Standardization of datafiles for the testing of simulation models

A contribution to the EC-project "Nitrate in soils"

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ABSTRACT

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Within the EC-project "Nitrate in soils" several research groups in six different countries carried out studies on nitrogen transport and transformation processes in soil and groundwater. One of the main purposes of the project was the evaluation of available nitrogen simulation models, using experimental data of field studies, mainly focussed on nitrate leaching. Agreements were made about the type of data to be collected in such field studies. To facilitate the exchange of data between research groups, a standardized format for datasets, including both datafiles with time independent background data and with time series of monitored data, was designed. The standardized format is presented in this report.

Keywords: data collection, field study, hydrology, leaching, nitrogen, soil

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PREFACE

The EC-project "Nitrate in soils", carried out in the years 1988-1990, resulted in a final report that has been published in 1991 (CEC, 1991). Because the standardization of datafiles as used in this project has not been treated in the final report, a separate report is devoted to this subject.

The presented datafile standardization has played an important role in the facilitation of data exchange between the different groups of scientists working in this project. The draft version of this report has been distributed among the participants of the afore mentioned project "Nitrate in soils" in the beginning of 1989. Therefore, already since that time, a lot of experience was gained in using datasets complying with the presented standardization. Hence, it was possible to include some extensions and improvements in this final version of the report.

Several datasets, complying with the described standardization, are available. Everyone who wishes to run a simulation model on these data, can obtain the datasets by contacting the institutes which collected the data (see also Annex 17).

The concept of datafile standardization, presented in this report, can be applied in all sorts of (field) studies for which the exchange of data is important, both within and between research groups. This can especially be important in international cooperative research.

To be able to read this report some basic knowledge of the FORTRAN-language would be advisable.

1 INTRODUCTION

The EC-project "Nitrate in soils", carried out in the years 1988-1990, included research on both field measurements and simulation of nitrogen transport and transformation processes in soil and groundwater, conducted by several research groups in six different countries.

One of the main purposes of the project was the evaluation of different nitrogen models available amongst the participating research groups. The available simulation models are all different in approach and have different levels of complexity (Vereecken et al., 1991b). The evaluation of the models was mainly focussed on nitrate leaching, but attention was also paid to other important terms of the nitrogen balance, such as plant uptake and mineralization (Vereecken et al., 1991a). Data of several field studies, including a range of different soils, hydrological conditions and agricultural practices, were used for the evaluation of the models (Breeuwsma et al., 1991).

Experience gained from earlier field studies on the subject of nitrogen transport and transformation processes, together with information on the input requirements of simulation models, resulted in guidelines for the collection of data in field studies (Steenvoorden & Loveland, 1988) which were generally accepted by the project participants. As a consequence these guidelines, when obeyed in a field study, result in a complete standardized dataset.

To promote the exchange of data of different field studies between research groups a standardized format for the data has been designed, as presented in this report. In this way the processing of the data has also been facilitated. Once a package of computer programs is built to process the data e.g. for the conversion of raw data to model input, for comparison of measured data with simulation results or for plotting purposes, the programs can easily be used again for any other dataset in this standardized format.

Within the project, several sets of data have been used according to the presented format. One example of a standardized dataset, including experimental data of a grassland site in the Netherlands is presented by Jansen (1991). All datasets can be obtained by contacting the institutes mentioned in Annex 17.

In this report successively the contents of a standardized set of field data (Chapter 2) and the contents and format of each individual datafile (Chapter 3) will be discussed.

2 CONTENTS OF A STANDARDIZED DATASET

2.1 Introduction

In the framework of the EC-project "Nitrate in soils" guidelines were developed for the collection of data in field studies concerning the quantification of N-fluxes in the soil (Steenvoorden & Loveland, 1988). These guidelines consequently determine the contents of a field study dataset. Such a dataset is suitable for the use in simulation models. A complete standardized dataset should contain the following kinds of data:

- general background data;
- soil chemical data and particle size distribution;
- water retention characteristics;
- hydraulic conductivity;
- meteorological data;
- evapotranspiration;
- irrigation;
- crop management and yields;
- management data;
- soil mineral N;
- soil moisture content;
- pressure head;
- soil temperature;
- groundwater level;
- leaching data.

These data can either be used as input variables for simulation models because they represent certain driving forces or characteristics of the system, or as data for comparison with simulation results.

Not for all kinds of data the presence in the standardized dataset is obligatory. Obviously, data on for instance irrigation and groundwater level have to be included only when they are relevant, i.e. when irrigation is applied and when the fluctuation of the groundwater table influences the moisture content in the considered soil profile. Furthermore, the presence of some data, such as pressure head and soil temperature, is recommendable, but not obligatory, and generally depends on the intensity of the monitoring programme. In this chapter it is described how the required data should be distributed among the different datafiles. The contents and format of each file is described in chapter 3.

Together with each dataset a general description should be given of the experiment in which the data have been collected, including e.g. the situation of the field, design of the experiment etc. This description will enable the user of the data to get an overall view of the experiment. A comprehensive example of such a description is given by Jansen (1991).

2.2 Nomenclature of files

All the filenames for the standardized dataset have the same general form. The consistent use of these filenames will facilitate the easy recognition of the contents of each file by its name, and will also facilitate the searching of a file when searching for specific data.

All file names consist of a 7-character name and a 3-character extension with the following general form:

CCSSNNN.XXX

in which:

CC = 2 character country code, e.g.:
BE = Belgium,
GE = Germany,
UK = United Kingdom,
DK = Denmark,
NL = the Netherlands,
etc.

SS = 2 character code of the site name, e.g. (as used in this project):
PI = Pittem,
RU = Ruurlo,
etc.

NNN = Field or plot number;
if only one plot is available on a site the code 000 is used; also for general data, e.g. meteorology, the code 000 is used.

XXX = 3 character code for the kind of data; an explanation of the codes is given in Table 1.

An example of a data file name is NLRU019.MAN.
This is a data file from the Netherlands (NL), from the Ruurlo site (RU), fieldnumber 019, containing the management data (.MAN).

Table 1 Explanation of extensions (XXX) of file names (CCSSNNN.XXX), used for different kinds of data in a standardized dataset

File extension XXX	**Kind of data**	**Treated in section**
GEN	**general background data**	**3.1**
SCP	**soil chemical data and particle size distribution**	**3.2**
WRC	**water retention characteristics**	**3.3**
HCU	**hydraulic conductivity**	**3.4**
CLI	**meteorological data**	**3.5**
ETR	**evapotranspiration**	**3.6**
IRR	**irrigation**	**3.7**
CRP	**crop data**	**3.8**
MAN	**management data**	**3.9**
SMN	**soil mineral N**	**3.10**
SMO	**soil moisture content**	**3.11**
PRH	**pressure head**	**3.12**
STE	**soil temperature**	**3.13**
GWL	**groundwater level**	**3.14**
LEA	**leaching**	**3.15**

2.3 Additional information

The data described in section 2.2 comprise the most important variables in a field study. One of the recommendations at the end of the EC-project "Nitrate in soils", however, was to also gather data on mineralization, denitrification etc. in field studies (CEC, 1991). Therefore, to be able to perform correct simulations and to enhance the evaluation of the simulation results it is preferable to have these and some more additional data available. This may include:

- measurements of mineralization and/or immobilization;
- measurements of denitrification;
- measurement of changes in organic N in the soil;
- quantification of biological N-fixation, if relevant;
- the production of (N in) milk and meat in case of experiments with grazing;
- quantification of volatilization of ammonia in the case of surface application of slurry, either by direct measurement or by estimation based on literature and the actual weather conditions;
- information on atmospheric deposition of nitrate and ammonia, both dry and wet (concentration in the rain), derived either from direct measurement or from literature;
- information on crop development in time during the growing season, e.g. Leaf Area Index, root length, root mass, etc.
- information on the (geo)hydrological situation, including the presence of tile drains, ditches etc. to facilitate the hydrological simulations by a correct definition of the bottom boundary conditions;
- quantification of surface runoff, if relevant;
- information on spatial variability.

No standard format is designed for datafiles with these miscellaneous data. The provider of the data should decide on how to present them. This can be either as written information or in a datafile of which the format has to be specified explicitely.

3 CONTENTS AND FORMAT OF THE DATAFILES

In this chapter the contents and format of each datafile are described. Files containing time independent background data and files containing time series of monitored data can be distinguished. In the files with monitored data, a daynumber is given; the definition of daynumber 1 must be included in the accompanying description of the dataset, whilst the use of daynumbers should be consistent throughout the entire dataset.

All files are sequential ASCII files with a maximum record length of 80 characters on one line. The files are available for list-directed I/O; a (sequence of) blank(s) and "end of record"-character are used as value separators.

The first few records of each file have been reserved for information on the contents of the file. This information must include:
- name of the file;
- version of the file;
- author of the file;
- date of last revision of the file;
- code in which the file is written (ASCII, binary, etc.);
- access of the file in a computer program (direct, sequential, etc.);
- source of the data;
- additional comments.

This file header with comments is followed by a full line of asterisks (*) to enable automatic searching for the first data record.

In the description of the format, for every kind of data the following items have been tabulated:
- location: the characters # and + indicate the location of each variable: no fixed fields have been used but values are separated by "end of record" (indicated by #) or (a sequence of) spaces (indicated by +);
- name: variable names have been used, constructed using a number of 2-character codes; an explanation of these codes can be found in Annex 1. The primary goal of the use of these variable names is to facilitate the reference of this report; furthermore, it is to use the same variable names in computer programs for processing of the data;
- description: explanation of the required type of data; if necessary some additional comments have been given;
- unit: in case of a numeric value the unit in which the value should be expressed;
- range: possible values determined by practical limits to allow for basic input checking. If any additional restrictions for the values exist, these restrictions have been given in footnotes. Obviously these ranges and restrictions only help to avoid apparent fatal errors, no minor (typing) errors can be detected this way;
- data type: in these files the following data types have been used:
  - CHARACTER (C): sequence of printable characters (ASCII-values 32-126), embedded in single quotes ('),
  - INTEGER (I): non-decimal numeric value,
  - REAL (R): decimal numeric value.

Of each file an example is given in Annexes 2-16, using data from the Ruurlo site in The Netherlands (NLRU...). If datafiles didnot exist a fictitious example is given.

3.1 General background data

The general background data comprise a brief outline of the location, the soil and the land use of the field, used in the presented experiment. Data should be presented in the following format (comments are given in italics):

Filename: ----000.GEN (example in Annex 2)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	-
#	-	author, version, date	-	-	-
#	-	source of the data	-	-	-
#	-	comment line *number of comment lines is free*	-	-	-
#	-	series of asterisks (*)	-	-	-
#	-	location (name)	-	-	C
#	LT1	coordinates latitude (degrees)	°	0-180	I
+	LT2	coordinates latitude (minutes)	'	0-60	I
+	LT3	coordinates latitude (seconds)	"	0-60	I
+	LT4	coordinates latitude (north/south)	-	NL, SL	C
#	LG1	coordinates longitude (degrees)	°	0-180	I
+	LG2	coordinates longitude (minutes)	'	0-60	I
+	LG3	coordinates longitude (seconds)	"	0-60	I
+	LG4	coordinates longitude (east/west)	-	EL, WL	C
#	SL	slope	$m.m^{-1}$	≥0	R
#	AL	altitude (above sea level)	m	-100-2000	R
#	AR	area of one experimental unit	m^2	≥0	R
#	DR	drainage characteristics *description of the drainage system (e.g. free drainage, tile drains at ... depth, ditches etc.)*	-	-	C
#	SOTY	soil type (FAO classification) *a written profile description should be included in the accompanying text.*	-	-	C
+	NUHO	number of soil horizons	-	>0	I

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

Filename: ----000.GEN (continued) (example in Annex 2)

L[1]	Name	Description	Unit	Range	Type[2]
		The following record is repeated for each soil horizon:			
#	HO	horizon name	-	-	C
+	UPDP	depth upper boundary	m-soil surface	≥0	R
+	LODP	lower depth	m-soil surface	>0[3]	R
#	CK	existance of cracks *0 = no cracks* *1 = cracks*	-	0, 1	I
		If CK equals 1 then the following record is repeated for each soil layer with cracks:			
#	UPDP	depth upper boundary	m-soil surface	≥0	R
+	LODP	lower depth	m-soil surface	>0[4]	R
+	CKWD	crack width	m	0-1	R
+	CKFR	surface fraction of a horizontal cross-section occupied by cracks	%	0-100	R
#	-	land use *cropping system in the experiment*	-	-	
#	-	history *land use and fertilization of at least 5 years preceeding the experiment*	-	-	C

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] restriction: LODP > UPDP

[4] restriction: LODP > UPDP

3.2 Soil chemical data and particle size distribution

For the definition of the soil system a number of chemical parameters are of major importance, e.g. pH, organic matter content and C/N-ratio of the organic matter in the soil layers distinguished. Furthermore, data on the organic matter content and particle size distribution can be used in pedotransfer functions to calculate for instance rate constants and soil hydraulic functions (Vereecken, 1988; Wösten & Van Genuchten, 1988).

Data should be presented in the following format (comments are given in italics):

Filename: -------.SCP (example in Annex 3)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
#	NULA	number of soil layers	-	>0	I
	The following record is repeated for each soil layer (NULA times):				
#	UPDP	depth upper boundary	m-soil surface	≥0	R
+	LODP	lower depth	m-soil surface	>0[4]	R
+	FROC	amount of organic carbon	% weight	0-100[4]	R
+	FRNT	amount of total N	% weight	0-100[4]	R
+	PH	pH-H_2O	-	2-12	R
+	FRCL	clay (particles < 2 µm)	% weight[3]	0-100[4]	R
+	FRSI	silt (2 µm < particles < 50 µm)	% weight[3]	0-100[4]	R
+	FRSA	sand (particles > 50 µm)	% weight[3]	0-100[4]	R

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] % weight of mineral part of the soil

[4] restrictions: LODP > UPDP
FROC + FRNT < 100
FRCL + FRSI + FRSA = 100

3.3 Water retention characteristics

For a correct simulation of the water balance in the soil, the water retention characteristics of all soil horizons are necessary. The data requirement depends on the used model. Detailed hydrological models usually require a full water retention curve, whereas more simple models require only few points of this curve. The minimum requirement consist of the moisture contents at saturation (pF = 0.0), at field capacity (pF = 2.0) and at wilting point (pF = 4.2). Since the determination of a water retention curve is a time consuming and costly procedure, analytical functions to describe the water retention curves are frequently used (e.g. Van Genuchten, 1980). Parameters for these analytical functions can be derived either from other soil characteristics (Vereecken, 1988; Wösten & Van Genuchten, 1988) or from relatively simple experiments.

To store the data concerning water retention, two possible formats are presented, one for laboratory measurements, and one for analytical functions. In case of laboratory measurements, data should be presented in the following format (comments are given in italics):

Filename: -------.WRC (example in Annex 4)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
#	NULA	number of soil layers	-	>0	I
	The following record is repeated for each soil layer (NULA times):				
#	UPDP	depth upper boundary	m-soil surface	≥0	R
+	LODP	lower depth	m-soil surface	>0[3]	R
+	BD	dry bulk density	$kg.m^{-3}$	0-3000	R
+	PFDE	presence of a drying pF-curve 0 = not present 1 = present	-	0, 1	I

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] restriction: LODP > UPDP

Filename: -------.WRC (continued) (example in Annex 4)

L[1]	Name	Description	Unit	Range	Type[2]
+	PFWE	presence of a wetting pF-curve 0 = not present 1 = present	-	0, 1	I
+	NUOB	number of observations	-	>0	I
		For each soil layer the following record is repeated for each observation (NUOB times):			
#	PF	pF-value	-	0-7	R
+	MOFR	volumetric moisture content	$m^3.m^{-3}$	0-1	R
		In case of both a drying and a wetting pF-curve complete record with:			
+	PF	pF-value	-	0-7	R
+	MOFR	volumetric moisture content	$m^3.m^{-3}$	0-1	R

In case of an analytical function, data should be presented in the following format (comments are given in italics):

Filename: -------.WRC (example in Annex 4)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free. N.B. include a description of the analytical function and an explanation of the parameters*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
#	NULA	number of soil layers	-	>0	I

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

Filename: -------.WRC (continued) (example in Annex 4)

L[1]	Name	Description	Unit	Range	Type[2]
	The following record is repeated for each soil layer (NULA times):				
#	UPDP	depth upper boundary	m-soil surface	≥0	R
+	LODP	lower depth	m-soil surface	>0[3]	R
+	PM01	parameter 1 *e.g.* θ_s *(Van Genuchten, 1980)*	...	...	R
+	PM02	parameter 2 *e.g.* θ_r *(Van Genuchten, 1980)*	...	...	R
+	*etc.*				

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] restriction: LODP > UPDP

3.4 Hydraulic conductivity

For a correct simulation of the water balance in the soil, hydraulic conductivity curves of all soil horizons are necessary. The data requirement depends on the used model. Detailed hydrological models usually require a full hydraulic conductivity curve, whereas more simple models require only few points of such a curve. The minimum requirement consists of the hydraulic conductivity at saturation. Since the determination of a hydraulic conductivity curve is a time consuming and costly procedure, analytical functions to describe such curves are frequently used (e.g. Gardner, 1958; Van Genuchten, 1980). Parameters for analytical functions can be derived either from other soil characteristics (Vereecken, 1988; Wösten & Van Genuchten, 1988) or from relatively simple experiments.

To store the data concerning hydraulic conductivity two possible formats are presented, one for laboratory measurements and one for analytical functions. In case of direct measurements data should be presented in the following format (comments are given in italics):

Filename: -------.HCU (example in Annex 5)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
#	NULA	number of soil layers	-	>0	I
	The following section is repeated for each soil layer (NULA times):				
#	UPDP	depth upper boundary	m-soil surface	≥0	R
+	LODP	lower depth	m-soil surface	>0[3]	R
+	NUOB	number of observations	-	>0	I
	For each soil layer the following record is repeated for each observation (NUOB times):				
+	CD	hydraulic conductivity	$m.day^{-1}$	0-1000	R
+	MOFR	volumetric moisture content	$m^3.m^{-3}$	0-1	R

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] restriction: LODP > UPDP

In case of an analytical function, data should be presented in the following format (comments are given in italics):

Filename: -------.HCU (example in Annex 5)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free.* *N.B. include a description of the analytical function and an explanation of the parameters*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
#	NULA	number of soil layers	-	>0	I
	The following record is repeated for each soil layer (NULA times):				
#	UPDP	depth upper boundary	m-soil surface	≥0	R
+	LODP	lower depth	m-soil surface	>0[3]	R
+	PM01	parameter 1 *e.g. K_{sat} (Gardner, 1958)*	...	...	R
+	PM02	parameter 2 *e.g. b (Gardner, 1958)*	...	...	R
+	PM03	parameter 3 *e.g. n (Gardner, 1958)*	...	...	R
+	*etc.*				

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] restriction: LODP > UPDP

3.5 Meteorological data

Meteorological data are important input variables for simulation models, representing driving forces for a number of processes. For instance the air temperature affects soil temperature and consequently influences the rates of transformation processes, whilst global radiation is an important variable for crop growth and evapotranspiration. Since not all data are always available from Meteorological Services, and the file should be available for list directed reading, special numbers have to be used instead of missing values (see footnote 3). Minimal requirements consist of daily average air temperature and precipitation.
Data should be presented in the following format (comments are given in italics):

Filename: ----000.CLI (example in Annex 6)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
	The following record is repeated for each monitoring day[3]:				
#	YR	year	-	1900-..	I
+	MH	month	-	1-12	I
+	DA	day	-	1-31	I
+	DANU	daynumber (from ...)[4]	-	>0	I
+	MITE	minimum air temperature	°C	-30-50	R
+	MATE	maximum air temperature	°C	-30-50	R
+	AVTE	average air temperature	°C	-30-50	R
+	PR	precipitation	$mm.day^{-1}$	≥0	R
+	GLRA	global radiation	$J.cm^{-2}.day^{-1}$	>0	R
+	AVWS	average wind speed	$m.s^{-1}$	≥0	R
+	AVHM	average relative humidity	%	0-100	R

1 location: # = new record; + = same record, use at least one space

2 C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

3 use the following missing values: 99 for MITE, MATE and AVTE
-1 for PR, GLRA, AVWS and AVHM

4 daynumbers should be used consistently throughout the entire dataset

3.6 Evapotranspiration

Data on (reference) evapotranspiration are usually obtained from Meteorological Services, sometimes for periods longer than one day, for instance ten day periods or even a month. It is important to describe the way the reference evapotranspiration is calculated (e.g. Penman, Makkink, etc.) in order to correctly calculate the potential crop evapotranspiration, using crop specific reduction factors (e.g. Feddes, 1987).

Data should be presented in the following format (comments are given in italics):

Filename: ----000.ETR (example in Annex 7)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
	The following record is repeated for each monitoring day:				
#	YR	year	-	1900-..	I
+	MH	month	-	1-12	I
+	DA	day	-	1-31	I
+	DANU	daynumber (from ...)[3] *if evapotranspiration is only available for longer periods, then list the last daynumber of that period*	-	>0	I
+	ET	evapotranspiration *cumulative value (since previous DANU)*	mm	≥0	R

1 location: # = new record; + = same record, use at least one space

2 C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

3 daynumbers should be used consistently throughout the entire dataset

3.7 Irrigation

Obviously data on irrigation need to be supplied only if irrigation has taken place. Besides the amount of irrigation water, also the irrigation method is important. Therefore the accompanying description of the dataset should also contain a description of the way irrigation has been applied, e.g. by sprinkling, flooding, dripping, subsurface infitration etc. Irrigation water is a possible source of nitrogen in the soil profile. Therefore also the concentrations of nitrate and ammonium in the irrigation water need to be specified.

Data should be presented in the following format (comments are given in italics):

Filename: -------.IRR (example in Annex 8)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
	The following record is repeated for each monitoring day:				
#	YR	year	-	1900-..	I
+	MH	month	-	1-12	I
+	DA	day	-	1-31	I
+	DANU	daynumber (from ...)[3]	-	>0	I
+	AMIR	irrigation amount	mm	>0	R
+	CONI	concentration of nitrate in irrigation water	$g.m^{-3}$ NO_3^--N	≥0	R
+	CONH	concentration of ammonium in irrigation water	$g.m^{-3}$ NH_4^+-N	≥0	R

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] daynumbers should be used consistently throughout the entire dataset

3.8 Crop management and yields

Data on crop management (sowing/planting and harvesting date) are important input variables for simulation models, whilst data on yield and N-uptake are useful data for comparison with simulation results. The minimum requirement consists of data on yield and N-uptake at harvest, but it is preferable to include yield and N-uptake measurements during the growing season as well. In this file crop types and actions are given as codes. If other crops or actions have been used in the field study, the added codes should be explained separately.

Data should be presented in the following format (comments are given in italics):

Filename: -------.CRP (example in Annex 9)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
	The following section is repeated for each monitoring day:				
#	YR	year	-	1900-..	I
+	MH	month	-	1-12	I
+	DA	day	-	1-31	I
+	DANU	daynumber (from ...)[3]	-	>0	I
#	CRTY	crop type (variety) *1 = english ryegrass (....)* *2 = maize (....)* *3 = sugar beet (....)* *4 = winter wheat (....)* *5 = summer wheat (....)* *6 = winter barley (....)* *7 = summer barley (....)* *8 = potatoes (....)* *etc.*	-	1-10	I

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] daynumbers should be used consistently throughout the entire dataset

Filename: -------.CRP (continued) (example in Annex 9)

L[1]	Name	Description	Unit	Range	Type[2]
+	AC	action *1 = sowing* *2 = planting* *3 = harvesting* *4 = sampling* *etc.*	-	1-10	I
#	CRYD	crop yield *dry matter*	kg.ha^{-1}	≥0	R
+	CRNT	crop N-content	kg.kg^{-1} N	0-1	R
+	CRNTYD	crop N-yield	kg.ha^{-1} N	≥0[3]	R
+	RSYD	crop residuals, left on the field *dry matter*	kg.ha^{-1}	≥0	R
+	RSNT	N-content crop residuals	kg.kg^{-1} N	0-1	R
+	RSNTYD	N-yield crop residuals	kg.ha^{-1} N	≥0[3]	R

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] restrictions: CRNT * CRYD = CRNTYD
RSNT * RSYD = RSNTYD

3.9 Management

Another important type of input data for nitrogen simulation models is the input of fertilizers and manure, along with their constituants. This file also contains data on soil tillage. Furthermore, data on grazing of cattle on grassland should be included if relevant; this also is an important, but highly spatially variable source of nitrogen in the soil. In this file material types and actions are given as codes. If other materials or actions have been used in the field study, the added codes should be explained separately.

Data should be presented in the following format (comments are given in italics):

Filename: -------.MAN (example in Annex 10)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
	The following section is repeated for each monitoring day:				
#	YR	year	-	1900-..	I
+	MH	month	-	1-12	I
+	DA	day	-	1-31	I
+	DANU	daynumber (from ...)[3]	-	>0	I
#	AC	action *1 = addition* *2 = start grazing* *3 = end grazing* *4 = ploughing* *etc.*	-	1-10	I
+	NUAN	number of animals *If NUAN > 0 then also specify the application rate of animal manure (kg.animal^{-1}.yr^{-1}). The kind of animals is implicitly given by specifying the material type*	-	≥0	I

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] daynumbers should be used consistently throughout the entire dataset

Filename: -------.MAN (continued) (example in Annex 10)

L[1]	Name	Description	Unit	Range	Type[2]
+	MTTY	material type *1 = cattle slurry* *2 = calve slurry* *3 = pig slurry* *4 = poultry slurry* *5 = dry poultry manure* *6 = mineral fertilizer* *7 = slow release fertilizer[3]* *8 = nitrification inhibitor[3]* *9 = sewage sludge* *10 = plant residues* *etc.*	-	1-20	I
#	DP	depth *0.0 = surface application* *>0.0 = slurry injection depth or ploughing depth*	m-soil surface	≥0	R
+	AMMT	total amount of material *in case of mineral fertilizer use a dummy value*	$kg.ha^{-1}$	≥0	R
+	AMDM	total amount of dry matter *in case of mineral fertilizer use a dummy value*	$kg.ha^{-1}$	≥0[4]	R
+	AMOM	total amount of organic matter *in case of mineral fertilizer use a dummy value*	$kg.ha^{-1}$	≥0[4]	R
+	AMNT	amount of total nitrogen	$kg.ha^{-1}$	≥0[4]	R
+	AMNH	amount of ammonium	$kg.ha^{-1}$ NH_4^+-N	≥0[4]	R
+	AMNI	amount of nitrate	$kg.ha^{-1}$ NO_3^--N	≥0[4]	R
	The following variables are optional:				
+	AMPT	amount of total phosphate	$kg.ha^{-1}$ P	≥0[4]	R
+	AMK	amount of potassium	$kg.ha^{-1}$ K	≥0[4]	R
+	AMCA	amount of calcium	$kg.ha^{-1}$ Ca	≥0[4]	R
+	AMMG	amount of magnesium	$kg.ha^{-1}$ Mg	≥0[4]	R

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] include information on composition and decomposition rate in the accompanying text

[4] restrictions: AMDM ≤ AMMT
AMOM ≤ AMDM
AMNT + AMPT + AMK + AMCA + AMMG ≤ AMDM
AMNI + AMNH ≤ AMNT

3.10 Soil mineral nitrogen

The amount of mineral nitrogen (NH_4^+ and NO_3^-) in the soil and the distribution of this amount among the different soil layers are useful variables for comparison with simulation results, provided that the sampling frequency is sufficient. Especially in periods with rapid changes in mineral nitrogen content it can be important to carry out frequent sampling. The data can also be used to specify an initial condition in the soil profile for a simulation.

In the accompanying text additional information should be given on the sampling procedure (e.g. number of subsamples per layer) and the extraction procedure (e.g. extraction in 2 M KCl solution) of the soil samples.

Data should be presented in the following format (comments are given in italics):

Filename: -------.SMN (example in Annex 11)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
	The following section is repeated for each monitoring day:				
#	YR	year	-	1900-..	I
+	MH	month	-	1-12	I
+	DA	day	-	1-31	I
+	DANU	daynumber (from ...)[3]	-	>0	I
+	NULA	number of layers sampled	-	>0	I
	For each monitoring day the following record is repeated for each layer sampled (NULA times):				
#	UPDP	depth upper boundary	m-soil surface	≥0	R
+	LODP	lower depth	m-soil surface	>0[4]	R
+	BD	dry bulk density	$kg.m^{-3}$	0-3000	R

1 location: # = new record; + = same record, use at least one space

2 C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

3 daynumbers should be used consistently throughout the entire dataset

4 restriction: LODP > UPDP

Filename: -------.SMN (continued) (example in Annex 11)

L[1] Name	Description	Unit	Range	Type[2]
+ AMNH	amount of ammonium in soil layer	$kg.ha^{-1}$ NH_4^+-N	≥0	R
+ AMNI	amount of nitrate in soil layer	$kg.ha^{-1}$ NO_3^--N	≥0	R

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

3.11 Soil moisture content

For evaluation of the simulation of soil moisture dynamics, the direct measurement of moisture contents in the soil is important information. Especially when non-destructive methods are used, it is preferable to conduct frequent measurements in different soil layers. The data can also be used to specify an initial condition in the soil profile for a simulation.

The description accompanying the dataset should give information on the monitoring procedure used, for instance gravimetry, neutron probe, γ-radiation, time domain reflectrometry (TDR), etc.

Data should be presented in the following format (comments are given in italics):

Filename: -------.SMO (example in Annex 12)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
	The following section is repeated for each monitoring day:				
#	YR	year	-	1900-..	I
+	MH	month	-	1-12	I
+	DA	day	-	1-31	I
+	DANU	daynumber (from ...)[3]	-	>0	I
+	NULA	number of layers sampled	-	>0	I
	For each monitoring day the following record is repeated for each layer sampled (NULA times):				
#	UPDP	depth upper boundary	m-soil surface	≥0	R
+	LODP	lower depth	m-soil surface	>0[4]	R
+	MOFR	volumetric moisture content	$m^3.m^{-3}$	0-1	R

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] daynumbers should be used consistently throughout the entire dataset

[4] restriction: LODP > UPDP

3.12 Pressure head

In addition to the data on moisture contents in the soil (section 3.11), pressure head data at different depths in the soil provide important information for the evaluation of simulations of soil moisture dynamics. The data can also be used to specify an initial condition in the soil profile for a simulation. The monitoring procedure should be described in the description of the dataset.

Data should be presented in the following format (comments are given in italics):

Filename: -------.PRH (example in Annex 13)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
	The following section is repeated for each monitoring day:				
#	YR	year	-	1900-..	I
+	MH	month	-	1-12	I
+	DA	day	-	1-31	I
+	DANU	daynumber (from ...)[3]	-	>0	I
+	NUDP	number of monitoring depths	-	>0	I
	For each monitoring day the following record is repeated for each monitoring depth (NUDP times):				
#	DP	depth	m-soil surface	≥0	R
+	HD	pressure head	cm	-1.10^{7}-0	R

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] daynumbers should be used consistently throughout the entire dataset

3.13 Soil temperature

Many transformation processes in the soil depend on temperature. Soil temperatures, measured at different depths, are therefore important parameters in field studies. The description, accompanying the dataset should include an outline of the measurement procedure. If heat transport is included in the simulation model, the data can be used for testing this model part.

Data should be presented in the following format (comments are given in italics):

Filename: -------.STE (example in Annex 14)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
#	NUDP	number of depths	-	>0	I
+	DP(1)	first monitoring depth	m-soil surface	≥0	R
+	DP(2)	second monitoring depth	m-soil surface	>0	R
+	..				
+	DP(NUDP)	NUDPth monitoring depth	m-soil surface	>0	R
#					
	The following record is repeated for each monitoring day:				
#	YR	year	-	1900-..	I
+	MH	month	-	1-12	I
+	DA	day	-	1-31	I
+	DANU	daynumber (from ...)[3]	-	>0	I
+	SOTE(1)	soil temperature at 1st monitoring depth	°C	-20-50	R

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] daynumbers should be used consistently throughout the entire dataset

Filename: -------.STE (continued) (example in Annex 14)

L[1]	Name	Description	Unit	Range	Type[2]
+	SOTE(2)	soil temperature at 2^{nd} monitoring depth	°C	-20-50	R
+	..				
+	SOTE(NUDP)	soil temperature at $NUDP^{th}$ monitoring depth	°C	-20-50	R

1 location: # = new record; + = same record, use at least one space

2 C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

3.14 Groundwater level

Data on the phreatic groundwater level are of major importance if the groundwater influences the moisture regime of the considered soil layers. Frequent measurements of the groundwater level can serve either as input for a hydrological simulation model to determine the bottom boundary condition. When other bottom boundary conditions are used, such as a relation between bottom flux and hydraulic head or drainage characteristics these data can be used for evaluation of the simulations.

If the groundwater potential in the underlying aquifer(s) is significant for seepage and/or leakage, these date should be given in a separate file with identical format. This is especially important for correct simulation of the amount of leakage.

Data should be presented in the following format (comments are given in italics):

Filename: -------.GWL (example in Annex 15)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
	The following record is repeated for each monitoring day:				
#	YR	year	-	1900-..	I
+	MH	month	-	1-12	I
+	DA	day	-	1-31	I
+	DANU	daynumber (from ...)[3]	-	>0	I
+	GWLV	groundwater level	m-soil surface	≥0[4]	R

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] daynumbers should be used consistently throughout the entire dataset

[4] in case of ponding or in case of groundwater potential of a (semi) confined aquifer this value can become negative

3.15 Nitrate leaching

For field studies focussed on nitrate leaching, direct measurements of the nitrate leaching or measurements of nitrate concentrations in leaching water are of major importance. Therefore, these data also provide important material for the evaluation of nitrogen simulation models.

Different methods are available to establish the amount of leached nitrogen, ranging from quite more detailed (suction cup sampling) to more global methods (sampling of upper groundwater from augerholes). Therefore the description of the dataset should include an extensive description of the procedure used for the leaching measurements.

Data should be presented in the following format (comments are given in italics):

Filename: -------.LEA (example in Annex 16)

L[1]	Name	Description	Unit	Range	Type[2]
#	-	file name, code, access	-	-	C
#	-	author, version, date	-	-	C
#	-	source of the data	-	-	C
#	-	comment line *number of comment lines is free*	-	-	C
#	-	series of asterisks (*)	-	-	C
#					
#	SMMD	sampling method *1 = drain* *2 = suction cups* *3 = boreholes*	-	1-3	I
+	UPDP	depth upper boundary *In case of drainage water sampling: drainage depth*	m-soil surface	≥0	R
+	LODP	lower depth *In case of drainage water sampling: drainage depth*	m-soil surface	>0[3]	R
#					
	The following record is repeated for each monitoring day:				
#	YR	year	-	1900-..	I
+	MH	month	-	1-12	I

[1] location: # = new record; + = same record, use at least one space

[2] C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

[3] restriction: LODP > UPDP

Filename: -------.LEA (continued) (example in Annex 16)

L[1]	Name	Description	Unit	Range	Type[2]
+	DA	day	-	1-31	I
+	DANU	daynumber(from ...)[3] [4]	-	>0	I
+	CONI	nitrate concentration	$g.m^{-3}$ NO_3^--N	≥0	R
	In case of drainage water sampling:				
+	DRFL	drainage flux	$mm.day^{-1}$	≥0	R

1 location: # = new record; + = same record, use at least one space

2 C = data type CHARACTER; I = data type INTEGER; R = data type REAL; - = not applicable

3 daynumbers should be used consistently throughout the entire dataset

4 If data collection of a sample takes more than one day, give the last daynumber of the sampling period.

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STEENVOORDEN, J.H.A.M. & P. LOVELAND, 1988. *Quantification of N-fluxes in the rootzone*. ICW-Note 1847. Winand Staring Centre, Wageningen, The Netherlands. 9 pp + 2 appendices.

ANNEX 1 Vocabulary of variable names

Variable names used in this report are constituted of 2-character codes, which are explained below.
Examples: AMNT = amount of total nitrogen
NULA = number of layers

code	explanation	code	explanation
AC	= action	MD	= method
AL	= altitude	MG	= Magnesia
AM	= amount	MH	= month
AN	= animal	MI	= minimum
AR	= area	MO	= moisture
AV	= average	MT	= material
BD	= bulk density	NH	= ammonium
CA	= Calcium	NI	= nitrate
CD	= hydraulic conductivity	NL	= northern latitude
CK	= crack	NT	= total nitrogen
CL	= clay	NU	= number
CO	= concentration	OB	= observation
CR	= crop	OC	= organic carbon
DA	= day	OM	= organic matter
DM	= dry matter	PF	= pF
DP	= depth	PH	= pH
DR	= drainage	PM	= parameter
ET	= evapotranspiration	PR	= precipitation
FL	= flux	PT	= total phosphorus
FR	= fraction	RA	= radiation
GL	= global	RS	= residual
GW	= groundwater	SA	= sand
HD	= head	SI	= silt
HM	= relative humidity	SL	= slope
HO	= horizon	SM	= sample
IR	= irrigation	SO	= soil
K	= Potassium	TE	= temperature
LA	= layer	TY	= type
LG	= longitude	UP	= upper
LO	= lower	WD	= width
LT	= latitude	WS	= wind speed
LV	= level	YD	= yield
MA	= maximum	YR	= year

ANNEX 2 Example of file ----000.GEN

```
File:   NLRU000.GEN        Code:    ASCII          Access: sequential
Author: E.J. Jansen        Version: 2              Date:   23-07-1991
Source: -

**********************************************************************

'Ruurlo, The Netherlands'
 52 02 00 'NL'
 06 28 00 'EL'
 0.0
 18.0
 37.5
'Ditches approx. 1 meter deep, surrounding the field'
'Humic gleysol'   2
'A'       0.00      0.20
'C'       0.20      1.20
 0
'Land use: permanent grassland'
'History: grassland with grazing and application of
          300-400 kg.ha-1.yr-1 N from mineral fertilizer'
```

ANNEX 3 Example of file -------.SCP

```
File:   NLRU000.SCP        Code:    ASCII          Access: sequential
Author: E.J. Jansen        Version: 2              Date:   23-07-1991
Source: soil chemical data: Snijders et al. (1987)
        particle size distribution: Jansen (1991)
        Ruurlo, The Netherlands, average for the entire field

NULA
UPDP    LODP    FROC     FROT       PH       FRCL      FRSI      FRSA

**********************************************************************

   5
0.00    0.05    6.44     0.43       5.7      5.4       26.9      67.7
0.05    0.25    3.02     0.23       5.5      4.9       27.6      67.5
0.25    0.50    1.03     0.03       5.5      3.8       19.4      76.8
0.50    0.75    1.08     0.02       6.0      6.3        8.2      85.5
0.75    1.00    0.63     0.01       6.6      3.2        9.2      87.6
```

ANNEX 4 Example of file -------.WRC

```
File:   NLRU037.WRC        Code:    ASCII            Access: sequential
Author: E.J. Jansen        Version: 2                Date:   23-07-1991
Source: laboratory measurements, Fonck (ICW)
        Drying pF-curve; Ruurlo, The Netherlands, field 37

NULA
UPDP     LODP      BD  PFDE  PFWE  NUOB
PF       MOFR

**********************************************************************

  7
0.05     0.10     1.26     1     0    10
0.0      0.495
0.5      0.489
1.0      0.470
1.5      0.434
1.8      0.388
2.0      0.350
2.3      0.290
2.7      0.237
3.4      0.185
4.2      0.161
0.125    0.175    1.44   1     0     10
0.0      0.425
0.5      0.421
1.0      0.418
1.5      0.390
1.8      0.326
2.0      0.276
2.3      0.220
2.7      0.181
3.4      0.150
4.2      0.128
0.25     0.30     1.63   1     0     10
0.0      0.348
0.5      0.347
1.0      0.346
1.5      0.254
1.8      0.149
2.0      0.102
2.3      0.068
2.7      0.049
3.4      0.069
4.2      0.024
0.375    0.425    1.70   1     0     10
0.0      0.331
0.5      0.328
1.0      0.331
1.5      0.305
1.8      0.248
2.0      0.193
2.3      0.149
2.7      0.121
3.4      0.112
4.2      0.079
0.50     0.55     1.69   1     0     10
0.0      0.335
0.5      0.330
1.0      0.338
1.5      0.324
1.8      0.279
2.0      0.231
etc.
```

Example of file -------.WRC (analytical function)

```
File:   NLRU099.WRC       Code:    ASCII          Access: sequential
Author: E.J. Jansen       Version: 1              Date:   23-07-1991
Source: fictitious data
        parameters for Van Genuchten water retention function:
        MOFR = MOFRRS + ((MOFRSA - MOFRRS)/(1+A*HD)**N)
        with: MOFRRS = residual moisture content
              MOFRSA = saturated moisture content
              HD     = hydraulic head

NULA
UPDP     LODP      MOFRRS     MOFRSA      A        N

**********************************************************************

   2
0.00     0.40      0.078      0.396    0.005    0.79
0.40     1.20      0.026      0.327    0.002    0.86
```

ANNEX 5 Example of file -------.HCU

```
File:   NLRU000.HCU       Code:    ASCII          Access: sequential
Author: E.J. Jansen       Version: 3              Date:   23-07-1991
Source: Staring soil series (Wosten et al., 1987)
        0-40 cm-soil surface: topsoil B3
        >40 cm-soil surface: subsoil O2

      NULA
      UPDP   LODP   NUOB
      HYCO   MOFR

**********************************************************************

         2
      0.00   0.40     45
 0.178E+00   0.449
 0.893E-01   0.44
 0.438E-01   0.43
 0.247E-01   0.42
 0.140E-01   0.41
 0.890E-02   0.40
 0.655E-02   0.39
 0.519E-02   0.38
 0.412E-02   0.37
 0.331E-02   0.36
 0.269E-02   0.35
 0.222E-02   0.34
 0.184E-02   0.33
 0.152E-02   0.32
 0.125E-02   0.31
 0.102E-02   0.30
 0.083E-02   0.29
 0.066E-02   0.28
 0.051E-02   0.27
 0.038E-02   0.26
 0.028E-02   0.25
 0.019E-02   0.24
 0.013E-02   0.23
 0.863E-04   0.22
 0.562E-04   0.21
 0.370E-04   0.20
 0.250E-04   0.19
 0.171E-04   0.18
 0.119E-04   0.17
 0.848E-05   0.16
 0.608E-05   0.15
 0.427E-05   0.14
 0.293E-05   0.13
 0.197E-05   0.12
 0.129E-05   0.11
 0.809E-06   0.10
 0.503E-06   0.09
 0.301E-06   0.08
 0.157E-06   0.07
 0.593E-07   0.06
 0.186E-07   0.05
 0.497E-08   0.04
 0.117E-08   0.03
 0.249E-09   0.02
 0.488E-10   0.01
      0.40   1.20     39
 0.639E+00   0.381
 0.604E+00   0.38
 0.351E+00   0.37
 etc.
```

Example of file -------.HCU (analytical function)

```
File:   BEPI000.HCU        Code:    ASCII           Access: sequential
Author: M. Vanclooster     Version: 1               Date:    13-01-1990
Source: KU Leuven, Belgium
        measurements with crust method, analytical function fitted.
        Pittem, Belgium
        Hydraulic conductivity according to the Gardner relationship:
        K = KSAT /(1+(B*H)**N), with H = pressure head

NULA
UPDP     LODP        KSAT        B        N

**********************************************************************

   4
0.00     0.30       8.420    0.036     1.72
0.30     0.60      43.720    0.080     1.58
0.60     1.20     306.667    0.300     1.61
1.20     2.00    4206.670    0.300     2.00
```

ANNEX 6 Example of file ----000.CLI

```
File:   NLRU000.CLI       Code:    ASCII          Access: sequential
Author: E.J. Jansen       Version: 2              Date:   23-07-1991
Source: precipitation: experimental field,
        temperature: Meteorological Station Almen
        radiation: Meteorological Station Haren

Meteorological data from 1-1-1980 to 31-5-1985
Missing values: MITE, MATE, AVWS and AVHM

  YR  MH  DA  DANU   MITE   MATE   AVTE     PR     GLRA  AVWS  AVHM

**********************************************************************

1980   1   1     1    99.    99.    0.9    2.4     333.   -1.   -1.
1980   1   2     2    99.    99.   -0.4    2.3     127.   -1.   -1.
1980   1   3     3    99.    99.    2.3    0.4     319.   -1.   -1.
1980   1   4     4    99.    99.    1.6    2.2      63.   -1.   -1.
1980   1   5     5    99.    99.    3.9    6.3      94.   -1.   -1.
1980   1   6     6    99.    99.    5.0    4.4     110.   -1.   -1.
1980   1   7     7    99.    99.    3.2    8.7      50.   -1.   -1.
1980   1   8     8    99.    99.    1.4    0.0     177.   -1.   -1.
1980   1   9     9    99.    99.    0.1    0.0      66.   -1.   -1.
1980   1  10    10    99.    99.   -0.5    0.0     246.   -1.   -1.
1980   1  11    11    99.    99.   -2.7    0.0     179.   -1.   -1.
1980   1  12    12    99.    99.   -5.5    0.0     417.   -1.   -1.
1980   1  13    13    99.    99.   -7.0    0.0     438.   -1.   -1.
1980   1  14    14    99.    99.   -6.1    0.0     158.   -1.   -1.
1980   1  15    15    99.    99.   -4.1    0.0      99.   -1.   -1.
1980   1  16    16    99.    99.   -2.1    0.0     183.   -1.   -1.
1980   1  17    17    99.    99.   -3.5    0.0     528.   -1.   -1.
1980   1  18    18    99.    99.   -4.5    0.0     121.   -1.   -1.
1980   1  19    19    99.    99.   -2.5    0.0     231.   -1.   -1.
1980   1  20    20    99.    99.   -0.9    0.0     238.   -1.   -1.
1980   1  21    21    99.    99.    2.5    0.0     303.   -1.   -1.
1980   1  22    22    99.    99.    4.3    4.3     127.   -1.   -1.
1980   1  23    23    99.    99.    3.1    2.0     124.   -1.   -1.
1980   1  24    24    99.    99.    2.1    0.6     102.   -1.   -1.
1980   1  25    25    99.    99.    2.6    0.0     120.   -1.   -1.
1980   1  26    26    99.    99.    0.9    0.5     344.   -1.   -1.
1980   1  27    27    99.    99.    1.8    1.4     564.   -1.   -1.
1980   1  28    28    99.    99.   -0.6    0.0     111.   -1.   -1.
1980   1  29    29    99.    99.    1.2    4.7      88.   -1.   -1.
1980   1  30    30    99.    99.    6.2    0.9     191.   -1.   -1.
1980   1  31    31    99.    99.    7.0    4.6     186.   -1.   -1.
1980   2   1    32    99.    99.    1.3   11.4     483.   -1.   -1.
1980   2   2    33    99.    99.    5.5    1.7      83.   -1.   -1.
1980   2   3    34    99.    99.    4.0    9.3     206.   -1.   -1.
1980   2   4    35    99.    99.    1.6   11.1     236.   -1.   -1.
1980   2   5    36    99.    99.    7.8    8.0     103.   -1.   -1.
1980   2   6    37    99.    99.    7.0   11.5      77.   -1.   -1.
1980   2   7    38    99.    99.    6.3    0.8     129.   -1.   -1.
1980   2   8    39    99.    99.    7.5    0.4     112.   -1.   -1.
1980   2   9    40    99.    99.    8.5    0.0     349.   -1.   -1.
1980   2  10    41    99.    99.    7.0    0.0     205.   -1.   -1.
1980   2  11    42    99.    99.    5.6    0.0     303.   -1.   -1.
1980   2  12    43    99.    99.    4.5    3.2     161.   -1.   -1.
1980   2  13    44    99.    99.    5.0    1.3     294.   -1.   -1.
1980   2  14    45    99.    99.    1.6    1.4     302.   -1.   -1.
1980   2  15    46    99.    99.    5.1    0.0     195.   -1.   -1.
1980   2  16    47    99.    99.    6.2    1.7     155.   -1.   -1.
1980   2  17    48    99.    99.    5.6    0.0     246.   -1.   -1.
1980   2  18    49    99.    99.    5.0    0.0     605.   -1.   -1.
etc.
```

ANNEX 7 Example of file ----000.ETR

```
File:   NLRU000.ETR        Code:     ASCII         Access: sequential
Author: E.J. Jansen        Version: 1              Date:   08-03-1989
Source: Meteorological Station Winterswijk,
        Penman open water evaporation (mm.decade-1)

  YR       MH   DA   DANU    ET

*********************************************************************

1980        1   10     10     0
1980        1   20     20     1
1980        1   31     31     2
1980        2   10     41     4
1980        2   20     51     3
1980        2   29     60     5
1980        3   10     70     6
1980        3   20     80     8
1980        3   31     91    12
1980        4   10    101    18
1980        4   20    111    24
1980        4   30    121    25
1980        5   10    131    33
1980        5   20    141    44
1980        5   31    152    30
1980        6   10    162    28
1980        6   20    172    30
1980        6   30    182    25
1980        7   10    192    20
1980        7   20    202    18
1980        7   31    213    34
1980        8   10    223    31
1980        8   20    233    23
1980        8   31    244    22
1980        9   10    254    19
1980        9   20    264    17
1980        9   30    274     9
1980       10   10    284     8
1980       10   20    294     7
1980       10   31    305     3
1980       11   10    315     2
1980       11   20    325     4
1980       11   30    335     2
1980       12   10    345     0
1980       12   20    355     1
1980       12   31    366     2
1981        1   10    376     1
1981        1   20    386     0
1981        1   31    397     0
1981        2   10    407     4
1981        2   20    417     3
1981        2   28    425     5
1981        3   10    435     9
1981        3   20    445    12
1981        3   31    456    24
1981        4   10    466    21
1981        4   20    476    34
1981        4   30    486    22
1981        5   10    496    32
1981        5   20    506    41
1981        5   31    517    38
1981        6   10    527    42
1981        6   20    537    29
1981        6   30    547    23
etc.
```

ANNEX 8 Example of file -------.IRR

```
File:   NLRU000.IRR       Code:    ASCII            Access: sequential
Author: E.J. Jansen       Version: 2                Date:   23-07-1991
Source: fictitious data
        daynumbers start at 1-1-1980

  YR  MH  DA    DANU    AMIR    CONI    CONH

**********************************************************************

1981  07  15     562    35.0     7.5     0.2
1981  07  29     576    25.0     3.0     0.1
1982  08  20     963    30.0    12.6     0.0
1983  06  30    1277    35.0     2.2     0.4
1983  07  24    1332    30.0     7.3     0.5
1984  07   9    1652    25.0     6.8     0.1
```

ANNEX 9 Example of file -------.CRP

```
File:   NLRU037.CRP        Code:    ASCII          Access: sequential
Author: E.J. Jansen        Version: 1              Date:   26-01-1989
Source: Snijders et al. (1991)
        Data on crop sowing and harvest dates, yields and residues
        Ruurlo, The Netherlands, field nr. 37
        daynumbers start at 1-1-1980

  YR     MH   DA   DANU
CRTY     AC
CRYD     CRNT    CRNTYD      RSYD       RSNT    RSNTYD

*********************************************************************

1980      5    6    127
  1       3
3635    0.0301    127.6       0          0          0
1980      5   28    149
  1       3
1880    0.0390     73.3       0          0          0
1980      6   24    176
  1       3
2445    0.0425    103.9       0          0          0
1980      7   24    206
  1       3
2562    0.0334     85.6       0          0          0
1980      8   19    232
  1       3
2017    0.0422     85.1       0          0          0
1980      9   17    261
  1       3
2121    0.0412     87.4       0          0          0
1980     10   23    297
  1       3
1655    0.0421     69.9       0          0          0
1981      4   14    470
  1       3
 659    0.0286     18.9       0          0          0
1981      5   19    505
  1       3
2804    0.0421    118.0       0          0          0
1981      6   16    533
  1       3
2807    0.0418    117.3       0          0          0
1981      7   14    561
  1       3
1625    0.0457     74.3       0          0          0
1981      8    5    583
  1       3
3084    0.0267     82.3       0          0          0
1981      9    8    617
  1       3
2448    0.0373     91.3       0          0          0
1981     10   28    667
  1       3
2331    0.0335     78.1       0          0          0
1982      3   22    812
  1       1
   0    0.0000      0.0       0          0          0
1982      5   11    862
  1       3
1500    0.0476     71.4       0          0          0
1982      6    1    883
  1       3
3645    0.0408    148.7       0          0          0
etc.
```

ANNEX 10 Example of file -------.MAN

```
File:   NLRU039.MAN       Code:    ASCII          Access: sequential
Author: E.J. Jansen       Version: 2              Date:   03-08-1989
Source: Snijders et al. (1987)
        Ruurlo, The Netherlands, field nr. 39
        daynumbers start at 1-1-1980

  YR    MH    DA  DANU
  AC  NUAN  MTTY
  DP  AMMT  AMDM  AMOM  AMNT    AMNH    AMNI  AMPT    AMK  AMCA  AMMG

**************************************************************************
Management data

1980     3    18    78
   1     0     1
0.20 42000  4368  3276 201.6    80.6     0.0  36.7  223.3  87.2  35.6
1980     3    24    84
   1     0     6
0.00    -1    -1     0 100.0    50.0    50.0  36.9  119.5   0.0  27.7
1980     5     7   128
   1     0     6
0.00    -1    -1     0  80.0    40.0    40.0   0.0    0.0   0.0  21.7
1980     5    29   150
   1     0     6
0.00    -1    -1     0  80.0    40.0    40.0   0.0    0.0   0.0   0.0
1980     6    25   177
   1     0     6
0.00    -1    -1     0  60.0    30.0    30.0  30.6   99.6   0.0   0.0
1980     7    29   211
   1     0     6
0.00    -1    -1     0  40.0    20.0    20.0   0.0    0.0   0.0   0.0
1980     8    19   232
   1     0     6
0.00    -1    -1     0  40.0    20.0    20.0  24.5   79.7   0.0   0.0
1980     9    17   261
   1     0     6
0.00    -1    -1     0  40.0    20.0    20.0   0.0   46.5   0.0   0.0
1981     3    24   449
   1     0     6
0.00    -1    -1     0   0.0     0.0     0.0  34.9   83.0   0.0  30.1
1981     4    15   471
   1     0     1
0.20 41460  4560  3524 207.3    82.9     0.0  28.9  220.3  65.2  32.5
1981     4    16   472
   1     0     6
0.00    -1    -1     0 100.0    50.0    50.0   0.0    0.0   0.0  27.4
1981     5    22   508
   1     0     6
0.00    -1    -1     0  80.0    40.0    40.0   0.0   83.0   0.0  21.9
1981     6    19   536
   1     0     6
0.00    -1    -1     0  80.0    40.0    40.0   0.0   66.4   0.0   0.0
1981     7    14   561
   1     0     6
0.00    -1    -1     0  60.0    30.0    30.0   0.0   66.4   0.0   0.0
1981     8     5   583
   1     0     6
0.00    -1    -1     0  40.0    20.0    20.0   0.0   66.4   0.0   0.0
1981     9     8   617
   1     0     6
0.00    -1    -1     0  40.0    20.0    20.0   0.0   66.4   0.0   0.0
etc.
```

ANNEX 11 Example of file -------.SMN

```
File:   NLRU037.SMN        Code:     ASCII          Access: sequential
Author: E.J. Jansen        Version: 1               Date:    25-01-1989
Source: Measurements IB Haren.
        Soil mineral N; Ruurlo, The Netherlands, field nr. 37
        daynumbers start at 1-1-1980

  YR      MH   DA    DANU NULA
  UPDP        LODP      BD     AMNH     AMNI

*********************************************************************

1980      3   12     72    5
  0.00       0.05     1.15     4.0      8.1
  0.05       0.25     1.44     2.9      8.6
  0.25       0.50     1.59     4.0      4.0
  0.50       0.75     1.54     0.0     11.6
  0.75       1.00     1.60     0.0     16.0
1980      4   18    109    5
  0.00       0.05     1.15    12.1     14.9
  0.05       0.25     1.44     2.9     37.4
  0.25       0.50     1.59     0.0     11.9
  0.50       0.75     1.54     0.0      7.7
  0.75       1.00     1.60     0.0      8.0
1980      5    9    130    4
  0.00       0.05     1.15    46.0     64.4
  0.05       0.25     1.44    17.3     25.9
  0.25       0.50     1.59     4.0      8.0
  0.50       1.00     1.57     0.0     23.6
1980      6    4    156    4
  0.00       0.05     1.15    32.2     75.9
  0.05       0.25     1.44    11.5     60.5
  0.25       0.50     1.59     4.0     15.9
  0.50       1.00     1.57     0.0     23.6
1980      6   26    178    4
  0.00       0.05     1.15    97.2     40.3
  0.05       0.25     1.44    17.3     80.6
  0.25       0.50     1.59     0.0     11.9
  0.50       1.00     1.57    39.3     78.5
1980      7   25    207    4
  0.00       0.05     1.15    12.6     14.9
  0.05       0.25     1.44     5.8     23.0
  0.25       0.50     1.59     0.0     67.6
  0.50       1.00     1.57     0.0     55.0
1980      8   19    232    4
  0.00       0.05     1.15    17.3     10.3
  0.05       0.25     1.44    14.4     23.0
  0.25       0.50     1.59     4.0     19.9
  0.50       1.00     1.57     0.0     23.6
1980      9   17    261    4
  0.00       0.05     1.15    15.5      2.9
  0.05       0.25     1.44     5.8     40.3
  0.25       0.50     1.59     0.0     43.7
  0.50       1.00     1.57     0.0     47.1
1980     11   20    325    5
  0.00       0.05     1.15     8.1      6.9
  0.05       0.25     1.44     2.9     17.3
  0.25       0.50     1.59     0.0     47.7
  0.50       0.75     1.54     0.0     42.4
  0.75       1.00     1.60     0.0     36.0
1981      4    6    462    5
  0.00       0.05     1.15     7.5      6.9
  0.05       0.25     1.44     0.0      8.6
etc.
```

ANNEX 12 Example of file -------.SMO

```
File:   NLRU037.SMO        Code:     ASCII          Access: sequential
Author: E.J. Jansen        Version: 2               Date:   16-10-1990
Source: gamma-radiation measurements Fonck (ICW)
        Soil moisture contents
        Ruurlo, The Netherlands, field nr. 37
        daynumbers start at 1-1-1980

  YR      MH   DA    DANU NULA
  UPDP      LODP      MOFR

**********************************************************************

1980     4   24     115   12
  0.05      0.15     0.347
  0.15      0.25     0.340
  0.25      0.35     0.224
  0.35      0.45     0.170
  0.45      0.55     0.197
  0.55      0.65     0.266
  0.65      0.75     0.295
  0.75      0.85     0.337
  0.85      0.95     0.341
  0.95      1.05     0.361
  1.05      1.15     0.362
  1.15      1.25     0.337
1980     5   21     142   12
  0.05      0.15     0.244
  0.15      0.25     0.197
  0.25      0.35     0.153
  0.35      0.45     0.201
  0.45      0.55     0.189
  0.55      0.65     0.244
  0.65      0.75     0.270
  0.75      0.85     0.317
  0.85      0.95     0.332
  0.95      1.05     0.346
  1.05      1.15     0.356
  1.15      1.25     0.344
1980     5   28     149   12
  0.05      0.15     0.221
  0.15      0.25     0.185
  0.25      0.35     0.135
  0.35      0.45     0.130
  0.45      0.55     0.184
  0.55      0.65     0.232
  0.65      0.75     0.290
  0.75      0.85     0.320
  0.85      0.95     0.341
  0.95      1.05     0.350
  1.05      1.15     0.356
  1.15      1.25     0.336
1980     6    6     158   12
  0.05      0.15     0.203
  0.15      0.25     0.166
  0.25      0.35     0.126
  0.35      0.45     0.124
  0.45      0.55     0.185
  0.55      0.65     0.243
  0.65      0.75     0.293
  0.75      0.85     0.325
  0.85      0.95     0.334
  0.95      1.05     0.347
  1.05      1.15     0.356
etc.
```

ANNEX 13 Example of file -------.PRH

```
File:   NLRU099.PRH        Code:    ASCII          Access: sequential
Author: E.J. Jansen        Version: 1              Date:   23-07-1991
Source: fictitious data
        daynumbers start at 1-1-1980

  YR      MH   DA   DANU NUDP
  DP           HD

***********************************************************************

1980       4   24    115   5
  0.05    -1200.
  0.25     -140.
  0.35      -90.
  0.60      -50.
  0.90      -20.
1980       5   21    142   5
  0.05     -105.
  0.25     -145.
  0.35      -98.
  0.60      -72.
  0.90      -45.
1980       5   28    149   5
  0.05     -753.
  0.25     -221.
  0.35     -130.
  0.60      -97.
  0.90      -65.
1980       6    6    158   5
  0.05     -115.
  0.25      -95.
  0.35      -85.
  0.60      -60.
  0.90      -30.
etc.
```

ANNEX 14 Example of file -------.STE

```
File:   NLRU000.STE        Code:    ASCII          Access: sequential
Author: E.J. Jansen        Version: 1              Date:   22-12-1988
Source: measurements CABO, Wageningen
        Average soil temperature (oC) at three depths
        Ruurlo, The Netherlands
        daynumbers start at 1-1-1980

NUDP  DP(1,2...NUDP
 YR     MH   DA   DANU        SOTE(1)       SOTE(2)       SOTE(3)

**********************************************************************

   3  0.05  0.15  0.30
1980     4    2    93            7.7           7.1           7.0
1980     4   15   106            8.3           8.3           8.7
1980     4   23   114            6.6           6.8           7.6
1980     5    1   122            9.1           8.8           8.9
1980     5    8   129            9.8           9.4           9.4
1980     5   16   137           10.6          10.5          10.9
1980     5   22   143           11.8          12.2          12.5
1980     5   27   148           13.0          11.9          11.8
1980     6    5   157           18.7          14.9          13.3
1980     6   12   164           19.8          16.1          14.7
1980     6   19   171           13.8          13.8          14.3
1980     6   25   177           14.9          14.1          13.7
1980     7    3   185           16.5          14.8          14.3
1980     7   10   192           16.1          15.5          15.3
1980     7   17   199           15.6          14.3          14.1
1980     7   25   207           16.1          15.5          15.0
1980     8    1   214           19.8          17.8          17.6
1980     8    8   221           20.5          18.6          17.7
1980     8   15   228           17.5          17.0          16.9
1980     8   22   235           16.7          16.4          16.5
1980     8   30   243           17.8          17.0          16.8
1980     9    8   252           17.2          15.7          15.8
1980     9   12   256           15.5          15.1          15.2
1980     9   22   266           17.9          16.6          16.4
1980    10    3   277           11.9          12.9          13.6
1980    10   10   284           10.4          10.5          11.5
1980    10   18   292           10.9          10.6          11.0
1981     1   27   393            3.1           2.5           2.8
1981     2   11   408            2.1           3.1           4.0
1981     2   21   418            0.2           0.7           1.5
1981     3    6   431            0.4           2.5           5.4
1981     3   17   442            6.1           5.7           6.2
1981     3   31   456            8.5           6.6           5.3
1981     4   10   466           10.0           9.0           9.4
1981     4   21   477            7.5           7.6           8.4
1981     4   27   483            8.0           8.1           8.6
1981     5    8   494           13.9          11.4          10.0
1981     5   18   504           16.2          13.6          12.4
1981     5   29   515           15.2          13.5          13.3
1981     6    9   526           17.6          16.4          15.8
1981     6   16   533           15.7          15.3          15.4
1981     6   24   541           22.6          17.8          16.1
1981     7    3   550           17.2          16.4          15.7
1981     7    7   554           21.7          18.4          16.6
1981     7   16   563           18.7          17.5          17.0
1981     7   24   571           16.6          16.5          16.9
1981     7   31   578           16.2          15.3          15.9
1981     8   11   589           18.6          17.8          18.0
1981     8   22   600           16.4          15.4          15.9
etc.
```

ANNEX 15 Example of file -------.GWL

```
File:   NLRU037.GWL        Code:    ASCII        Access: sequential
Author: E.J. Jansen        Version: 2            Date:   31-07-1990
Source: piezometer measurements Fonck (ICW)
        groundwater levels
        Ruurlo, The Netherlands, field nr. 37
        daynumbers start at 1-1-1980

  YR     MH   DA   DANU     GWLV

*********************************************************************

1980     4   24    115     0.71
1980     5    2    123     1.04
1980     5    7    128     0.81
1980     5   21    142     1.04
1980     5   28    149     1.14
1980     6    6    158     1.18
1980     6   11    163     1.24
1980     6   27    179     1.19
1980     7    9    191     0.82
1980     7   25    207     0.46
1980     8    8    221     0.85
1980     8   20    233     0.87
1980     9    4    248     0.85
1980     9   19    263     0.68
1980    10    3    277     0.91
1980    10   14    288     0.81
1980    10   28    302     0.70
1981     1   24    390     0.17
1981     3    3    428     0.52
1981     3   24    449     0.43
1981     4    7    463     0.64
1981     4   13    469     0.73
1981     4   21    477     0.80
1981     4   27    483     0.85
1981     5    7    493     0.70
1981     5   13    499     0.92
1981     5   19    505     0.93
1981     5   26    512     0.95
1981     6    2    519     0.86
1981     6    9    526     0.89
1981     6   12    529     0.97
1981     6   16    533     1.03
1981     6   24    541     1.11
1981     6   30    547     0.52
1981     7    7    554     0.77
1981     7    9    556     0.85
1981     7   15    562     0.72
1981     7   21    568     0.83
1981     7   28    575     0.56
1981     8    4    582     0.79
1981     8   11    589     0.91
1981     8   18    596     1.08
1981     8   25    603     1.14
1981     8   31    609     1.21
1981     9    1    610     1.21
1981     9    3    612     1.25
1981     9    8    617     1.30
1981     9   15    624     1.30
1981     9   22    631     1.17
1981     9   30    639     1.18
1981    10    7    646     1.12
etc.
```

ANNEX 16 Example of file -------.LEA

```
File:   NLRU037.LEA       Code:     ASCII             Access: sequential
Author: E.J. Jansen       Version: 3                  Date:    31-07-1990
Source: ceramic cup measurements Fonck (ICW)
        NO3-N concentrations
        Ruurlo, The Netherlands, field nr. 37
        daynumbers start at 1-1-1980

SMMD    UPDP  LODP
  YR     MH    DA   DANU     CONI

*********************************************************************

   2   0.90   1.00

1980      8     8    221     13.6
1980     10    16    290     12.6
1981      1    22    388     50.1
1981      3     4    429     32.2
1981      4     1    457      9.4
1981      7    15    562     16.5
1981     10    27    666     15.3
1981     11    25    695     20.6
1982      1    26    757     30.3
1982      3    19    809     28.9
1982     11    25   1060     26.3
1983      1    11   1107     43.6
1983      3     9   1164     41.2
1983      5    13   1229     21.7
1983      6    20   1267     15.5
1984      1     6   1467     43.1
1984      1    30   1491     45.6
1984      2    22   1514     35.3
1984      3    22   1543     28.6
1984      4    10   1562     28.7
1984      7     9   1652     22.8
1984     10     3   1738     18.5
1984     11     1   1767     36.1
1984     11    29   1795     35.6
1985      3     5   1891     34.8
1985      4     4   1921     31.6
```

ANNEX 17 List of adresses where datasets of field studies can be obtained, which comply with the described standardization

1. Pittem, Belgium. Grain maize on a sandy loam; pig slurry; groundwater level at 1.0-2.5 meter depth; 1 field, 1 year.

   Laboratory of Land Management
   Catholic University of Leuven
   Kardinaal Mercierlaan 92
   3001 Heverlee, Belgium
   phone: +32 16 220931
   fax: +32 16 205032

2. Askov, Denmark. Spring barley on a sandy loam; pig slurry and mineral fertilizer; groundwater level at 40 meter depth; 3 fields, 2 years.
   Jyndevad, Denmark. Spring barley on sand; pig slurry and mineral fertilizer; groundwater level at 1.5-2 meter depth; 6 fields, 2 years.

   Institute of Soil Physics
   Soil Tillage and Irrigation
   Flensborgvej 22
   DK 6360 Tinglev, Denmark
   phone: +45 74 648316
   fax: +45 74 648489

3. Nauplio, Greece. Eggplants and oat; mineral fertilizer, irrigation; groundwater level deeper than 12 meter; 4 fields, 2 years.
   Agrinio, Greece. Tobacco on a clay soil; mineral fertilizer; irrigation; groundwater level deeper than 15 meter; 4 field, 2 years.

   Laboratory of Soils and Agricultural Chemistry
   Athens Faculty of Agriculture
   75, Iera Odos, Botanicos
   Athens 118 55, Greece
   phone: +30 3464 221
   fax: +30 3460 885

4. Ruurlo, the Netherlands; grassland on a loamy sand, cattle slurry and mineral fertilizer, groundwater at 0.5-1.7 meter depth; 12 fields, 5 years.

   The Winand Staring Centre
   Department of Environmental Protection
   P.O. Box 125
   6700 AC Wageningen, The Netherlands
   phone: +31 8370 74200
   fax: +31 8370 24812

5. Gleadthorpe, United Kingdom. Grass, winter wheat and potatoes on a loamy sand; mineral fertilizer, groundwater level at 20 meter depth, 3 fields, 2 years.
   Lockington, United Kingdom. Grass, winter wheat and potatoes on a sandy loam; mineral fertilizer, groundwater level at 1-3 meter depth, 3 fields, 2 years.

   Soil Survey and Land Research Centre
   Silsoe Campus
   Beds., MK45 4DT, UK
   phone: +44 525 60428
   fax +44 525 61147