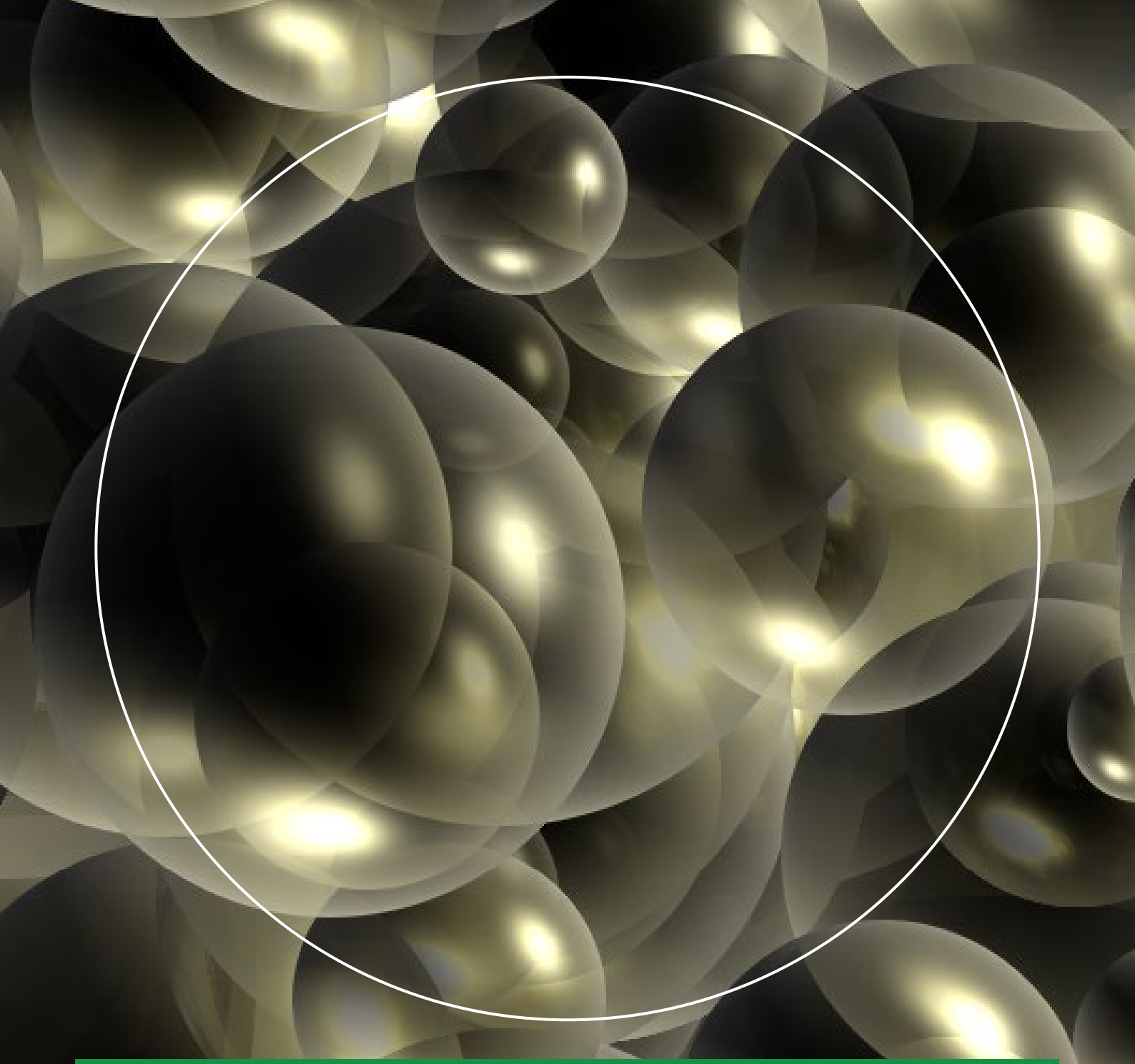

GeoPEARL version 4.4.4

Technical description of database and interface

D.W.G. van Kraalingen, F. van den Berg , A. Tiktak, J.J.T.I. Boesten

WOt-technical report 210

WAGENINGEN
UNIVERSITY & RESEARCH

GeoPEARL version 4.4.4

This Technical report was produced in accordance with the Quality Management System of the Statutory Research Tasks Unit for Nature & the Environment, part of Wageningen University & Research.

The mission of the Statutory Research Tasks Unit for Nature and the Environment (WOT Natuur & Milieu) is to carry out statutory research tasks on issues relating to nature and the environment. These tasks are implemented in order to support the Dutch Minister of Agriculture, Nature and Food Quality, who is responsible for these issues. We provide data about agri-environment, biodiversity and soil information to compile reports as part of national and international obligations, and we work on products of the PBL Netherlands Environmental Assessment Agency, such as the Assessment of the Human Environment reports.

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The 'WOt-technical reports' series presents the findings of research projects implemented for the Statutory Research Tasks Unit for Nature & the Environment by various centres of expertise.

This report/publication presents the findings of a research project by Wageningen Environmental Research together with PBL Netherlands Environmental Assessment Agency. PBL is an autonomous research institute in the fields of the environment, nature and spatial planning, as is safeguarded in the Protocol for the Policy Assessment Agencies (Aanwijzingen voor de Planbureaus), Staatscourant (government gazette) 3200, 21 February 2012.

This document contributes to the body of knowledge which will be incorporated in more policy-oriented publications such as the National Nature Outlook and Environmental Balance reports, and thematic assessments.

The research was funded by the Dutch Ministry of Agriculture, Nature and Food Quality (LNV).

GeoPEARL version 4.4.4

Technical description of database and interface

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Abstract
Kraalingen, D.W.G. van, F. van den Berg, A. Tiktak and J.J.T.I. Boesten (2022). *GeoPEARL version 4.4.4; Technical description of database and interface.* Wageningen, The Statutory Research Tasks Unit for Nature and the Environment (WOT Natuur & Milieu), WOt-technical report 210. 61 p.; 6 Figs; 3 Tabs; 7 Refs; 6 Annexes.

In the Dutch Decision Tree for the evaluation of the leaching potential of pesticides, the GeoPEARL model is used to calculate the 90th spatial percentile of the median leaching concentration in time at a depth of 1.0 m. This report describes the design and contents of the database as well as the exchange of data between the database and interface of GeoPEARL version 4.4.4.

Keywords: crop protection product, database structure, groundwater, leaching, pesticide, software design

Referaat
Kraalingen, D.W.G. van, F. van den Berg, A. Tiktak and J.J.T.I. Boesten (2022). *GeoPEARL 4.4.4; Technical description of database and interface.* Wettelijke Onderzoekstaken Natuur & Milieu, WOt-technical report 210. 61 blz.; 6 fig.; 3 tab.; 7 ref; 6 Bijlagen.

In de Nederlandse Beslisboom voor de evaluatie van het risico op uitspoeling van pesticiden wordt gebruik gemaakt van het GeoPEARL-model om het ruimtelijk 90-percentiel van de mediane uitspoelconcentratie in de tijd op een diepte van 1 m te berekenen. Dit rapport beschrijft het ontwerp en de inhoud van de database alsook de uitwisseling van gegevens tussen de database en het interface van GeoPEARL versie 4.4.4.

Trefwoorden: database-structuur, gewasbeschermingsmiddel, grondwater, pesticide, software-ontwerp, uitspoeling

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This report can be downloaded free of charge from https://doi.org/10.18174/556523 or from www.wur.nl/wotnatuurenmilieu. WOT Natuur & Milieu provides *no printed copies* of reports.

Preface

This technical report has been prepared to describe the design and structure of the database and the user interface of GeoPEARL 4.4.4.

The GeoPEARL database of this version no longer contains substance specific data. To edit, store and archive these data a separate application has been developed, i.e. SPIN. GeoPEARL version 4.4.4 is coupled to SPIN version 3.3.

Contents

Summary

In 2004, a new decision tree for the evaluation of the leaching of pesticides to groundwater in the Netherlands has been adopted. At Tier 2 of the tiered approach for this evaluation, the spatially-distributed leaching model GeoPEARL is used. The target value of this evaluation is the 90th spatial percentile of the median leaching concentration at a soil depth of 1 m for spatial units (plots) representative for the area of use of the pesticide. The decision tree was revised in 2022 because new insights revealed that the organic matter map in GeoPEARL was not representative for arable soils. For this reason, a new organic matter map was produced, which is implemented in the database of GeoPEARL 4.4.4. This model version is compatible with the revised decision tree described in Tiktak et al. (2022).

This technical report describes the design and contents of the GeoPEARL 4.4.4 database as well as the exchange of data between the database and the user interface. This document contributes to the quality assurance of the model and supports its further development.

Samenvatting

In 2004 werd een nieuwe beslisboom voor de beoordeling van de uitspoeling van pesticiden naar het grondwater in Nederland in gebruik genomen. In de tweede tree van de getrapte benadering voor deze beoordeling wordt gebruik gemaakt van het ruimtelijk-gedistribueerd uitspoelingsmodel GeoPEARL. De doelgrootheid voor deze beoordeling is het 90 ruimtelijk percentiel van de mediane uitspoelconcentratie op een bodemdiepte van 1 m voor ruimtelijke eenheden (plots) die representatief zijn voor het areaal waarbinnen het bestrijdingsmiddel toegepast wordt. De beslisboom werd herzien in 2022, aangezien op basis van nieuw inzicht gebleken was dat de organische-stof kaart in GeoPEARL niet representatief was voor akkerlandgronden. Daarom werd een nieuwe organische-stofkaart gemaakt die geïmplementeerd is in de database van GeoPEARL 4.4.4. Deze modelversie is compatibel met de herziene beslisboom zoals beschreven in Tiktak et al. (2022).

Dit technisch rapport beschrijft het ontwerp en de inhoud van de GeoPEARL database alsook de uitwisseling van data tussen de GeoPEARL 4.4.4 database en het gebruikersinterface. Dit document draagt bij aan de kwaliteitsborging van het model en ondersteunt de verdere ontwikkeling ervan.

1 Introduction

In 2004, the Netherlands have adopted a revised decision tree for the evaluation of the leaching potential of pesticides (Van der Linden et al., 2004). In this decision tree, it is evaluated whether the concentration in groundwater exceeds the EU drinking water limit, which is 0.1 µg/L. A spatially-distributed pesticide leaching model, GeoPEARL, has been developed. GeoPEARL calculates the leaching of a pesticide and its metabolites to the uppermost groundwater for the area of use. The target output for the Dutch pesticide registration procedure is the 90th spatial percentile of the median leaching concentration over a period of 20 years. As new insights revealed that the soil organic matter map in GeoPEARL was not representative for arable soils, an improved soil organic matter map was prepared and implemented in GeoPEARL 4.4.4. Further background information on the updated decision tree on leaching and the use of GeoPEARL 4.4.4 can be found in RIVM report 2022-0048 (Tiktak et al., 2022).

To assess the leaching concentration a spatial schematisation has been developed using data on weather, land use, soil profiles, drainage systems, hydrotypes and crop specific data. A relational database has been developed to store all these data. This document describes the design and the elements of the database as well as the use of the data to prepare the input to assess the leaching concentration using GeoPEARL 4.4.4.

1.1 Spatial schematisation

The spatial schematisation is based on a number of unique combinations of spatially-distributed model inputs. The following model inputs were considered: soil physical type, soil organic matter, land use type, climate district, groundwater depth classes, geometry of the subsoil ('hydrotypes') and drainage characteristics. These maps as shown in Figure 1.1 were converted to raster maps with a resolution of 250 by 250 m. The number of combinations was reduced using relation diagrams, so combinations with analogous properties were clustered. This resulted in a total of 6405 unique combinations. These unique combinations are called plots. More detailed information on the STONE schematisation is given by Kroes et al. (2001).

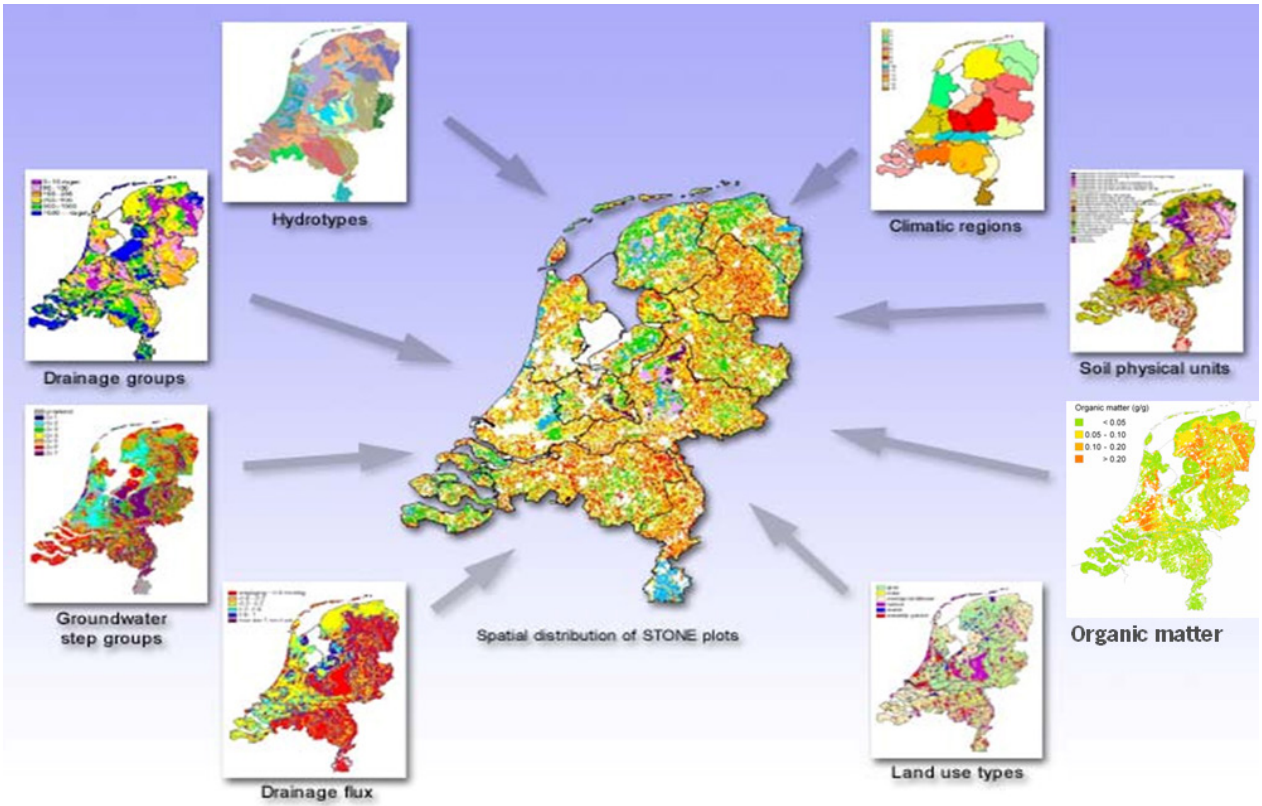

Figure 1.1 *Combination of spatial maps to derive the spatial schematisation of GeoPEARL.*

1.2 The GeoPEARL modelling system

An overview of the GeoPEARL user interface, which is an integrated environment for data storage and data retrieval, model control and viewing the output data is shown in Figure 1.2. The user communicates with the GeoPEARL modelling system through the graphical user interface. This interface is linked with a relational database for scenario and user data, and to SPIN, the Substance PlugIN, in which pesticides and their properties are managed. It also generates the input files for the GeoPEARL executable. The GeoPEARL executable then calls the PEARL model. It does so for each item of the spatial schematisation as described above, the so-called plots. The output of GeoPEARL is read by the user interface into the GeoPEARL database. Please note that after running the model and reading of the data files, all data are read into the db and display of results is done purely based on data that are in the db.

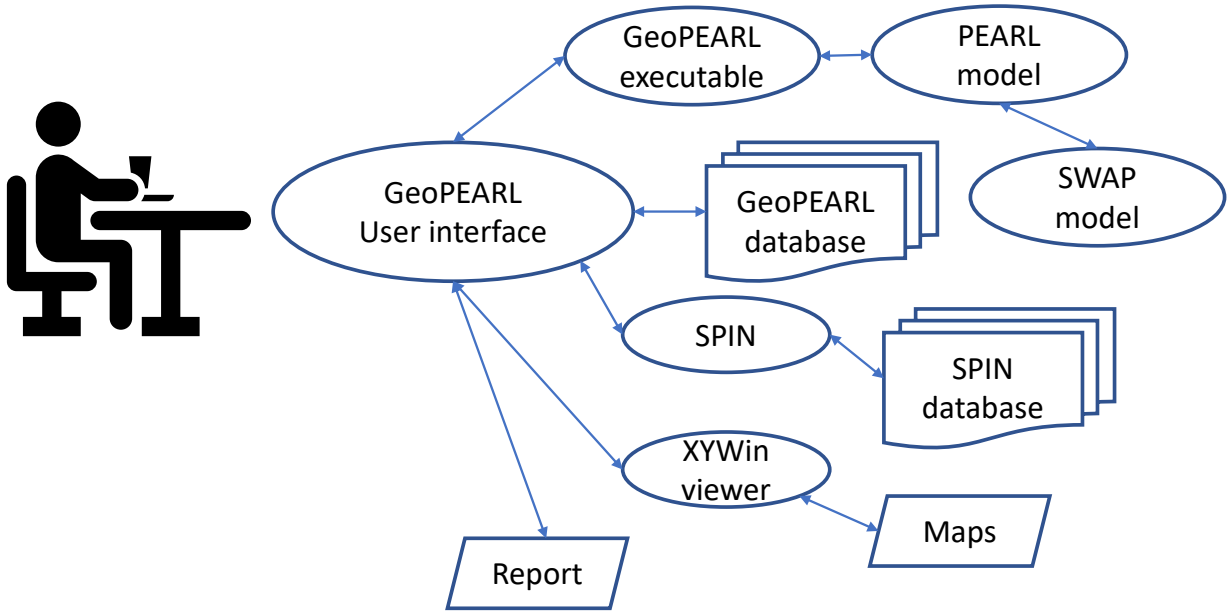

Figure 1.2 *Overview of the GeoPEARL modelling system.*

The GeoPEARL modelling system consists of the GeoPEARL database, the GeoPEARL interface and the model kernels, i.e. SWAP, PEARL and GeoPEARL. A separate viewer (XYWin) is provided to facilitate graphs and maps. The user interface of GeoPEARL is programmed in Delphi 11.1, and it facilitates the interaction between the user and the data available in the database. The user has to select the crop, the substance and application scheme for the substance. The data on the substance have to be specified by the user in the Substance PlugIN (SPIN) application, which has been coupled to the latest version of GeoPEARL, v 4.4.4. Data on application schemes as defined by the user are stored in the GeoPEARL database. The structure and the tables in the database are presented in Chapter 2. In Chapter 3 the directory structure for the execution of calculations for an assessment is described. The sequence of events while running an assessment is clarified in Chapter 4. The procedure to generate input for the execution of GeoPEARL assessments and the postprocessing of the output of the model kernels are presented in Chapter 5. No details are presented on the model kernels in this report, but detailed information on these models is given in Van den Berg et al. (2016, 2018).

2 The GeoPEARL database

2.1 General

The GeoPEARL database is a relational database consisting of 36 tables, implemented in FireBird, with ODS version 11.2 (see https://firebirdsql.org/). This platform was chosen for the embedded database drivers it provides, facilitating access to the database from a Delphi application (Embarcadero, Delphi 10.1 Berlin) without prior installation of special database server software. This greatly simplifies the deployment process.

References from one table to the other are always done with Bigint fields, for this datatype provides the greatest integer range. Relations from one table to another are always setup with cascading deletes and cascading updates.

References to substances are always made by a SUBSTANCEGUID field. The substances itself are not part of the GeoPEARL db, but of the SPIN db.

The structure of the GeoPEARL database is shown in Figure 2.1.

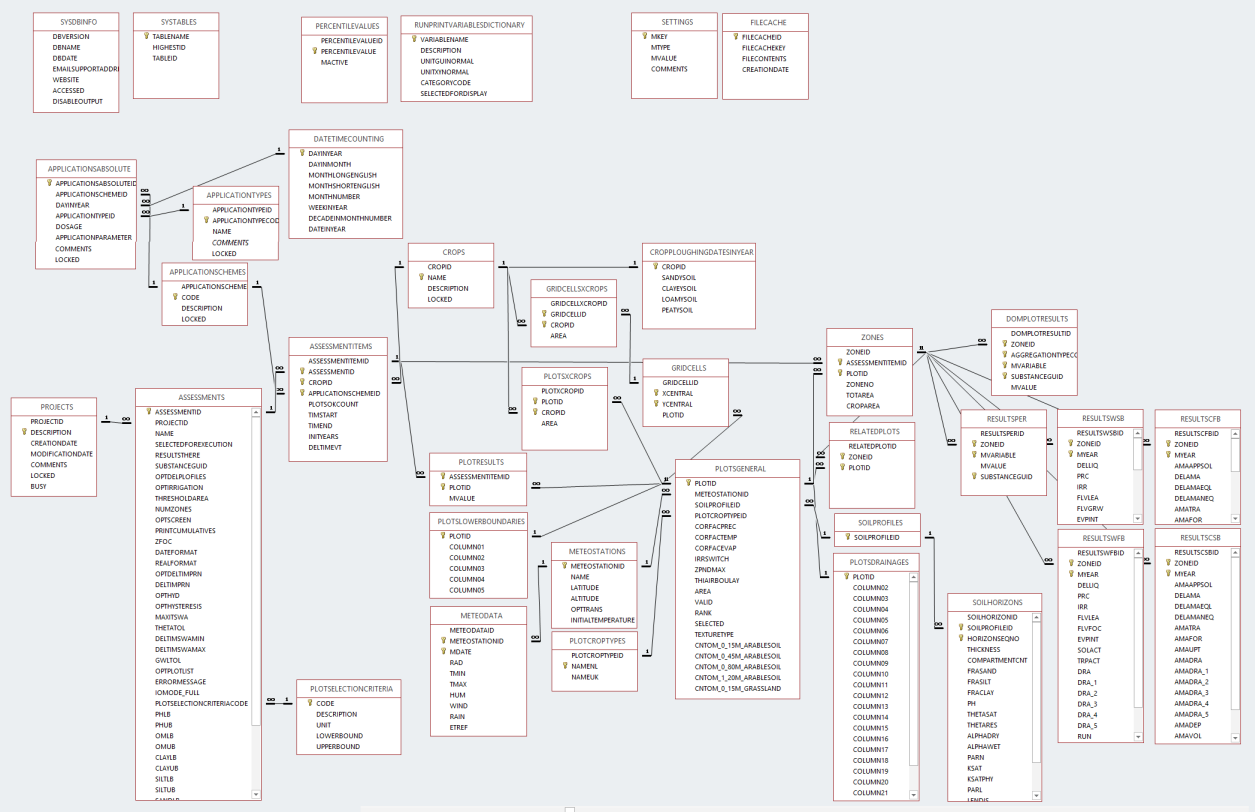

Figure 2.1 *The structure and relations in the GeoPEARL database version 65*

The database contains:

- tables that can be edited directly by the user (although some records may be locked for changes, such as the example project) through the GeoPEARL user interface
- tables that are modified by the GUI (when the user makes a run or interacts with GeoPEARL to make a map or a graph, to remember previous choices etc.)
- tables that are static (=read-only), containing mostly scenario data

These are described in the following sections 'User modifiable tables', 'UI and run support tables' and 'Read-only tables'.

2.2 ZONES, PLOTSGENERAL, GRIDCELLS, DOMPLOTRESULTS and RELATEDPLOTS relations explained

The PLOTSGENERAL table contains (as explained above) the STONE schematisation for the Netherlands, the so-called plots. However, plots do not have a geo location, and it is through the coupling with table GRIDCELLS that each plot is given a geo location.

Prior to actual simulation, a selection is made of plots in PLOTSGENERAL based on the user plot selection criteria (in table PLOTSELECTIONCRITERIA). These selected plots are written to file together with the user's choice of the total number of most relevant plots to calculate (for valid assessments this must be at least 250). It is now up to the GeoPEARL model kernel to determine the required dominant ones out of the selected plots. These are read into table ZONES upon termination of the assessment calculation. Plots that were in the selection, but were not the dominant ones, are read into table RELATEDPLOTS. The table DOMPLOTRESULTS is read after assessment calculation and contains for each dominant plot (in table ZONES), a number of predefined aggregated quantities such as lateral discharges, precipitations and evapotranspirations.

2.3 CROPS, PLOTSXCROPS, GRIDCELLSXCROPS and PLOTSGENERAL explained

As explained above, PLOTSGENERAL contains STONE schematisation plots but without a geo reference. It is the table GRIDCELLS that contains the geo locations for each individual plot.

The table GRIDCELLSXCROPS contains the crop maps (each grid cell is coupled to one or more crops in table CROPS, with an area within the grid cell). Table PLOTSXCROPS couples each plot to a crop, with an area within that plot. The PLOTSXCROPS table is in a way redundant, as it can be derived from GRIDCELLSXCROPS, but it is put in the database for reasons of simplicity.

2.4 User modifiable tables

2.4.1 PROJECTS

Table to hold the projects. A project is a grouping of assessments made by the user, nothing more, nothing less. This table can be modified by the user, except for the locked items. The BUSY flag is set when assessments are actually run.

The contents of this table are not used by the calculation kernel.

PROJECTID	Bigint NOT NULL
DESCRIPTION	Varchar(250) NOT NULL
CREATIONDATE	Timestamp
MODIFICATIONDATE	Timestamp
COMMENTS	Varchar(250)
LOCKED	Varchar(3) NOT NULL
BUSY	Varchar(3) NOT NULL

Unique fields: primary key: (DESCRIPTION), additional: (PROJECTID)

2.4.2 ASSESSMENTS

Table to hold the assessments that the user is working on. This is the 'working horse' of GeoPEARL. An important reference is SUBSTANCEGUID, the reference to the substance of the assessment.

The contents of this table are written to the .geo file.

ASSESSMENTID	Bigint NOT NULL
PROJECTID	Bigint NOT NULL
NAME	Varchar(50) NOT NULL
SELECTEDFOREXECUTION	Varchar(3) NOT NULL
RESULTSTHERE	Varchar(31)
SUBSTANCEGUID	Varchar(38) NOT NULL
OPTDELPLOFILES	Varchar(3) NOT NULL
OPTIRRIGATION	Varchar(3) NOT NULL
THRESHOLDAREA	Double precision
NUMZONES	Integer
OPTSCREEN	Varchar(3) NOT NULL
PRINTCUMULATIVES	Varchar(3) NOT NULL
ZFOC	Double precision
DATEFORMAT	Varchar(50)
REALFORMAT	Varchar(50)
OPTDELTIMPRN	Varchar(20)
DELTIMPRN	Double precision
OPTHYD	Varchar(20)
OPTHYSTERESIS	Varchar(3) NOT NULL
MAXITSWA	Integer
THETATOL	Double precision
DELTIMSWAMIN	Double precision
DELTIMSWAMAX	Double precision
GWLTOL	Double precision
OPTPLOTLIST	Varchar(50)
ERRORMESSAGE	Varchar(2000)
IOMODE_FULL	Varchar(3) NOT NULL
PLOTSELECTIONCRITERIACODE	Varchar(31) NOT NULL
PHLB	Double precision NOT NULL
PHUB	Double precision NOT NULL
OMLB	Double precision NOT NULL
OMUB	Double precision NOT NULL
CLAYLB	Double precision NOT NULL
CLAYUB	Double precision NOT NULL
SILTLB	Double precision NOT NULL
SILTUB	Double precision NOT NULL
SANDLB	Double precision NOT NULL
SANDUB	Double precision NOT NULL
SESQLB	Double precision NOT NULL
SESQUB	Double precision NOT NULL
OPTPERSISTENCY	Varchar(3) NOT NULL
THILAYPER	Double precision NOT NULL
SUBSTANCECHECKSUM	Varchar(9)
OPTPLOTSELECTION	Varchar(9)

Unique fields: primary key: (ASSESSMENTID), additional: (NAME)

2.4.3 ASSESSMENTITEMS

Table to hold assessment items, e.g. detail of records of table ASSESSMENTS. The details reference one crop and one substance application scheme. This table can be modified by the user.

The contents of this table are written to the .geo file.

ASSESSMENTITEMID	Bigint NOT NULL
ASSESSMENTID	Bigint NOT NULL
CROPID	Bigint NOT NULL
APPLICATIONSCHEMEID	Bigint NOT NULL
PLOTSOKCOUNT	Integer NOT NULL
TIMSTART	Timestamp
TIMEND	Timestamp
INITYEARS	Integer NOT NULL
DELTIMEVT	Integer NOT NULL

Unique fields: primary key: (ASSESSMENTID,CROPID,APPLICATIONSCHEMEID), additional: (ASSESSMENTITEMID), (ASSESSMENTID,CROPID)

2.4.4 APPLICATIONSCHEMES

Table to hold the substance application schemes. Implementation details of absolute date of application etc. are in table APPLICATIONSABSOLUTE. This table can be modified by the user, except for the locked items. This table is shown in the pick list 'Application:' on the 'Crops and Applications' tab of the assessment form, and in the application schemes form.

The contents are written to the section 'table Applications' in the Applications.app file.

APPLICATIONSCHEMEID	Bigint NOT NULL
CODE	Varchar(31) NOT NULL
DESCRIPTION	Varchar(250)
LOCKED	Varchar(3) NOT NULL

Unique fields: primary key: (CODE), additional: (APPLICATIONSCHEMEID)

2.4.5 APPLICATIONSABSOLUTE

Table to hold the absolute date of substance application and how the substance application was done. This table can be modified by the user, except for the locked items.

The contents are written to the section 'table Applications' in the Applications.app file.
N.B. GeoPEARL has no relative applications, unlike other applications in the field of pesticide modelling.

APPLICATIONSABSOLUTEID	Bigint NOT NULL
APPLICATIONSCHEMEID	Bigint NOT NULL
DAYINYEAR	Integer NOT NULL
APPLICATIONTYPEID	Bigint NOT NULL
DOSAGE	Double precision
APPLICATIONPARAMETER	Double precision
COMMENTS	Varchar(250)
LOCKED	Varchar(3) NOT NULL

Unique fields: primary key: (APPLICATIONSABSOLUTEID)

2.4.6 PLOTSELECTIONCRITERIA

Table to hold the plot selection criteria as defined by the 'Plot selection' button on the General tab of the main form. A plot selection record is linked to the ASSESSMENTS table, indicating the user's choice for selection of plots in table SOILHORIZONS. This selection is used to select the plots in table PLOTSGENERAL that have the selected soil horizons. Data of this table are not written directly to a file for processing of the calculation kernel.

CODE	Varchar(31) NOT NULL
DESCRIPTION	Varchar(255) NOT NULL
UNIT	Varchar(50) NOT NULL
LOWERBOUND	Double precision NOT NULL
UPPERBOUND	Double precision NOT NULL

Unique fields: primary key: (CODE)

2.5 User interface and run support tables

2.5.1 PLOTSGENERAL

Table to hold plot dependent info. Each plot references a meteo station for the plot, a soil profile and plot crop type. This table cannot be modified by the user. The SELECTED field changes dependent on the assessment that is being analysed.

The contents are written to the Schematisation.unc, Schematisation.plo and AssessmentItem.crf files in 'table PloCrpArea', 'table Plots' and 'table Plots', respectively. See the contents of this file for the meaning of the columns (also partly given in Annex 4, 5 and 6).

PLOTID	Bigint NOT NULL
METEOSTATIONID	Bigint
SOILPROFILEID	Bigint
PLOTCROPTYPEID	Bigint
CORFACPREC	Double precision
CORFACTEMP	Double precision
CORFACEVAP	Double precision
IRRSWITCH	Integer
ZPNDMAX	Double precision
THIAIRBOULAY	Double precision
AREA	Double precision
VALID	Varchar(3) NOT NULL
RANK	Integer
SELECTED	Varchar(3) NOT NULL
TEXTURETYPE	Integer NOT NULL
CNTOM_0_15M_ARABLESOIL	Double precision
CNTOM_0_45M_ARABLESOIL	Double precision
CNTOM_0_80M_ARABLESOIL	Double precision
CNTOM_1_20M_ARABLESOIL	Double precision
CNTOM_0_15M_GRASSLAND	Double precision

Unique fields: primary key: (PLOTID)

2.5.2 ZONES

Table to hold the calculated zones for an assessment item. This table cannot be modified by the user, but is appended after calculations by the user interface.

The contents of this table are written to the .geo file.

ZONEID	Bigint NOT NULL
ASSESSMENTITEMID	Bigint NOT NULL
PLOTID	Bigint NOT NULL
ZONENO	Integer
TOTAREA	Double precision
CROPAREA	Double precision

Unique fields: primary key (ASSESSMENTITEMID,PLOTID), additional: (ZONEID)

2.5.3 RELATEDPLOTS

Table to hold the plots related to a zone. This table cannot be modified by the user. However, this table is appended by the user interface with model calculation results.

RELATEDPLOTID	Bigint NOT NULL
ZONEID	Bigint NOT NULL
PLOTID	Bigint NOT NULL

Unique fields: primary key: (ZONEID,PLOTID), additional: (RELATEDPLOTID)

2.5.4 DOMPLOTRESULTS

Table to hold the aggregated dominant plot results. This table cannot be modified by the user. However, this table is appended by the user interface with aggregated model calculation results. Important to note is that the user interface is carrying out numerical aggregations which go into the MVALUE field based on the data in the RESULTSCFB, RESULTSCSB, RESULTSWFB and RESULTSWSB tables.

DOMPLOTRESULTID	Bigint NOT NULL
ZONEID	Bigint NOT NULL
AGGREGATIONTYPECODE	Varchar(31) NOT NULL
MVARIABLE	Varchar(31) NOT NULL
MVALUE	Double precision
SUBSTANCEGUID	Varchar(38) NOT NULL

Unique fields: primary key: (ZONEID,SUBSTANCEGUID,AGGREGATIONTYPECODE,MVARIABLE), additional: (DOMPLOTRESULTID)

2.5.5 PLOTRESULTS

Table to hold the intermediate data for mapping an output variable. This table cannot be modified directly by the user, but is filled during mapping of an output variable.

ASSESSMENTITEMID	Bigint
PLOTID	Bigint
MVALUE	Double precision

Unique fields: primary key: (ASSESSMENTITEMID,PLOTID)

2.5.6 RESULTSCFB

Table to hold the annual substance balance of the target layer. This table cannot be manually modified by the user. However, this table is appended by the user interface with model calculation results.

This table is filled with results from file AssessmentItems.cfb after completion of the calculations for the assessment. N.B. CFB means Compound, FOCUS (meaning target layer), Balance.

RESULTSCFBID	Bigint NOT NULL
ZONEID	Bigint NOT NULL
MYEAR	Integer NOT NULL
AMAAPPSOL	Double precision
DELAMA	Double precision
DELAMAEQL	Double precision
DELAMANEQ	Double precision
AMATRA	Double precision
AMAFOR	Double precision
AMAUPT	Double precision
AMADRA	Double precision
AMADRA_1	Double precision
AMADRA_2	Double precision
AMADRA_3	Double precision
AMADRA_4	Double precision
AMADRA_5	Double precision
AMADEP	Double precision
AMAVOL	Double precision
AMALEA	Double precision
SUBSTANCEGUID	Varchar(38) NOT NULL

Unique fields: primary key: (ZONEID,MYEAR,SUBSTANCEGUID), additional: (RESULTSCFBID)

2.5.7 RESULTSCSB

Table to hold the annual substance balance of the soil profile. This table cannot be manually modified by the user. However, this table is appended by the user interface with model calculation results.

This table is filled with results from file AssessmentItems.csb after completion of the calculations for the assessment. N.B. CSB means Compound, Soil profile, Balance.

RESULTSCSBID	Bigint NOT NULL
ZONEID	Bigint NOT NULL
MYEAR	Integer NOT NULL
AMAAPPSOL	Double precision
DELAMA	Double precision
DELAMAEQL	Double precision
DELAMANEQ	Double precision
AMATRA	Double precision
AMAFOR	Double precision
AMAUPT	Double precision
AMADRA	Double precision
AMADRA_1	Double precision
AMADRA_2	Double precision
AMADRA_3	Double precision
AMADRA_4	Double precision
AMADRA_5	Double precision
AMADEP	Double precision
AMAVOL	Double precision
AMALEA	Double precision
AMAGRW	Double precision
SUBSTANCEGUID	Varchar(38) NOT NULL

Unique fields: primary key: (ZONEID,MYEAR,SUBSTANCEGUID), additional: (RESULTSCSBID)

2.5.8 RESULTSWFB

Table to hold the annual water balance of the target layer. This table cannot be manually modified by the user. However, this table is appended by the user interface with model calculation results.

This table is filled with results from file AssessmentItems.wfb after completion of the calculations for the assessment. N.B. WFB means Water, FOCUS (meaning target layer), Balance.

RESULTSWFBID	Bigint NOT NULL
ZONEID	Bigint NOT NULL
MYEAR	Integer NOT NULL
DELLIQ	Double precision
PRC	Double precision
IRR	Double precision
FLVLEA	Double precision
FLVFOC	Double precision
EVPINT	Double precision
SOLACT	Double precision
TRPACT	Double precision
DRA	Double precision
DRA_1	Double precision
DRA_2	Double precision
DRA_3	Double precision
DRA_4	Double precision
DRA_5	Double precision
RUN	Double precision
EVPPND	Double precision
SOLPOT	Double precision
TRPPOT	Double precision

Unique fields: primary key: (ZONEID,MYEAR), additional: (RESULTSWFBID)

2.5.9 RESULTSWSB

Table to hold the annual water balance of the soil profile. This table cannot be manually modified by the user. However, this table is appended by the user interface with model calculation results.

This table is filled with results from file AssessmentItems.wsb after completion of the calculations for the assessment. N.B. WSB means Water, Soil profile, Balance.

RESULTSWSBID	Bigint NOT NULL
ZONEID	Bigint NOT NULL
MYEAR	Integer NOT NULL
DELLIQ	Double precision
PRC	Double precision
IRR	Double precision
FLVLEA	Double precision
FLVGRW	Double precision
EVPINT	Double precision
SOLACT	Double precision
TRPACT	Double precision
DRA	Double precision
DRA_1	Double precision
DRA_2	Double precision
DRA_3	Double precision
DRA_4	Double precision
DRA_5	Double precision
RUN	Double precision
EVPPND	Double precision
SOLPOT	Double precision
TRPPOT	Double precision

Unique fields: primary key: (ZONEID,MYEAR), additional: (RESULTSWSBID)

2.5.10 RESULTSPER

Table to hold the summary output for the PEC soil calculations. This table cannot be manually modified by the user. However, this table is appended by the user interface with model calculation results.

This table is filled with results from file AssessmentItems.per after completion of the calculations for the assessment. N.B. PER means PEC soil, Results.

RESULTSPERID	Bigint NOT NULL
ZONEID	Bigint NOT NULL
MVARIABLE	Varchar(31) NOT NULL
MVALUE	Double precision NOT NULL
SUBSTANCEGUID	Varchar(38) NOT NULL

Unique fields: primary key: (ZONEID,SUBSTANCEGUID,MVARIABLE), additional: (RESULTSPERID)

2.6 Read-only tables

2.6.1 APPLICATIONTYPES

Table to hold the different types of substance applications. This table cannot be modified by the user.

This table is shown in the GUI in the application schemes form in the 'Edit Absolute Applications' group box.

APPLICATIONTYPEID	Bigint NOT NULL
APPLICATIONTYPECODE	Varchar(50) NOT NULL
NAME	Varchar(250)
COMMENTS	Varchar(250)
LOCKED	Varchar(3) NOT NULL

Unique fields: primary key: (APPLICATIONTYPECODE), additional: (APPLICATIONTYPEID)

N.B. the LOCKED field is not used (because the table is read-only anyway) and will be removed in future versions.

2.6.2 CROPS

Table to hold the crops for which GeoPEARL can make calculations. This table cannot be modified by the user.

This table is shown in the GUI in the 'Crops and Applications' tab of the assessment form. The contents are written to the Schematisation.unc file in 'table Ctgb_Crops'.

CROPID	Bigint NOT NULL
NAME	Varchar(50) NOT NULL
DESCRIPTION	Varchar(50)
LOCKED	Varchar(3) NOT NULL

Unique fields: primary key: (NAME), additional: (CROPID)

N.B. the LOCKED field is not used and will be removed in future versions.

2.6.3 GRIDCELLS

Table to hold the grid cells for each plotID, in fact the area in the Netherlands represented by each plot. This table cannot be modified by the user.

GRIDCELLID	*Bigint NOT NULL*
XCENTRAL	*Integer NOT NULL*
YCENTRAL	*Integer NOT NULL*
PLOTID	*Bigint NOT NULL*

Unique fields: primary key: (XCENTRAL,YCENTRAL), additional: (GRIDCELLID)

2.6.4 GRIDCELLSXCROPS

Table to hold the land use map of the Netherlands, where for each grid cell a list of crops is given, along with their area. This table cannot be modified by the user.

GRIDCELLXCROPID	Bigint NOT NULL
GRIDCELLID	Bigint NOT NULL
CROPID	Bigint NOT NULL
AREA	Double precision

Unique fields: primary key: (GRIDCELLID,CROPID), additional: (GRIDCELLXCROPID)

2.6.5 CROPPLOUGHINGDATESINYEAR

Table to hold the ploughing dates (as day in the year) per crop. This table cannot be modified by the user.

The contents are written to the Schematisation.plg file in 'table PloughingData'.

CROPID	Bigint NOT NULL
SANDYSOIL	Varchar(50) NOT NULL
CLAYEYSOIL	Varchar(50) NOT NULL
LOAMYSOIL	Varchar(50) NOT NULL
PEATYSOIL	Varchar(50) NOT NULL

Unique fields: primary key: (CROPID)

2.6.6 METEOSTATIONS

Table to hold the meteo stations for which GeoPEARL can make calculations. This table cannot be modified by the user.

The contents are written to the .met files where the name of the station is used as name of the .met file. See the reference of the .met files for the meaning of the columns. This table is written in combination with the related data of the METEODATA table.

METEOSTATIONID	Bigint NOT NULL
NAME	Varchar(50)
LATITUDE	Double precision
ALTITUDE	Double precision
OPTTRANS	Varchar(20)
INITIALTEMPERATURE	Double precision

Unique fields: primary key: (METEOSTATIONID)

2.6.7 METEODATA

Table to hold the meteo data for each meteo station. This table cannot be modified by the user.

See table METEOSTATIONS for an explanation.

METEODATAID	Bigint NOT NULL
METEOSTATIONID	Bigint NOT NULL
MDATE	Timestamp NOTNULL
RAD	Double precision
TMIN	Double precision
TMAX	Double precision
HUM	Double precision
WIND	Double precision
RAIN	Double precision
ETREF	Double precision

Unique fields: primary key: (METEOSTATIONID,MDATE), additional: (METEODATAID)

2.6.8 SOILHORIZONS

Table to hold the soil horizon data for a soil profile. This table cannot be modified by the user.

The contents are written to the Schematisation.sol file in 'table SoilProfiles'. See the contents of this file for the meaning of the columns (also partly given in Annex 3).

SOILHORIZONID	Bigint NOT NULL
SOILPROFILEID	Bigint NOT NULL
HORIZONSEQNO	Integer NOT NULL
THICKNESS	Double precision
COMPARTMENTCNT	Integer NOT NULL
FRASAND	Double precision
FRASILT	Double precision
FRACLAY	Double precision
PH	Double precision
THETASAT	Double precision
THETARES	Double precision
ALPHADRY	Double precision
ALPHAWET	Double precision
PARN	Double precision
KSAT	Double precision
KSATPHY	Double precision
PARL	Double precision
LENDIS	Double precision
SESQOXID	Double precision
PRESSUREHEAD_AEP	Double precision
ANISOTROPY	Double precision

Unique fields: primary key: (SOILPROFILEID,HORIZONSEQNO), additional: (SOILHORIZONID)

2.6.9 SOILPROFILES

Table to hold the soil profiles. Currently, the unique list of soil profiles does not have any additional attributes, however, within the db, there is a technical need to have a list of unique ID's for each soil profile. This table cannot be modified by the user.

SOILPROFILEID	Bigint NOT NULL

Unique fields: primary key: (SOILPROFILEID)

2.6.10 PERCENTILEVALUES

Table to hold the percentile values for which GeoPEARL can make aggregations. This table cannot be modified by the user.

PERCENTILEVALUEID	Bigint NOT NULL
PERCENTILEVALUE	Integer NOT NULL
MACTIVE	Varchar(3) NOT NULL

Unique fields: primary key: (PERCENTILEVALUE) additional: (PERCENTILEVALUEID)

2.6.11 PLOTSDRAINAGES

Table to hold the drainage values for each plot. This table cannot be modified by the user.

The contents are written to the Schematisation.dra file in 'table Drainage'. See the contents of this file for the meaning of the columns (also partly given in Annex 1).

PLOTID	Bigint NOT NULL
COLUMN02	Double precision
COLUMN03	Double precision
COLUMN04	Double precision
COLUMN05	Double precision
COLUMN06	Double precision
COLUMN07	Double precision
COLUMN08	Double precision
COLUMN09	Double precision
COLUMN10	Double precision
COLUMN11	Double precision
COLUMN12	Double precision
COLUMN13	Double precision
COLUMN14	Double precision
COLUMN15	Double precision
COLUMN16	Double precision
COLUMN17	Double precision
COLUMN18	Double precision
COLUMN19	Double precision
COLUMN20	Double precision
COLUMN21	Double precision
COLUMN22	Double precision
COLUMN23	Double precision
COLUMN24	Double precision

Unique fields: primary key: (PLOTID)

2.6.12 PLOTSLOWERBOUNDARIES

Table to hold the per plot lower boundaries. This table cannot be modified by the user.

The contents are written to the Schematisation.lbo file in 'table GroundwaterSystem'. See the contents of this file for the meaning of the columns (also partly given in Annex 2).

PLOTID	Bigint NOT NULL
COLUMN01	Double precision
COLUMN02	Double precision
COLUMN03	Double precision
COLUMN04	Double precision
COLUMN05	Double precision

Unique fields: primary key: (PLOTID)

2.6.13 PLOTSXCROPS

Table to hold the area for each plot for each crop in the database. This table cannot be modified by the user.

PLOTXCROPID	Bigint NOT NULL
PLOTID	Bigint NOT NULL
CROPID	Bigint NOT NULL
AREA	Double precision

Unique fields: primary key: (PLOTID,CROPID), additional: (PLOTXCROPID)

2.6.14 PLOTCROPTYPES

Table to hold the crop types. This table cannot be modified by the user.

PLOTCROPTYPEID	Bigint NOT NULL
NAMENL	Varchar(50) NOT NULL
NAMEUK	Varchar(50)

Unique fields: primary key: (NAMENL), additional: (PLOTCROPTYPEID)

2.6.15 RUNPRINTVARIABLESDICTIONARY

Table to hold the detailed attributes for all mappable and graphable output data. This table cannot be modified by the user.

This table is meant for internal use of the GUI.

VARIABLENAME	Varchar(50) NOT NULL
DESCRIPTION	Varchar(250)
UNITGUINORMAL	Varchar(50)
UNITXYNORMAL	Varchar(50)
CATEGORYCODE	Varchar(250)

SELECTEDFORDISPLAUnique fields: primary key: (VARIABLENAME)

2.6.16 SYSDBINFO

Table to hold the general information of the database. This table cannot be modified by the user, is internal to workings of GeoPEARL. This table should hold only one record.

DBVERSION	Integer NOT NULL
DBNAME	Varchar(255)
DBDATE	Timestamp NOTNULL
EMAILSUPPORTADDRESS	Varchar(255) NOT NULL
WEBSITE	Varchar(255) NOT NULL
ACCESSED	Varchar(3) NOT NULL
DISABLEOUTPUT	Varchar(3) NOT NULL

Unique fields: table contains only one record.

2.6.17 SYSTABLES

Table to hold the highest ID's and ID column name(s) of every table in the database. This table cannot be modified by the user, is internal to workings of GeoPEARL.

TABLENAME	Varchar(31) NOT NULL
HIGHESTID	Bigint
TABLEID	Varchar(31)

Unique fields: primary key: (TABLENAME)

2.6.18 SETTINGS

Table to hold settings that need to be carried from one GeoPEARL session to another, such as the last opened project ID. This table cannot be modified by the user.

MKEY	Varchar(50) NOT NULL
MTYPE	Varchar(10)
MVALUE	Varchar(250)
COMMENTS	Varchar(250)

Unique fields: primary key: (MKEY)

2.6.19 FILECACHE

Table to hold all sorts of text information and works as an internal cache table. This table can be modified by the user, but contains some standard records.

FILECACHEID	Bigint NOT NULL
FILECACHEKEY	Varchar(250) NOT NULL
FILECONTENTS	Blobsub_type1
CREATIONDATE	Timestamp

Unique fields: primary key: (FILECACHEID), additional: (FILECACHEKEY)

2.6.20 DATETIMECOUNTING

Table to hold date related information. This table cannot be modified by the user.

This table is meant for internal use of the GUI.

DAYINYEAR	Integer NOT NULL
DAYINMONTH	Integer NOT NULL
MONTHLONGENGLISH	Varchar(255) NOT NULL
MONTHSHORTENGLISH	Varchar(3) NOT NULL
MONTHNUMBER	Integer NOT NULL
WEEKINYEAR	Integer NOT NULL
DECADEINMONTHNUMBER	Integer NOT NULL
DATEINYEAR	Varchar(50) NOT NULL

Unique fields: primary key: (DAYINYEAR), additional: (DATEINYEAR)

3 Directory structure of assessment calculations

Whenever GeoPEARL opens a db file on a location, it will immediately create a subdir with the name of the db on the directory of the db. So when a GeoPEARL database with the name dbGeoPEARL is opened, automatically a subdir with the name dbGeoPEARL will be created. This subdir is where all calculations, input and output of that db take place. Within that directory a certain pattern is followed with regard to input and outputs. As GeoPEARL can do multicore processing, each core also uses its own directory with inputs.

The highest level directory structure is:

AsmID=<ID>	A subdir is created for each assessment, where <ID> is replaced by the assessment ID
FileCache	Subdir for temporary use of the file cache (does not contain further subdirs)
Schematisation	Subdir with schematisation files that are not related to an assessment (does not contain further subdirs)

The structure of AsmID=<ID> is:

AsmItemID=<ID>	A subdir is created for each assessment item, where <ID> is replaced by the assessment item ID
PlotsIncluded.inc	File which is copied to each of the multicore subdirs, see below
Substances.cmp	File which is copied to each of the multicore subdirs, see below

The structure of AsmItemID=<ID> is:

CPU_<cpu number>	A subdir is created for each CPU core that the processing will use
Output	Subdir in which output is concatenated after processing
Applications.app	File which is copied, to each of the multicore subdirs
AssessmentItem_template.geo	Template file which is copied and filled in, to each of the multicore subdirs

The structure of CPU_<cpu number> is:

Output	A subdir in which the output of that core is gathered
Temp	Subdir for temporary storage
Applications.app	File containing the application scheme for the assessment item
AssessmentItem.geo	File read by the GeoPEARL.exe model kernel, this is the principal driving file for the assessment item of the model kernel
PlotsIncluded.inc	List of plots included, based on the user's plot selection criteria
Substances.cmp	File with substance chemical properties

4 Sequence of events while running an assessment

Below we give the sequence of events, in broad lines, that will take place when the user runs (=click button Calculate) an assessment (with assessmentID=1) with a pH-dependent plot selection (between pH=6 and 8, giving a plot count = 1606 out of a total of 6405) with a calculation plot count of 250. There is one assessment item with the crop: Cereals, repeat interval= 1, substance application scheme: GeoPEARL_01 (this is an example application scheme).

Prepare for exporting:
- Make sure all edits are saved to the db
- Ask the user for run options (window type, maximum number of cores)
- Set the project item to 'Busy'
- Check for all selected for execution assessments that the related substances are complete
- Check that 4 files for XY are in the FILECACHE table
- Ensure that for every variable name of category SoilInput in table RUNPRINTVARIABLESDICTIONARY, there are XY files ready in the db cache for the top 25 cm, and the top 100 cm (for fast retrieval, later on)
- Ensure that for every crop, there are crop land use maps for XY ready in the db cache (for fast retrieval, later on)
- Ensure integrity for every selected assessment, prior to actually running the assessments

Preparation of Schematisation dir (in directory Schematisation, in db dir). The Schematisation dir is a general directory with data files in which no user defined data are put, purely general data relevant for all assessment. Technically this involves writing chunks of text to ascii files combined with data from schematisation tables in the db.
- Ensure that the Schematisation dir is there
- Write schematisation files
- Set the project item to not 'Busy'

Prepare for running (except substance):
- Delete files on <db dir>\AsmID=1\
- Delete results file from table FILECACHE for assessmentID=1
- Delete results in details of table ASSESSMENTITEMS for assessmentID=1 (table ZONES which cascades to several other tables and PLOTRESULTS)
- Set proper values on some fields of table ASSESSMENTS for assessmentID=1 (clear previous errors etc.)
- Select the required plots in table PLOTSGENERAL by applying the user plot selection criteria (for this example pH between 6 and 8, giving 1606 plots), and save to file <db dir>\AsmID=1\PlotsIncluded.inc

Prepare substance info for running:
- Export the file header from table FILECACHE to <db dir>\AsmID=1\Substances.cmp and process substance data from SPIN into that file.

Prepare remaining:
- Export the used application scheme from table APPLICATIONSCHEMES (and details) to <db dir>\AsmID=1\AsmItemID=1\Applications.app
- Export template for geopearl input file from table FILECACHE and replace tags with proper info to <db dir>\AsmID=1\AsmItemID=1\AssessmentItem_template.geo (this is still a template, because other information still needs to be filled in).

Prepare for multicore running:
- Create subdirs for all parallel runs like: <db dir>\AsmID=1\AsmItemID=1\CPU_01
- Copy the AssessmentItem_template.geo and Applications.app to <db dir>\AsmID=1\AsmItemID=1\CPU_01
- Create output dir and temp dir and copy the assessment dependent PlotsIncluded.inc and Substances.cmp

Run the GeoPEARL.exe!! This will initiate as many pearl runs as was indicated where assessmentID=1.

Process output to <db dir>\AsmID=1\AsmItemID=1\Output\. Since each core was running on its own subdir with its own specific input (except schematisation input), we have to concatenate each type of output file from the different core subdirs into one. There is a total of 16 different output files.

Load and preprocess output (all is loaded into the db). More detailed information on the output is given in Section 5.2.

Loading table DOMPLOTRESULTS (this table is severely normalised and designed to hold all aggregations of all output variables).

- Load table DOMPLOTRESULTS by reading and aggregating all attributes of RESULTSWSB per zone
- Idem for RESULTSWFB, RESULTSCSB AND RESULTSCFB data
- Idem aggregation of RESULTSWSB for all frequency percentiles from table values PERCENTILEVALUES
- Idem aggregation of RESULTSWFB for all frequency percentiles from table values PERCENTILEVALUES
- Idem aggregation of RESULTSCSB for all frequency percentiles from table values PERCENTILEVALUES
- Idem aggregation of RESULTSCFB for all frequency percentiles from table values PERCENTILEVALUES
- Read focus target values from \AsmID=1\AsmItemID=1\Output\AssessmentItem.tgt and store in DOMPLOTRESULTS

Postprocess results (for quick display) (XYWin ready files are created and stored in the db cache):

- Map of CONLEAFOC (leaching concentration) for the parent substance for each assessment item, at frequency percentile=50% with XYWin generated legend classes
- Map of CONLEAFOC (leaching concentration) for the parent substance for each assessment item, at frequency percentile=50% with preset legend classes
- If persistency option is on, map of persistence codes with XYWin generated legend classes
- Graph of CONLEAFOC for all substances at frequency profile=20, 50 and 80%

Preprocess of reports (for quick display), in html form, are created and stored in the db cache:

- Information is pulled from several output tables to generate a useful report

Finalise status information of the assessment, such as the .ERRORMESSAGE and .RESULTSTHERE flags.

5 Preparation of input and processing output

5.1 Preparation of input for assessment calculations

The schematisation files are output to the directory Schematisation. In this directory the files are:

- .met files:
  The .met files are extracted from tables METEOSTATIONS and METEODATA. Every record in METEOSTATIONS is written to a separate .met file. The name of the .met file is derived from the METEOSTATIONS.NAME field, the contents of the .met file are taken from the METEODATA table for the relevant station. On first extraction these files are also stored in the FILECACHE table with FILECACHEKEY='METEO_%d_FILE' (%d signifies the METEOSTATIONS.METEOSTATIONID field
- PlotsExcluded.exc file:
  This file is extracted from FILECACHE with FILECACHEKEY='PLOTSEXCLUDED_HEADER' and FILECACHEKEY='PLOTSEXCLUDED_FILE'.
- Schematisation.crp file:
- This file is extracted from FILECACHE with FILECACHEKEY='CROP_FILE'.
- Schematisation.ctr file:
  This file is extracted from FILECACHE with FILECACHEKEY='CONTROL_FILE'.
- Schematisation.dra file:
  This file is extracted from FILECACHE with FILECACHEKEY='PLOTSDRAINAGES_HEADER' and FILECACHEKEY='PLOTSDRAINAGES_FILE'.
- Schematisation.lbo file:
  This file is extracted from FILECACHE with FILECACHEKEY='LOWERBOUNDARY_HEADER' and FILECACHEKEY='LOWERBOUNDARY_FILE'.
- Schematisation.plg file:
  This file is extracted from FILECACHE with FILECACHEKEY='PLOUGHING_HEADER' and FILECACHEKEY='PLOUGHING_FILE'.
- Schematisation.plo file:
  This file is extracted from FILECACHE with FILECACHEKEY='PLOTS_HEADER' and FILECACHEKEY='PLOTS_FILE'.
- Schematisation.sol file:
  This file is extracted from FILECACHE with FILECACHEKEY='SOL_HEADER' and FILECACHEKEY='SOL_FILE'.
- Schematisation.unc file:
  This file is extracted from FILECACHE with FILECACHEKEY='UNC_HEADER' and FILECACHEKEY='UNC_FILE'.

Directory \AsmID=x (where x is the assessment ID):

- PlotsIncluded.inc file:
  This file contains the plots that were selected as a result of the plot selection criteria as stored in table PLOTSELECTIONCRITERIA.
- Substances.cmp file:
  The header of this file is extracted from FILECACHE with FILECACHEKEY='SUBSTANCES_HEADER'.
  The remainder of this file is extracted from SPIN.

Directory \AsmID=x\AsmItemID=y\ (where y is the ID of the assessment item):

- Applications.app file:
  A template for this file is extracted from FILECACHE with FILECACHEKEY='APPLICATIONS_TEMPLATE' after which the values are filled in, derived from the tables APPLICATIONSCHEMES, APPLICATIONSABSOLUTE, APPLICATIONTYPES and DATETIMECOUNTING.
- AssessmentItem_template.geo file:
  A template for this file is extracted from FILECACHE with FILECACHEKEY='GEOFILE_TEMPLATE'.

Directory \AsmID=x\AsmItemID=y\CPU_z (where z is the cpu number):

- Applications.app file:
  File is copied from 1 directory up.
- AssessmentItem.geo file:
  Copy from AssessmentItem_template.geo one directory up, and filled in with data from tables ASSESSMENTS and ASSESSMENTITEMS.
- PlotsIncluded.inc file:
  File is copied from 2 directories up.
- Substances.cmp file:
  File is copied from 2 directories up.

5.2 Processing output of assessment calculations

The output files for the assessment are written to Directory \AsmID=x\AsmItemID=y\Output

In this directory the following files have been generated:

- AssessmentItem.cfb file:
  This file is read into table RESULTSCFB. The ZONEID for adding data to this table is found by looking up the plot number of the file (1st column of the file) in the ZONES table (field PLOTID). The SUBSTANCEGUID is found by looking up the SUBSTANCEGUID in SPIN for the substance code of the 4th column of the file. Aggregated data of this file are appended to table DOMPLOTRESULTS.
- AssessmentItem.crf and AssessmentItem.sta files:
  These files are read into table ZONES.
- AssessmentItem.csb file:
  This file is read into table RESULTSCSB. The ZONEID for adding data to this table is found by looking up the plot number of the file (1st column of the file) in the ZONES table (field PLOTID). The SUBSTANCEGUID is found by looking up the SUBSTANCEGUID in SPIN for the substance code of the 4th column of the file. Aggregated data of this file are appended to table DOMPLOTRESULTS.
- AssessmentItem.per file:
  This file is read into table RESULTSPER, only if the 'Persistence output' checkbox is checked on the main form. The ZONEID for adding data to this table is found by looking up the plot number of the file (1^{st} column of the file) in the ZONES table (field PLOTID). The SUBSTANCEGUID is found by looking up the SUBSTANCEGUID in SPIN for the substance code of the 4th column of the file.
- AssessmentItem.tgt file:
  This file is read into table DOMPLOTRESULTS. Please note that data from AssessmentItem.cfb, AssessmentItem.csb, AssessmentItem.wfb and AssessmentItem.wsb are also added to this table, after aggregation.
- AssessmentItem.wfb file:
  This file is read into table RESULTSWFB. The ZONEID for adding data to this table is found by looking up the plot number of the file (1st column of the file) in the ZONES table (field PLOTID). Aggregated data of this file are appended to table DOMPLOTRESULTS.
- AssessmentItem.wsb file:
  This file is read into table RESULTSWSB. The ZONEID for adding data to this table is found by looking up the plot number of the file (1st column of the file) in the ZONES table (field PLOTID). Aggregated data of this file are appended to table DOMPLOTRESULTS.

6 Coupling user interface controls to the database fields

The following section describes the coupling of the visible user interface controls to the database tables and fields.

The main form of the user interface is basically coupled to the ASSESSMENTS table. The couplings for the main part and the General tab are as follows:

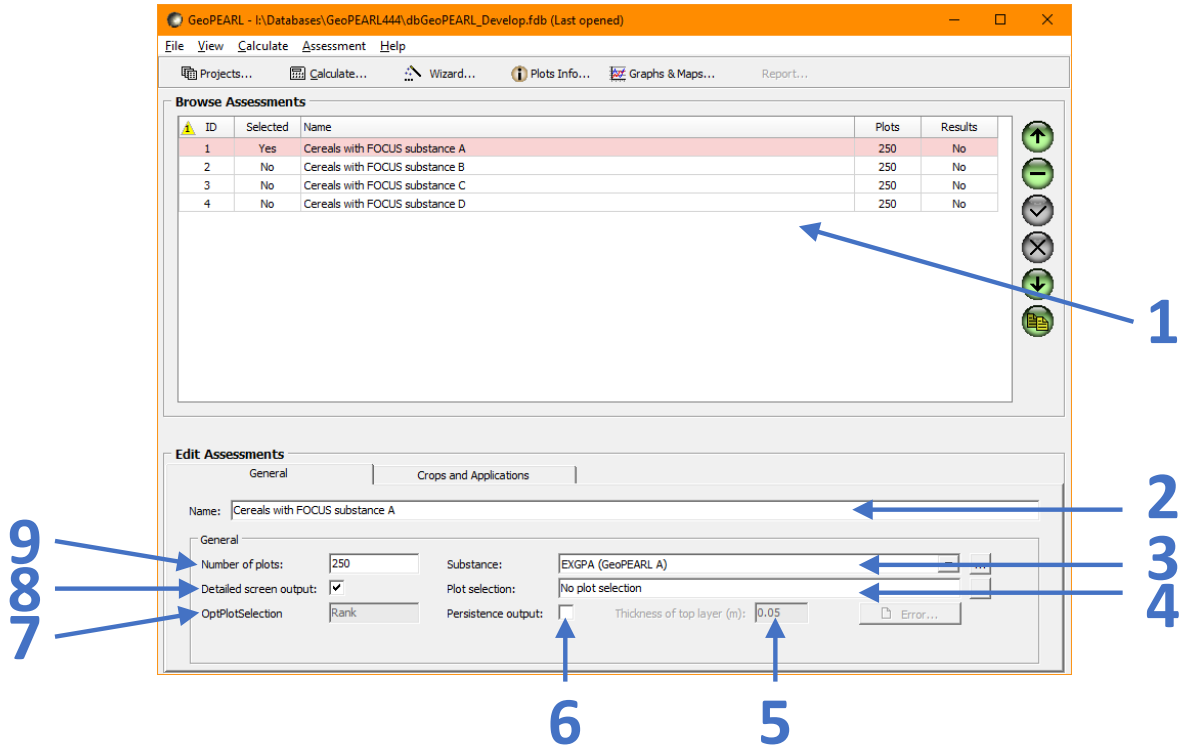

Figure 6.1 *Overview of the user interface controls on the General tab of the main screen of GeoPEARL. Numbers shown represent ID numbers as specified in Table 6.1.*

Table 6.1 *Specification of user interface controls on the General tab of the main screen of the user interface of GeoPEARL.*

ID	Coupled to
1	Selected fields of table ASSESSMENTS
2	ASSESSMENTS.NAME field
3	The substance name derived by SPIN of the ASSESSMENTS.SUBSTANCEGUID field
4	ASSESSMENTS.PLOTSELECTIONCRITERIACODE field looked up in PLOTSELECTIONCRITERIA and displayed the DESCRIPTION field
5	ASSESSMENTS.THILAYPER field
6	ASSESSMENTS.OPTPERSISTENCY field
7	ASSESSMENTS.OPTPLOTSELECTION field
8	ASSESSMENTS.IOMODE_FULL field
9	ASSESSMENTS.NUMZONES field

The couplings for the 'Crops and applications' tab are as follows:

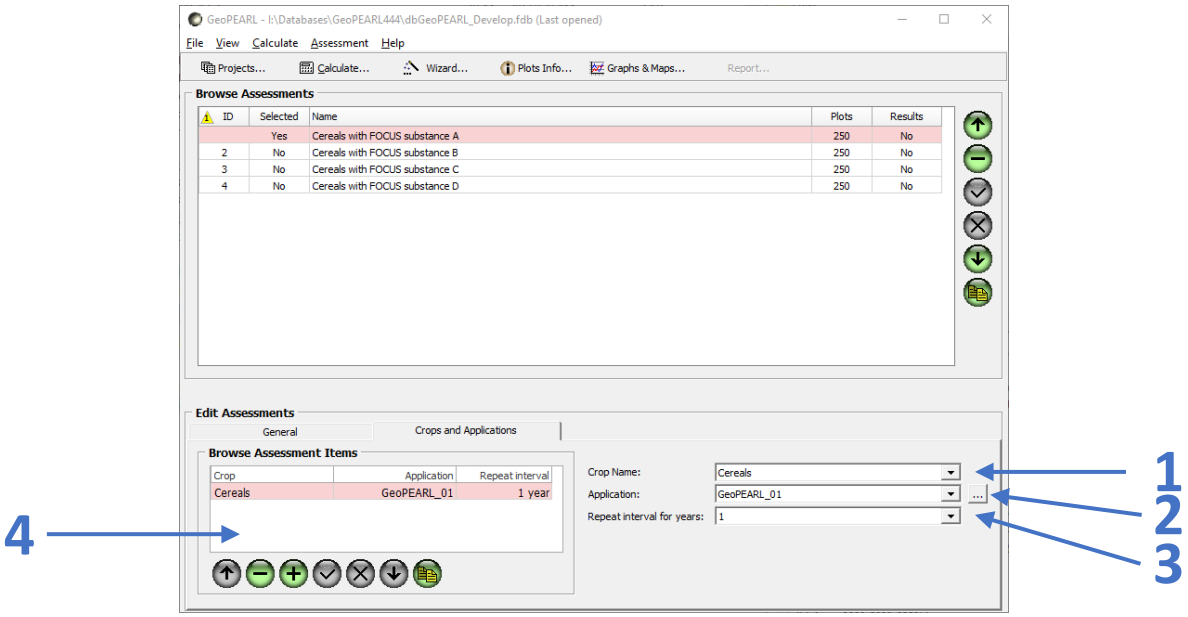

Figure 6.2 *Overview of the user interface controls on the Crop and applications tab of the main screen of GeoPEARL. Numbers shown represent ID numbers as specified in Table 6.2.*

Table 6.2 *Specification of user interface controls on the Crop and applications tab of the main screen of the user interface of GeoPEARL.*

ID	Coupled to
1	ASSESSMENTSITEMS.CROPID field lookup in table CROPS
2	ASSESSMENTSITEMS.APPLICATIONSCHEMEID field looked up in table APPLICATIONSCHEMES
3	ASSESSMENTSITEMS.DELTIMEVT field (list is defined within the source code of the UI)
4	Selected fields of the ASSESSMENTSITEMS of the selected assessment

The couplings for the 'Application schemes' button (ID no 2 in Figure 6.2) are as follows:

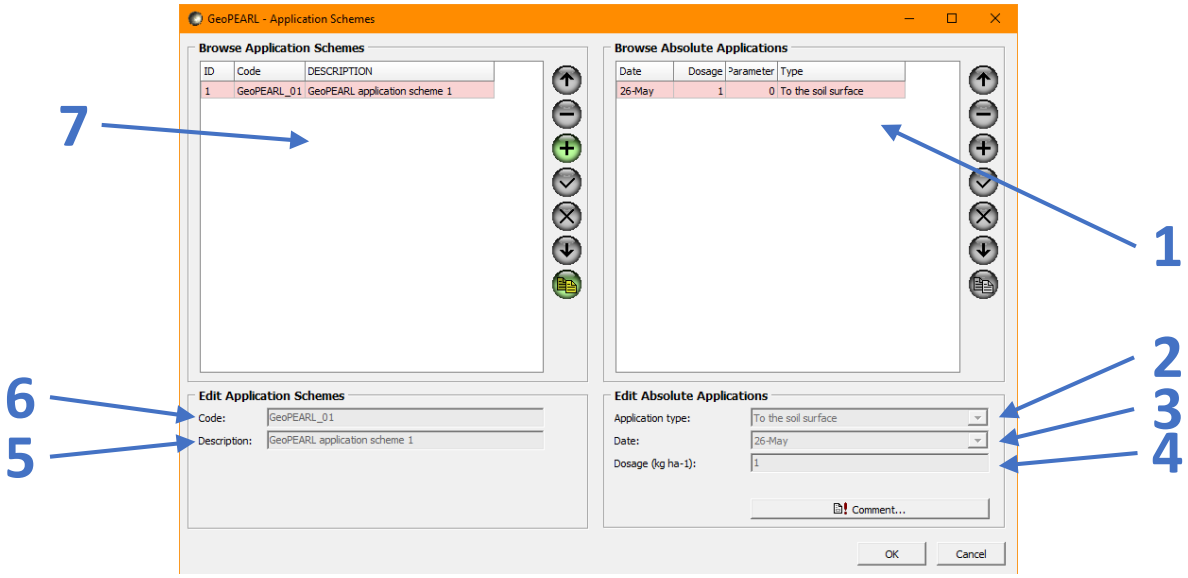

Figure 6.3 *Overview of the user interface controls on the Application Schemes form of GeoPEARL. Numbers shown represent ID numbers as specified in Table 6.3.*

Table 6.3 *Specification of user interface controls on the Application Schemes form of the user interface of GeoPEARL.*

ID	Coupled to
1	Selected fields of table APPLICATIONSABSOLUTE
2	APPLICATIONSABSOLUTE.APPLICATIONTYPEID field lookup in table APPLICATIONTYPES
3	APPLICATIONSCHEMES.DAYINYEAR field looked up in table DATETIMECOUNTING
4	APPLICATIONSCHEMES.DOSAGE field
5	APPLICATIONSCHEMES.DESCRIPTION field
6	APPLICATIONSCHEMES.CODE field
7	Selected fields of table APPLICATIONSCHEMES

7 Future developments

The current design and structure of the database can be expected to remain fully operational in the foreseeable future. However, some aspects may need further attention. At present, the use of the GeoPEARL software application is limited to Windows platforms. As the interest in the use of GeoPEARL on Linux platforms has increased over the years, the development of a version of the GeoPEARL application that can be used on Linux platforms may be worthwhile. Recently, a Linux version of the model kernels has been developed, so GeoPEARL assessments can already be executed on Linux platforms. For the development of a version of the user interface to be used in a Linux environment, the interface code has to be redesigned using a different visual component library, but much of the software logic of the GeoPEARL application can be retained. In addition, the embedded FireBird database would have to be replaced by an embedded InterBase database which is produced by the same company that provides the Delphi software for the interface (Embarcadero). As the new GeoPEARL version is coupled to the SPIN application for creating, storing and editing substance data, a SPIN version that can be used on a Linux platform would also be required.

The software design is not suitable for an online version of GeoPEARL. If such a tool were needed, then a completely new software design would have to be developed.

At present the software application can be used only by one user at a time. However, there is scope to facilitate the use of the GeoPEARL application by multiple users in a network environment. In a network environment several options might be possible. One of the options is that only one user would be able to add, modify or delete assessments and substances, whereas the other simultaneous users can only view results of the existing assessments items in the database. Another option could be organised at the project level. If one user is editing or running assessments in a project a busy flag would be set for that project. This would mean that other users could see results of assessments in that project but are not allowed to start assessments or modify or delete assessments in this project. This restriction is not in force if the user defines a new project with assessments using newly defined substances and application schemes.

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Glossary

Application
Refers to the mechanical act of applying a substance (i.e. a pesticide) to the surface. An application using a specific dose is carried out on a date, using an application type (= technique), such as spraying to the crop canopy, soil injection etcetera.

Assessment
A GeoPEARL study (it is part of a project with possibly other assessments) in which a substance is applied to the Netherlands for a combination of crops and application schemes.

AssessmentItem
A crop and application scheme combination as part of an assessment capable of having multiple crop and application scheme combinations.

Database
In the case of GeoPEARL, a special type of file, containing multiple tables. A database table is a bit like a spreadsheet but has much stronger capabilities for data validation, retrieval and querying (such as aggregations).

Model kernel
A console program specifically designed for scientific calculations. Usually, these programs read one or more text input files, do the calculations from a start date up to an end date, and write the results to one or more text output files.

Plot
An item from the GeoPEARL spatial schematisation. See the chapter on spatial schematisation for further details.

Postprocessing
Refers to extra calculations, at the end of a model kernel run, before giving back control to the user interface.

Schematisation
A numeric representation (=approximation) of certain aspects of reality. For instance, a geographical map with land use classes.

Justification

WOt-technical report: 210
BAPS-project number: WOT-04-008-024

This document describes the design and structure of the database and interface of GeoPEARL v 4.4.4. The report has been reviewed and approved by Ir J.A. te Roller.

This project belongs to the WOT theme 'Agromilieu' with theme leader Erwin van Boekel (WOT Natuur & Milieu). The project is funded by the Ministry of Agriculture, Nature and Food Quality (project number WOT-04-008-024) with contact person Eelco Riemens.

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datum: 14 juni 2022

Annex 1 File Schematisation.dra

The ‘table Drainage’ in the Schematisation.dra file is as follows (only first and last 2 lines are given here, data lines are too long for this document and are cut off):

```
* Column 1  :  The plot ID
* Column 2  :  Distance between primary drainage system (m)
* Column 3  :  Depth of bottom of primary drainage system (m)
* Column 4  :  Surface water level in primary drainage system (m)
* Column 5  :  Drainage resistance of primary drainage system (d)
* Column 6  :  Infiltration resistance of primary drainage system (d)
* Column 7  :  Distance between secondary drainage system (m)
* Column 8  :  Depth of bottom of secondary drainage system (m)
* Column 9  :  Surface water level in secondary drainage system (m)
* Column 10 :  Drainage resistance of secondary drainage system (d)
* Column 11 :  Infiltration resistance of secondary drainage system (d)
* Column 12 :  Distance between tertiary drainage system (m)
* Column 13 :  Depth of bottom of tertiary drainage system (m)
* Column 14 :  Surface water level in tertiary drainage system (m)
* Column 15 :  Drainage resistance of tertiary drainage system (d)
* Column 16 :  Infiltration resistance of tertiary drainage system (d)
* Column 17 :  Distance between pipe drainage system (m)
* Column 18 :  Depth of bottom of pipe drainage system (m)
* Column 19 :  Surface water level in pipe drainage system (m)
* Column 20 :  Drainage resistance of pipe drainage system (d)
* Column 21 :  Infiltration resistance of pipe drainage system (d)
* Column 22 :  Surface water level in summer (m)
* Column 23 :  Surface water level in winter (m)
* Column 24 :  Surface water supply capacity


table Drainage
1       5155    -2.15   -2.15   38879   38879   3067    -1.1    -1.1    18108   18108   continued ->
2       3125    -2.15   -2.15   31528   31528   3012    -1.1    -1.1    8993    8993    continued ->
<lines removed>
6404    50000   -1.8    -1.8    49996   49996   2994    -0.8    -0.8    2549    2549    continued ->
6405    29412   -1.8    -1.8    47027   47027   13158   -0.8    -0.8    4428    4428    continued ->
end_table
```

Annex 2 File Schematisation.lbo

The ‘table GroundwaterSystem’ in the Schematisation.lbo file is as follows (only first and last 2 lines are given here, data lines are too long for this document and are cut off):

```
* GroundwaterSystem table. Format depends on OptLbo
*
* If OptLbo = GrwLev
* Column 1  :  The plot ID
* Column 2  :  Groundwater level
*
* If OptLbo = Flux
* Column 1  :  The plot ID
* Column 2  :  Initial groundwater level
* Column 3  :  Average flux at the lower boundary (mm.d-1)
* Column 4  :  Amplitude of the lower boundary flux (mm.d-1)
* Column 5  :  Day that the maximum flux is reached
*
* If OptLbo = Cauchy
* Column 1  :  The plot ID
* Column 2  :  Initial groundwater level (m)
* Column 3  :  Resistance of aquitard (d)
* Column 4  :  Head below aquitard (m)
*
* If OptLbo = Mixed
* Column 1  :  The plot ID
* Column 2  :  Initial groundwater level (m)
* Column 3  :  Regional flux at the lower boundary (mm.d-1)
* Column 4  :  Resistance of aquitard (d)
* Column 5  :  Head below aquitard (m)


table GroundwaterSystem
1       -1.4    2.426   0       90      0
2       -1.4    -1.2    0       270     0
<lines removed>
6404    -1.4    -0.972  0       270     0
6405    -1.4    -1.029  0       270     0
end_table
```

Annex 3 File Schematisation.sol

The 'table SoilProfiles' in the Schematisation.sol file is as follows (only first and last 2 lines are given here, data lines are too long for this document and are cut off):

```
* Column 1  :  Soil profile number
* Column 2  :  Soil horizon number
* Column 3  :  Horizon thickness (m)
* Column 4  :  Number of numerical soil compartments
* Column 5  :  Sand fraction (kg.kg-1) as part of mineral soil
* Column 6  :  Silt fraction (kg.kg-1) as part of mineral soil
* Column 7  :  Clay fraction (kg.kg-1) as part of mineral soil
* Column 8  :  pH-KCl
* Column 9  :  Saturated soil water content (m3.m-3)
* Column 10 :  Residual water content (m3.m-3)
* Column 11 :  Parameter alpha (dry) (cm-1)
* Column 12 :  Parameter alpha (wet) (cm-1)
* Column 13 :  Parameter n (-)
* Column 14 :  Saturated hydraulic conductivity (m.d-1)
* Column 15 :  Physical saturated hydraulic conductivity (m.d-1)
* Column 16 :  Parameter L (-)
* Column 17 :  Dispersion length (m)
* Column 18 :  Sesqui-oxide content (mmol.kg-1)
* Column 19 :  Pressure head at air entry point (cm)
* Column 20 :  Anisotropy factor (-)


table SoilProfiles
1       1       0.05    5       0.35    0.224   0.426   4.5     0.77    0       0.0197  continued ->
1       2       0.1     4       0.35    0.224   0.426   4.5     0.77    0       0.0197  continued ->
<lines removed>
456     10      1       10      0.294   0.552   0.154   4.2     0.41    0.01    0.0071  continued ->
456     11      11      22      0.294   0.552   0.154   4.2     0.41    0.01    0.0071  continued ->
end_table
```

Annex 4 File Schematisation.unc

The ‘table PloCrpArea’ in the Schematisation.unc file is as follows (only first and last 2 lines are given here, data lines are too long for this document and are cut off):

```
* record    plot-ID        plot-area           1           2           3           4  continued ->
table PloCrpArea
1           1               1418.750       0.000       0.000       0.000       0.000  continued ->
2           2               2037.500       0.000       0.000       0.000       0.000  continued ->
<lines removed>
6404        6404              68.750       0.000       0.000       0.000       3.465  continued ->
6405        6405             106.250       2.297       0.000       0.023      14.434  continued ->
end_table
```

Annex 5 File Schematisation.plo

The ‘table Plots’ in the Schematisation.plo file is as follows (only first and last 2 lines are given here, data lines are too long for this document and are cut off):

```
* Column 1  :  The plot ID
* Column 2  :  Area (km2)
* Column 3  :  Meteo district, corresponds with meteo stations in geo file
* Column 4  :  The soil profile number, corresponds with holland.sol
* Column 5  :  The crop type (1 = grass, 2 = maize, 3 = potato, 4 = nature)
* Column 6  :  Correction factor for precipitation (-)
* Column 7  :  Correction temperature (C)
* Column 8  :  Correction factor for evapotranspiration (-)
* Column 9  :  Irrigation switch
* Column 10 :  Maximum ponding depth (m)
* Column 11 :  Air boundary layer thickness (m)
* Column 12 :  Relative vulnerability rank (1 = lowest score; 6405 = highest score)
* Column 13 :  Texture class of soil profile (1 = sand, 2 = clay, 3 = loam, 4 = peat)
* Column 14 :  Organic matter content (kg.kg-1) at a depth of 0.15 m for arable soil)
* Column 15 :  Organic matter content (kg.kg-1) at a depth of 0.45 m for arable soil)
* Column 16 :  Organic matter content (kg.kg-1) at a depth of 0.80 m for arable soil)
* Column 17 :  Organic matter content (kg.kg-1) at a depth of 1.20 m for arable soil)
* Column 18 :  Organic matter content (kg.kg-1) at a depth of 0.15 m for grassland)


table Plots
1           1418.75     3           166         4           1           0           1      continued ->
2           2037.5      3           166         4           1           0           1      continued ->
<lines removed>
6404        68.75       15          309         2           1           0           1      continued ->
6405        106.25      15          317         3           1           0           1      continued ->
end_table
```

Annex 6 File AssessmentItem.crf

The ‘table Plots’ in the AssessmentItem.crf file is as follows (only first and last 2 lines are given here, data lines are too long for this document and are cut off):

```
* Table Plots
* Column 1: The plot number
* Column 2: The zone number
* Column 3: Area of plot (ha)
* Column 4: Crop area per plot (ha)
* Column 5: Relative crop area per plot (%)
* ------------------------------------------------------------------------------
table Plots
  1197       1          312.500            0.146      0.0467
  1211       1          587.500            2.060      0.3506
<lines removed>
   249    2956         5200.000          174.866      3.3628
   250    4565         5237.500          158.857      3.0331
end_table
```

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