Digital Photogrammetric System

PHOTOMOD

Version 7.5

USER MANUAL

The GeoCalculator program

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 Gb of free hard disk space.

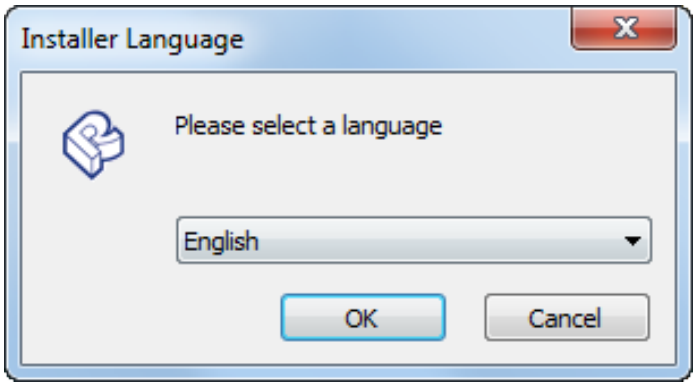
To start the *GeoCalculator* installation, run the `PH_GeoCalc_NN_[CCCC]_x64.exe` file, where N is the version number, CCCC is the build number.

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

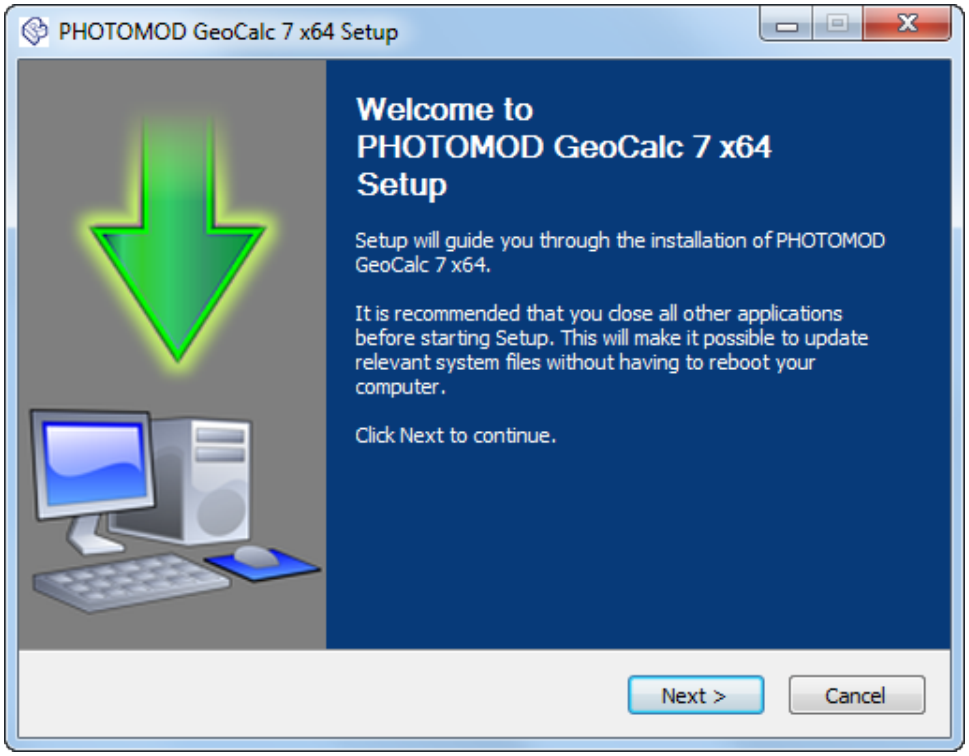
In case of cancel at any step, installed program files and data are not removed. To complete the system installation, restart the `PH_GeoCalc_NN_[CCCC]_x64.exe` file and go through all steps again.

The installation process consists of the following steps:

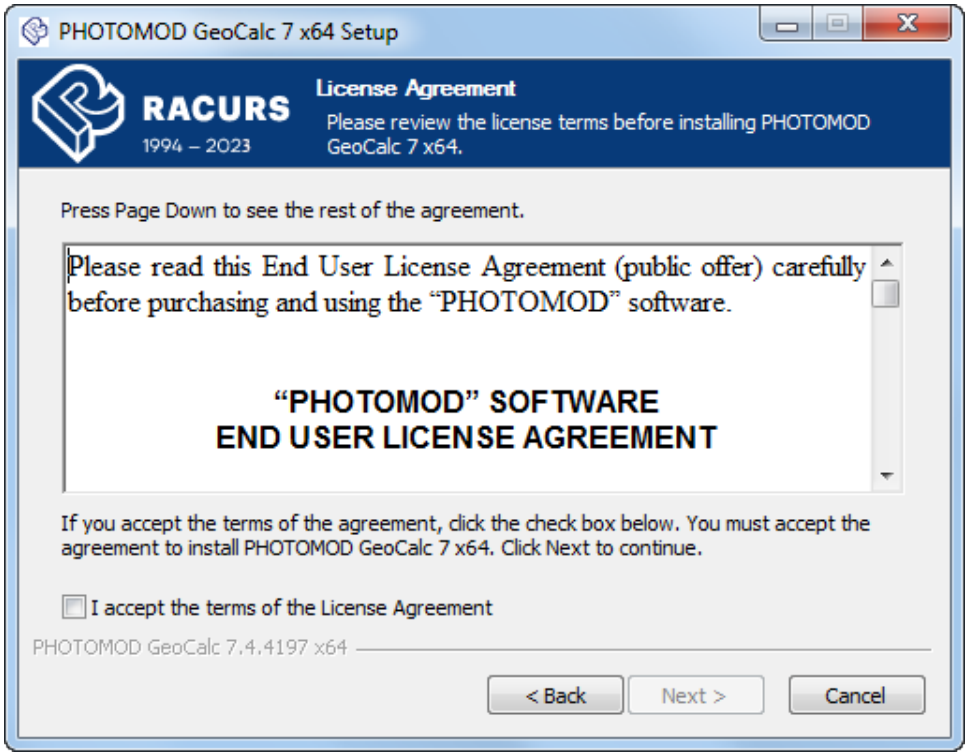
1. Choose the installation language. Click OK;



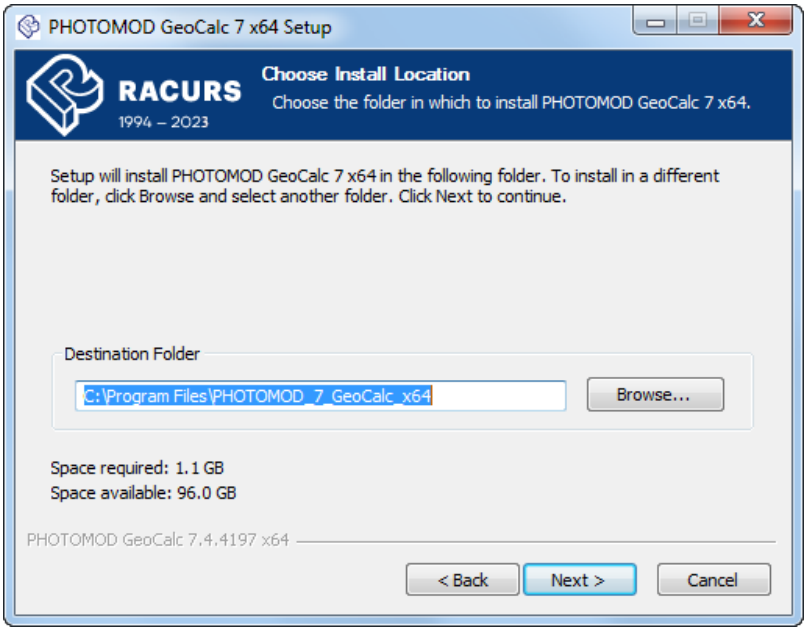
2. Read the welcome and warning messages. Click the **Next** button.



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.

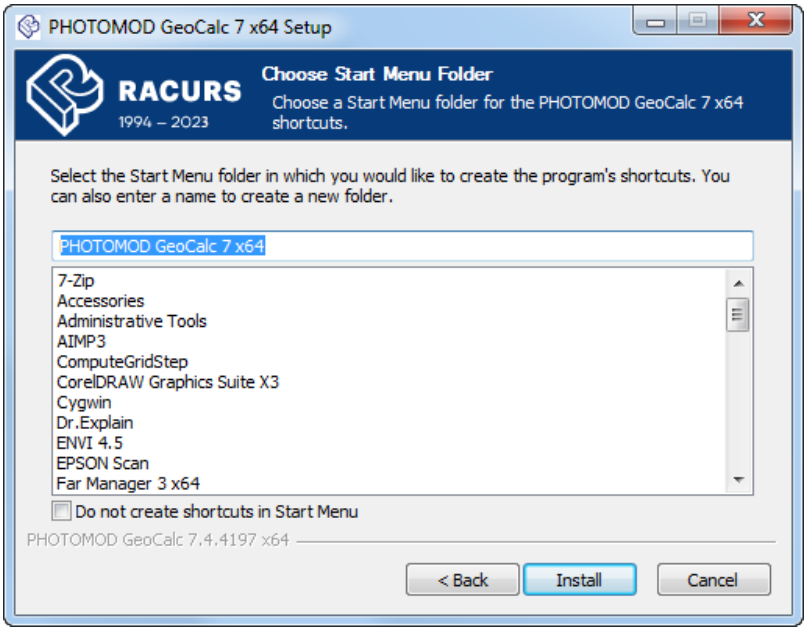


4. [optional] Define the folder to install the program;

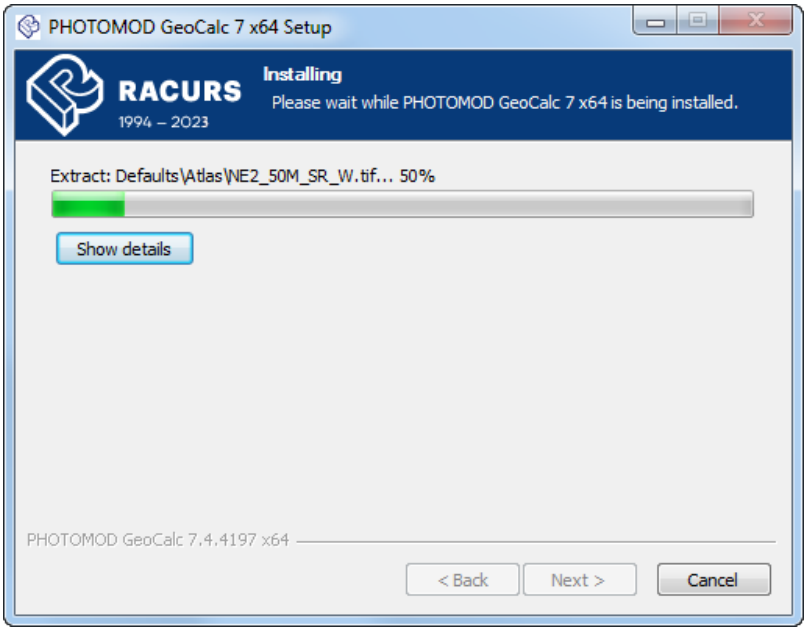


It is strongly not recommended to install the program in folder with name, which contains letters, different from Latin. By default the *C:\Program Files\PHOTOMOD_7_GeoCalc_x64* folder is used.

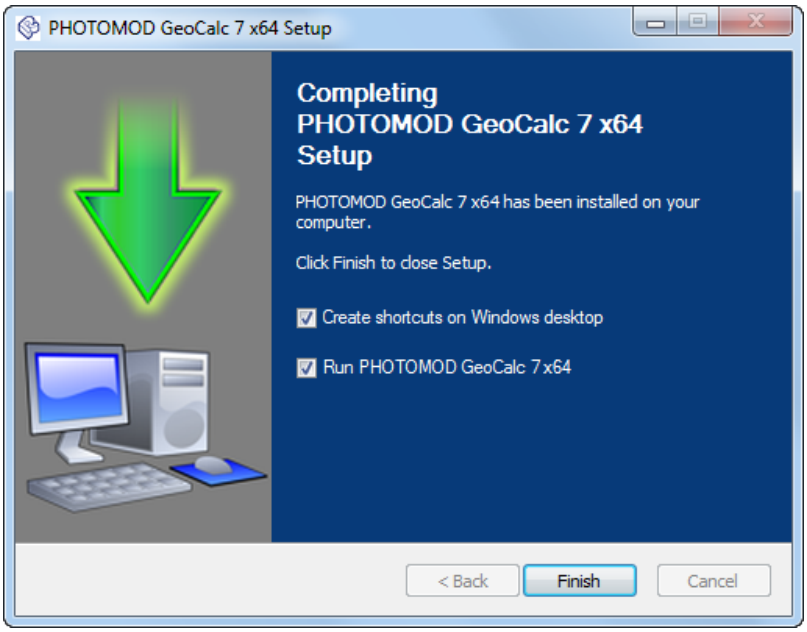
5. [optional] Enter a folder name for the *GeoCalculator* program in the *Windows* **Start** menu. A shortcuts in the *Windows* **Start** menu will be created by default. Otherwise – set the appropriate checkbox. Click the **Install** button.



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	allows 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	allows to choose datum transformation type
Datum transform	opens the window allowing to manage the presets of datum transformation settings
Map projections type	allows to choose map projection type
Map projections	opens the window allowing to manage map projections
Height system	allows to choose height system
Coordinate systems type	allows 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	allows to open the current document
Hotkeys	allows 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
	allows to open the default `PhCoordSys.db` database with current parameters (without restoration of initial data)
	allows to open the database
	allows to create an empty database
	allows to close database
	allows to close the current database and to open default `PhCoordSys.db` database, restored to its initial settings
	allows to perform the batch coordinate systems import from the selected folder
	allows to perform the batch coordinate systems import from the selected database
	allows to perform the batch coordinate systems export to the selected folder
	allows to add a geoid
	allows to open the **Settings** window

4. GeoCalculator database

Database files have `*.db` extensions. A link to the current file of the coordinate system database 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).

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.

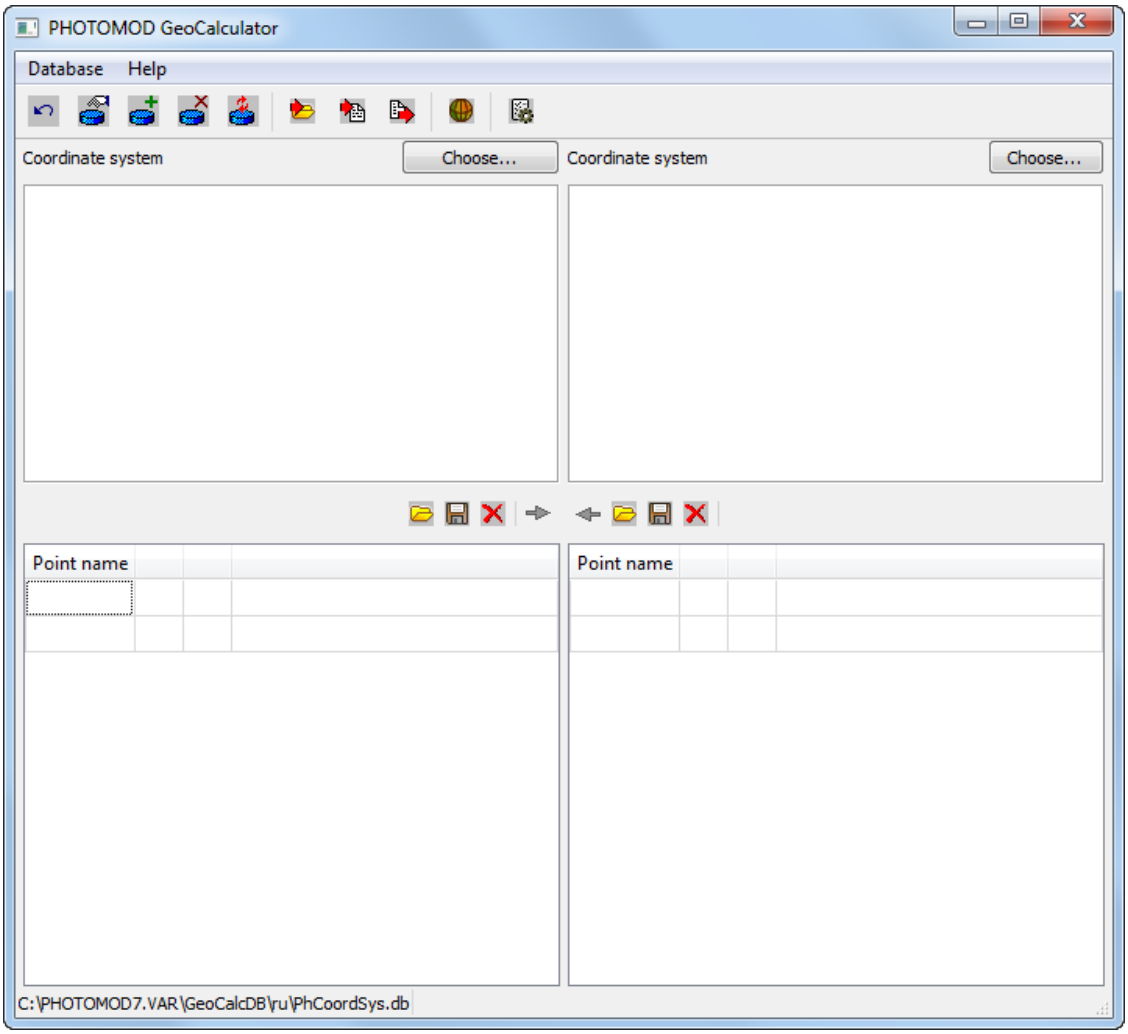


Fig. 1. The main program's window

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:

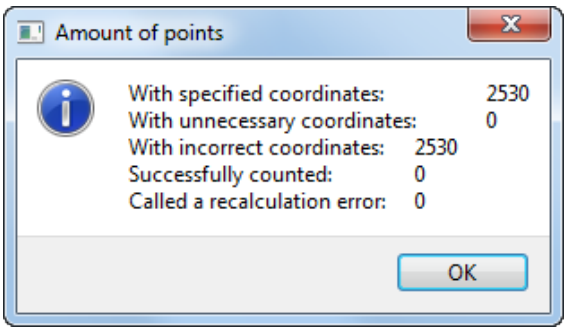


Fig. 2. The statistics window

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:

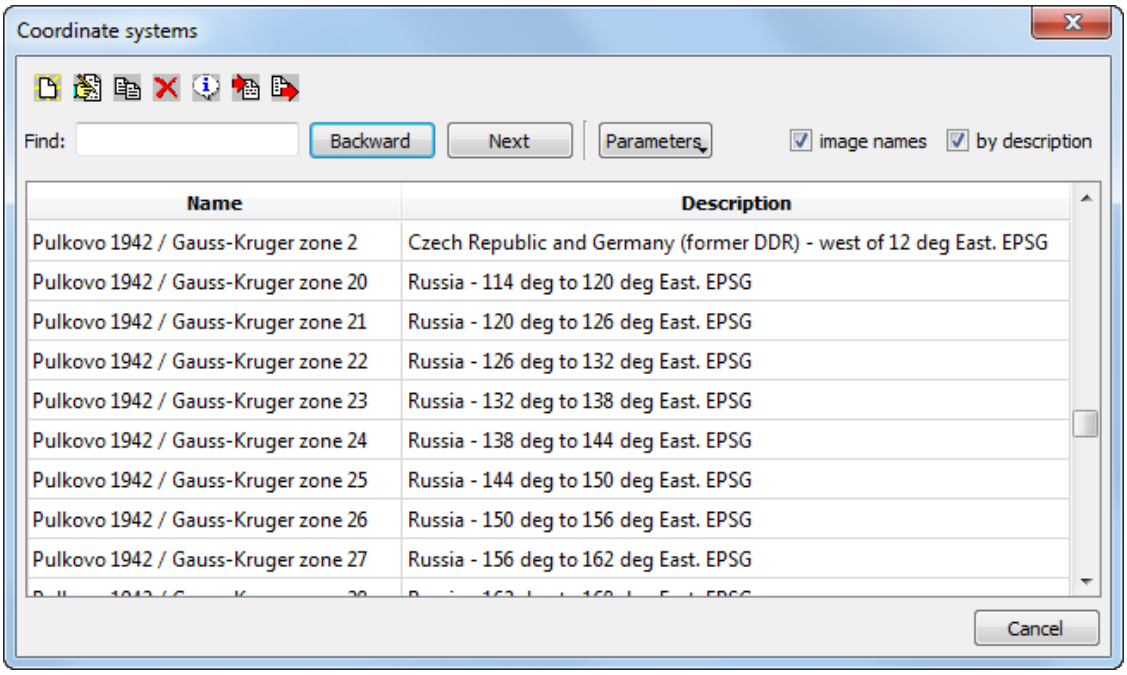


Fig. 3. The window containing coordinate systems list

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
	allows to open a window for creating new coordinate system
	allows to edit chosen coordinate system
	allows to duplicate chosen coordinate system
	allows to remove chosen coordinate system from database
	allows to show parameters of selected reference system
	allows to import coordinate system from the selected file
	allows 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.

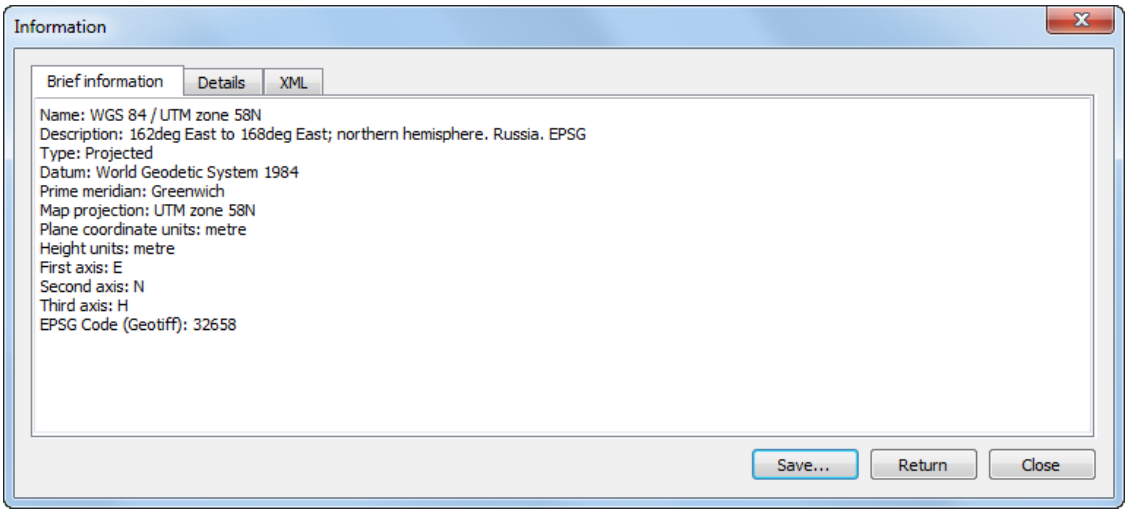


Fig. 4. The “Information” window

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.

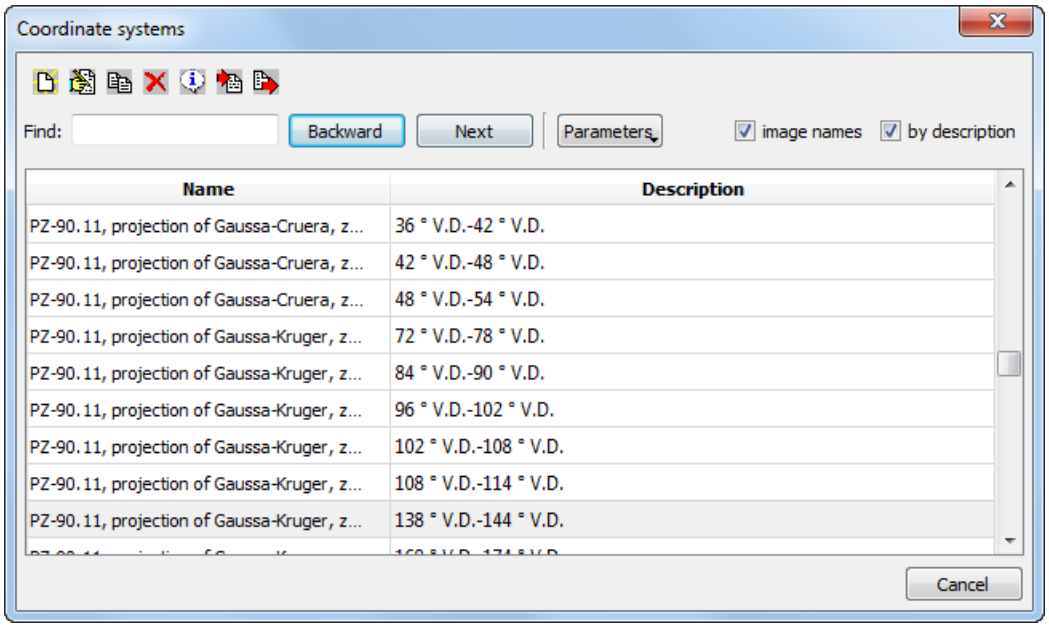


Fig. 5. The “Coordinate systems” window

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

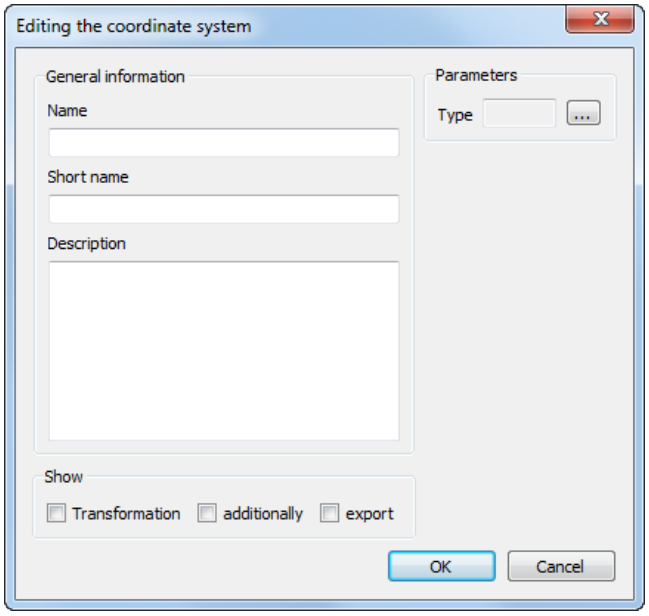


Fig. 6. Reference system creation

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

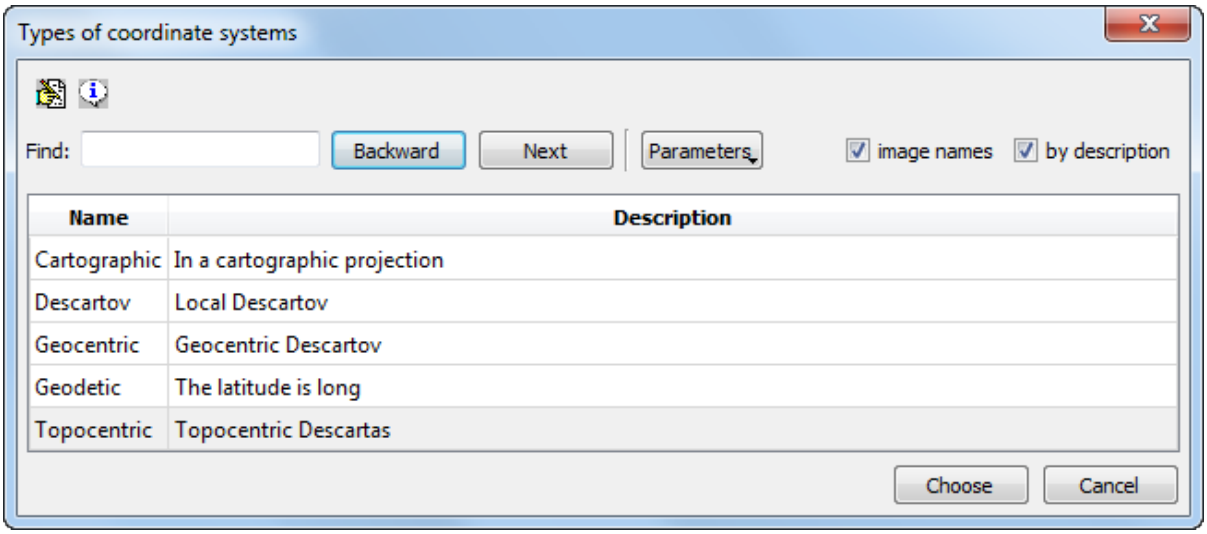


Fig. 7. Selecting of the coordinate system type

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. [опционально] установите флажок **показать экспорт**, для того чтобы привязать EPSG-код (или код, используемый программой *MapInfo*);

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;

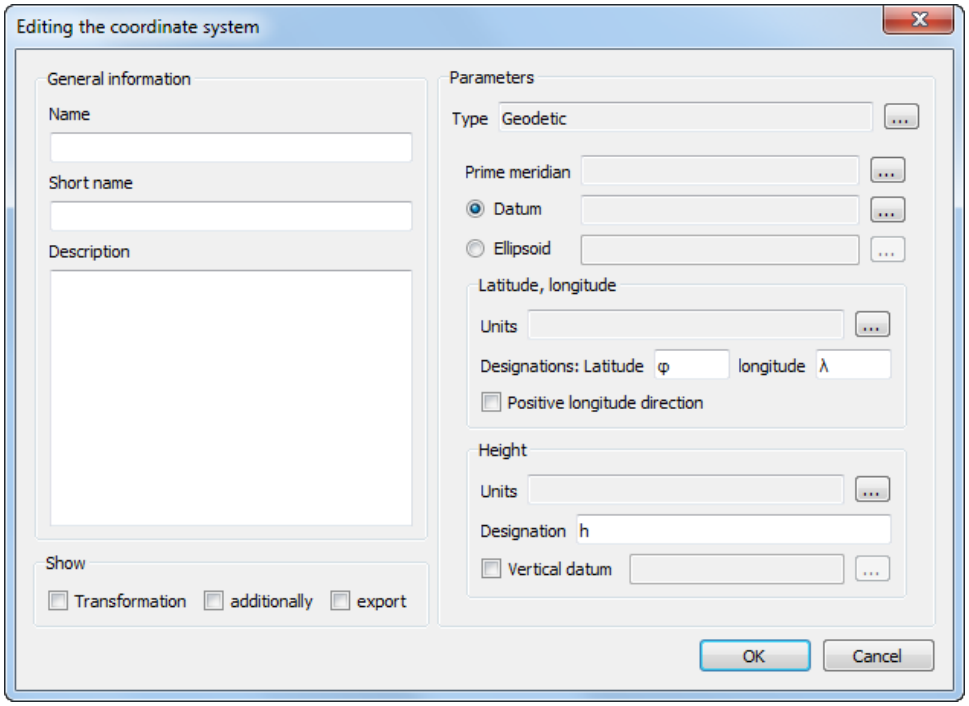


Fig. 8. Creating the Geodetic (latitude/longitude) coordinate system

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.

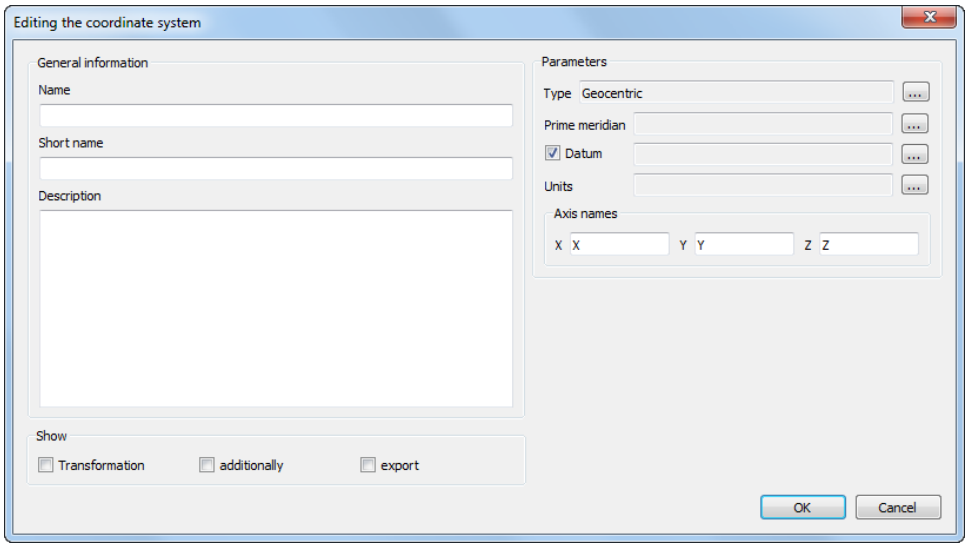


Fig. 9. Creating the geocentric coordinate system

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 **axes 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.

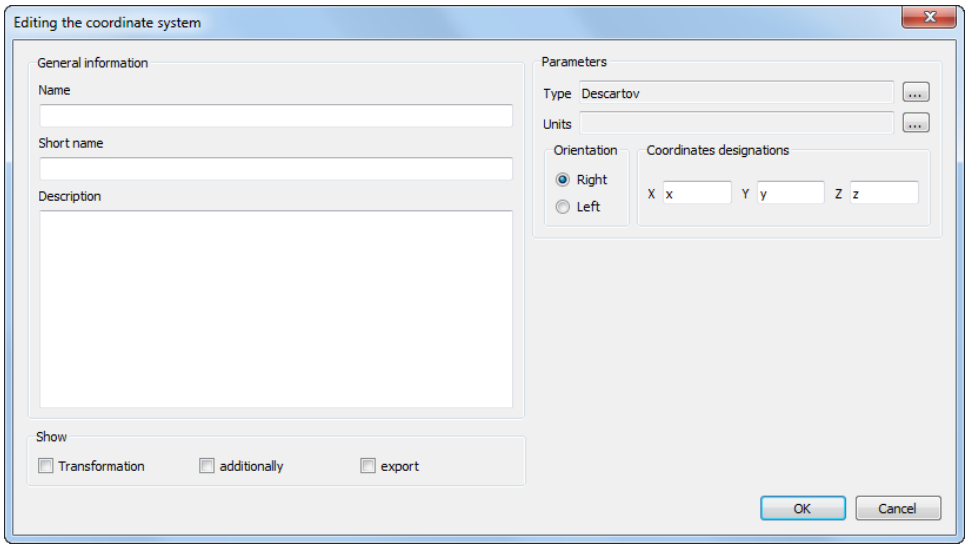


Fig. 10. Creating the Cartesian coordinate system

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.

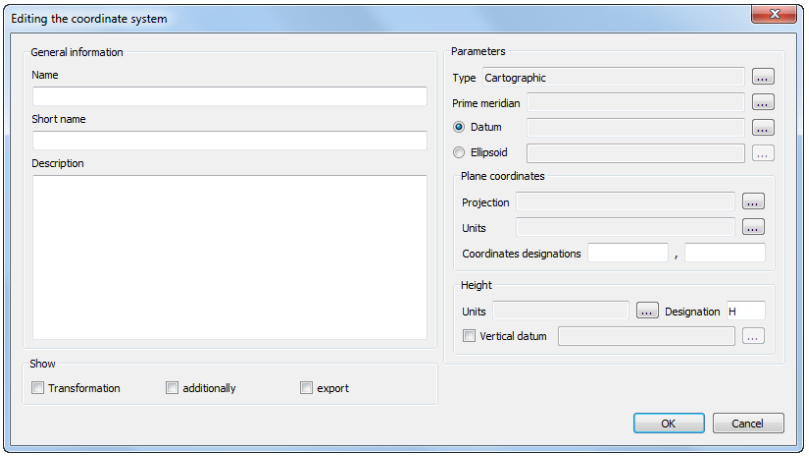


Fig. 11. Creating the cartographic coordinate system

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;

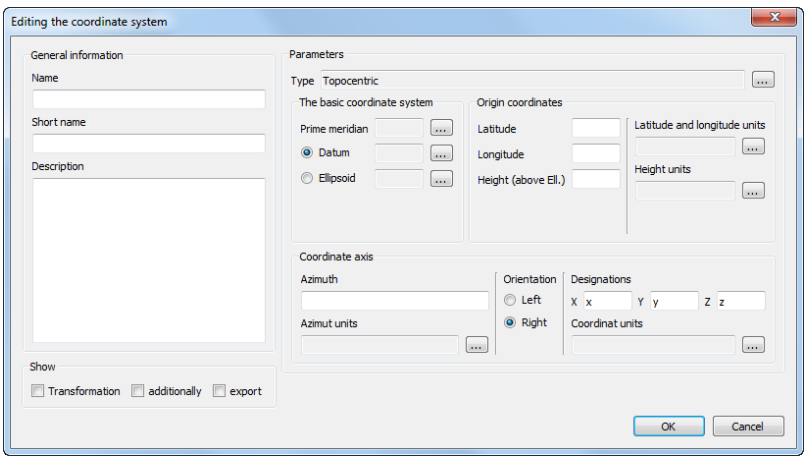


Fig. 12. Creating topocentric coordinate system

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 axes: **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

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.

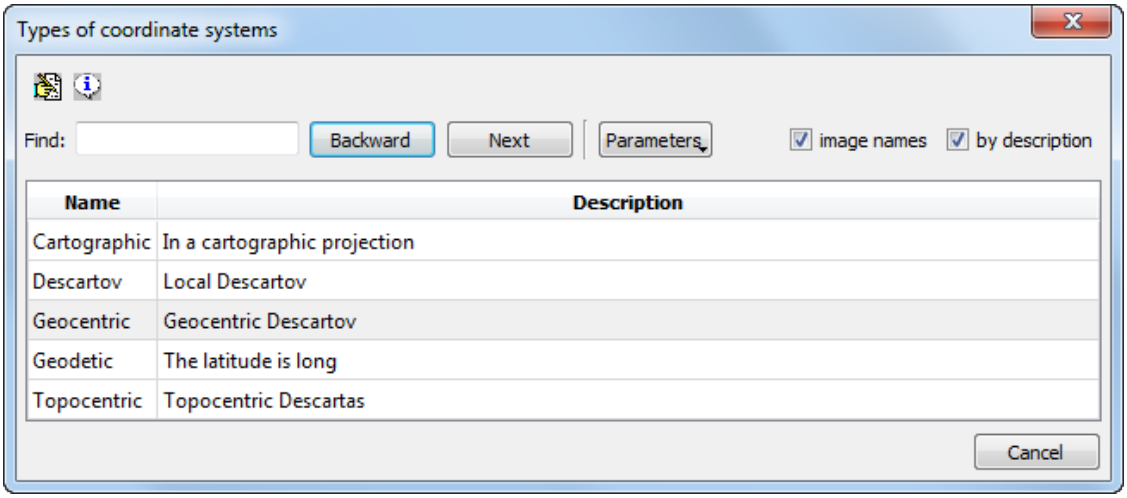


Fig. 13. The list of types of coordinate systems

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:

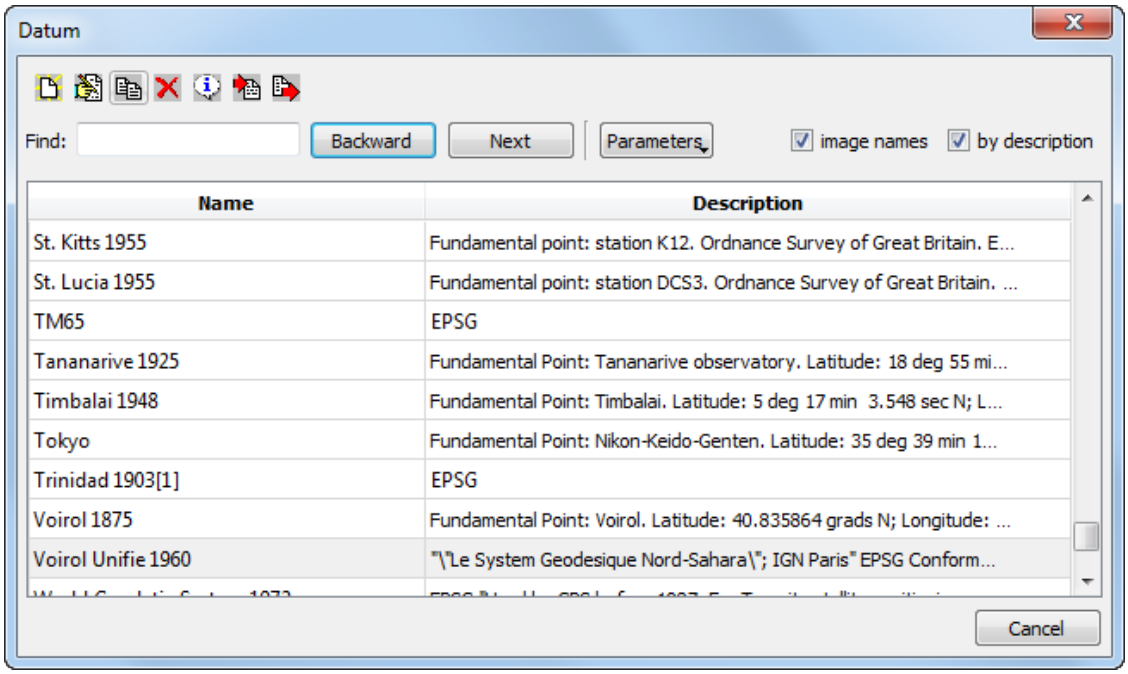


Fig. 14. The “Datum” window

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

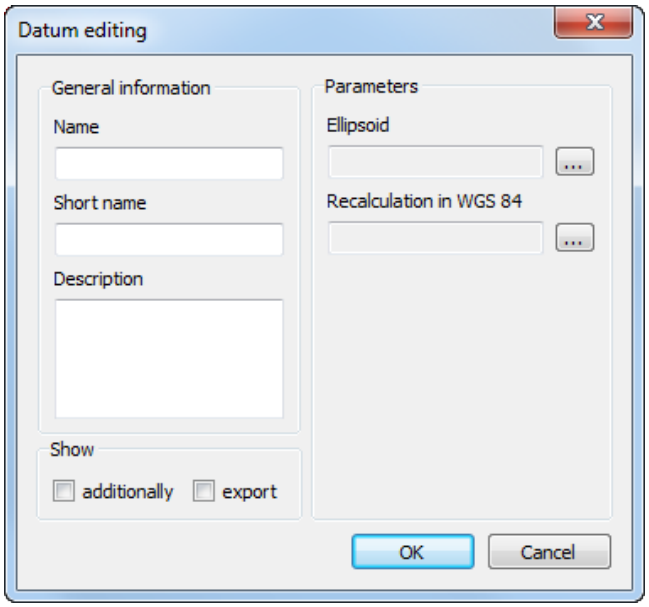


Fig. 15. Datum settings window

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. 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:

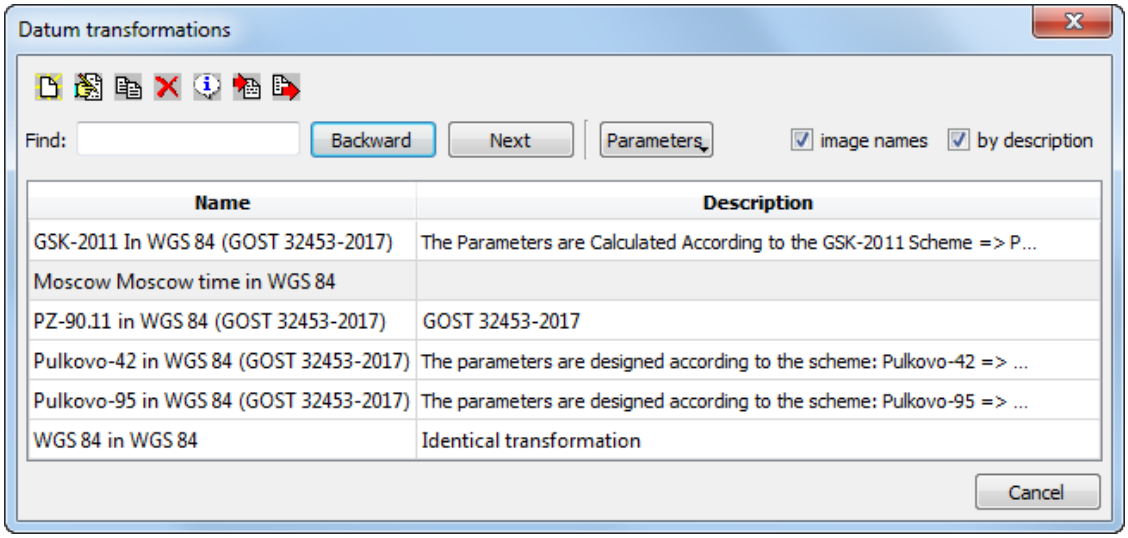


Fig. 16. Default datum transformation parameters presets

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

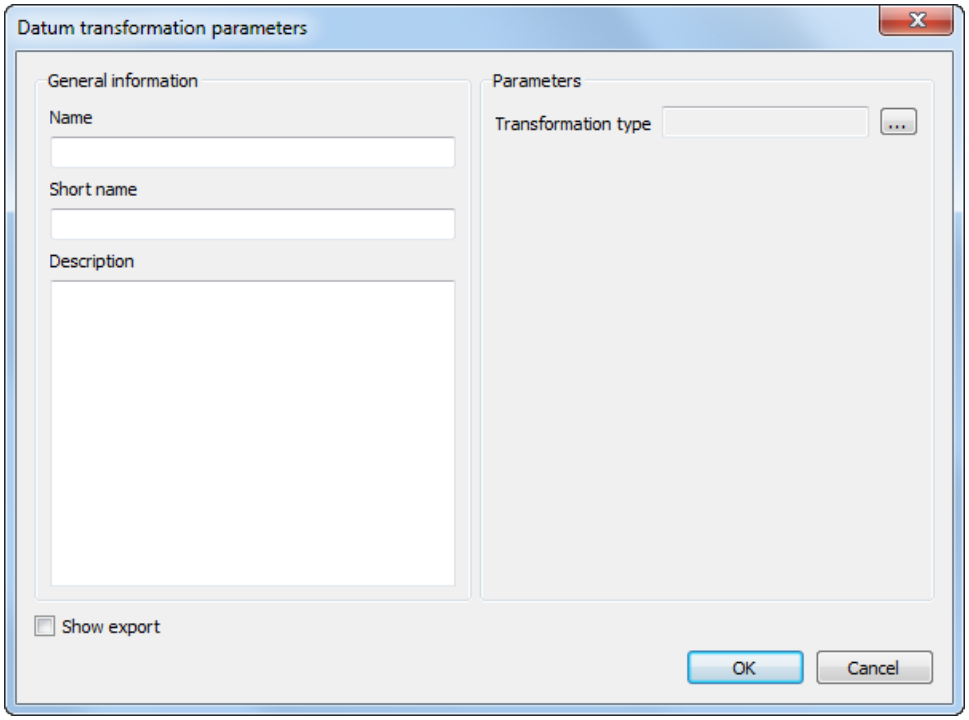


Fig. 17. Datum shift parameters

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. 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;

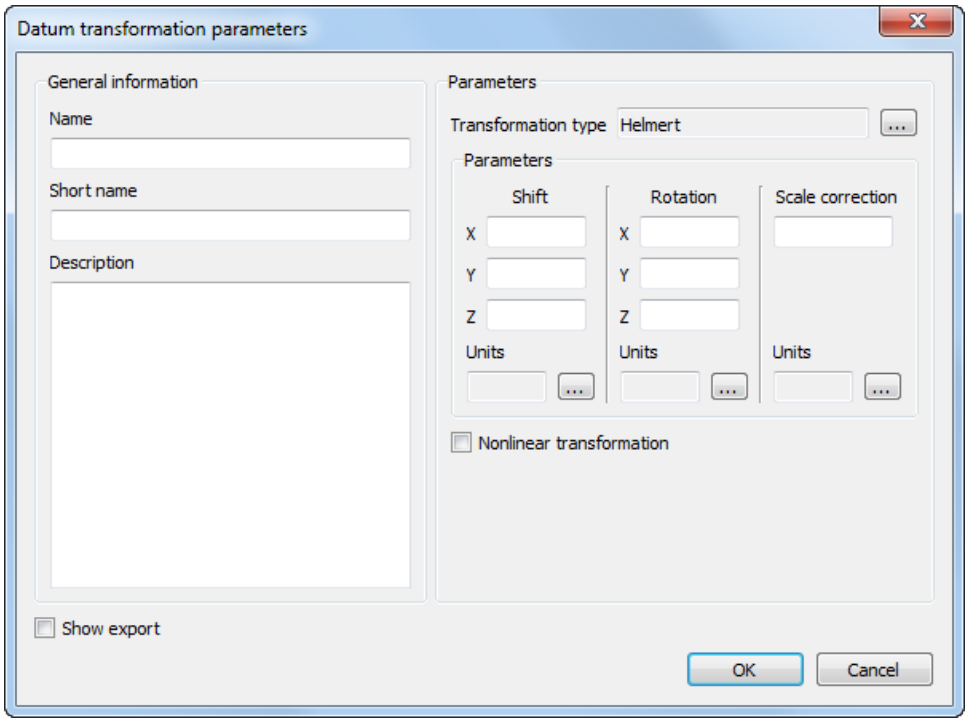


Fig. 18. The Helmert transformation

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.

The Molodensky transformation

1. Configure the general settings of datum transformations;

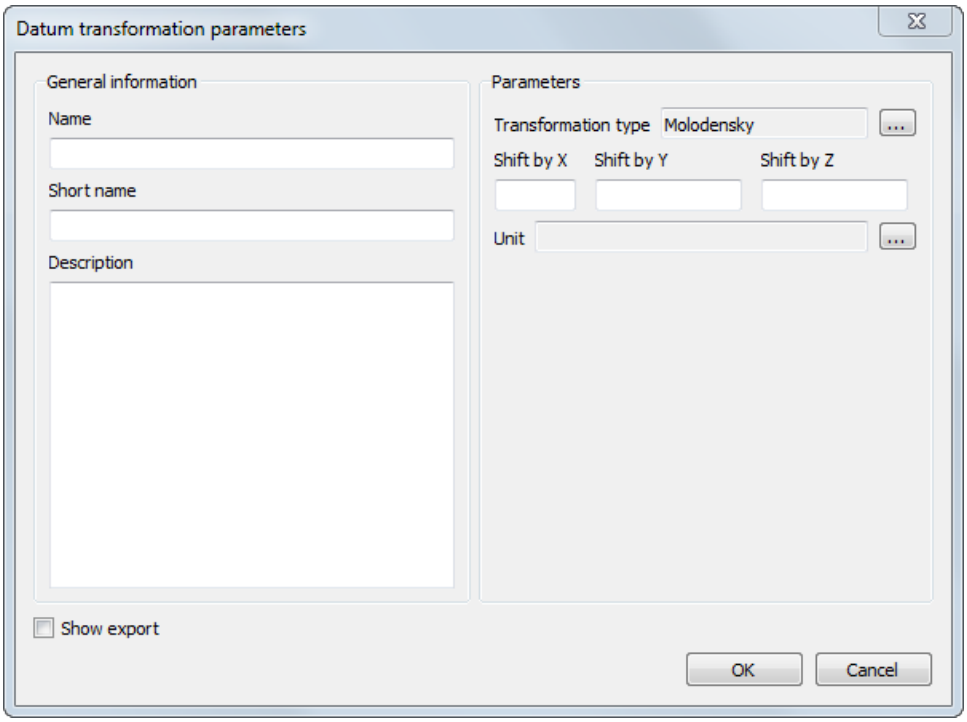


Fig. 19. The Molodensky transformation

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;

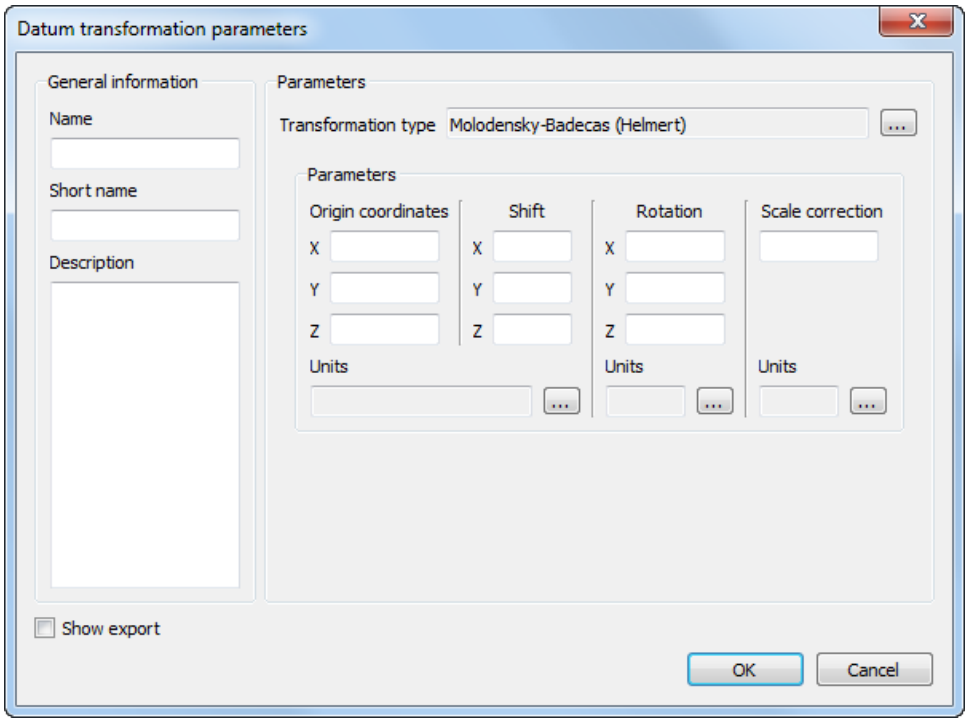


Fig. 20. The Molodensky-Badekas (Helmert) transformation

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;

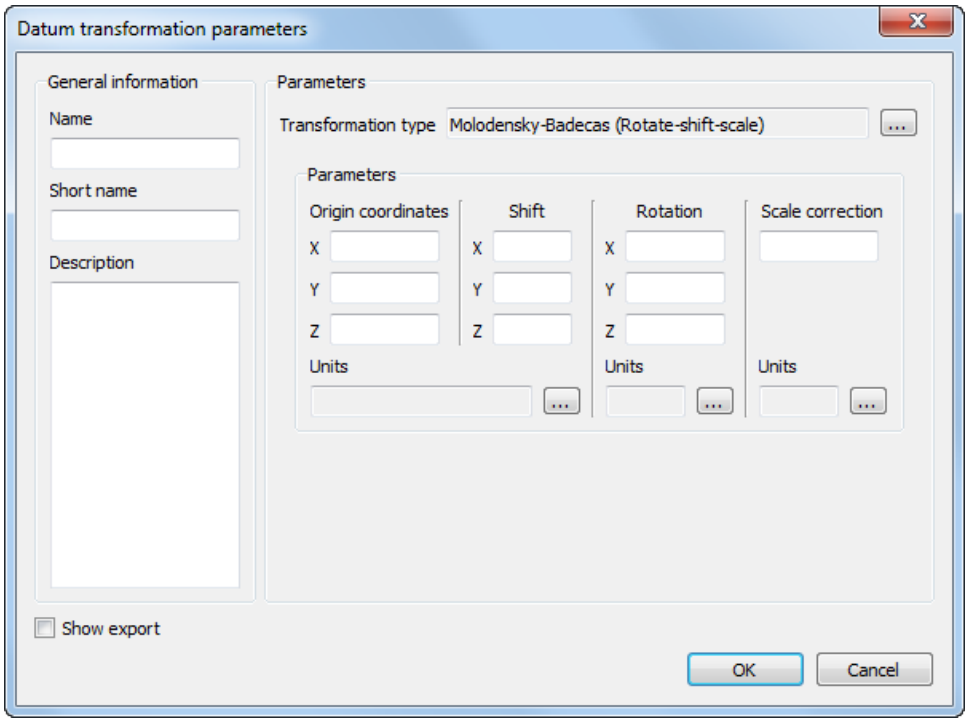


Fig. 21. The Molodensky-Badekas (rotatie-shift-scale)

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;

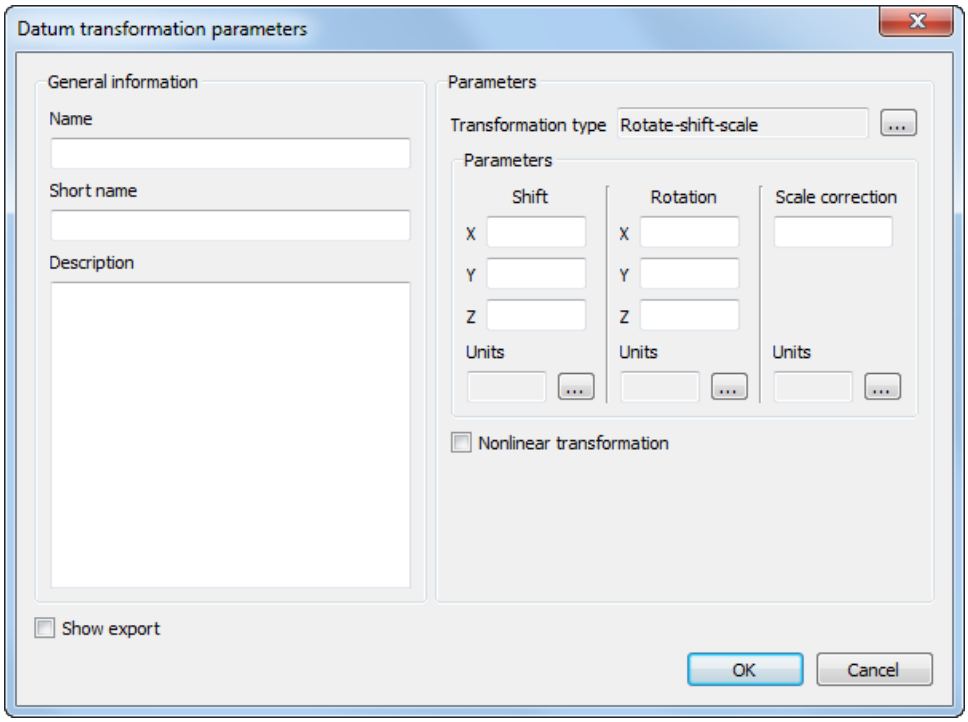


Fig. 22. Rotation-Shift-Scale configuration parameters

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.

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.

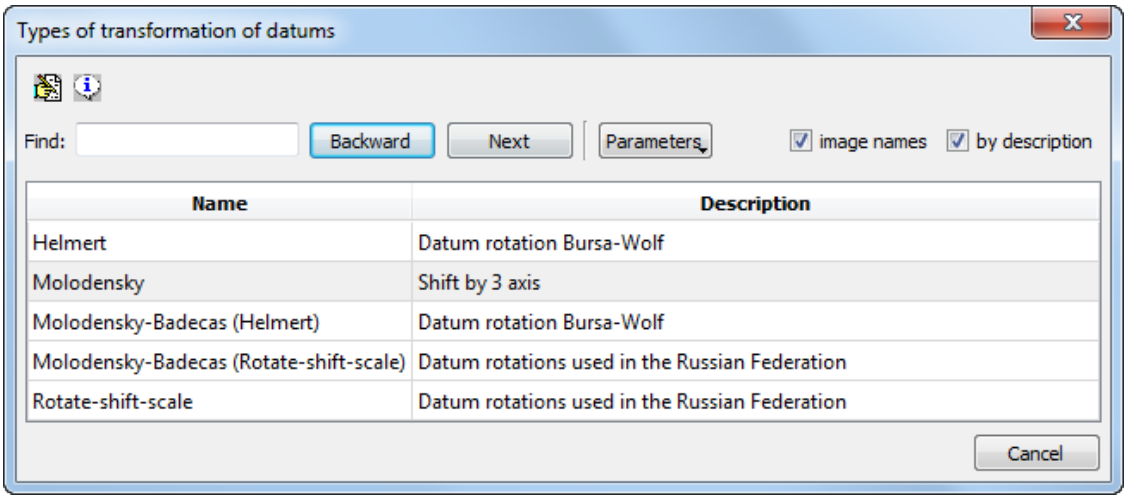


Fig. 23. The list of available datum transformation types

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:

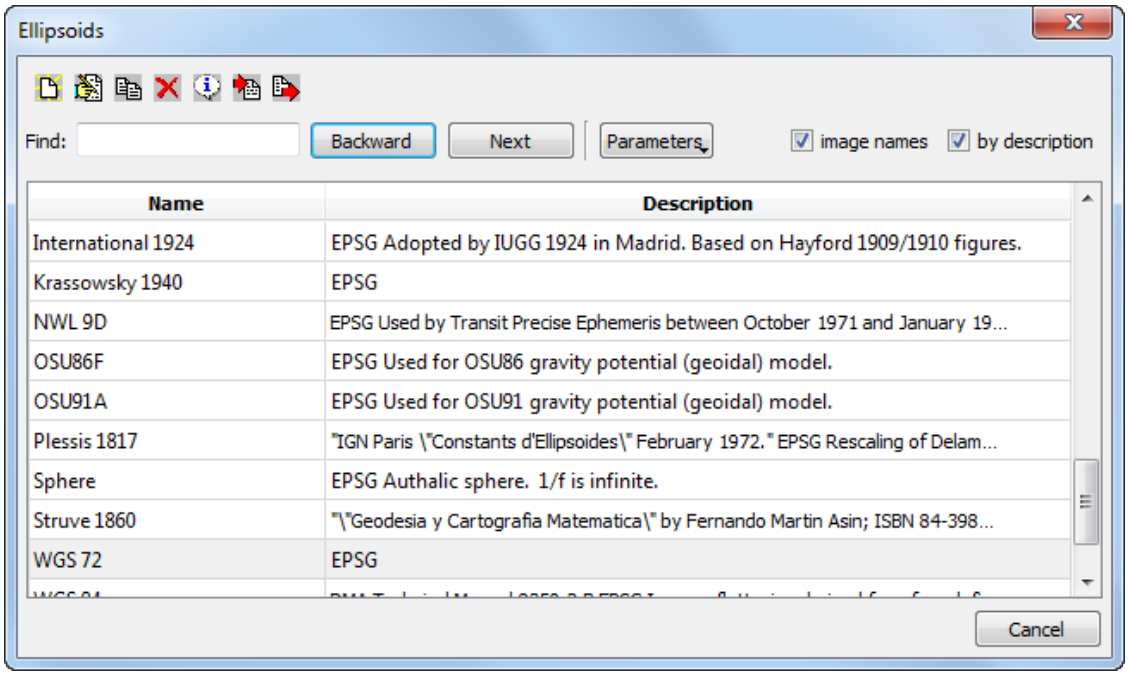


Fig. 24. The list of default ellipsoids in database

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

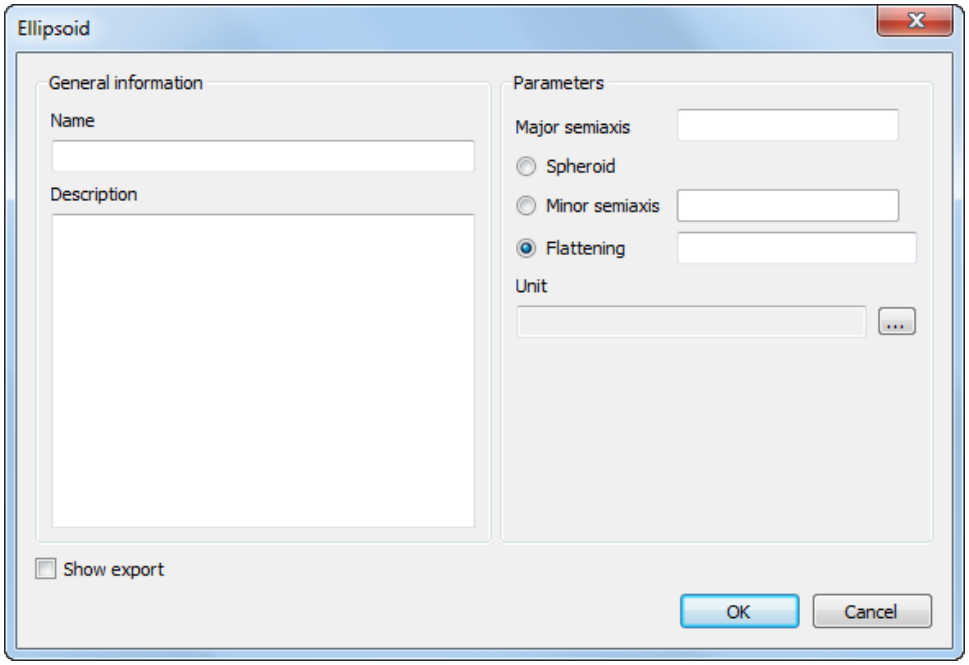


Fig. 25. Reference ellipsoid parameters

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. 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:

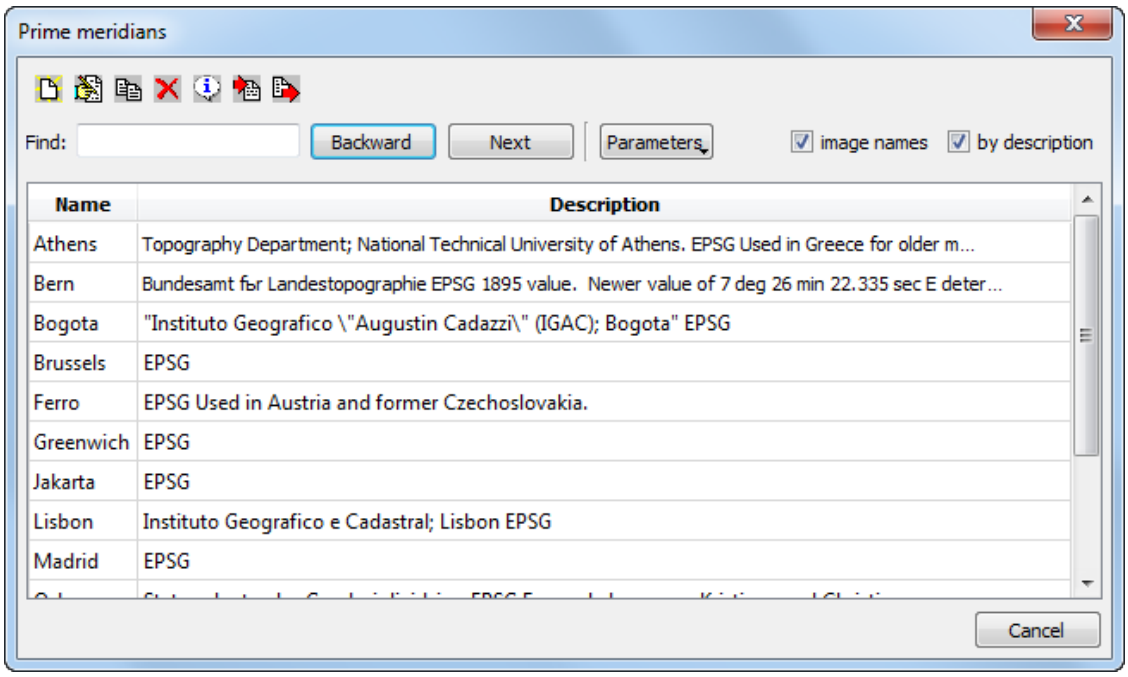


Fig. 26. The list of prime meridians in default database

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

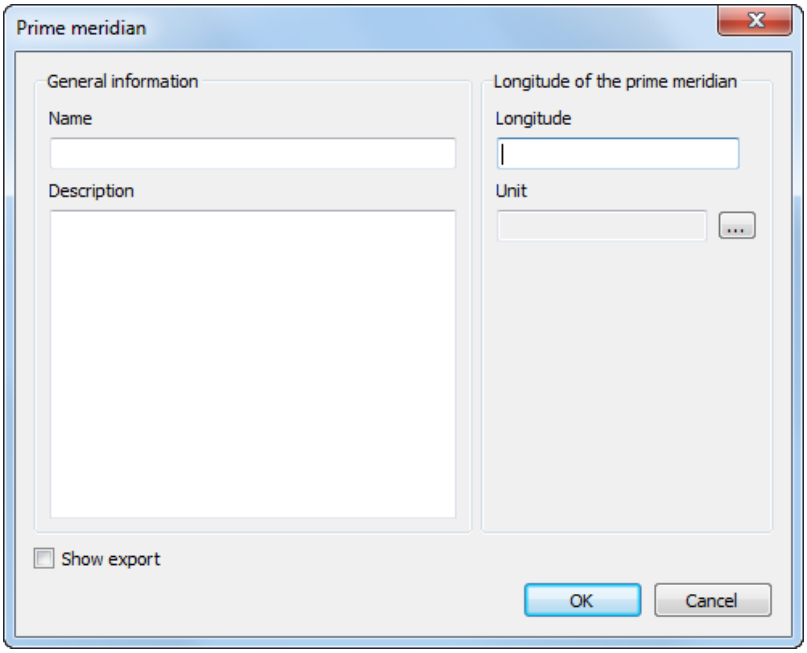


Fig. 27. Prime meridian settings

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. 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:

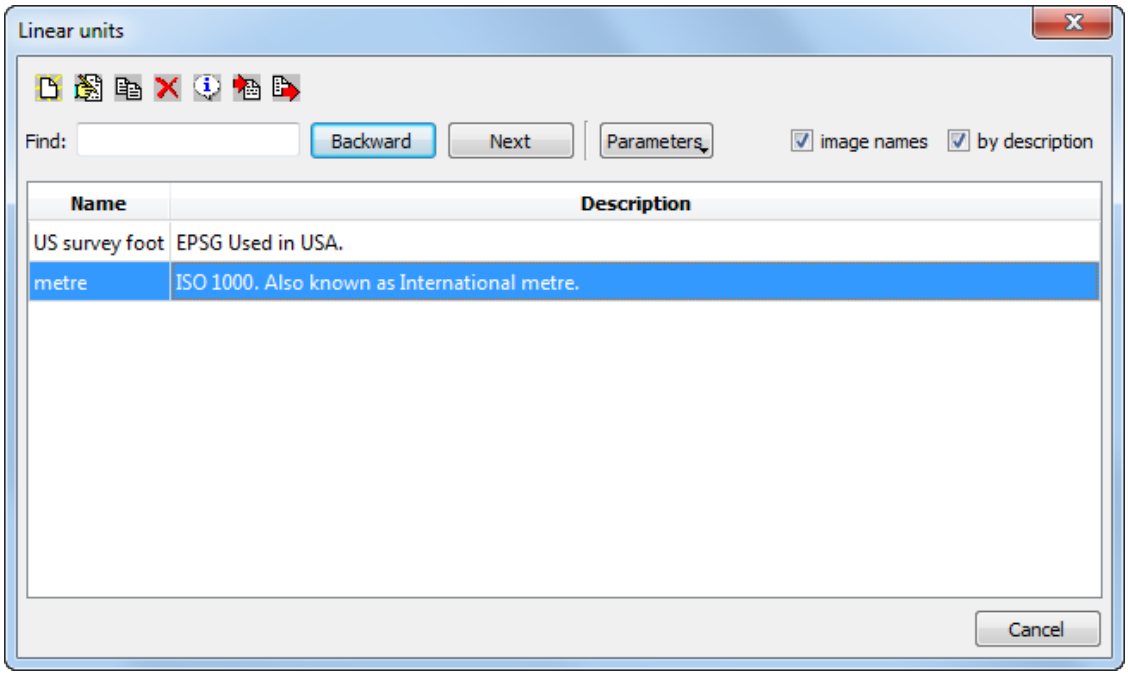


Fig. 28. The “Linear units” window

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

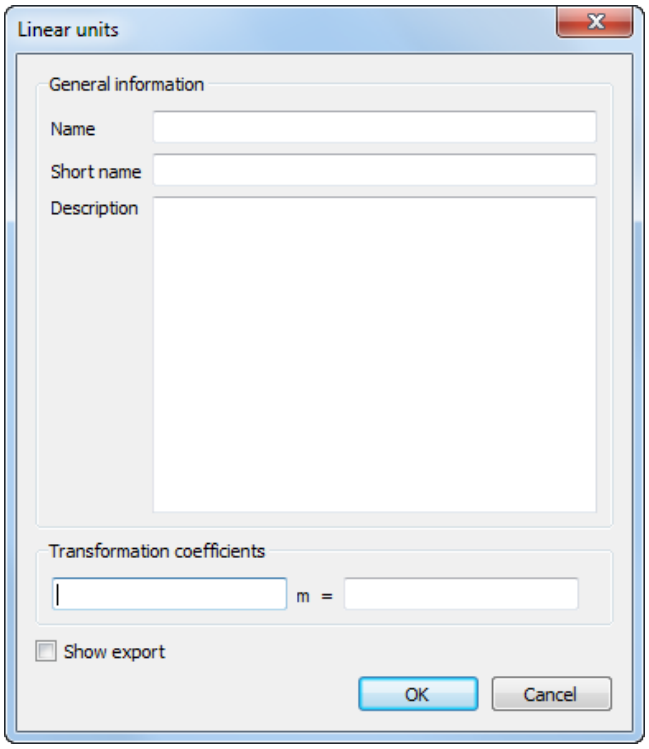


Fig. 29. The “Linear units” window

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. 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:

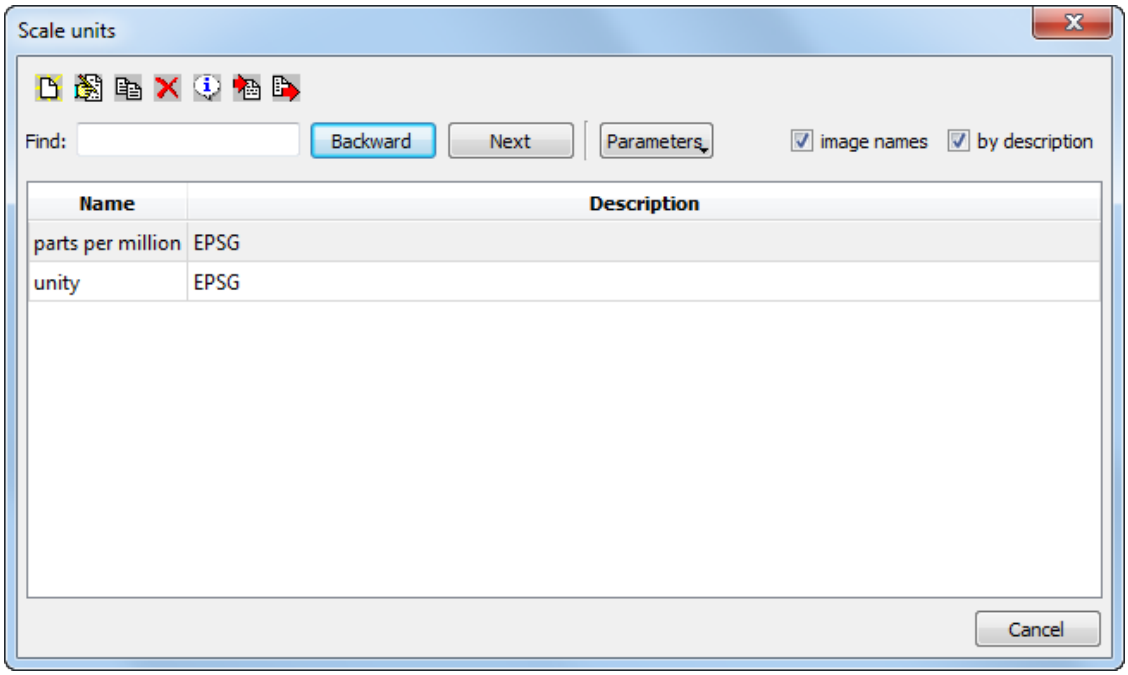


Fig. 30. The “Scale units” window

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

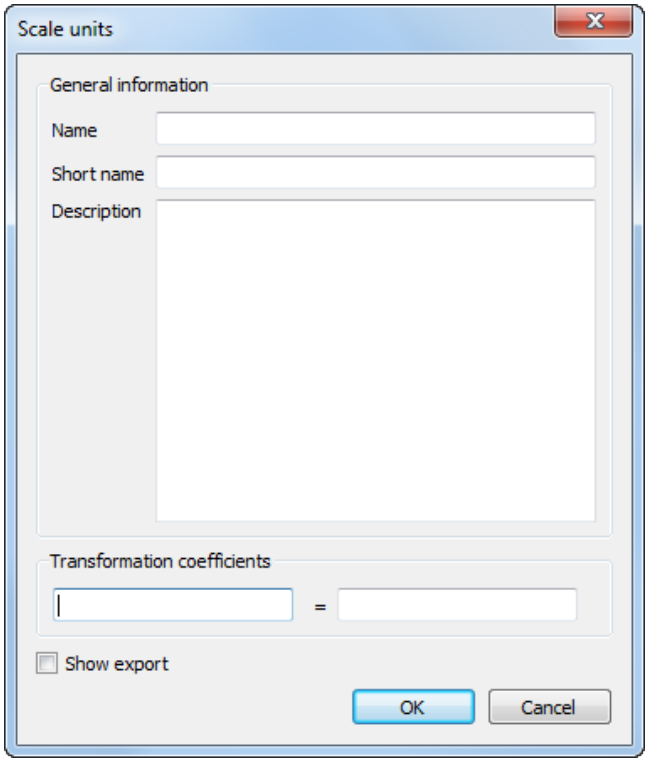


Fig. 31. The “Scale units” window

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. 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:

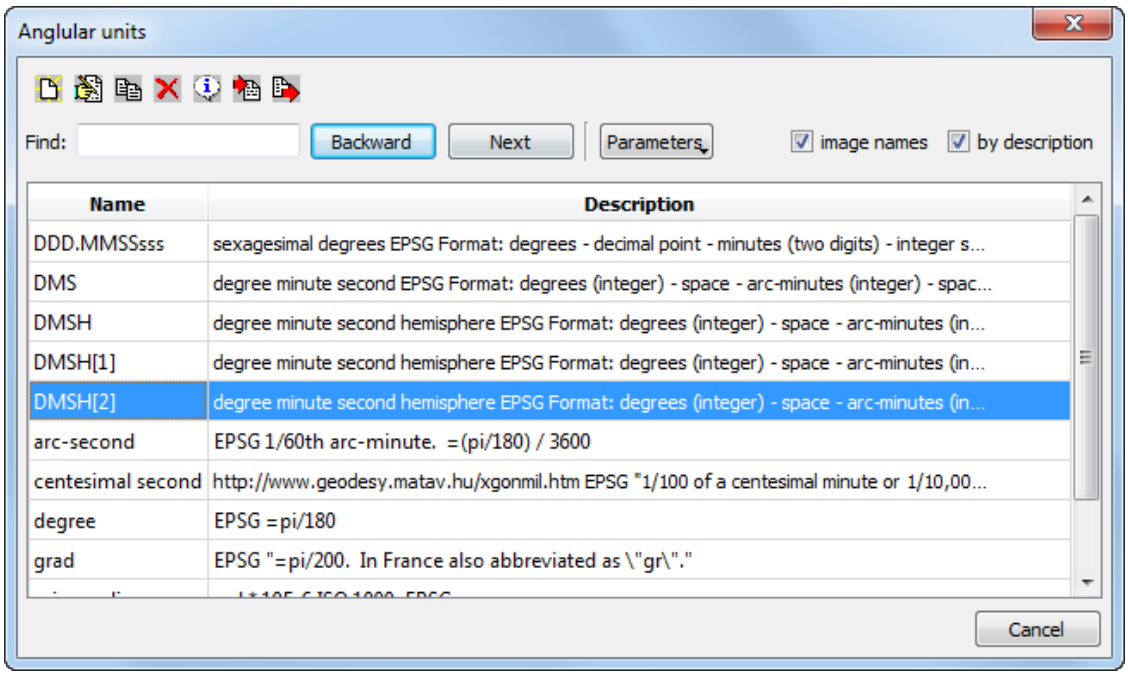


Fig. 32. The “Angular units” window

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

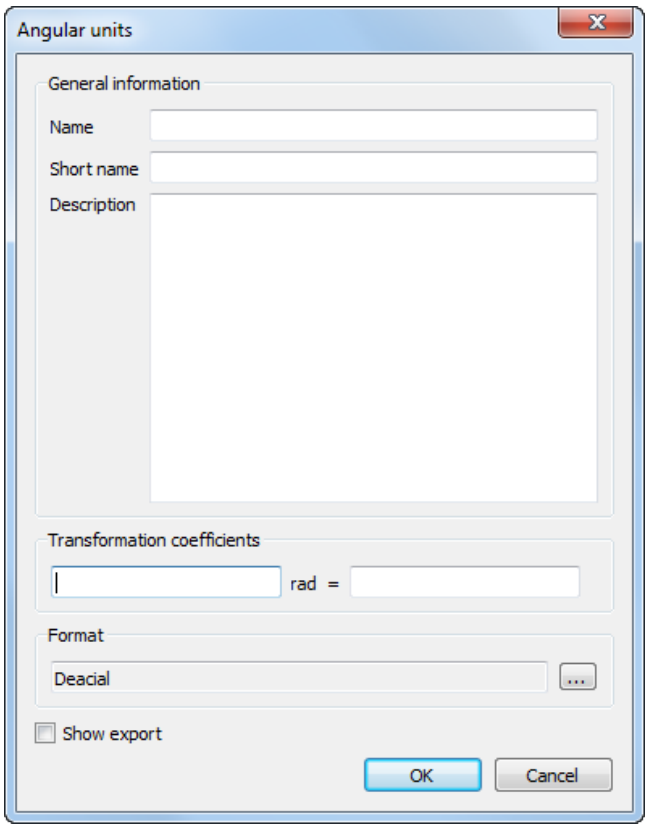


Fig. 33. The “Angular units” window

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.

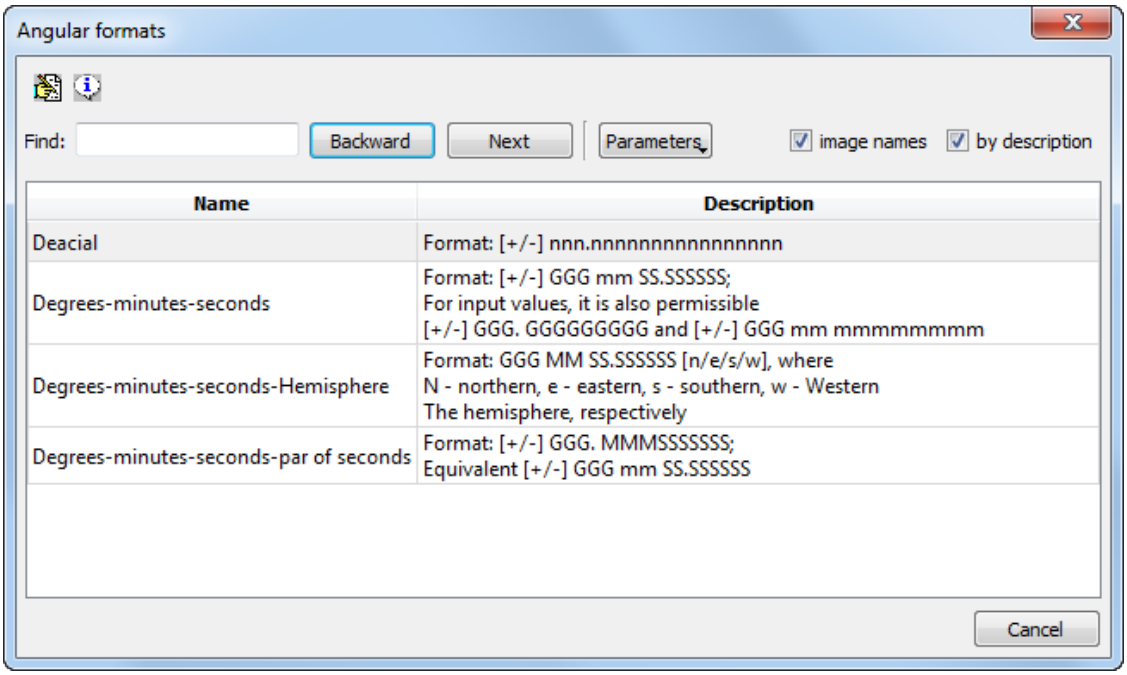


Fig. 34. The available angular formats list

7.5. Cartographic projections

The **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 **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 **The values of parameters of cartographic projections** window opens:

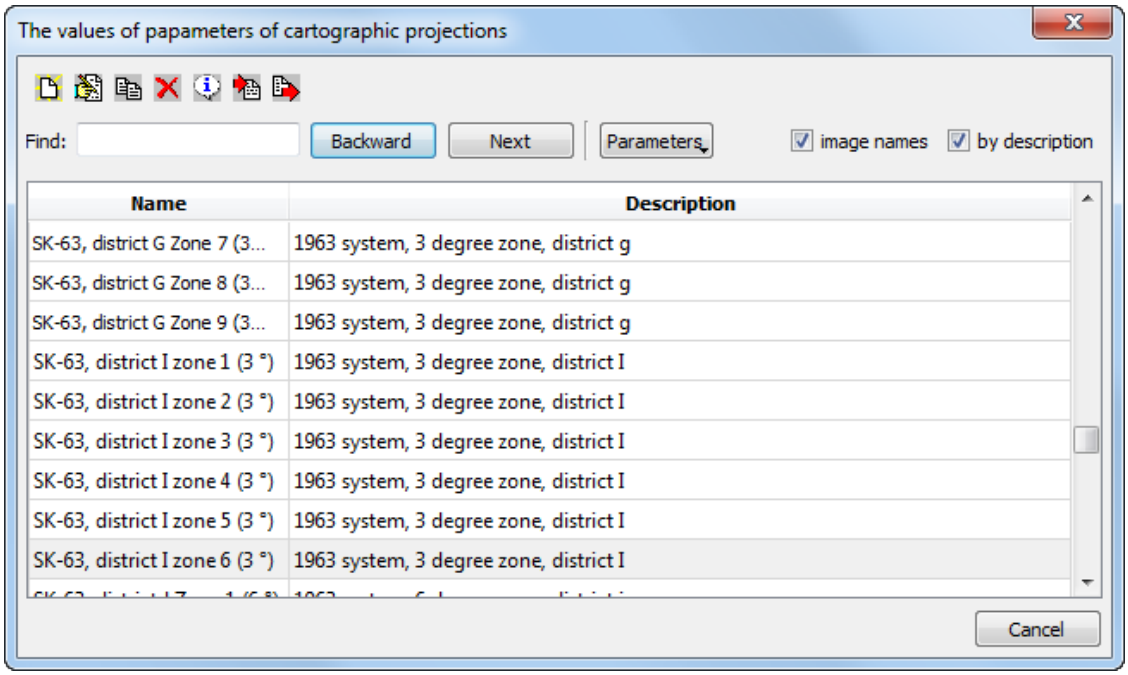


Fig. 35. The “The values of parameters of cartographic projections” window

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

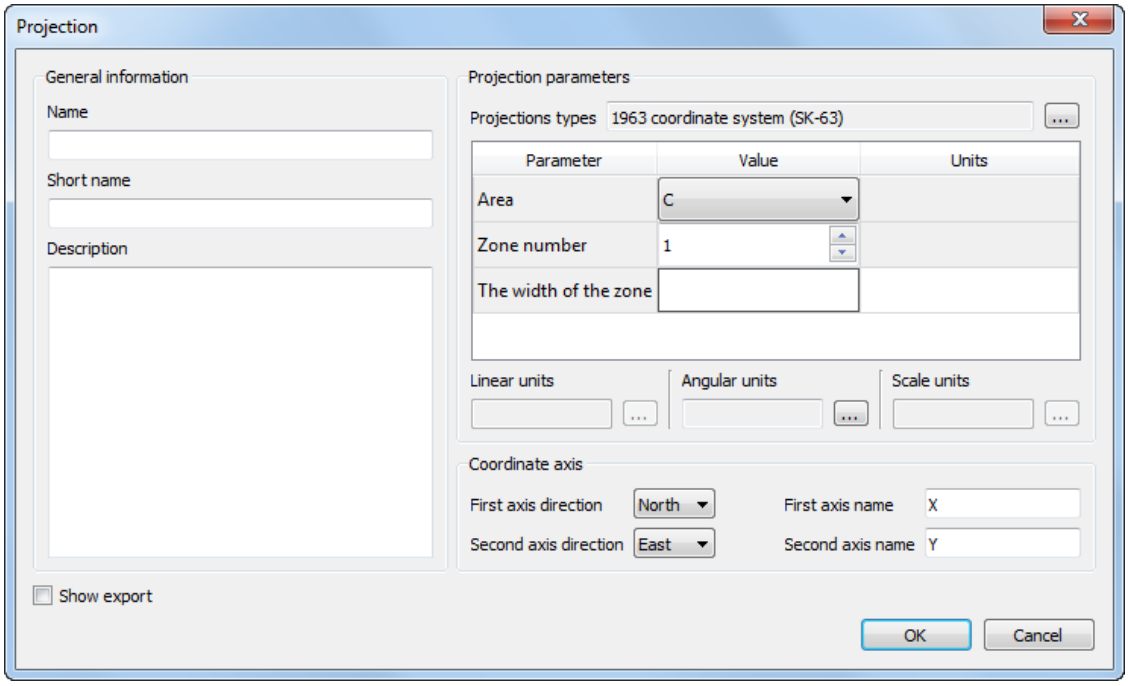


Fig. 36. Creating map projection

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 axes;
   - **First/Second axis name** – allows to set abbreviation for axes.

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

7. 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.

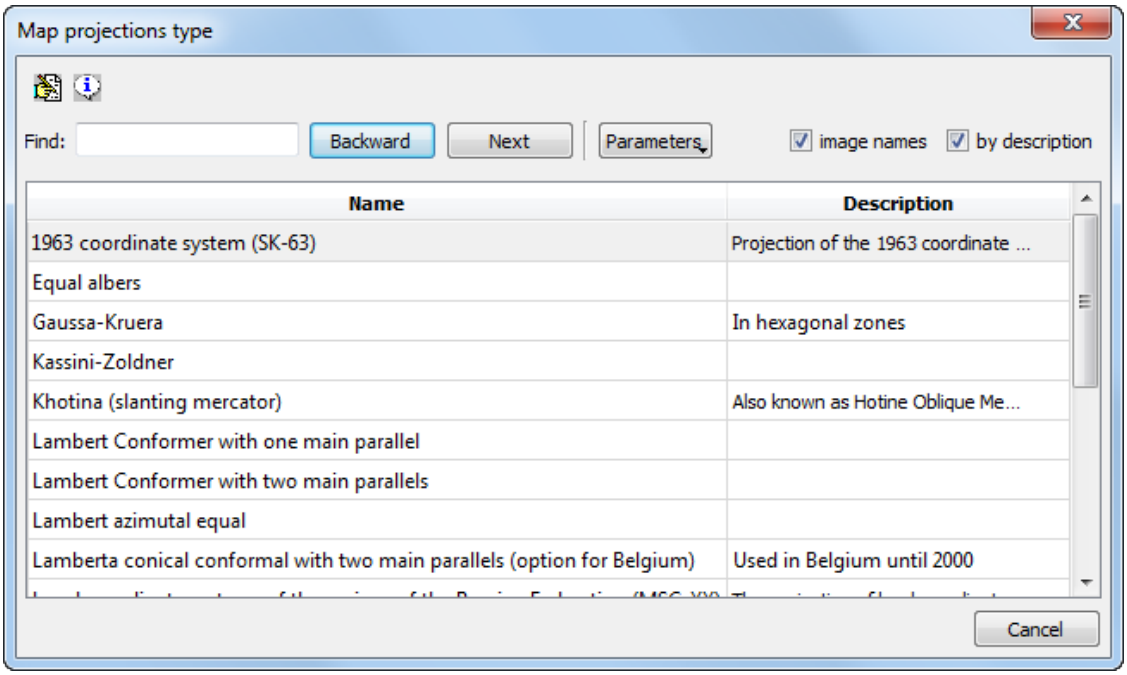


Fig. 37. Типы картографических проекций

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. Importing new 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. EGM2008 geoids with 1' and 2.5' grids are available for downloading on the racurs.ru web page.

The EGM2008 geoid is the Earth gravitational model, which includes detailed gravitational anomalies and is more accurate compared to the EGM96 model.

To import the EGM2008 geoid, perform the following:

1. Load the `*.zip` archive from the racurs.ru web page
2. Unpack the archive;
3. Click the button in *GeoCalculator* main window toolbar;
4. In the window for file selection that opens, select a `*.dat` file from the downloaded archive;

5. Wait until the geoid import is complete (an info message appears).

Appendix A. Coordinate transformations

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

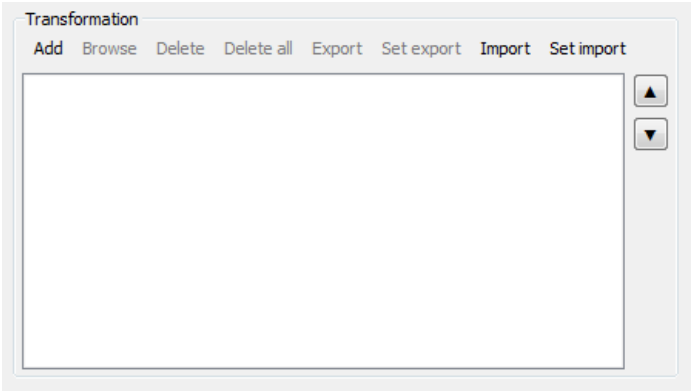


Fig. A.1. The “Transformation” section

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:

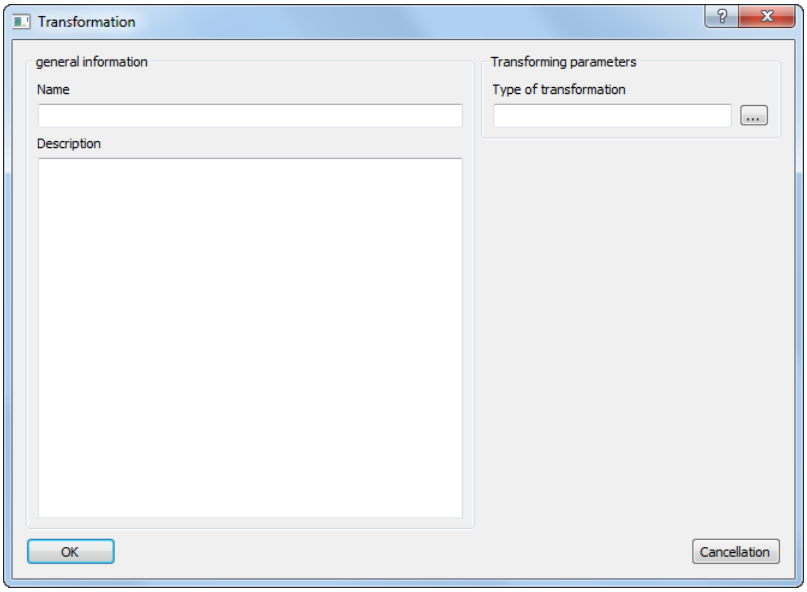


Fig. A.2. The “Transformation” window

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.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.

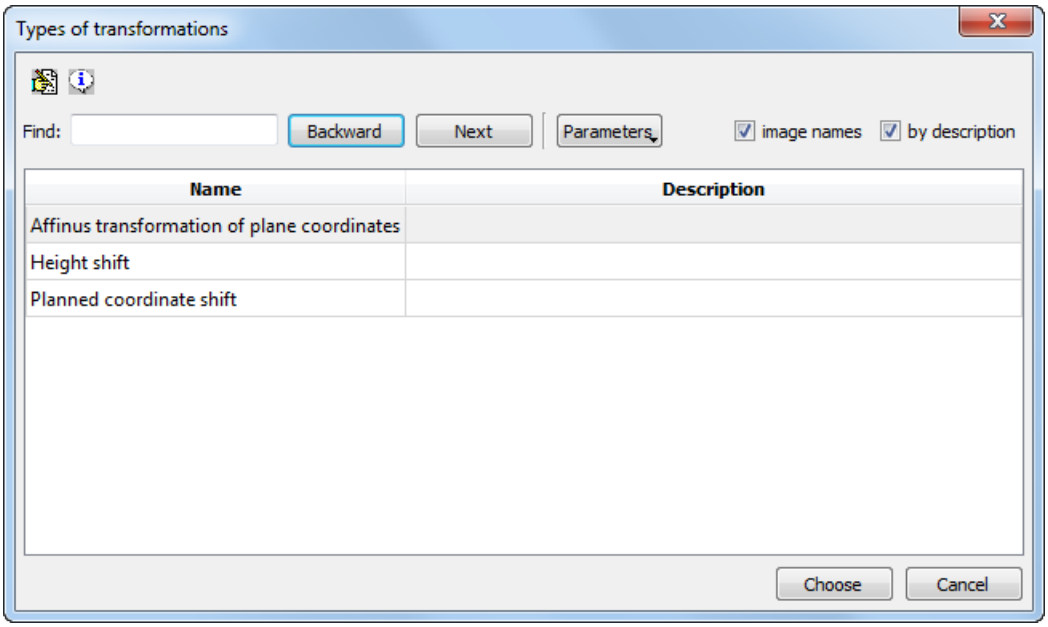


Fig. A.3. The transformation rules types list

Appendix B. Hotkeys

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

Table B.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 C. 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 D. GeoCalculator settings

To open **Settings** window choose **Tools › Settings** or click the button on the main toolbar.

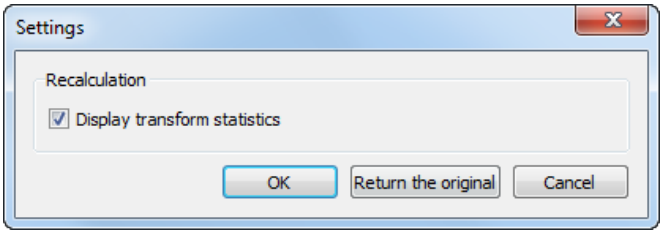


Fig. D.1. Program settings

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