Digital Photogrammetric System

PHOTOMOD

Version 7.51

USER MANUAL

The GeoCalculator program (Windows x64)

RACURS

Table of Contents

1. About the program

The *PHOTOMOD GeoCalculator* (further – *GeoCalculator*, program) is used for coordinates transformation from one coordinate system to another. The program includes to the *PHOTOMOD* system and installing with it automatically, as a separate module. Also it could be installed and used as a separate application, without *PHOTOMOD*.

The coordinate systems database is installed automatically with the program. It is required to work with *GeoCalculator*.

To start the program perform one of the following:

- If *PHOTOMOD GeoCalculator* is installed as a part of the *PHOTOMOD* system – choose **Service › GeoCalculator** in the main *PHOTOMOD* window;
- If *PHOTOMOD GeoCalculator* is installed as separate application – choose **Start › Programs › PHOTOMOD GeoCalc 7 x64 › GeoCalculator** or run `PhGeoCalcApp.exe` manually (stored in *C:\Program Files\PHOTOMOD_7_GeoCalc_x64* folder by default).

2. GeoCalculator installation

The program (as separate application) requires 1.5 Gb of free hard disk space.

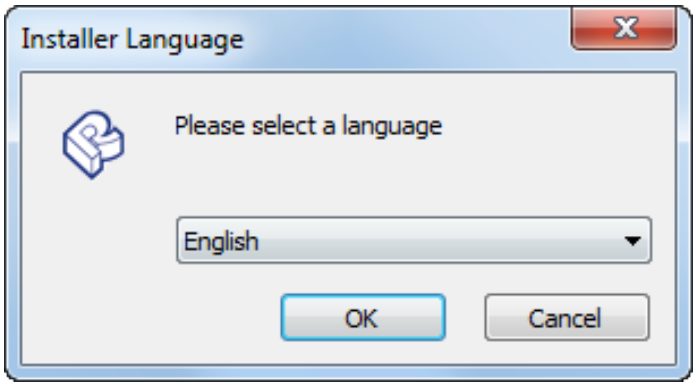
To start the *GeoCalculator* installation, run the `Ph_GeoCalc_NN_[CCCC]_x64.exe` file, where N is the version number, CCCC is the build number.

The system initial installation process consists of a sequence of steps with instructions.

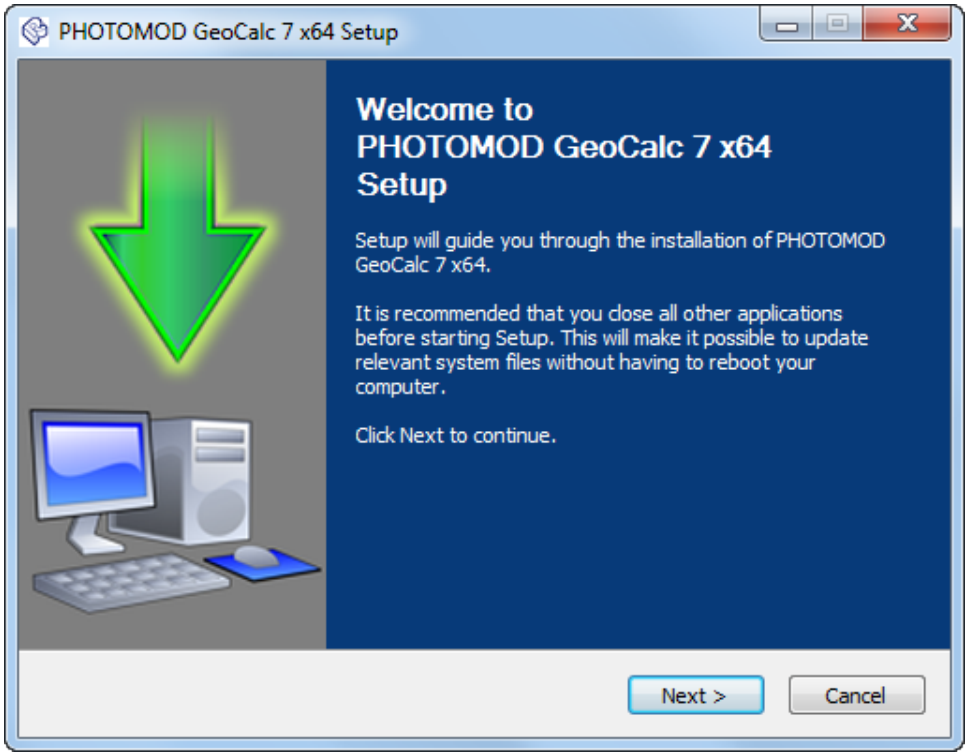
In case of cancel at any step, installed program files and data are not removed. To complete the system installation, restart the `Ph_GeoCalc_NN_[CCCC]_x64.exe` file and go through all steps again.

The installation process consists of the following steps:

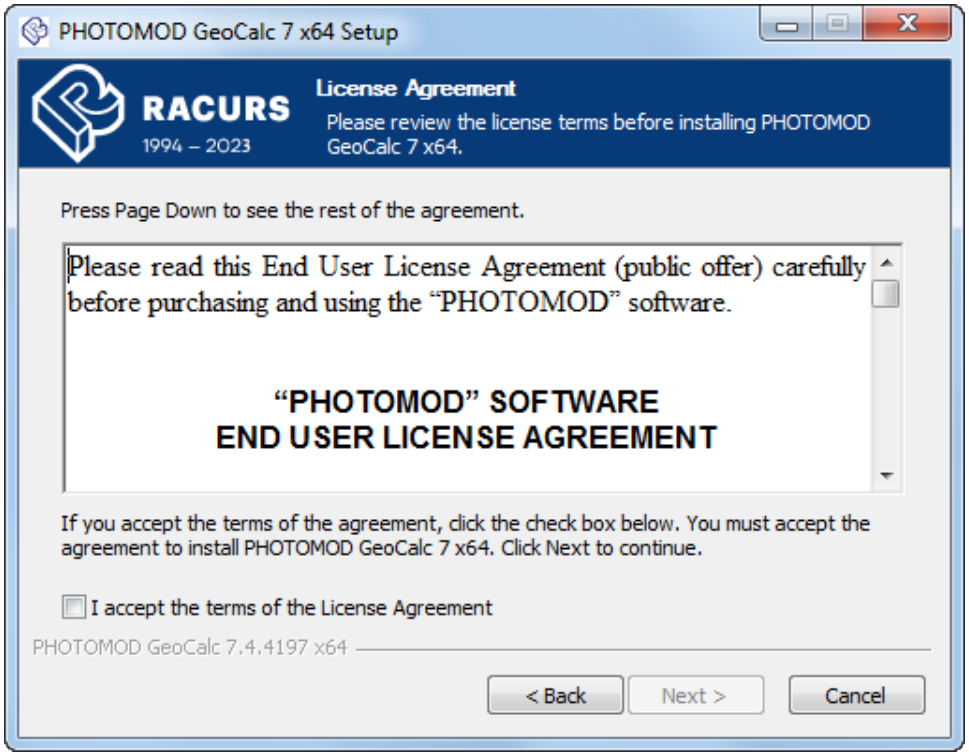
1. Choose the installation language. Click OK;



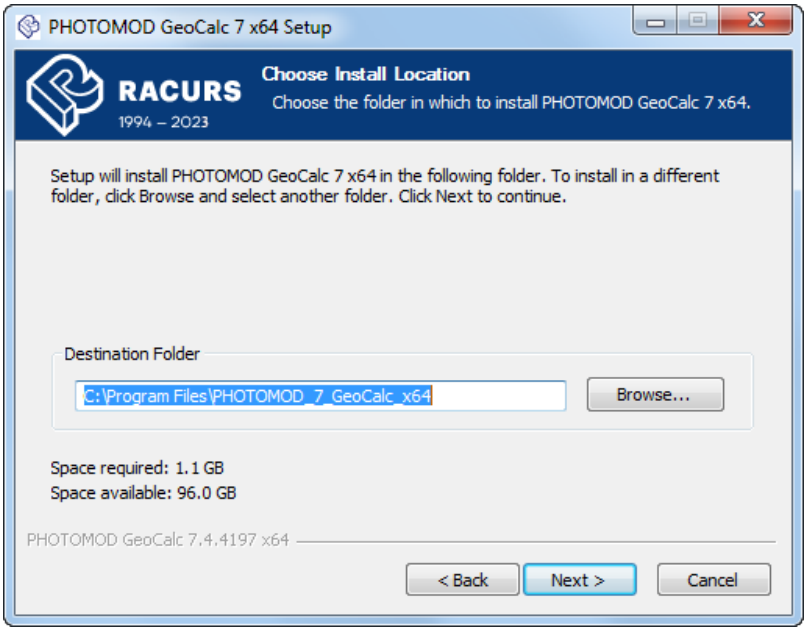
2. Read the welcome and warning messages. Click the **Next** button.



3. Read the license agreement. If you agree with it, set the **I accept the terms of the License Agreement** checkbox on and click the **Next** button.

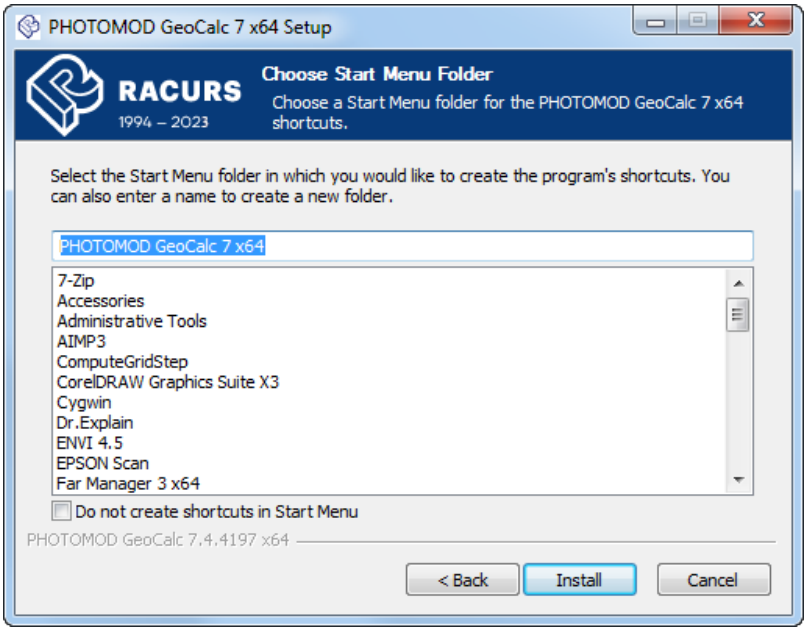


4. [optional] Define the folder to install the program;

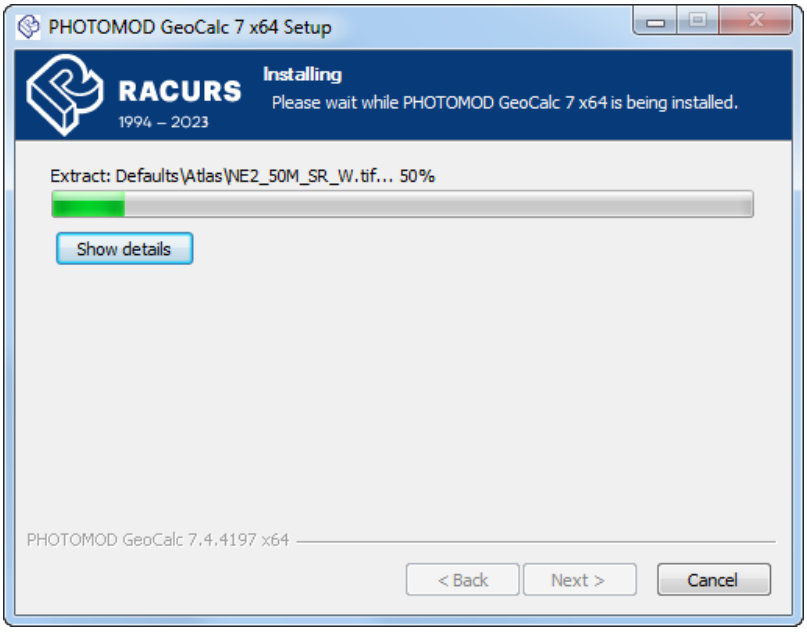


It is strongly not recommended to install the program in folder with name, which contains letters, different from Latin. By default the *C:\Program Files\PHOTOMOD_7_GeoCalc_x64* folder is used.

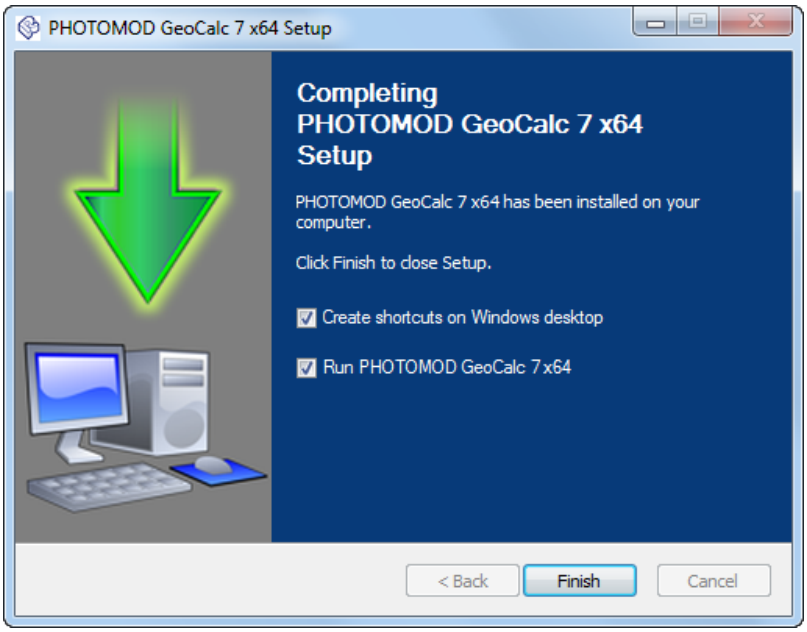
5. [optional] Enter a folder name for the *GeoCalculator* program in the *Windows* **Start** menu. A shortcuts in the *Windows* **Start** menu will be created by default. Otherwise – set the appropriate checkbox. Click the **Install** button.



6. The installation process begins;



7. When installation complete perform one of the following actions:



- [optional] clear the **Run PHOTOMOD GeoCalc 7x64** checkbox and click the **Finish** button to complete the installation process without program launch;
- [optional] leave the **Run PHOTOMOD GeoCalc 7x64** checkbox set and click the **Finish** button to launch the program.

The **Create shortcuts on Windows desktop** checkbox is set on by default. Clear it if needed.

To delete the program (installed as separate application) choose the **Start › Programs › PHOTOMOD GeoCalc 7 x64 › Uninstall GeoCalculator**.

3. Interface and its elements

3.1. The “Database” menu

Table 1. Brief description of the “Database” menu

Menu items	Function
Linear units	opens the window allowing to manage linear units
Angle units	opens the window allowing to manage angular units
Scale units	opens the window allowing to manage scale units
Angular types format	to choose the angular types format
Ellipsoids	opens the window allowing to manage reference ellipsoids
Prime meridians	opens the window allowing to manage prime meridians
Datums	opens the window allowing to manage datums
Types of datum transform	to choose datum transformation type
Datum transform	opens the window allowing to manage the presets of datum transformation settings
Map projections type	to choose map projection type
Map projections	opens the window allowing to manage map projections
Height system	to choose height system
Coordinate systems type	to choose coordinate system type
Coordinate systems	opens the window allowing to manage coordinate system in current database

3.2. The “Help” menu

Table 2. Brief description of the “MapInfo” menu

Menu items	Function
Help	to open the current document
Hotkeys	to open the window with thehotkeys description
About	opens a window indicating the number of system build

3.3. The main toolbar

Table 3. Brief description of main toolbar

Buttons	Functions
	to open the default `PhCoordSys.db` database with current parameters (without restoration of initial data)
	to open the database
	to create an empty database
	to close database
	to close the current database and to open default `PhCoordSys.db` database, restored to its initial settings
	to perform the batch coordinate systems import from the selected folder
	to perform the batch coordinate systems import from the selected database
	to perform the batch coordinate systems export to the selected folder
	to open the **Settings** window

4. GeoCalculator database

PHOTOMOD GeoCalculator databases contain information on coordinate systems as well as on individual elements of coordinate systems. Database files have `*.db` extensions. A link to the current coordinate system database file is displayed in the bottom left corner of the main program window.

The default international coordinate systems database – `PhCoordSys.db`. This database is installed automatically with the program in *PHOTOMOD7.VAR\GeoCalcDB\en* folder (see the “The PHOTOMOD7.VAR configuration folder” chapter in “General information” User Manual, from the *PHOTOMOD* documentation).

Coordinate systems, as well as sets of coordinate system elements contained in the default database, differ for the Russian and English versions of the program.

The *GeoCalculator* database is intended for combined use with *PHOTOMOD*, so it is always located in the *PHOTOMOD7.VAR* settings folder of the *PHOTOMOD* by default (this folder is used even if *GeoCalculator* is installed and used as a separate application).

If *GeoCalculator* is installed for the first time as a separate application on a workstation where *PHOTOMOD* software products haven’t been installed before, the *PHOTOMOD7.VAR* folder will anyway be created automatically (and can be further used as a settings folder for *PHOTOMOD* software products, in the case if they are later installed on this workstation).

A user can either use the default database as provided and make their own changes to it or create their own databases with optional names and locations (by importing information about coordinate systems there from other databases, from separate files, or by entering it manually).

In the case of the combined use of *GeoCalculator* and *PHOTOMOD*, *PHOTOMOD* can use the coordinate system database currently connected to the *GeoCalculator*, including user databases

(however, only if it has access to the location of the user-created file). If the file is not accessible, *PHOTOMOD* will use the `PhCoordSys.db` file by default.

In the event of the system updating or reinstalling, the availability of the `PhCoordSys.db` file in the appropriate *PHOTOMOD7.VAR* folder is to be checked. In order to save user data, if detected, the `PhCoordSys.db` file is not to be overwritten.

To access the updated version of the default database after reinstalling (updating) the program, click the button. If the “old” database previously worked with user coordinate systems, it is strongly recommended to first backup the previous database file in a separate folder (or export the user coordinate systems to files in the *Windows* file system).

5. The coordinates transformation

The main window consists of two similar parts. There are the source data in one part, and the results of calculation in the other part.

It is possible to load source data both in left and in right part of the window.

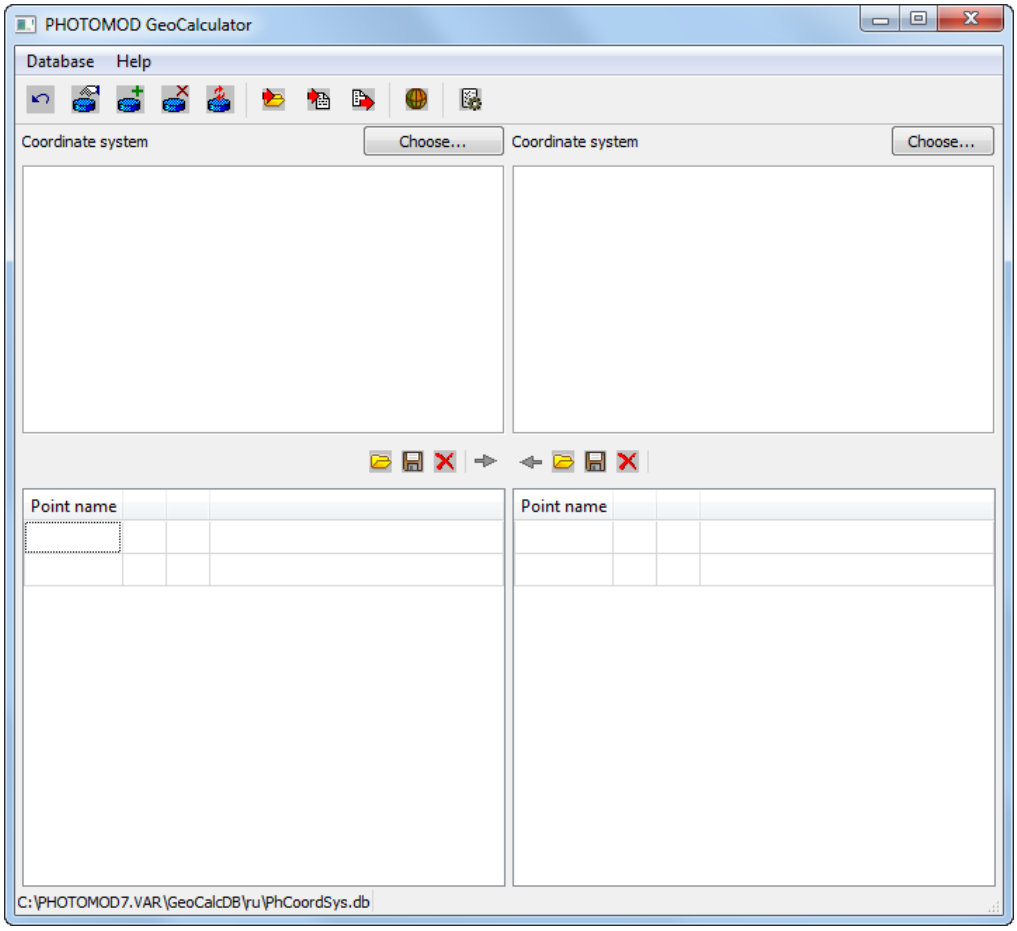


Fig. 1. The main program’s window

To transform coordinates of points from one coordinate system to another perform the following:

1. Click the **Choose...** button in the left part of the main window, in the **Coordinate system** section, to define input coordinate system of source data;

   Information about the selected coordinate system is displayed in the appropriate field in the **Coordinate system** section.

2. Click the button in the left part of the main window, in the **Point name** section, to choose the file in ASCII format with source coordinates of points;

   For correct automatic recognition of point coordinates from a txt file, a comma or semicolon is to be used as a separator between columns in the file. A period must be used as a decimal separator. Commas as decimal separators are not allowed.

   Manual coordinate input is also provided.

   When inputting coordinates as `degrees/minutes/seconds`, use a space as a separator. In this case, to ensure correct recalculation, the coordinate system selected in the corresponding half of the window must have the appropriate latitude and longitude units, i.e. `degrees/minutes/seconds`.

   To clear loaded or entered point data, click the button.

   Hotkeys are available when working with tables, in **point name** sections (see **Help › Hotkeys**).

3. Click the **Choose...** button in the right part of the main window, in the **Coordinate system** section, to choose the output coordinate system;

4. Click the button in the left part of the main window, for coordinates system transformation. As a result the list of points with recalculated coordinates from the left part of the main window is shown in the **Point name** section in the right part.

   To transform coordinates of points, loaded into the right part of the main window, to the coordinate system defined in the left part, click the button on the right part of the main window.

   Click the button in the appropriate part of the main window to save results in ASCII-file.

   If the **Display transform statistics** checkbox is set in the **Settings** window, after performing the operation, the statistics window opens:

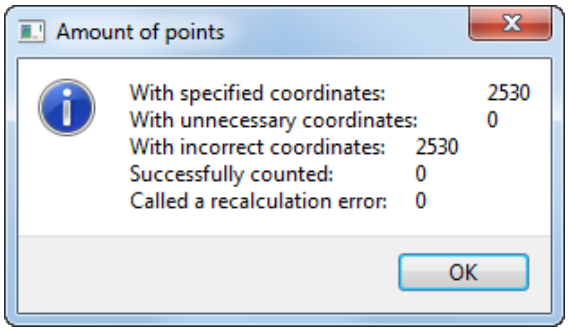


Fig. 2. The statistics window

To not show this window, clear the **Display transform statistics** checkbox in the **Settings** window.

6. Coordinate systems management

6.1. The “Coordinate systems” window

The program provides a possibility to search, view settings, create, edit, remove, import and export coordinate systems. The **Coordinate systems** window’s is used for this.

To open the **Coordinate systems** window, choose **Database › Coordinate systems** (or click the **Choose** button in the left or right part of the program’s main window). The **Coordinate systems** window opens:

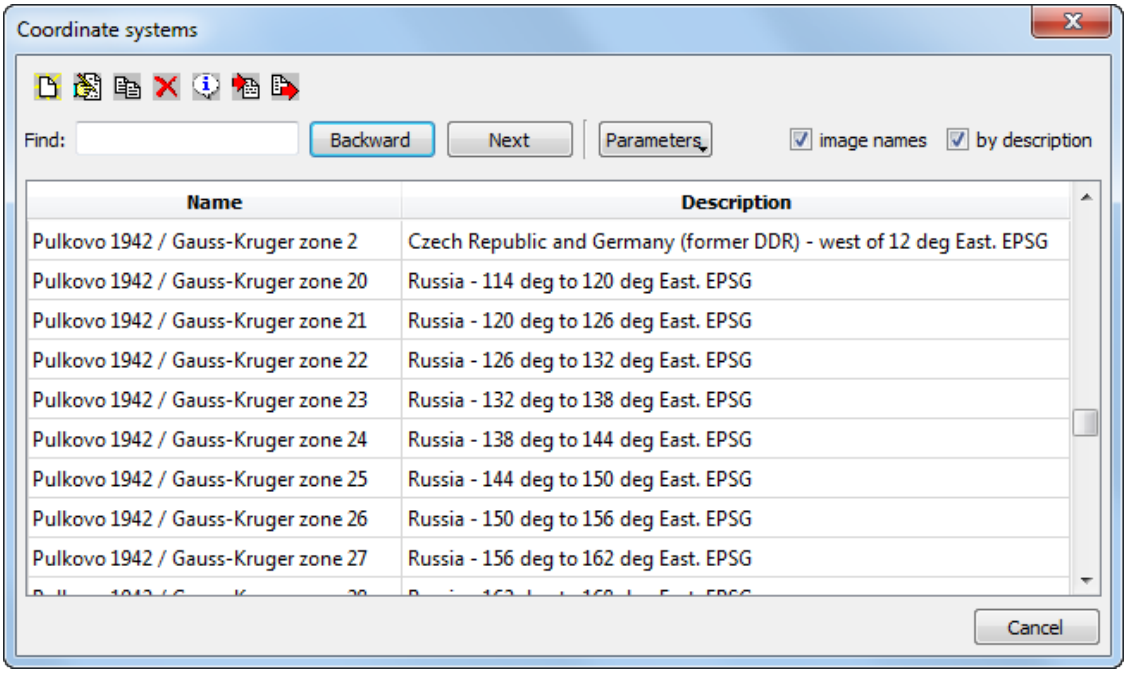


Fig. 3. The window containing coordinate systems list

The **Coordinate systems** window contains the following sections: the table, containing coordinate system's data, the search instruments and the **Coordinate systems** window's toolbar.

Table with coordinate system's data contains two columns: **Name** and **Description**. In the table are displayed parameters, obtained from database or specified during creating of new coordinate system.

It is often required to know the coordinates of all points, recalculated if necessary into one zone.

Thus, the **name** of the coordinate system looks as follows, for example: `Pulkovo 1942 / Gauss-Kruger zone 2`, where `Pulkovo 1942` is the datum name, `Gauss-Kruger` is the coordinate system, and `zone 2` is the zone number.

Abscissa coordinate values in the Gauss-Krüger coordinate system must include the zone number.

It is recommended to enter detailed information in the **Description** field during creating of a coordinate system or its parameters.

To **choose** the coordinate system for the points coordinates transformation – select the coordinate system from the list and click the appropriate button (if the **Choose** button in main window toolbar is used to open the **Coordinate systems** window);

Table 4. Brief description of Coordinate systems window toolbar

Buttons	Functions
	to open a window for creating new coordinate system
	to edit chosen coordinate system
	to duplicate chosen coordinate system
	to remove chosen coordinate system from database
	to show parameters of selected reference system
	to import coordinate system from the selected file
	to export coordinate system to the file of selected format

6.2. Searching for the coordinate system

The list of coordinate systems opens in **Coordinate systems** window. It allows to choose, create new one, edit, remove, export and import coordinate system from external file.

To **find** a coordinate system, input name or its part (or keyword) into appropriate field and choose direction of search: **next** or **backward**. The string of found coordinate system is marked by grey color.

The search can be carried out either **by name** or **by description**. The system provides for extra search **parameters**:

- To match the whole word, enable the appropriate mode;
- To perform a case-sensitive search, enable the **Match case** mode.

6.3. Coordinate system detailed description

A detailed description of the properties of the selected coordinate system is displayed in the **Information** window. To open it, select the needed coordinate system in a table and click the button in **Coordinate systems** window toolbar.

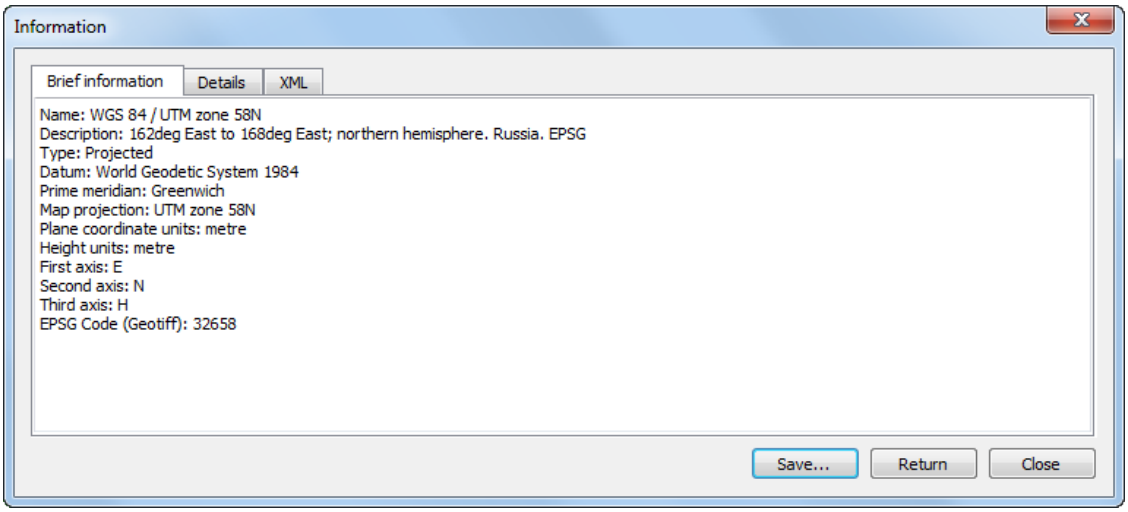


Fig. 4. The Information window

There are three tabs in the Information window: coordinate system **Brief information**, as well as two tabs, where the coordinate system is described in **Details** in an easy-to-view form, and in the original **XML** format.

Quick edit of both coordinate system **Brief information** and **Details** is available in the **Information** window. The **Brief information** is edited in the appropriate tab. Making changes to the detailed description requires editing the data in the original **XML** format. The system allows to **return** information about the coordinate system from the database, canceling changes made by the user.

If the user wants to **save** the changes made working with the **Information** window, both brief and detailed info on the coordinate system will not be edited in the database but saved as separate files in the *Windows* file system, with possible further import of these data.

To edit the coordinate system by saving the information immediately in the database, select the desired coordinate system in the **Coordinate systems** window and click the button. It is highly recommended to back up the selected coordinate system and make changes to its copy ().

6.4. Creating new coordinate system

Program provides a possibility both to use existing reference system or to create a new one.

Use the following steps to create a reference system:

1. Choose **Database › Coordinate systems** in the main window of the program. The **Coordinate systems** window opens.

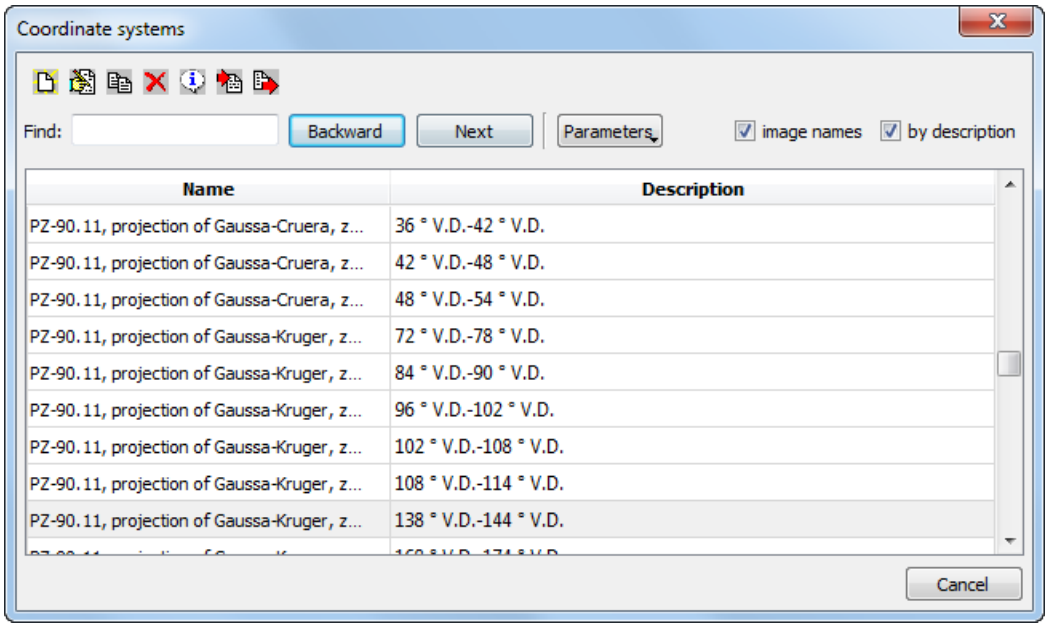


Fig. 5. The Coordinate systems window

2. Click the button in **Coordinate systems** window toolbar. The **Editing the coordinate system** window opens:

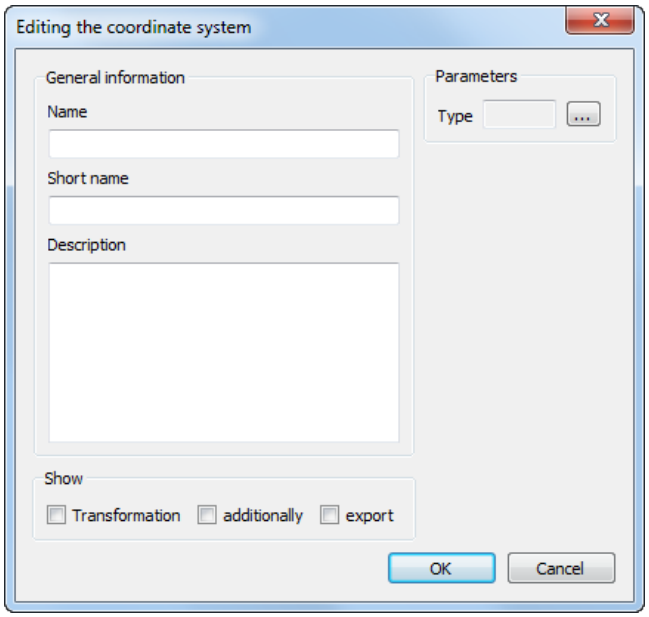


Fig. 6. Reference system creation

3. In **parameters** section click the ... button to select the coordinate system type. The **Types of coordinate systems** window opens:

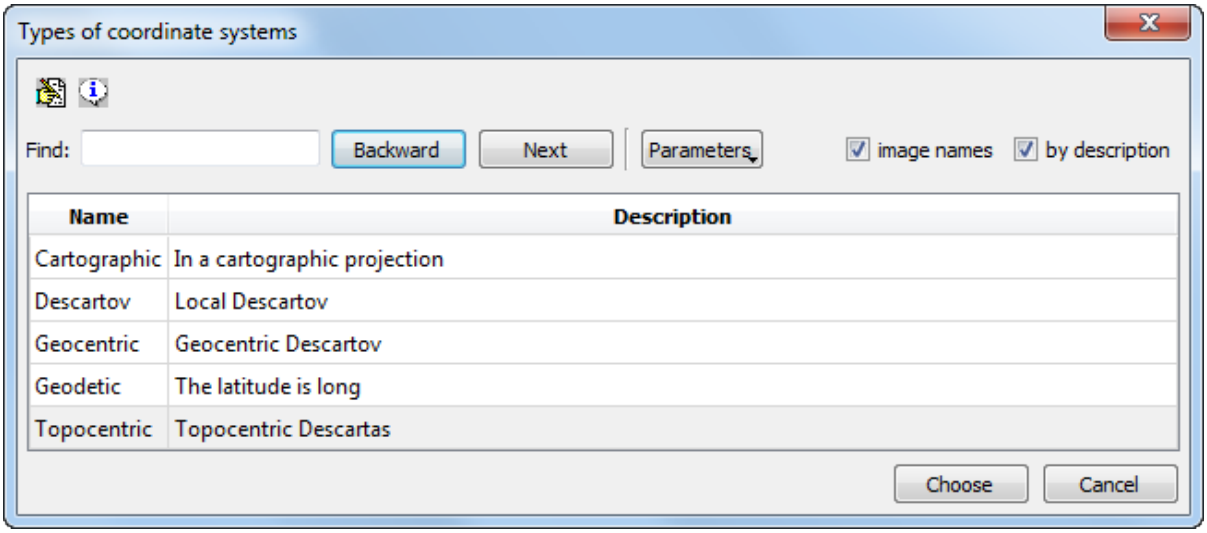


Fig. 7. Selecting of the coordinate system type

Choose the coordinate system type and click **choose** to close the window;

4. In **general information** section fill the following fields to describe the coordinate system:

   - **Name** – arbitrary name (e.g., Gauss-Kruger, 10 zone);

- **Abbreviation** – arbitrary short name;
- **Description** – arbitrary description.

5. Define other settings of the coordinate system depending on chosen coordinate system's type (see the separate chapters below);
6. [optional] to create the additional coordinate **transformation** rules, set the appropriate checkbox and specify the needed parameters;
7. [optional] Set the **export** checkbox to assign an EPSG code (or a *MapInfo* code);
8. Click the **Ok** button. Created reference system is shown in the list with defined name and description.

Do the same actions to edit settings of existing reference system.

6.5. Coordinate system's parameters

6.5.1. Parameters of geodetic coordinate system

To create `Geodetic` (latitude/longitude) coordinate system perform the following:

1. Define the general settings of the coordinate system;

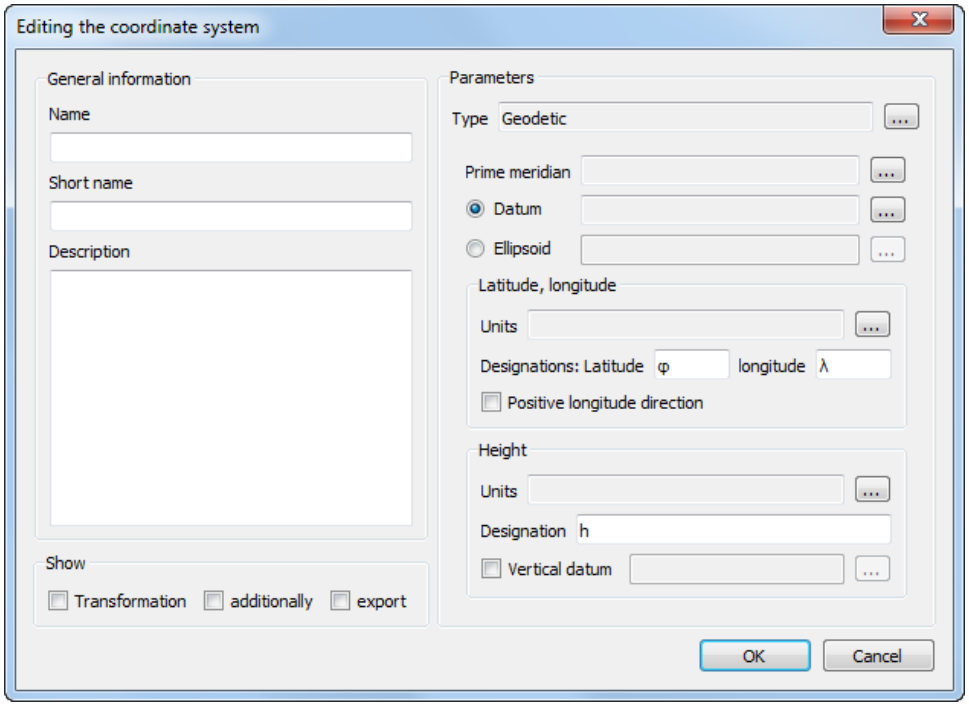


Fig. 8. Creating the Geodetic (latitude/longitude) coordinate system

2. Click the ... button to choose **Prime meridian**;

3. Perform one of the following actions:

   - [optional] Click the ... button to choose the **Datum** from the list;

   - [optional] To set the **Ellipsoid** click the ... button and choose ellipsoid from the list.

4. In the **Latitude, Longitude** section define the following settings:

   - click the ... button rightward to the **Units** field to choose the latitude and longitude angular units from the list (see Section 7.4);

   - set the arbitrary symbol as a **latitude** designation;

   - set the arbitrary symbol as a **longitude** designation;

   - [optional] to create a coordinate system measured positively to the east from the Greenwich meridian, set the **Positive longitude direction** checkbox.

5. In the **Height** section set the following parameters:

   - click the ... button rightward to the **Units** field to choose the linear units from the list (see Section 7.4);

   - set the **Designation** as an arbitrary symbol for the Height:

   - [optional] to set the **Vertical datum** set the appropriate checkbox and click the ... button (see Section 7.6).

6.5.2. Parameters of geocentric coordinate system

To create a **geocentric** coordinate system perform the following:

1. Set the general parameters of coordinate system.

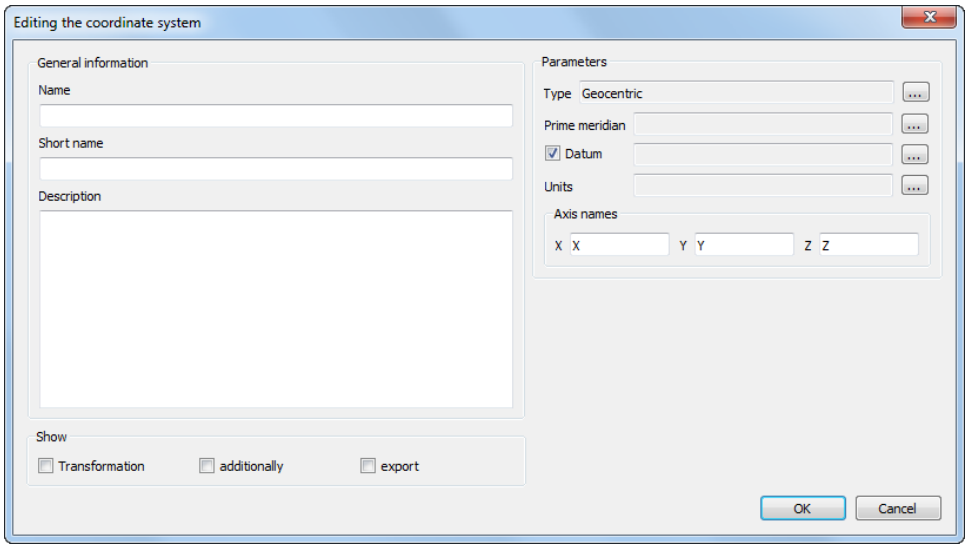


Fig. 9. Creating the geocentric coordinate system

2. Click the ... button to choose **Prime meridian**;

3. [optional] to choose the **Datum**, set the appropriate checkbox and click the ... button to select the datum from the list;

4. Click the ... button rightward to the **Units** field to choose the linear coordinate measure units from the list (see Section 7.4);

5. Set the arbitrary symbol in the **axis names** fields to denote **X**, **Y** and **Z** axis.

6.5.3. Parameters of Cartesian coordinate system

To create a **Cartesian** coordinate system perform the following:

1. Set the general parameters of coordinate system.

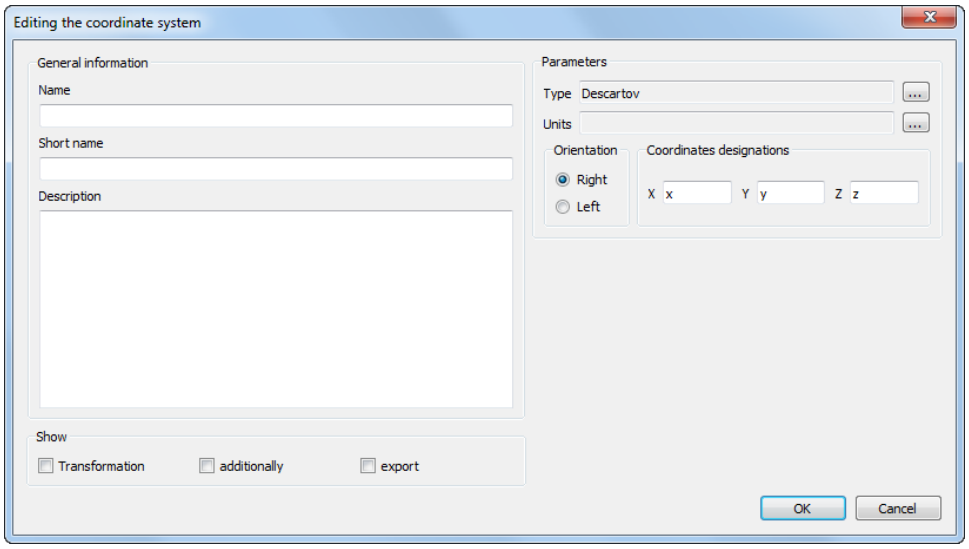


Fig. 10. Creating the Cartesian coordinate system

2. Click the ... button rightward to the **Units** field to choose the linear coordinate measure units from the list (see Section 7.4);

3. Set the arbitrary symbol in appropriate fields to denote the **coordinate designations** for **X**, **Y** and **Z** axis.

4. Set the axis orientation: **Right** or **Left**.

6.5.4. Parameters of cartographic coordinate system

To create a **cartographic** coordinate system perform the following:

1. Set the general parameters of coordinate system.

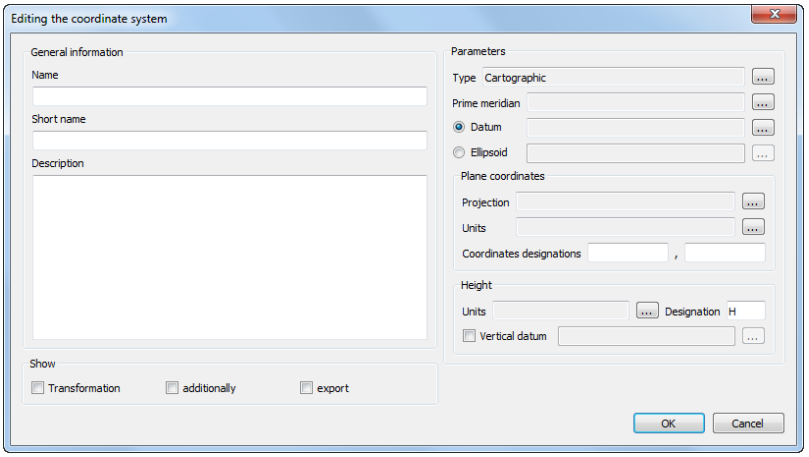


Fig. 11. Creating the cartographic coordinate system

2. Click the ... button to choose **Prime meridian**;

3. Perform one of the following actions:

   - [optional] Click the ... button to choose the **Datum** from the list;

   - [optional] To set the **Ellipsoid** click the ... button and choose ellipsoid from the list.

4. Set the following parameters:

   - Click the ... button to choose the **projection** from the list;

   - Click the ... button rightward to the **Units** field to choose the linear coordinate measure units from the list (see Section 7.4);

   - Define the short **coordinate designations**.

5. Set the following **height** parameters:

   - click the ... button rightward to the **Units** field to choose the linear units from the list (see Section 7.4);

   - Define the short height **designation**;

   - [optional] to set the **Height system** set the appropriate checkbox and click the ... button (see Section 7.6).

6.5.5. Parameters of topocentric coordinate system

To create a **topocentric** coordinate system perform the following:

1. Define the general settings of the coordinate system;

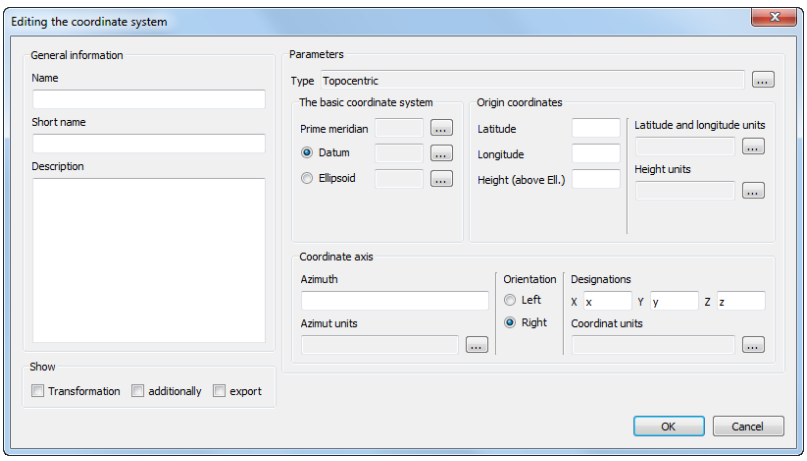


Fig. 12. Creating topocentric coordinate system

2. Click the ... button to choose **Prime meridian**;

3. Perform one of the following actions:

   - [optional] Click the ... button to choose the **Datum** from the list;

   - [optional] To set the **Ellipsoid** click the ... button and choose ellipsoid from the list.

4. Set the following parameters:

   - Input the **origin coordinates** – **latitude**, **longitude** and **height** (above the ellipsoid);

   - click the appropriate ... buttons to choose the latitude and longitude angular units from the lists (see Section 7.4);

   - click the appropriate ... button to choose the linear height units from the list (see Section 7.4).

5. Set the **coordinate axis** parameters:

   - Set the **Azimuth** in degrees;

   - Click the appropriate ... button to choose the **azimuth** angular units from the list (see Section 7.4);

   - Set the **orientation** of the axis: **Right** or **Left**;

   - Set the arbitrary symbol in the **X**, **Y** and **Z** axis **designations** fields;

   - Click the appropriate ... button to choose the linear coordinate measure units from the list (see Section 7.4).

6.6. Import and export of coordinate systems

To import the current coordinate system database from the selected file, click in the **Coordinate system** window toolbar and indicate the desired file in the file selection box that opens. Coordinate system import is available for the following types of files:

- XML files (`*.xml`);

- WKT files (`*.wkt`);

- XML files used by *PHOTOMOD* (`*.x-ref-system`);

- text files previously used by *PHOTOMOD* (`*.reference system`).

In the case of the same names, the imported coordinate system will not be written over the existing one but saved as a separate copy.

To export the individual coordinate system, select the required one in the **Coordinate system** window and click in the window toolbar. Export of coordinate systems is available for the following types of files:

- XML files (`*.xml`);
- XML files used by *PHOTOMOD* (`*.x-ref-system`);
- text files previously used by *PHOTOMOD* (`*.reference system`).

6.6.1. Batch import and export

To perform a batch import of coordinate systems from a database file (`*.db`) to the current database, click the in main window toolbar. This functionality allows one to import coordinate systems from one `*.db` file to another.

To export coordinate systems to a folder from the current database, click the button of the main window toolbar. Each coordinate system in the database will be exported into the chosen folder as a single `*.xml` file.

To perform a batch Import of coordinate systems from a folder into the current database, click the button of the main window toolbar. Select a folder with `*.xml` files that contain data on coordinate systems.

If working with a user coordinate system, ensure periodically creating backups of database files in a separate folder.

6.7. Coordinate systems types

The **Types of coordinate systems** window (**Database › Types of coordinate systems**) allows to show provided types of coordinate systems. The **Types of coordinate systems** window user interface (the table, toolbar, search tools) is similar to the interface of the **Coordinate systems** window.

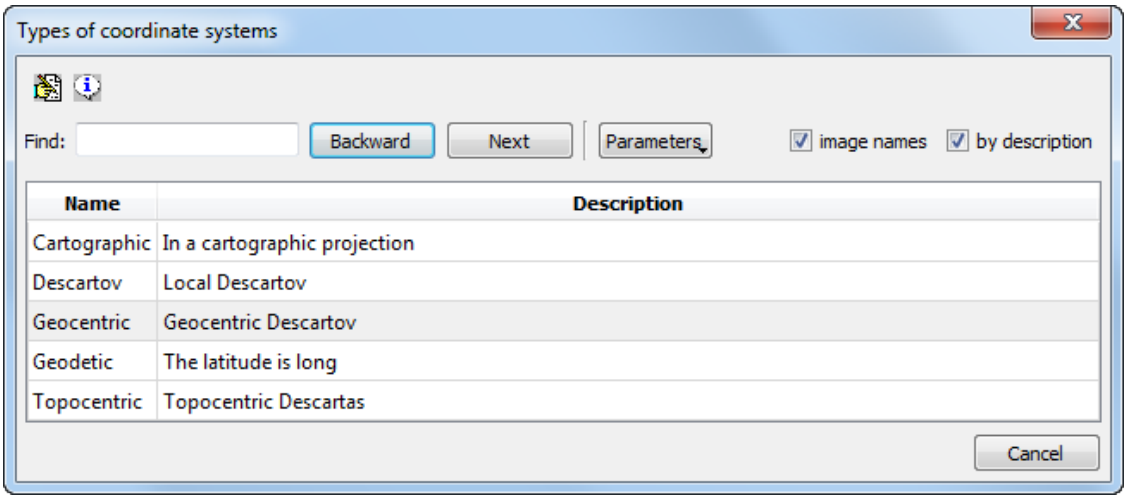


Fig. 13. The list of types of coordinate systems

The program supports the following coordinate system's types:

- **Geodetic**;
- **Geocentric**;
- **Cartesian**;
- **Cartographic**;
- **Topocentric**.

7. Coordinate systems elements

7.1. Datums

Datum – is set of parameters used for shift and transform reference ellipsoind into local geographic coordinates.

The **Datum** window (**Database › Datums**) is used for the datums management. The **Datum** window user interface (the table, toolbar, search tools) is similar to the interface of the **Coordinate systems** window.

7.1.1. Creating new datum

To create a new datum perform the following actions:

1. Choose **Database › Datums**. The **Datum** window opens:

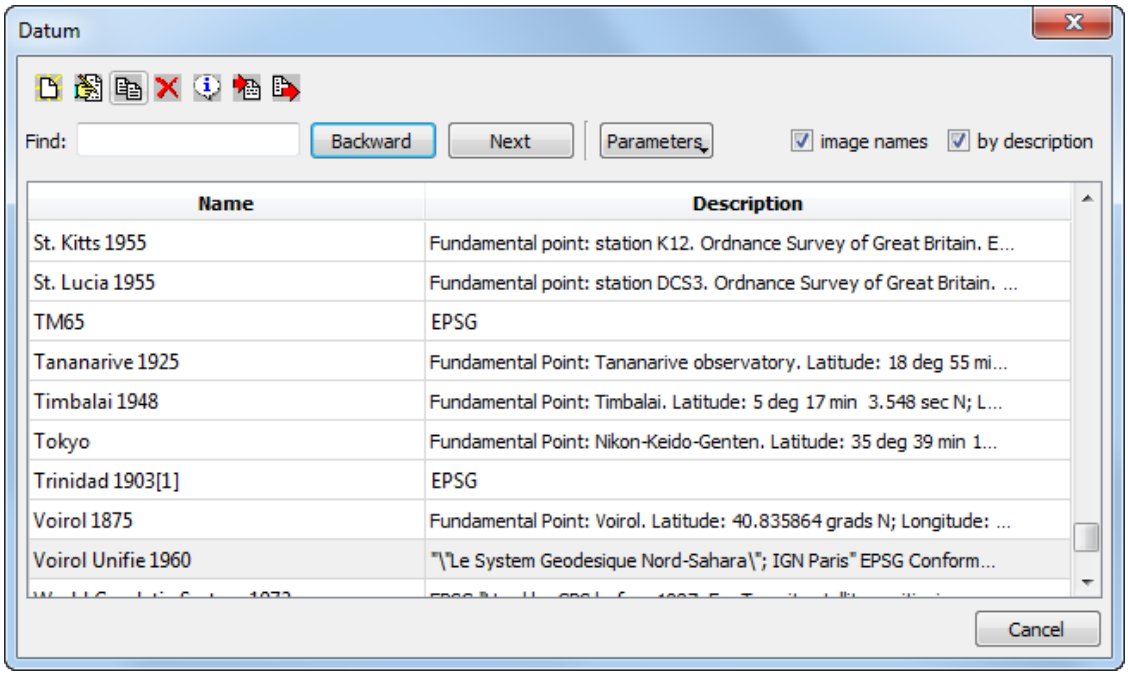


Fig. 14. The Datum window

2. Click the button in **Datum** window. The **Datum editing** window opens:

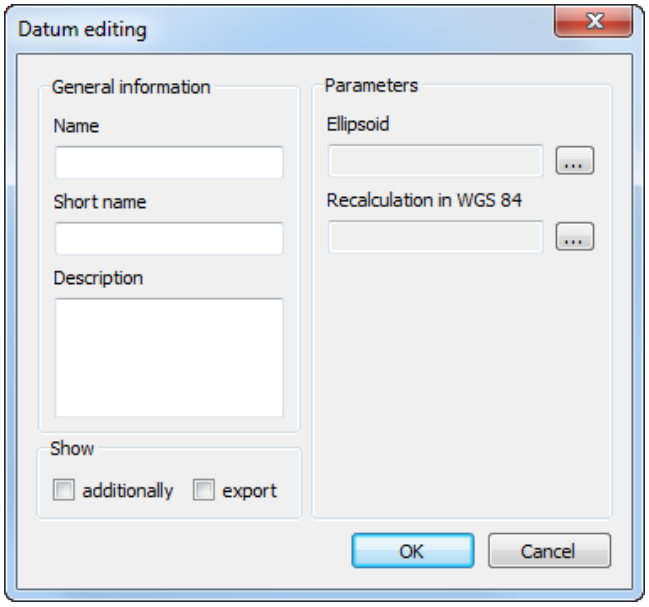


Fig. 15. Datum settings window

3. Define the datum **General information** – **Name**, **Short name** and **Description** of the datum in appropriate fields;

4. Click the ... button rightward to the **Ellipsoid** field to choose reference-ellipsoid from the list (see the Section 7.2);

5. Click the ... button rightward to the **Recalculation in WGS 84** field to choose the datum transformation parameters preset;

6. [optional] Set the **export** checkbox to assign an EPSG code (or a *MapInfo* code);

7. Click the **Ok** button. Created datum is shown in the list with defined name and description.

7.1.2. Datum transformation parameters presets

The default database contains the list of most popular datum transformation parameters presets. Besides, it is possible to create a new set of datum transformation parameters.

The **Datum transformations** window (**Database › Datum transform**) is used for the datum transformation presets management. The **Datum transformations** window user interface (the table, toolbar, search tools) is similar to the interface of the **Coordinate systems** window.

7.1.3. Creating new datum transformation parameters preset

To create a set of datum transformation parameters, perform the following actions:

1. Choose the **Database › Datum transform** in the main window of the program. The **Datum transformations** window opens:

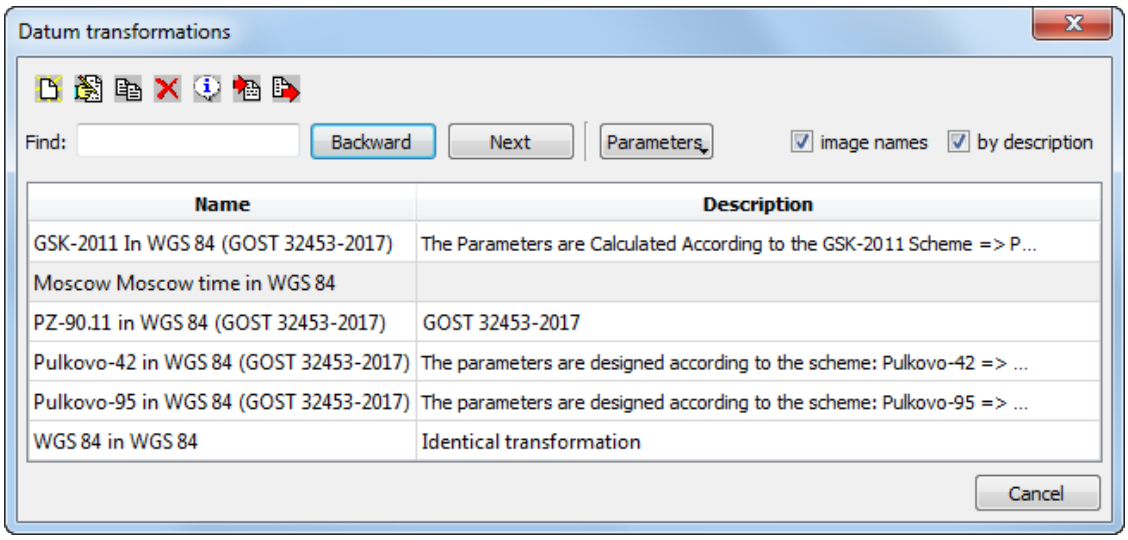


Fig. 16. Default datum transformation parameters presets

2. Click the button. The **Datum transformation parameters** window opens:

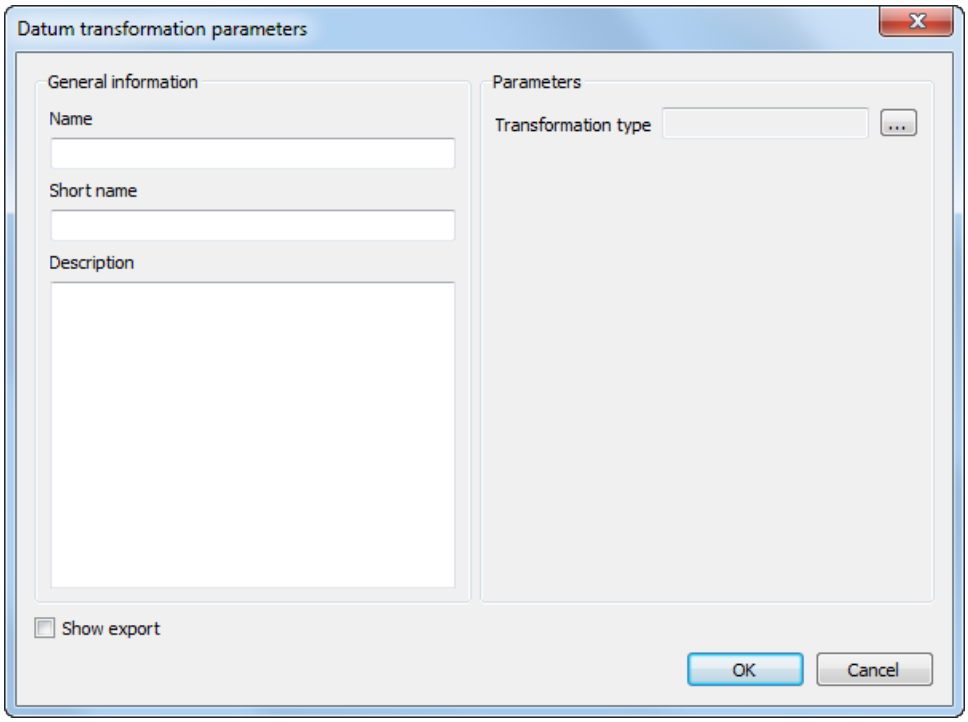


Fig. 17. Datum shift parameters

3. Choose the datum **transformation type**:

   - **Helmert** – datum rotation Bursa-Wolf;
   - **Molodensky** – three shifts;
   - **Molodensky-Badecas (Helmert)** – datum rotation Bursa-Wolf;
   - **Molodensky-Badecas (rotate-shift-scale)** – datum rotations used in Russian Federation;
   - **Rotate-shift-scale** – datum rotations used in Russian Federation;

4. Define the following parameters of datum:

   - **Name**;

     It is recommended to include names of source and target datum in the name of shift parameters.

   - **Short name** – arbitrary short name of datum shift;
   - **Description** – arbitrary text, description of shift's physical meaning.

5. Define other datum transformation parameters, depending on chosen datum **transformation type** (see below in the separate chapter);

6. [optional] Set the **export** checkbox to assign an EPSG code (or a *MapInfo* code);

7. Click the **OK** button. Created datum is shown in the list with defined name and description.

7.1.4. Datum transformation parameters

The Helmert transformation

1. Configure the general settings of datum transformations;

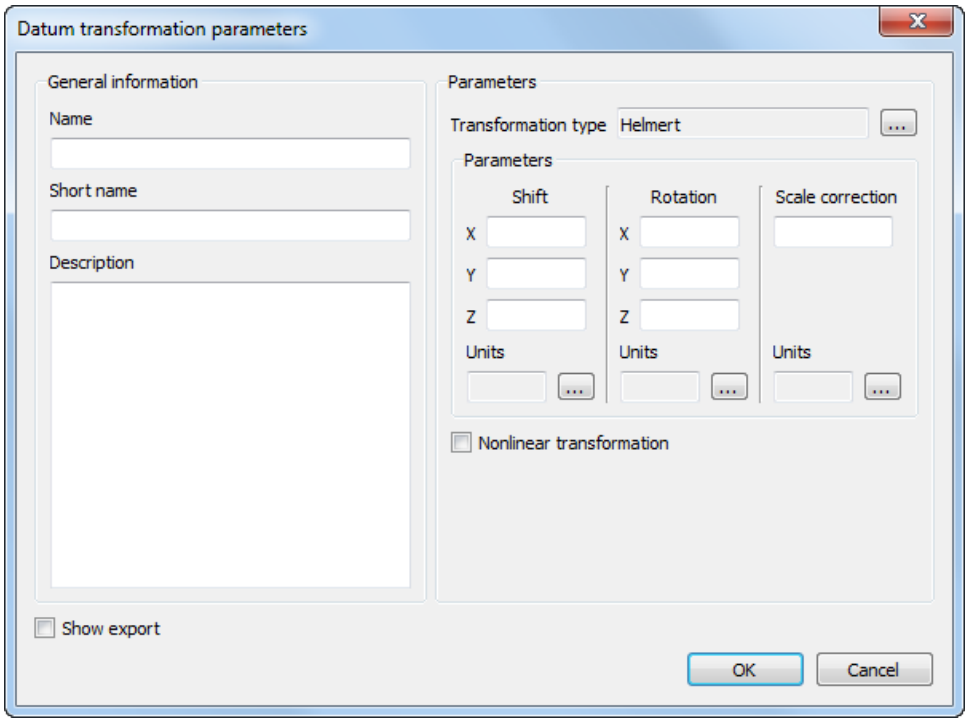


Fig. 18. The Helmert transformation

2. Configure the following parameters, in the appropriate sections:

   - **Shift** – shift units and Tx, Ty, and Tz values;
   - **Rotation** – rotation units and Rx, Ry, and Rz values;
   - **Scale correction** – scale factor, S units and values.

   Click ... to select units of shift, rotation, or scale from the list.

3. [optional] If a quite large value (about tens of angular seconds or more) is entered in at least one of the fields describing the rotation parameters, it is strongly recommended to set the **nonlinear transformation** checkbox in order to ensure sufficient accuracy of calculations (at the expense of system performance).

The Molodensky transformation

1. Configure the general settings of datum transformations;

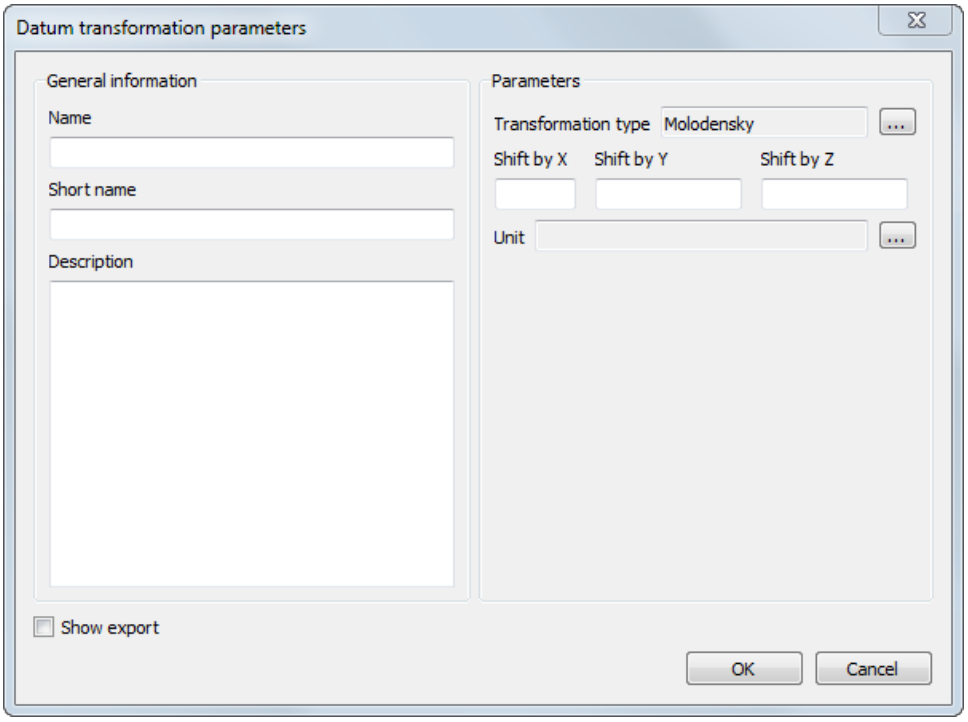


Fig. 19. The Molodensky transformation

2. **Shift** – shift units and Tx, Ty, and Tz values;

Click ... to select units of shift from the list.

The Molodensky-Badekas (Helmert) transformation

1. Configure the general settings of datum transformations;

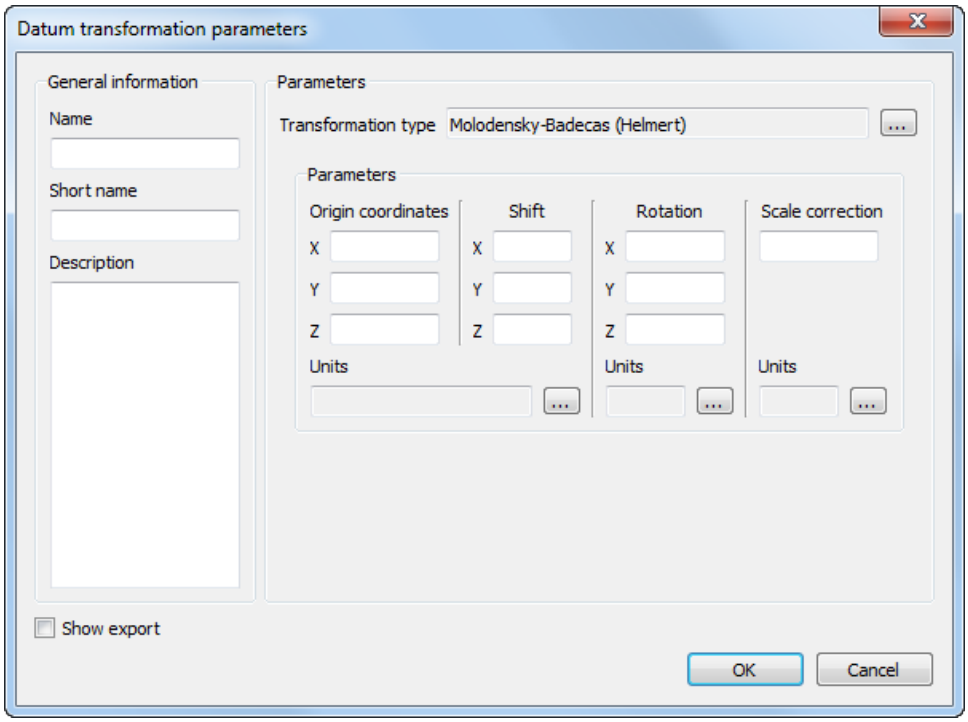


Fig. 20. The Molodensky-Badekas (Helmert) transformation

2. Configure the following parameters, in the appropriate sections:

   - **Origin coordinates** – units and X, Y, and Z coordinates;
   - **Shift** – shift units and Tx, Ty, and Tz values;
   - **Rotation** – rotation units and Rx, Ry, and Rz values;
   - **Scale correction** – scale factor, S units and values.

   Click ... to select units of shift, rotation, or scale from the list.

The Molodensky-Badekas (rotate-shift-scale)

1. Configure the general settings of datum transformations;

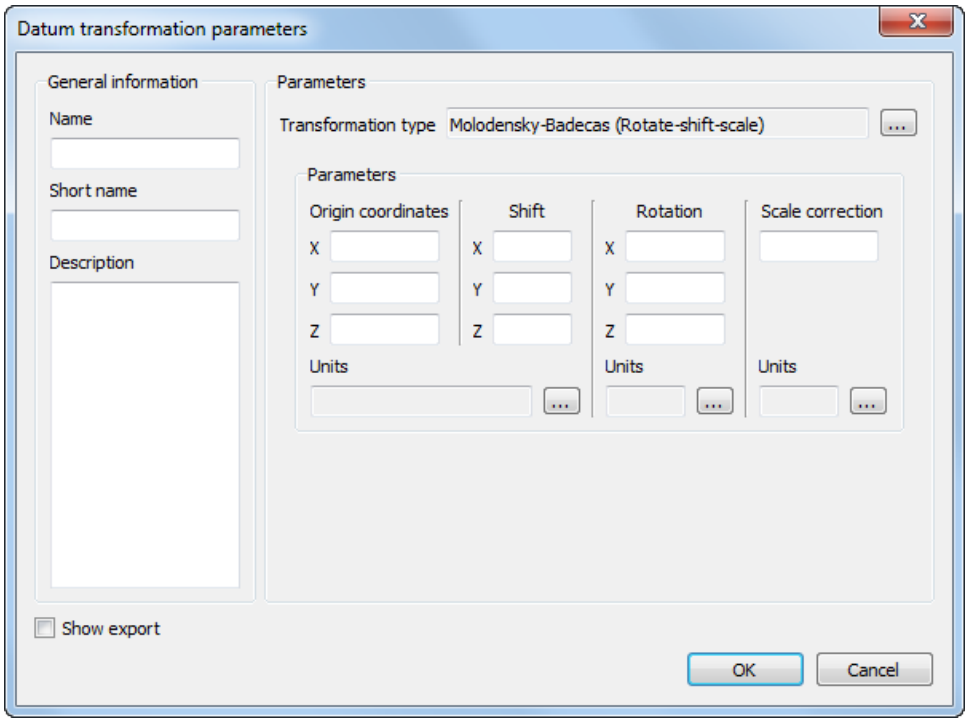


Fig. 21. The Molodensky-Badekas (rotatie-shift-scale)

2. Configure the following parameters, in the appropriate sections:

- **Origin coordinates** – units and X, Y, and Z coordinates;
- **Shift** – shift units and Tx, Ty, and Tz values;
- **Rotation** – rotation units and Rx, Ry, and Rz values;
- **Scale correction** – scale factor, S units and values.

Click ... to select units of shift, rotation, or scale from the list.

Rotation-Shift-Scale

1. Configure the general settings of datum transformations;

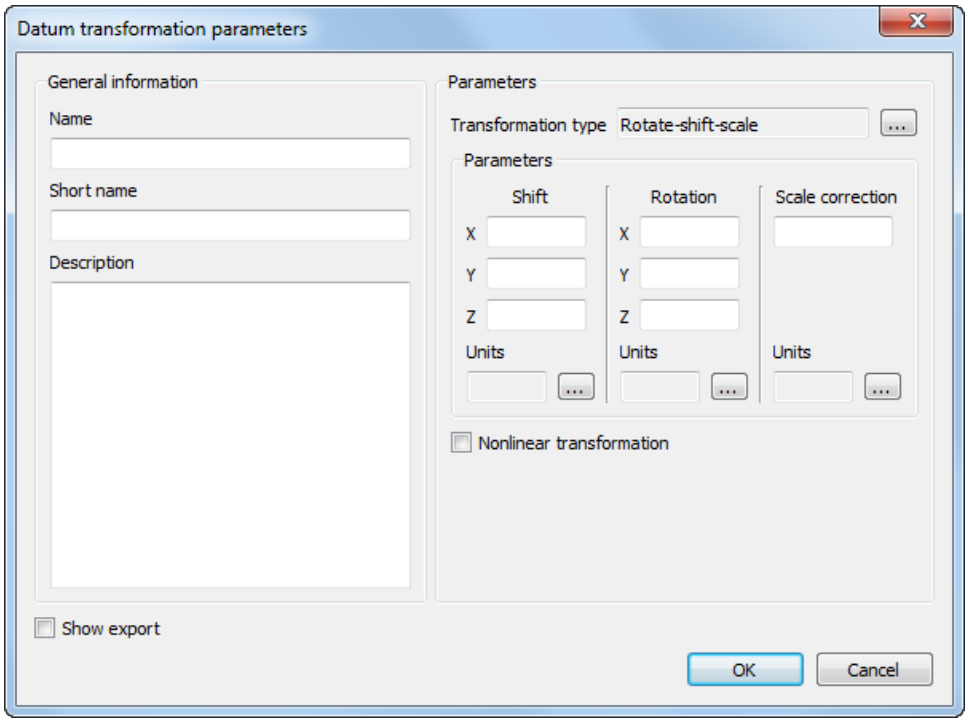


Fig. 22. Rotation-Shift-Scale configuration parameters

2. Configure the following parameters, in the appropriate sections:

   - **Shift** – shift units and Tx, Ty, and Tz values;
   - **Rotation** – rotation units and Rx, Ry, and Rz values;
   - **Scale correction** – scale factor, S units and values.

   Click ... to select units of shift, rotation, or scale from the list.

3. [optional] If a quite large value (about tens of angular seconds or more) is entered in at least one of the fields describing the rotation parameters, it is strongly recommended to set the **nonlinear transformation** checkbox in order to ensure sufficient accuracy of calculations (at the expense of system performance).

7.1.5. Datum transformation types

The **Types of transformations of datums** window is used for choosing datum transformation type (**Database › Types of transformation of datums**). The **Types of transformations of datums** window user interface (the table, toolbar, search tools) is similar to the interface of the **Coordinate systems** window.

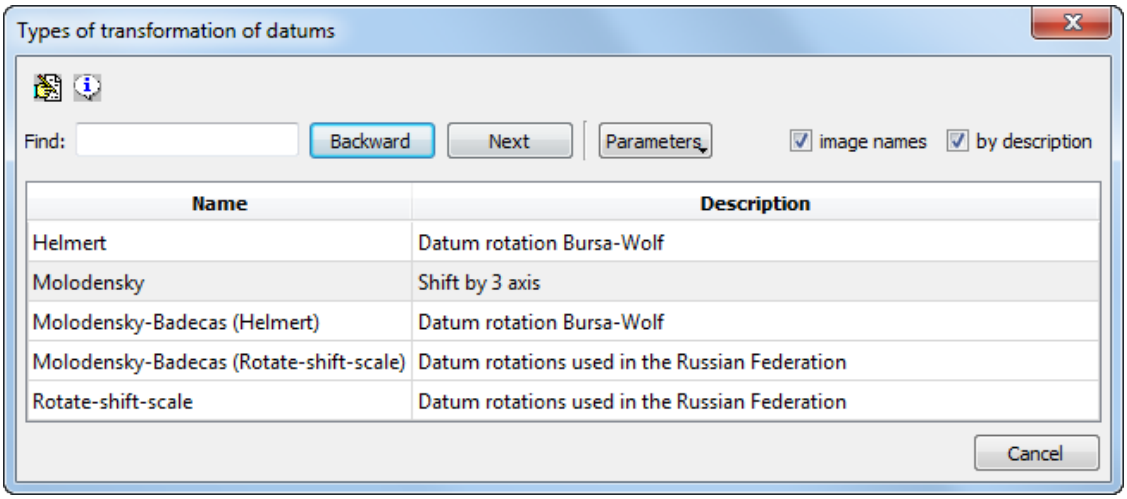


Fig. 23. The list of available datum transformation types

7.2. Ellipsoids

Reference ellipsoid is a mathematically-defined surface that approximates the geoid, the truer figure of the Earth, or other planetary body. Because of their relative simplicity, reference ellipsoids are used as a preferred surface on which geodetic network computations are performed and point coordinates such as latitude, longitude, and elevation are defined. Reference ellipsoid figure is best suited for the area of one country or several countries.

The **Ellipsoids** window (**Database › Ellipsoid**) is used for the ellipsoids management. The **Ellipsoids** window user interface (the table, toolbar, search tools) is similar to the interface of the **Coordinate systems** window.

7.2.1. Creating new ellipsoid

To create a new reference ellipsoid with c defined parameters, perform the following actions:

1. Choose **Database › Ellipsoid**. The **Ellipsoids** window opens:

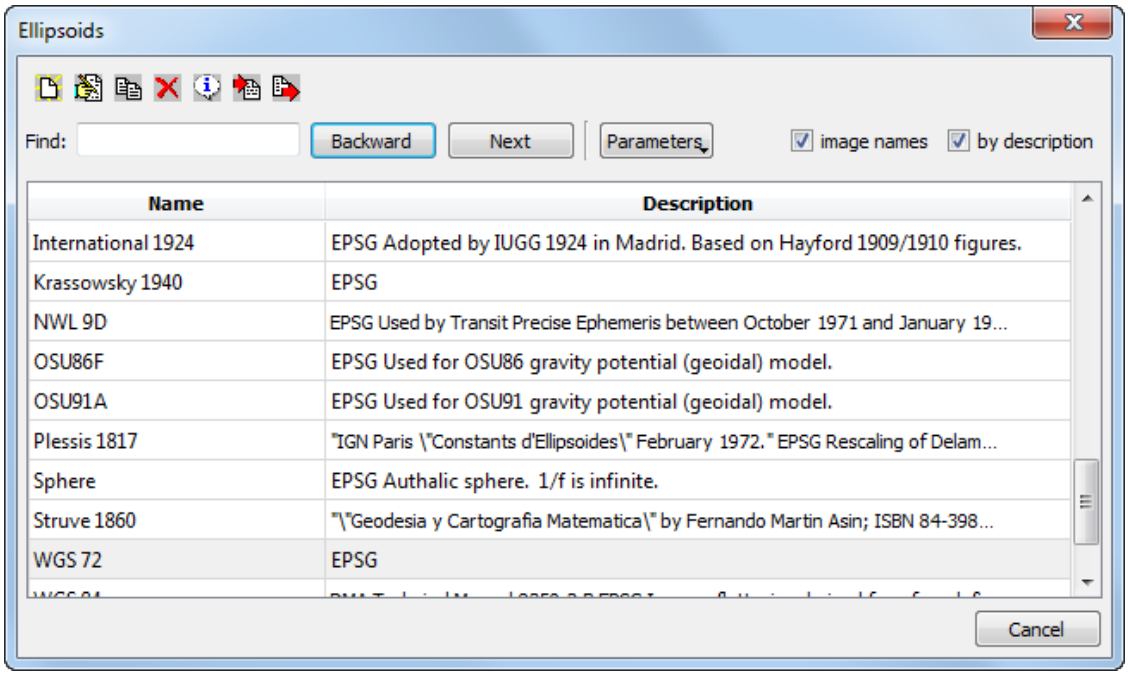


Fig. 24. The list of default ellipsoids in database

2. Click the button. The **Ellipsoid** window opens:

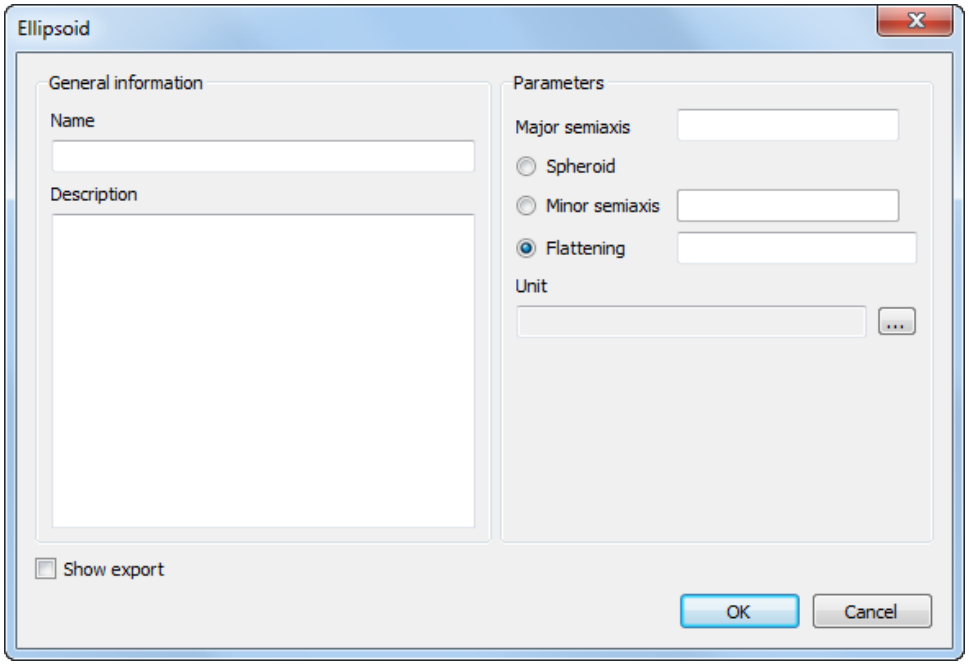


Fig. 25. Reference ellipsoid parameters

3. Define the **Name** and **Description** of the reference ellipsoid in the fields;

4. Specify the folowing ellipsoid **parameters**:
   - **Major semiaxis**;
   - [optional] **Minor semiaxis** or **flattening** (or create the **Spheroid**).
5. Click the ... button rightward to the **unit** field to choose linear units from the list (see the Section 7.4);
6. [optional] Set the **export** checkbox to assign an EPSG code (or a *MapInfo* code);
7. Click the **OK** button. Created reference ellipsoid is shown in the list with defined name and description.

7.3. Prime meridian

The program provides an opportunity to choose **prime meridian** for used reference system. The **Prime meridian** window (**Database › Prime meridians**) is used for the ellipsoids management. The **Prime meridian** window user interface (the table, toolbar, search tools) is similar to the interface of the **Coordinate systems** window.

7.3.1. Creating new prime meridian

To create prime meridian, different from standard, perform the following actions:

1. Choose the **Database › Prime meridians** in the main window of the program. The **Prime meridian** window opens:

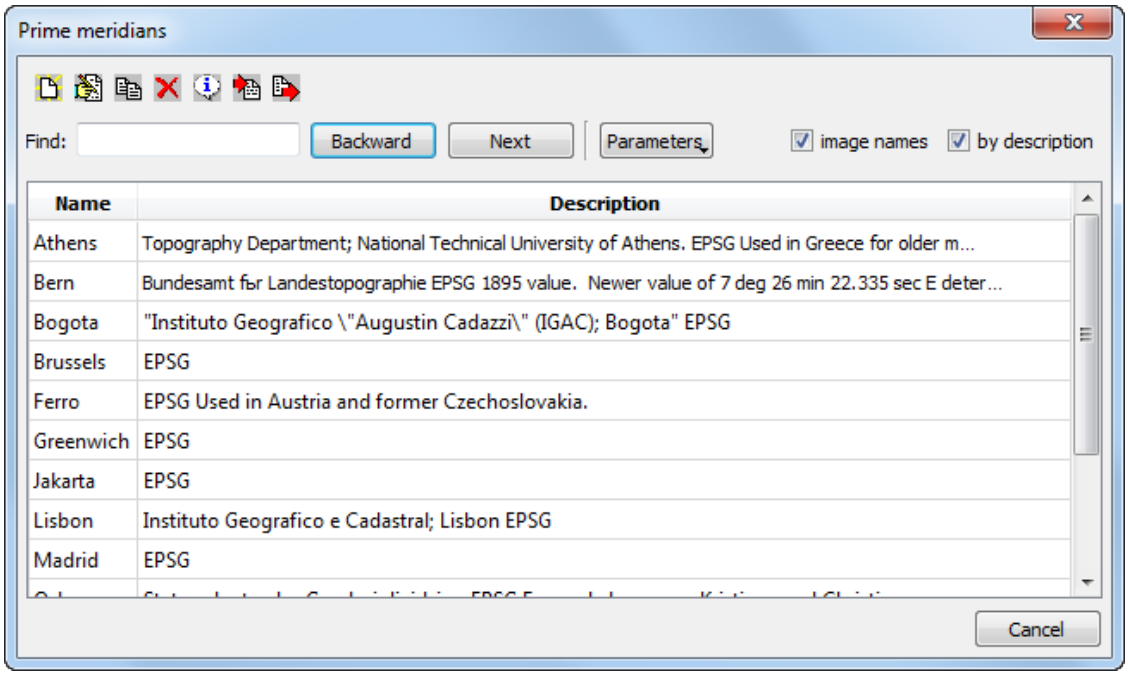


Fig. 26. The list of prime meridians in default database

2. Click the button. The **Prime meridian** window opens:

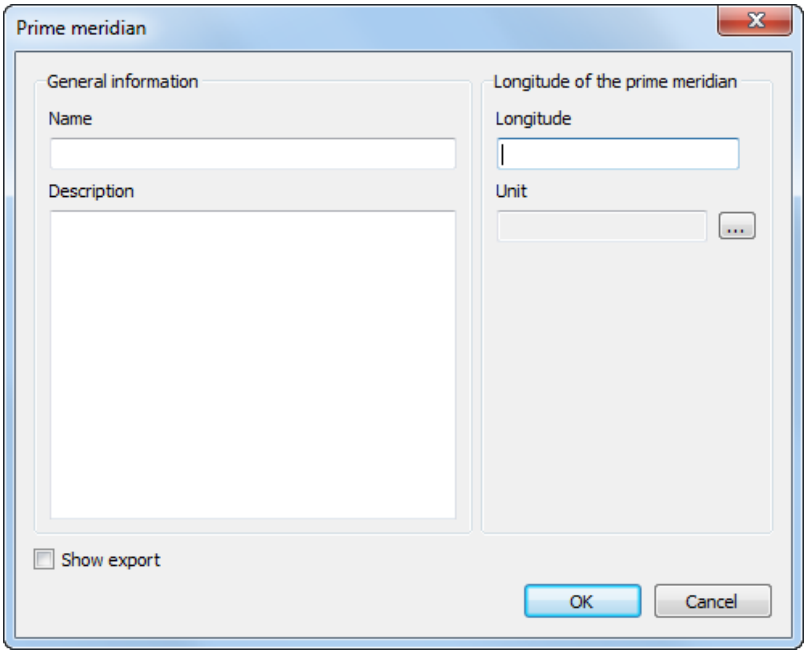


Fig. 27. Prime meridian settings

3. Define the **Name** and **Description** of the prime meridian in the fields;

4. Define the **Longitude** of the prime meridian;

5. Click the ... button rightward to the **Unit** field to choose linear units from the list (see the Section 7.4);

6. [optional] Set the **export** checkbox to assign an EPSG code (or a *MapInfo* code);

7. Click the **OK** button. Created prime meridian is shown in the list with defined name and description.

7.4. Measurement units

The program provides an opportunity to choose angular, linear and scale units for parameters that have a dimension.

The following windows are used to manage the units of measure:

- **Linear units** (**Database › Linear units**);
- **Angular units** (**Database › Angle units**);
- **Scale units** (**Database › Scale units**).

The user interface of these windows (the table, toolbar, search tools) is similar to the interface of the **Coordinate systems** window.

7.4.1. Creating new linear units

To create a new **linear** unit, perform the following:

1. Choose **Database › Linear units**. The **Linear units** window opens:

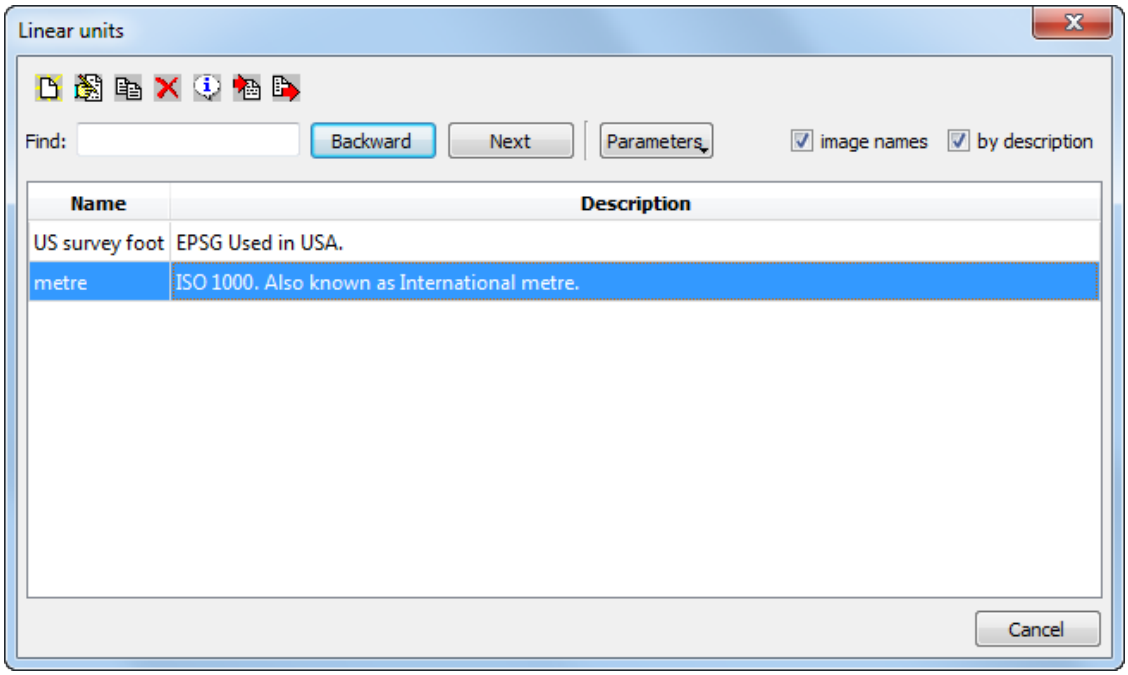


Fig. 28. The Linear units window

2. Click the button. The **Linear units** window opens:

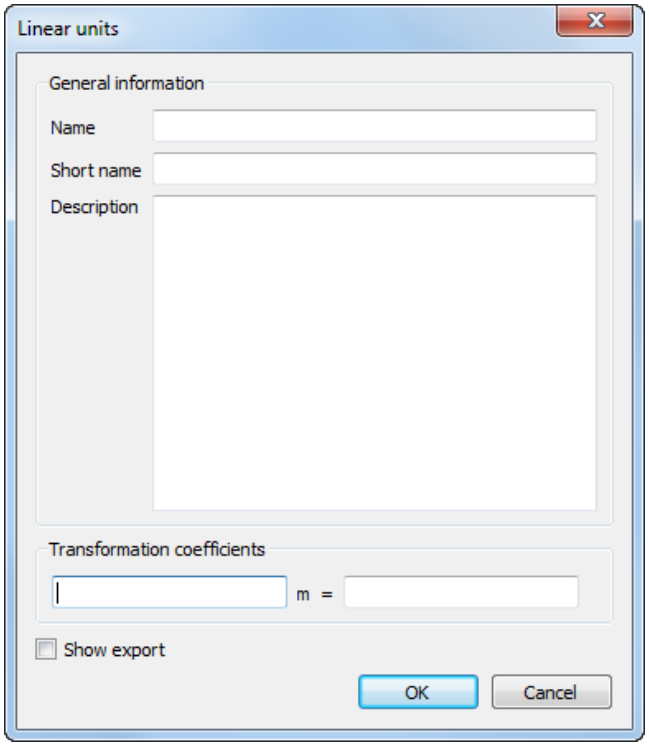


Fig. 29. The Linear units window

3. Enter **Name**, **Short name** and **Description** in the appropriate fields. The **Short name** is used for the dimension abbreviation (for example *m* for meters).

4. Enter the following data in the **transformation coefficients** input fields:

   - In the left input field, enter the value in meters;

   - In the right input field, enter the part of the selected unit value that corresponds to the value specified in the left input field.

5. [optional] Set the **export** checkbox to assign an EPSG code (or a *MapInfo* code);

6. Click **OK**. The created unit is displayed in the list with the specified name.

7.4.2. Creating new scale units

To create a new **scale** unit, perform the following:

1. Choose **Database › Scale units**. The **Scale units** window opens:

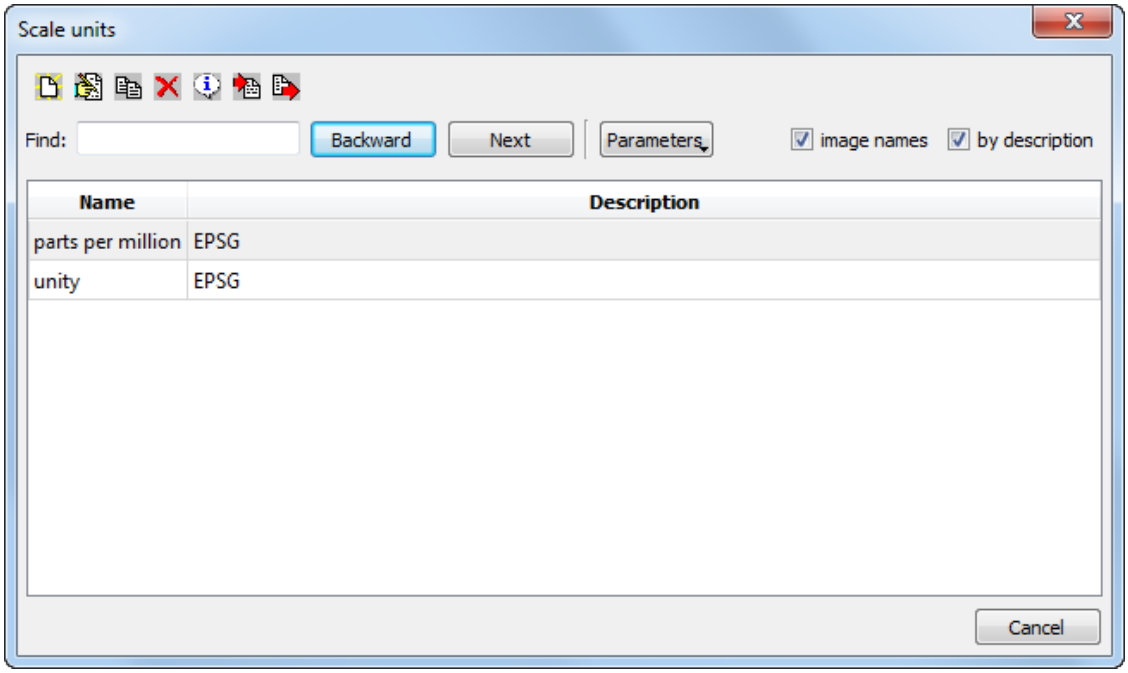


Fig. 30. The Scale units window

2. Click the button. The **Scale units** window opens:

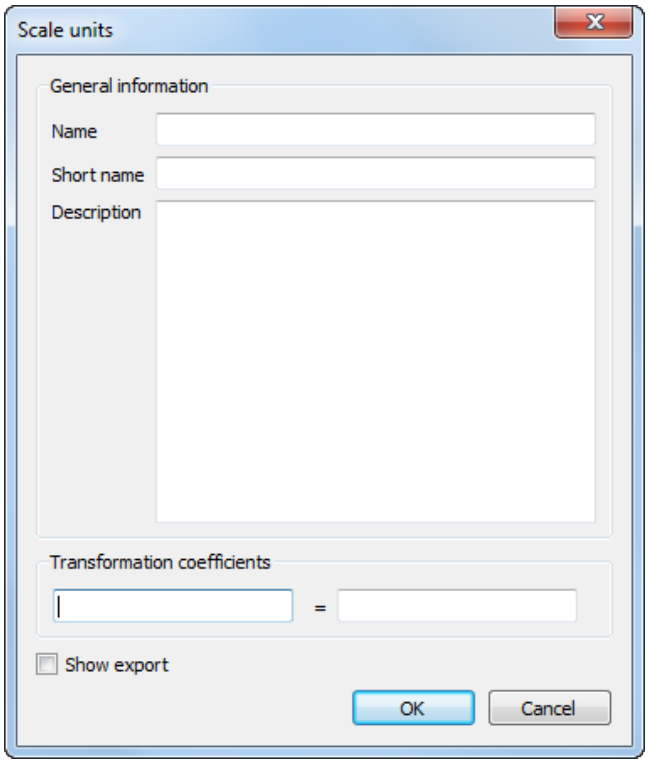


Fig. 31. The Scale units window

3. Enter **Name**, **Short name** and **Description** in the appropriate fields. The **Short name** is used for the dimension abbreviation (for example *ppm* for parts per million).

4. Specify the needed parameters in **transformation coefficients** input fields;

5. [optional] Set the **export** checkbox to assign an EPSG code (or a *MapInfo* code);

6. Click **OK**. The created unit is displayed in the list with the specified name.

7.4.3. Creating new angular units

To create a new **angular** unit, perform the following:

1. Choose **Database › Angle units**. The **Angular units** window opens:

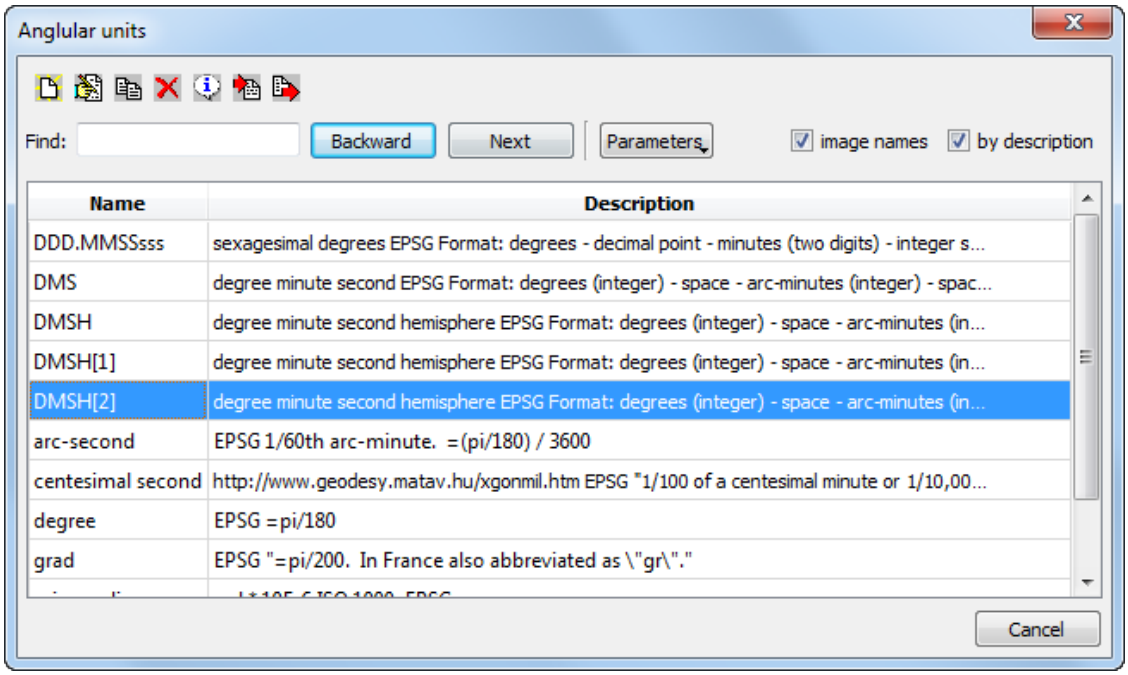


Fig. 32. The Angular units window

2. Click the button. The **Angular units** window opens:

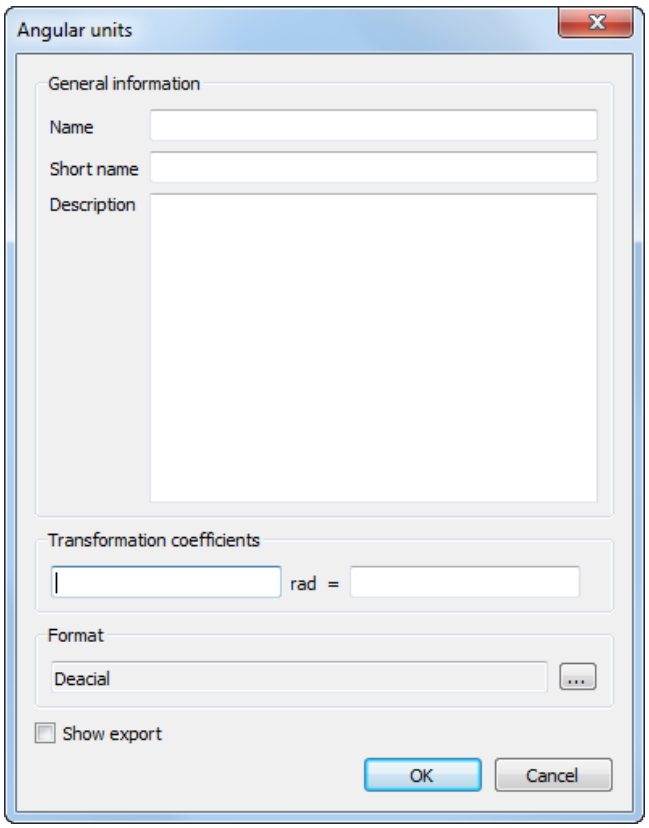


Fig. 33. The Angular units window

3. Enter **Name**, **Short name** and **Description** in the appropriate fields. The **Short name** is used for the dimension abbreviation (for example *deg* for degree).

4. Enter the following data in the **transformation coefficients** input fields:

   - In the left input field, enter the value in radians;

   - In the right input field, enter the part of the selected unit value that corresponds to the value specified in the left input field.

5. Click the ... button to choose the angular unit **format**;

6. Click **OK**. The created unit is displayed in the list with the specified name.

7.4.4. The angular formats list

The **Angular formats** window is used for choosing angular units **format** (**Database › Angular types formats**). The **Angular formats** window user interface (the table, toolbar, search tools) is similar to the interface of the **Coordinate systems** window.

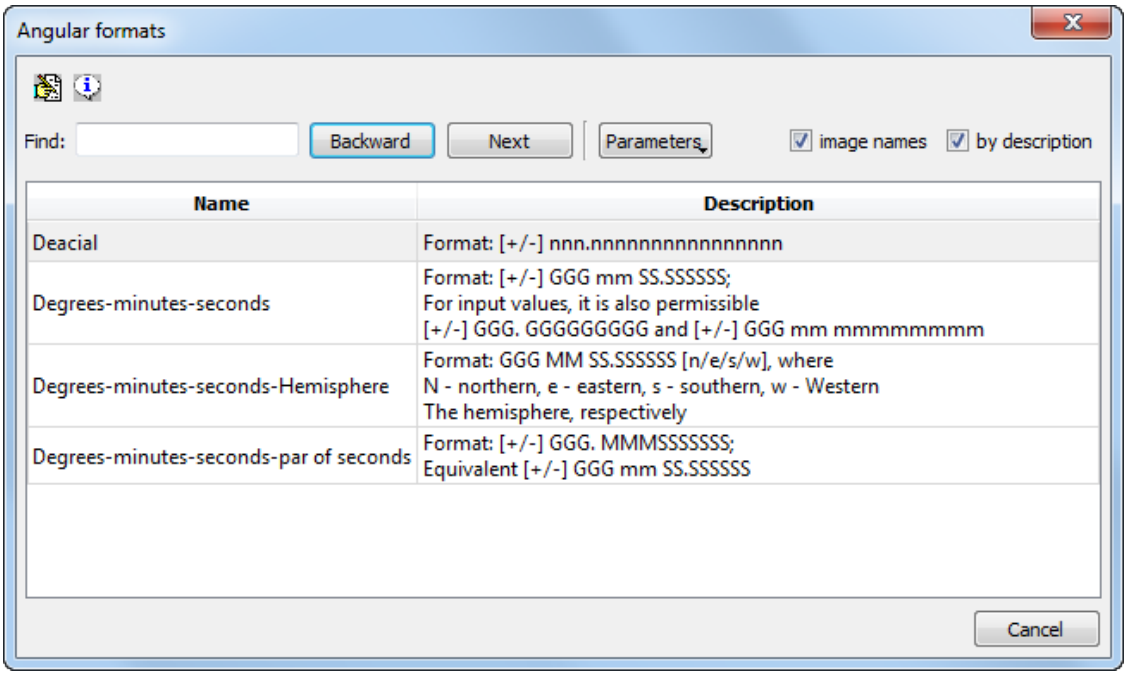


Fig. 34. The available angular formats list

7.5. Cartographic projections

The values of parameters of cartographic projections window is used for viewing the available types of map projections in default database (**Database › Map projections**). **The values of parameters of cartographic projections** window user interface (the table, toolbar, search tools) is similar to the interface of the **Coordinate systems** window.

7.5.1. Creating new cartographic projection

To define parameters of cartographic projection manually, perform the following actions:

1. Choose the **Database › Map projections** in the main window of the program. **The values of parameters of cartographic projections** window opens:

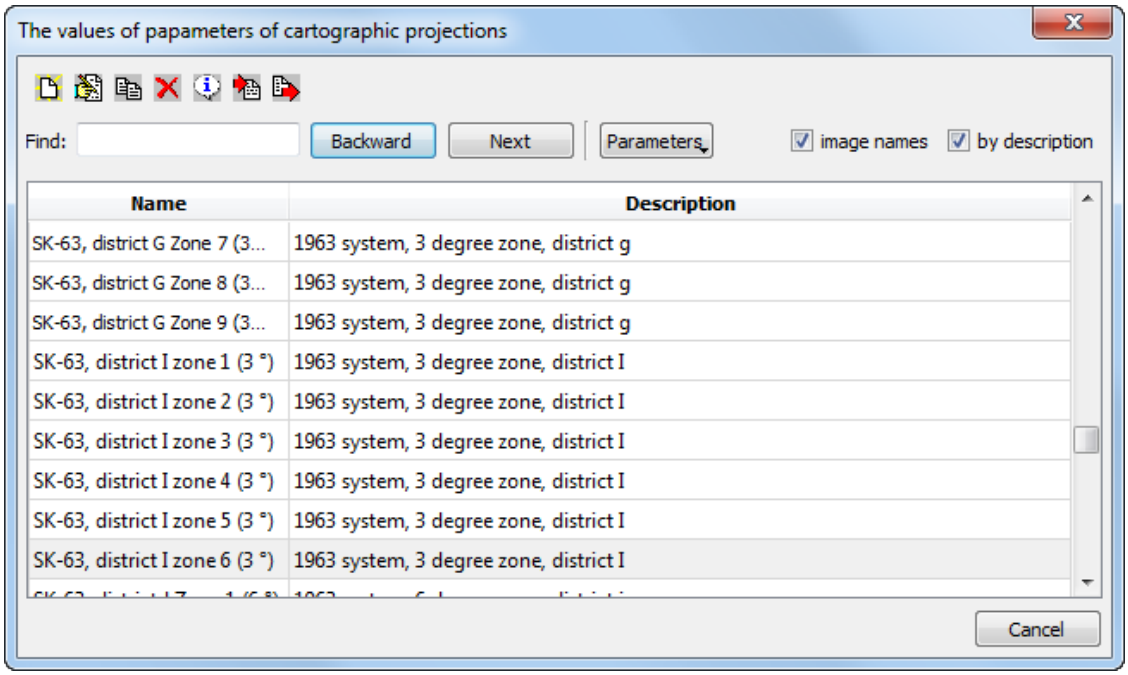


Fig. 35. The values of parameters of cartographic projections window

2. Click the button. The **Projection** window opens:

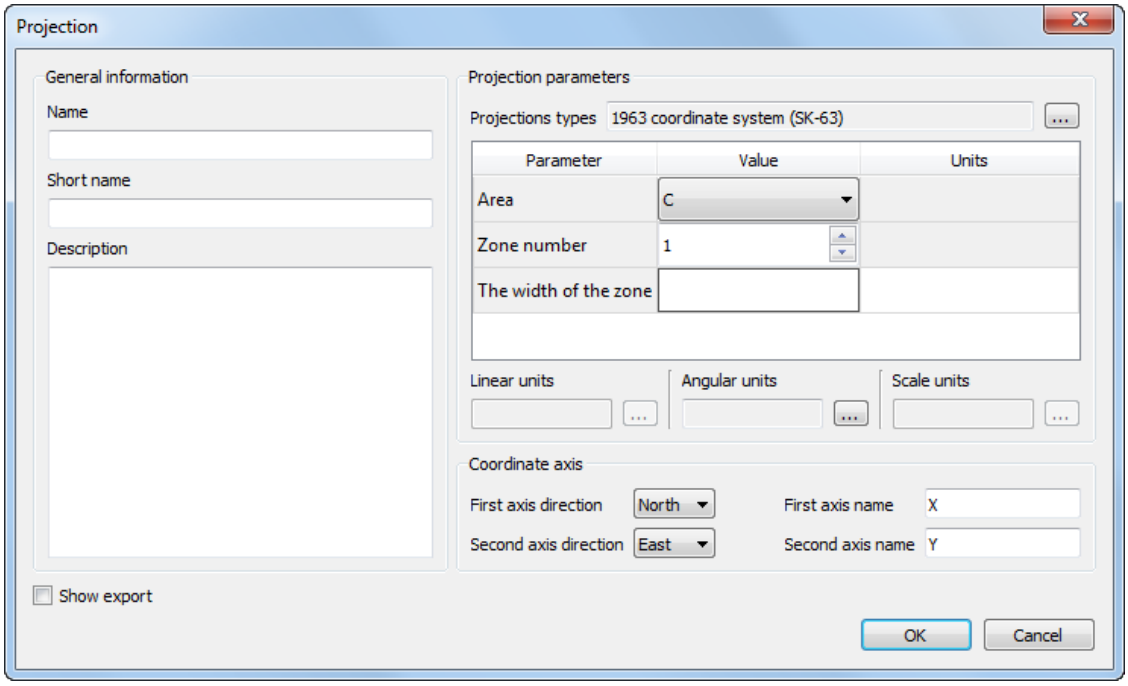


Fig. 36. Creating map projection

3. Set the general map projection parameters:

- **Name** – arbitrary name of projection;
- **Short name** – arbitrary short name;
- **Description** – arbitrary description it's additional information to identify projection in the list.

4. Click the ... button and choose **Projection type**.
5. Specify in table the detail parameters of projection depending on its type.

   Click the empty field in parameter row to add detain parameters in the table.

6. Define the following parameters of map projection:
   - **Linear/Angular/Scale units** – allows to set units of measure for parameters;
   - **First/Second axis direction** – allows to set the direction of reference axis;
   - **First/Second axis name** – allows to set abbreviation for axis.

   Units, direction and names of axis are defined automatically, but they can be edited later.

7. [optional] Set the **export** checkbox to assign an EPSG code (or a *MapInfo* code);
8. Click the **OK** button. Created map projection is shown in the list with defined name and description.

7.5.2. Map projections types

The **Map projections type** window is used for choosing projections type (**Database › Map projections type**). The **Map projections type** window user interface (the table, toolbar, search tools) is similar to the interface of the **Coordinate systems** window.

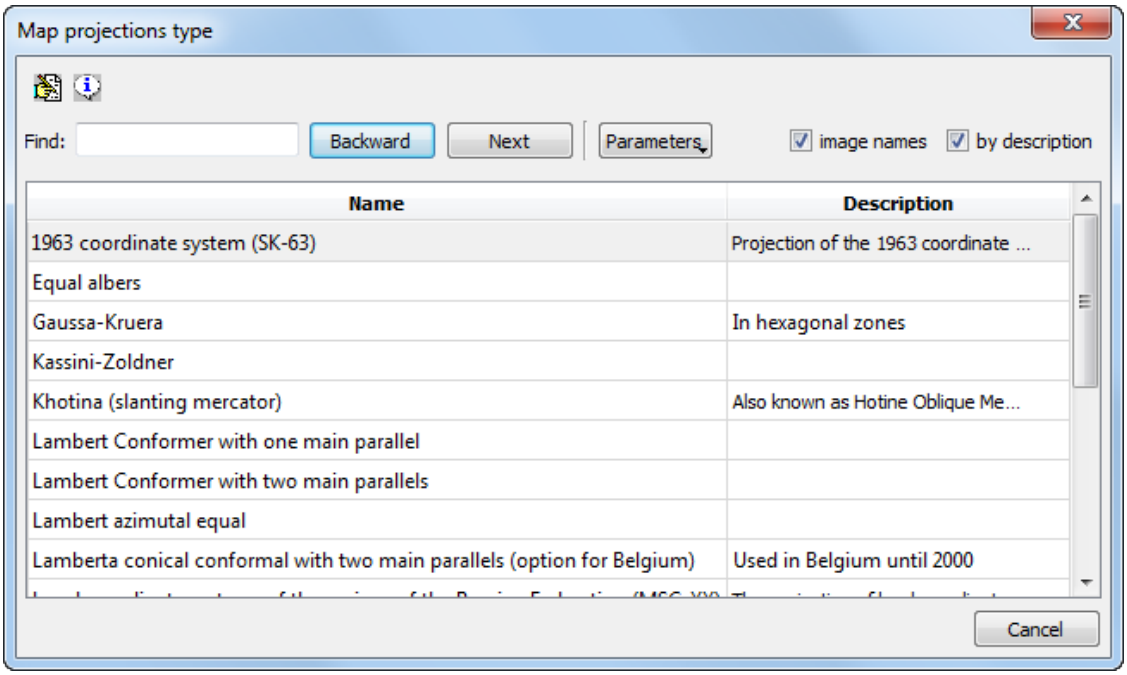


Fig. 37. Типы картографических проекций

7.6. Height systems

The **Vertical datums** window is used to manage the height systems (**Database › Height system**). The **Vertical datums** window user interface (the table, toolbar, search tools) is similar to the interface of the **Coordinate systems** window.

7.6.1. EGM2008 height system

The *GeoCalculator* delivery package includes the table of elevations for the **EGM96** geoid model. The system also provides for importing the **EGM2008** geoid model table of elevations. The **EGM2008** geoid is the Earth gravitational model, which includes detailed gravitational anomalies and is more accurate compared to the **EGM96** model (see the "EGM2008 Geoid installation" User Manual).

To observe changes in the *GeoCalculator* interface (the **Height systems** window), restart *PHOTOMOD GeoCalculator* after geoid installation (or removal).

PHOTOMOD GeoCalculator shares the installed **EGM2008** geoid with *PHOTOMOD*. The information about the installed geoid is stored in the *PHOTOMOD* settings folder (*PHOTOMOD7.VAR*), which is shared by *PHOTOMOD* and *PHOTOMOD GeoCalculator*.

If user intend to use the **EGM2008** geoid in conjunction with *PHOTOMOD GeoCalculator* installed as a separate application, to ensure correct interaction of the program with the **EGM2008** geoid, install *GeoCalculator* first, and then the geoid itself.

The system provides for removing the **EGM2008** geoid. It is strongly discouraged to remove the installed **EGM2008** geoid from the workstation if it is planned further to use

already existing user coordinate systems created using this geoid when working with *PHOTOMOD* (and/or *PHOTOMOD GeoCalculator*).

If, when trying to use such a coordinate system, the **EGM2008** geoid is not found by the programs, then the default **EGM96** geoid will be used for recalculations.

In the case of **EGM2008** reinstallation, such coordinate systems will be able to use this geoid again (without any additional user's operations required).

Appendix A. Coordinate transformations

The system allows the user to define extra coordinate **transformations** for the coordinate system or height system.

To configure the coordinate **transformations**, set the appropriate checkbox in the current window (**Editing the coordinate system** for example). The **Transformation** section opens

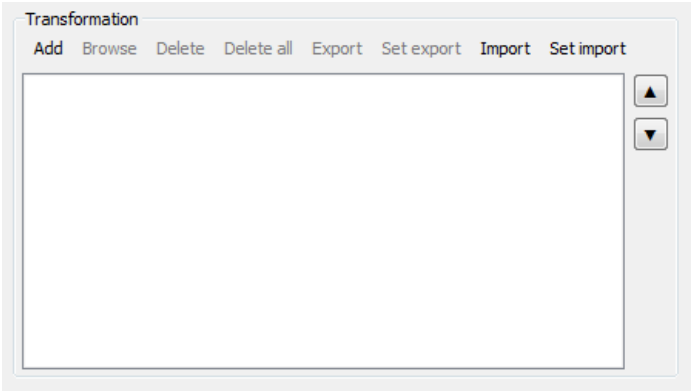


Fig. A.1. The "Transformation" section

The **Transformation** section has the following interface elements

- A look up field for created transformations;
- Buttons ▼ and ▲, are designed to configure the sequence of transformations;
- A button to **Add** a new transformation rule;
- A button to **Change** a transformation rule;
- A button to **Export** data on the transformation into the `*.xml` format;
- A button to **Import** data on the transformation into the `*.xml` format;
- A button to **Delete** a transformation;
- A button to **Delete everything** (all the transformations);

- A button to export a set of data on several transformations into the `*.xml` format;
- A button to import a set of data on several transformations from the `*.xml` format.

A.1. Creating new coordinate transformation rule

To **Add** a new transformation rule, perform the following:

1. Click **Add**. The **Transformation** window opens:

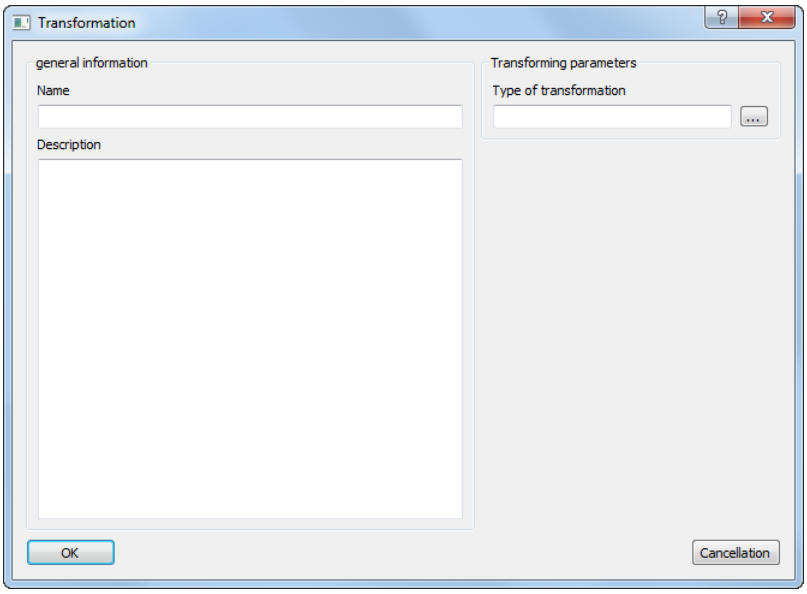


Fig. A.2. The Transformation window

2. Enter transformation common parameters:
   - **Name**;
   - **Description**.
3. Click the ... button to select the **transformation type**;
   - **Affine transformation of plane coordinates**;
   - **Plane coordinates shift**;
   - **Height shift**.
     - Click ... to select a linear unit.
4. Specify the detail transformation parameters depending on its type;

5. Click **OK**.

A.1.1. Affine transformation of XY coordinates

1. Configure the basic options of the coordinate transformation rule.

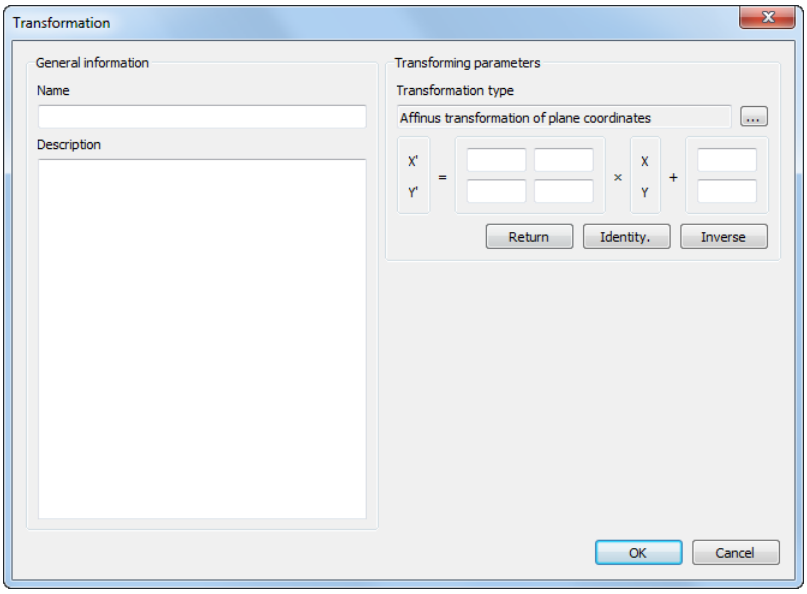


Fig. A.3. The “Transformation” window

2. Configure affine transformation options in the appropriate fields:
   - [optional] To clear the data entered, click **Undo**;
   - [optional] To enter the identity transformation options, click **Identity**;
   - [optional] To invert transformation parameters, click **Invert**.

A.1.2. Shift of XY coordinates

1. Configure the basic options of the coordinate transformation rule.

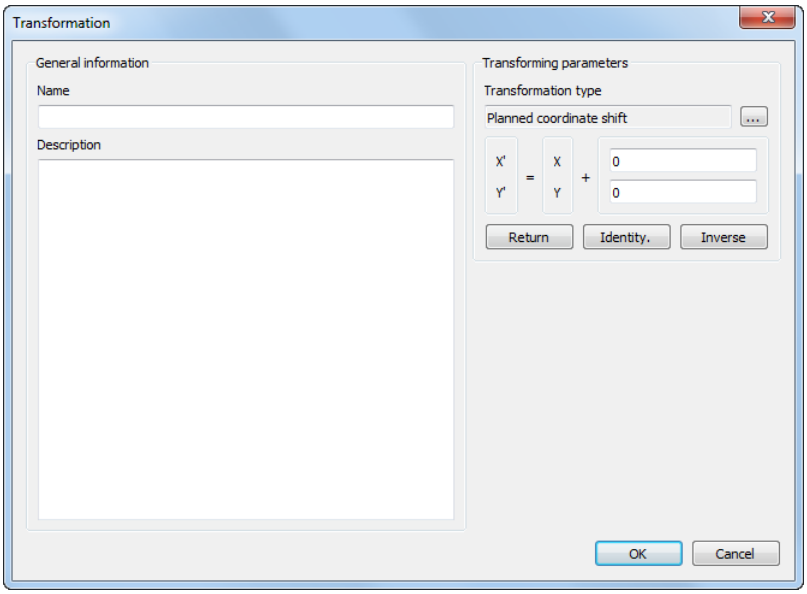


Fig. A.4. The “Transformation” window

2. Configure Shift of XY coordinates options in the appropriate fields:
   - [optional] To clear the data entered, click **Undo**;
   - [optional] To enter the identity transformation options, click **Identity**;
   - [optional] To invert transformation parameters, click **Invert**.

A.1.3. Z-axis shift

1. Configure the basic options of the coordinate transformation rule.

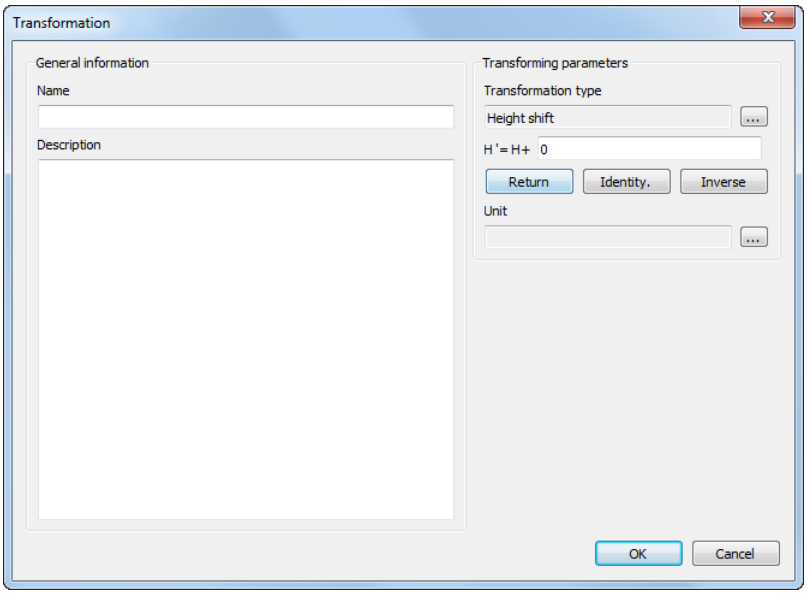


Fig. A.5. The “Transformation” window

2. Set a value in the **H’ = H+**+ field;
   - [optional] To clear the data entered, click **Undo**;
   - [optional] To enter the identity transformation options, click **Identity**;
   - [optional] To invert transformation parameters, click **Invert**.
3. Click ... to select the linear unit.

A.2. The transformation rules types list

The **Types of transformations** window is used for choosing transformation rule type. The **Types of transformations** window user interface (the table, toolbar, search tools) is similar to the interface of the **Coordinate systems** window.

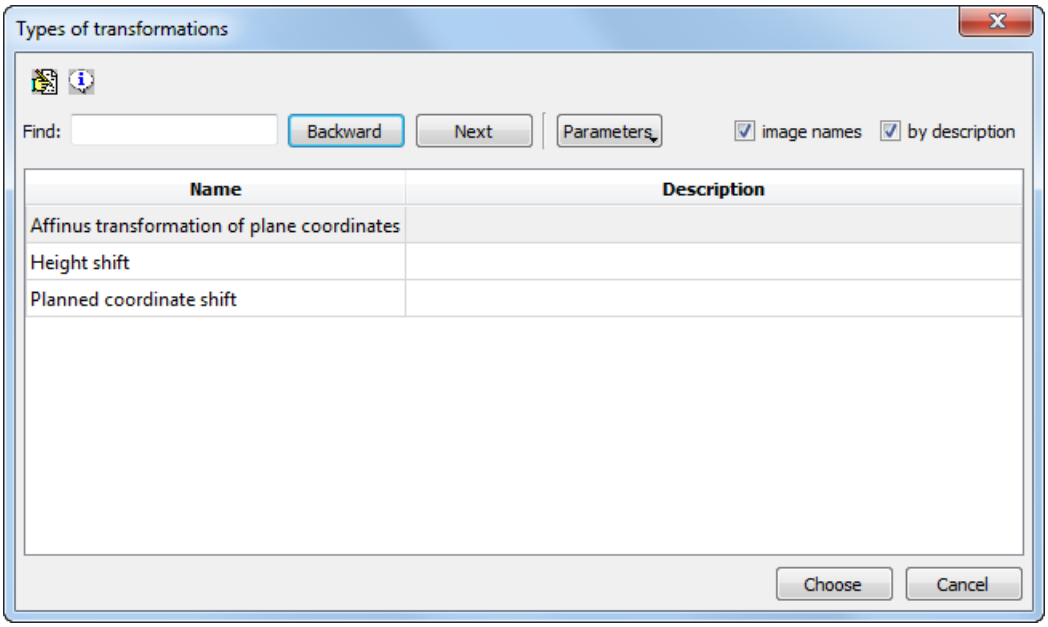


Fig. A.6. The transformation rules types list

Appendix B. EPSG and MapInfo codes

The *GeoCalculator* supports *EPSG* registry codes (and also *MapInfo* codes) used for the description of both coordinate systems and their individual elements, such as datums, ellipsoids, measurement units, etc.

The *EPSG* code is a convenient brief identifier of different coordinate systems (along with all their parameters). *EPSG* codes were introduced by the European Petroleum Survey Group (now *OGP*, *International Association of Oil and Gas Producers*). The *EPSG* abbreviation itself is still widely used.

EPSG codes containing information on the coordinate system can be used, in particular, as metadata elements of TIFF imagery. The default *GeoCalculator* database already includes assigned *EPSG* and *MapInfo* codes for certain database entities.

Assigning EPSG codes is supported for **Coordinate systems**, as well as for the following coordinate system elements:

- **Distance units**;
- **Angular units**;
- **Scale units**;
- **Ellipsoids**;
- **Datums**;

- **Datum shift** option sets.

Assigning *MapInfo* codes is supported for the following:

- **Distance units**;
- **Ellipsoids**;
- **Datums**.

The system allows:

- Preliminary generation a code for any database entity (if codes are provided);
- Assigning a code to an entity.

B.1. Code assigning

To assign an entity a EPSG code (or *MapInfo* code) created for this entity in advance, set the **Export** checkbox in the current window for creating or editing this entity (,). The **Export** section opens:

Fig. B.1. The Export section

The transformation section has the following interface elements:

- The ..., button is to assign a code from a pre-prepared list;
- The , button is to clear a code.

B.2. Code generation

To assign an EPSG code (or a *MapInfo* code) to the database to some entity, perform the following:

1. Open the window for creating or editing an entity (e.g., **Datum**) for which EPSG (or code *MapInfo*) assigning is supported
2. Set the **Export** checkbox in the current window. The **Export** section opens:

Fig. B.2. The Export section

3. In the **Export** section, click the ... button that corresponds, e.g. the **GeoTIFF (EPSG)** line. The **EPSG datum codes** window opens

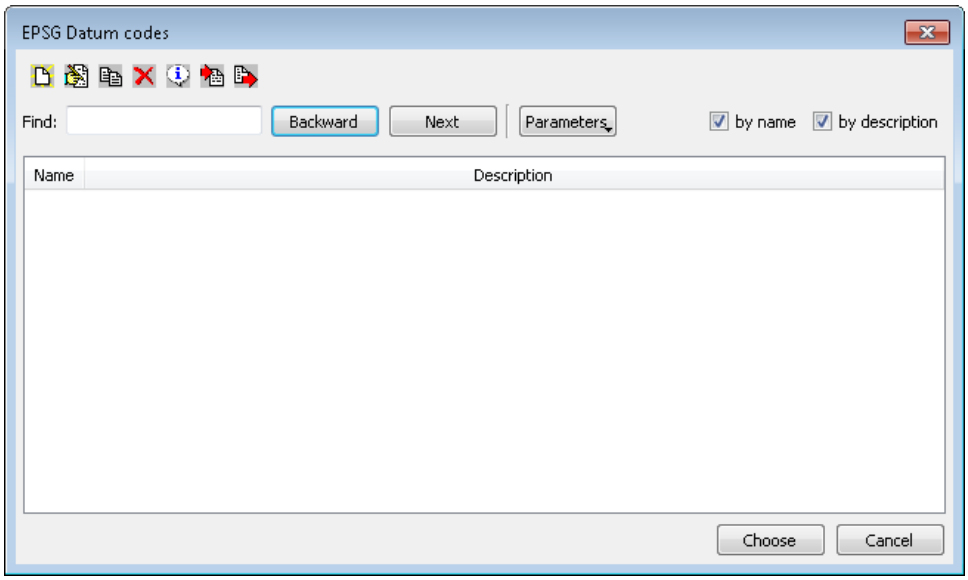


Fig. B.3. The EPSG datum codes window

To view the already existing code, select its entry in the table and click .

4. Click the button. The **EPSG code editor** window opens:

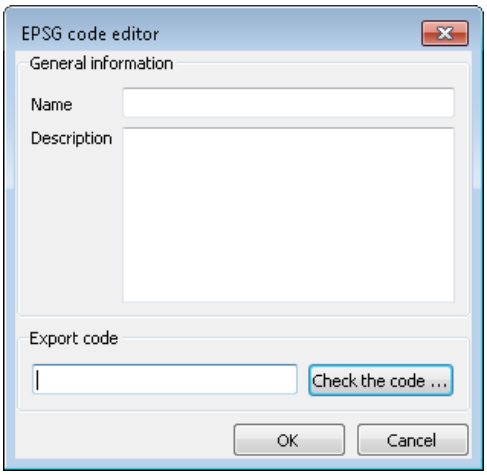


Fig. B.4. The EPSG code editor window

5. Enter the following:
   - **Name**;
   - **Description**.
6. Enter the numerical code from the *EPSG* registry in the **Export code** input field;
7. [optional] To **check the code**, click the appropriate button. Checking for code matching is carried out using the internal database of the *GeoCalculator* program:
   - [optional] If the given code is not found in the database, an appropriate info message is issued:

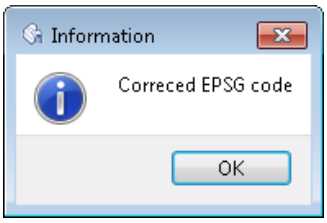


Fig. B.5. The info message

   - [optional] If the given code is already found in the database, an appropriate info message is issued:

Fig. B.6. The info message

8. Click OK.

Generating codes for other entities, as well as *MapInfo* codes, is carried out in a similar way.

Appendix C. Hotkeys

The following hotkeys are designed for working with tables placed in the **points** sections of the main window.

Table C.1. Hotkeys

Button combinations	Purpose
Ctrl+Insert	Insert a line in the point list
Ctrl+Delete	Remove a line from the point list
Ctrl+N	Counting lines in the point list
Ctrl+I	Searching for incorrect points
Ctrl+D	Delete incorrect points
Ctrl+E	Delete empty lines
Ctrl+U	Swap point lists

Appendix D. Coordinate file format

Content of a coordinate txt file (ASCII format) is to be as follows:

For correct automatic recognition of point coordinates from a txt file, a comma or semicolon is to be used as a separator between columns in the file. A period must be used as a decimal separator. Commas as decimal separators are not allowed.

```
NAME,X,Y,Z

IMG_0009,51.959359,104.763096,1064.804463

IMG_0010,51.959356,104.762557,1064.986490
```

```
IMG_0011,51.959355,104.762057,1065.002512

IMG_0012,51.959357,104.761507,1065.300536
```

Appendix E. GeoCalculator settings

To open **Settings** window click the button on the main toolbar.

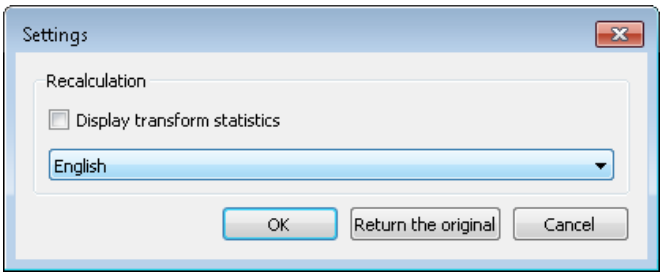


Fig. E.1. Program settings

To **display transform statistics** on coordinate **recalculation** after every recalculation operation, set the appropriate checkbox. To revert to default settings, click the appropriate button.

[optional] To change the interface language of a program launched as a separate application, select the desired language in the drop-down list, close, and restart *PHOTOMOD GeoCalculator*.

The reason of the program's restart is due to the fact that the coordinate systems, as well as sets of coordinate system elements contained in the default database, differ for the Russian and English versions of the program.

For *GeoCalculator* installed as a part of *PHOTOMOD*, as well as for all other *PHOTOMOD* modules, it is possible to switch the interface language in the *System Monitor* service module (see "System Monitor service module" in the "General information" User Manual of the *PHOTOMOD* documentation kit).