Environmental Modelling, US EPA.

## Uncertainty analysis

Quantification of uncertainty in model results due to incomplete knowledge of model parameters, input data, boundary conditions and conceptual model. In an uncertainty analysis the combined effects of these uncertainties are taken into account.

## Unconfined aquifer

An aquifer that contains the water table and is normally exposed to the surface. Occasionally there may be a low-permeability layer overlying this type of aquifer protecting it from the surface.

### References

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## Unsaturated zone

The zone between the land surface and the water table. It includes the root zone, intermediate zone and capillary fringe. The pore spaces contain water at less than atmospheric pressure, as well as air and other gases. Saturated bodies, such as perched groundwater, may exist in the unsaturated zone.

### Synonyms

Vadose zone

### References

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## Updating

Approach in which observed data are integrated in a model simulation in a way that the information content of both data and model result are made explicit and weighted. Data assimilation is a feedback process where the model simulation is updated as a response to field observations. This is in certain domains denoted updating.

**Synonym of:** *Data Assimilation*

## Upscaling

Upscaling means that the process equations and the associated parameter values that constitute a model in principle are modified or substituted when moving the scale of interest from smaller scale to the larger scale.

### Synonyms

Scaling

## Vadose zone

The zone between the land surface and the water table. It includes the root zone, intermediate zone and capillary fringe. The pore spaces contain water at less than atmospheric pressure, as well as air and other gases. Saturated bodies, such as perched groundwater, may exist in the unsaturated zone.

**Synonym of:** *Unsaturated zone*

### References

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## Validation

Substantiation that a model within its domain of applicability possesses a satisfactory range of accuracy consistent with the intended application of the model.

**Synonym of:** *Model Validation*

### References

Refsgaard JC, Henriksen HJ (2004) Modelling guidelines - terminology and guiding principles. *Advances in Water Resources*, 27, 71-82.

### Footnotes

Validation versus verification The terms validation and verification are controversial in the scientific community, because there is no consensus on the fundamental question concerning whether a water resources model can be validated or verified, and whether it as such can be claimed to be suitable or valid for particular applications. Examples of such discussion is given in Hassanizadeh and Carrera (1992) Konikow and Bredehoeft (1992) De Marsily et al. (1992) Oreskes et al. (1994). An overview is provided by Refsgaard and Henriksen (2002). All existing guidelines use either the term validation and/or the term verification. However, the two terms are used with different, and some times interchangeable, meaning in different guidelines. Almost all guidelines use the term verification about demonstration of the adequacy of the numerical algorithms of the computer code. The term dealing with the adequacy of the site-specific model is denoted validation in guidelines from The Netherlands (Van Waveren et al., 2000)

## Variable

A quantity that varies in time. Variables may be divided into state variables (or internal variables), input variables and output variables.

### Synonyms

Output variable; Input variable; State variable

## Verification

Substantiation that a model code is in some sense a true representation of a conceptual model within certain specified limits or ranges of application and corresponding ranges of accuracy.

**Synonym of:** *Code Verification*

### Footnotes

Validation versus verification The terms validation and verification are controversial in the scientific community, because there is no consensus on the fundamental question concerning whether a water resources model can be validated or verified, and whether it as such can be claimed to be suitable or valid for particular applications. Examples of such discussion is given in Hassanizadeh and Carrera (1992) Konikow and Bredehoeft (1992) De Marsily et al. (1992) Oreskes et al. (1994). An overview is provided by Refsgaard and Henriksen (2002). All existing guidelines use either the term validation and/or the term verification. However, the two terms are used with different, and some times interchangeable, meaning in different guidelines. Almost all guidelines use the term verification about demonstration of the adequacy of the numerical algorithms of the computer code. The term dealing with the adequacy of the site-specific model is denoted validation in guidelines from The Netherlands (Van Waveren et al., 2000)

## Viscosity

The property of a fluid describing its resistance to flow. Units of viscosity are newton-seconds per meter squared or pascal-seconds. Viscosity is also known as dynamic viscosity.

### References

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

## Visualisation techniques

Time series plots and other visual displays form the basis for comparisons between system and model. Validation is often subjectively described.

### References

<http://www.arches.uga.edu/~cmwagner/idf.html>

Rykiel, E.J. (1996) Testing ecological models: the meaning of validation. Ecological Modelling, 90, 229-244.

### Footnotes

Taken from the cited reference.

## Water balance

Balance of water flows, see balance.

## Water management

Planned development, distribution and use of water resources (both quantity and quality).

## Water Manager

A water manager is the person or organisation responsible for the management or protection of the water resource, and thus of the modelling study and its outcome (the problem owner). The water manager is the counterpart of the modeller. If the water manager and the modeller belong to different organisations their roles will typically be denoted client and consultant, respectively

### Synonyms

Manager; Client

### Footnotes

MoST term - User type

## Water table

The surface in an unconfined aquifer or confining bed at which the pore pressure is equal to the atmospheric pressure.

### References

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## Watershed

An area of land, bounded by a divide, in which water flowing across the surface will drain into a stream or river and flow out of the area through a specified point on that stream or river. Synonymous terms are catchment and watershed. Generally a basin is defined at a regional scale whereas a catchment or a watershed can be of smaller area. The term catchment is mostly used in Europe, while watershed is a preferred term in USA.

Synonym of: *Basin*

### **Well - full penetrating**

A well drilled to the bottom of an aquifer and constructed in such a way that it withdraws water from the entire thickness of the aquifer.

#### **References**

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

### **Well - partially penetrating**

A well constructed in such a way that it draws water directly from a fractional part of the total thickness of the aquifer.

#### **References**

Fetter CW (1980) Applied Hydrogeology. Merril Publishing Co.

### **Well development**

The process whereby a well is pumped or surged to remove any fine material that may be blocking the well screen or the aquifer outside of the well screen.

#### **References**

Murray-Darling Basin Commision (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

### **Well efficiency**

The ratio of the idealised drawdown in a well, where there are no head losses in the well screen and sand pack, to the actual measured drawdown in the well.

#### **References**

Murray-Darling Basin Commision (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

### **Well screen**

A tubular device with either slots, holes, gauze or continuous-wire wrap; used at the end of a well casing to complete the well. Water enters a well through the well screen.

#### **References**

Murray-Darling Basin Commision (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Yield - safe**

The amount of naturally occurring groundwater that can be economically and legally withdrawn from an aquifer on a sustained basis without impairing the native groundwater quality or creating an undesirable effect such as environmental damage. It cannot exceed the increase in recharge or leakage from adjacent strata plus the reduction in discharge that is due to the decline in head caused by pumping.

### **References**

Fetter CW (1980) Applied Hydrogeology. Merrill Publishing Co.

## **Yield - sustainable**

That portion of the long term average annual recharge which can be extracted each year without causing unacceptable impacts on groundwater users or the environment.

### **References**

Murray-Darling Basin Commission (2000) Groundwater Flow Modelling Guideline. Aquaterra Consulting Pty Ltd, South Perth, Australia.

## **Zonation**

Structure or arrangement in zones.

### **References**

Merriam-Webster dictionary (<http://www.m-w.com/home.htm>)