Digital Photogrammetric System



Version 8.0

USER MANUAL

The GeoCalculator program (Windows x64)



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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;
 - Choose GeoCalculator in the right-click menu of the System Monitor module (the icon in the Windows system tray).
- If PHOTOMOD GeoCalculator is installed as separate application choose Start > Programs > PHOTOMOD GeoCalc 8 x64 > PHOTOMOD GeoCalc 8 x64 or run PhGeoCalcApp.exe manually (stored in C:\Program Files\PHOTOMOD_8_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.

S PHOTOMOD GeoCalc 8 x64 Setup
RACURS 1994 - 2024 License Agreement Please review the license terms before installing PHOTOMOD GeoCalc 8 x64.
Press Page Down to see the rest of the agreement.
Please read this End User License Agreement (public offer) carefully ^ before purchasing and using the "PHOTOMOD" software.
"PHOTOMOD" SOFTWARE END USER LICENSE AGREEMENT
If you accept the terms of the agreement, click the check box below. You must accept the agreement to install PHOTOMOD GeoCalc 8 x64. Click Next to continue.
I accept the terms of the License Agreement
PHOTOMOD GeoCalc 8.0.4519 x64
< Back Next > Cancel

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

S PHOTOMOD GeoCalc 8 x64 Setup	
Choose Install Location Choose the folder in which to install PHOTOMOD GeoCalc 8 x64.	
Setup will install PHOTOMOD GeoCalc 8 x64 in the following folder. To install in a different folder, click Browse and select another folder. Click Next to continue.	
Destination Folder C:\Program Files\PHOTOMOD_8_GeoCalc_x64 Browse	
Space required: 287.4 MB Space available: 123.7 GB PHOTOMOD GeoCalc 8.0.4519 ×64	



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_8_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.

PHOTOMOD GeoCalc 8	x64 Setup
RACURS 1994 - 2024	Choose Start Menu Folder Choose a Start Menu folder for the PHOTOMOD GeoCalc 8 x64 shortcuts.
Select the Start Menu folde can also enter a name to c PHOTOMOD GeoCalc 8 x6	
7-Zip Accessories Administrative Tools AIMP3 ComputeGridStep ComputeSevenParams CoreIDRAW Graphics Suite Cygwin Dr.Explain ENVI 4.5 EPSON Scan	
Do not create shortcuts PHOTOMOD GeoCalc 8,0,4519	
	< Back Install Cancel

6. The installation process begins;

PHOTOMOD GeoCalc 8 x64	4 Setup
	n stalling Please wait while PHOTOMOD GeoCalc 8 x64 is being installed.
Extract: Help\en\contrib.pdf	
Show details	
PHOTOMOD GeoCalc 8.0.4519 xi	64 < Back Next > Cancel

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

PHOTOMOD GeoCalc 8 x64	l Setup
	Completing PHOTOMOD GeoCalc 8 x64 Setup PHOTOMOD GeoCalc 8 x64 has been installed on your computer. Click Finish to close Setup. I create shortcuts on Windows desktop I Run PHOTOMOD GeoCalc 8 x64
	< Back Finish Cancel

- [optional] clear the **Run PHOTOMOD GeoCalc 8 x64** checkbox and click the **Finish** button to complete the installation process without program launch;
- [optional] leave the **Run PHOTOMOD GeoCalc 8 x64** 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 8 x64 > Uninstall PHOTOMOD GeoCalc 8 x64**.

3. Interface and its elements

3.1. 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 projec- tions
Height system	to choose height system
Coordinate systems types	to choose coordinate system type
Coordinate systems	opens the window allowing to manage coordinate system in current database

Table 1. Brief description of the "Database" menu

3.2. The "Help" menu

Table 2. Brief description of	of the	"Help"	menu
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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

Buttons	Functions
	to open the default PhCoordSys.db database with current parameters (without restoration of initial data)
e	to open the database

Buttons	Functions
ġ	to create an empty database
ě	to close database
4	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
B	to perform the batch coordinate systems export to the selected folder
2	to show points in the map (if <i>GeoCalculator</i> is installed as a part of the <i>PHOTOMOD</i> system)
	to calculate Datum transformation parameters (if <i>GeoCalculator</i> is installed as a part of the <i>PHOTOMOD</i> system)
	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 *PHOTOMOD8.VAR\GeoCalcDB\en* folder (see the "The PHOTOMOD8.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 *PHOTOMOD8.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 *PHOTOMOD8.VAR* folder will anyway be created automatically (and can be further used as a settings folder for *PHOTO-MOD* 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 PHOTOMOD8.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, $\sqrt{3}$ 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.

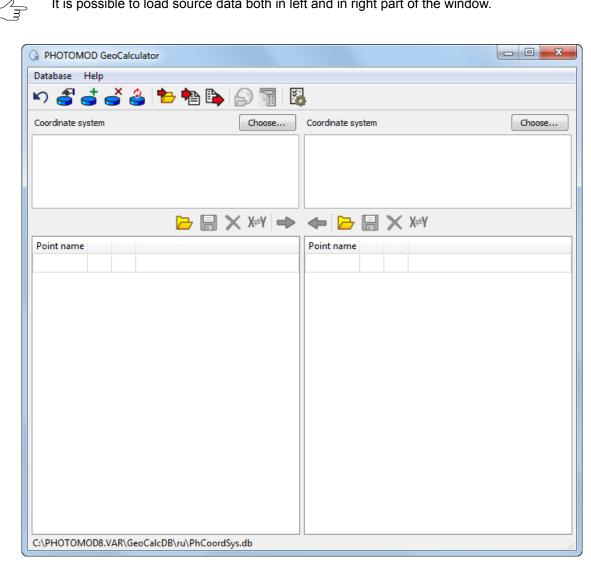


Fig. 1. The main program's window

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.

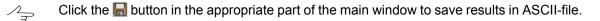


To swap the XY coordinates, click the 🚟 button in the appropriate table toolbar.



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 dutton on the right part of the main window.



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

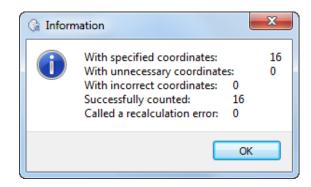


Fig. 2. The statistics window

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:

earch	
Name	Description
WGS 72BE / UTM zone 53N	132deg East to 138deg East; northern hemisphere. EPSG
WGS 72BE / UTM zone 53S	132deg East to 138deg East; southern hemisphere. EPSG
WGS 72BE / UTM zone 54N	138deg East to 144deg East; northern hemisphere. EPSG
WGS 72BE / UTM zone 54S	138deg East to 144deg East; southern hemisphere. EPSG
WGS 72BE / UTM zone 55N	144deg East to 150deg East; northern hemisphere. EPSG
WGS 72BE / UTM zone 55S	144deg East to 150deg East; southern hemisphere. EPSG
WGS 72BE / UTM zone 56N	150deg East to 156deg East; northern hemisphere. EPSG
WGS 72BE / UTM zone 56S	150deg East to 156deg East; southern hemisphere. EPSG
WGS 72BE / UTM zone 57N	156deg East to 162deg East; northern hemisphere. EPSG
WGS 72BE / UTM zone 57S	156deg East to 162deg East; southern hemisphere. EPSG

Fig. 3. The window containing coordinate systems list (opened by the **Choose** button)

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);

Buttons	Functions
Ľ	to open a window for creating new coordinate system
B	to edit chosen coordinate system
e	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
b	to export coordinate system to the file of selected format

Table 4. Brief description of Coordinate systems window toolbar

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 the coordinate system **search**, input name or its part (or keyword) into appropriate field.



To clear the entered data in the **search** field, click the \mathbf{X} button.



The string of last previously selected coordinate system is marked by grey color.

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 **1** button in **Coordinate systems** window toolbar.

G Information		
Brief information Details XML		
Name: WGS 72BE / UTM zone 5N Description: 156deg West to 150deg West; northern hemisphere. EPSG Type: Projected Datum: WGS 72 Transit Broadcast Ephemeris Prime meridian: Greenwich Map projection: UTM zone 5N Plane coordinate units: metre Height units: metre First axis: E Second axis: N Third axis: H EPSG Code (Geotiff): 32405		
Save Return Close		

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-toview 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.

arch		
Name	Description	
GDA94 / MGA zone 48	Australia - 102deg East to 108deg East. EPSG	
GDA94 / MGA zone 49	Australia - 108deg East to 114deg East. EPSG	
GDA94 / MGA zone 50	Australia - 114deg East to 120deg East. EPSG	
GDA94 / MGA zone 51	Australia - 120deg East to 126deg East. EPSG	
GDA94 / MGA zone 52	Australia - 126deg East to 132deg East. EPSG	
GDA94 / MGA zone 53	Australia - 132deg East to 138deg East. EPSG	
GDA94 / MGA zone 54	Australia - 138deg East to 144deg East. EPSG	
GDA94 / MGA zone 55	Australia - 144deg East to 150deg East. EPSG	
GDA94 / MGA zone 56	Australia - 150deg East to 156deg East. EPSG	
GDA94 / MGA zone 57	Australia - 156deg East to 162deg East. EPSG	

Fig. 5. The Coordinate systems window (opened from the Database menu)

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

G Editing the coordinate system	n	x
General information	Parameters	
Name	Туре	
Short name		
Description		
Show		
Transformations Export		
	ок с	ancel

Fig. 6. Reference system creation

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

Garage Types of coordinate systems	x		
Search			
Name	Description		
Geocentric	Geocentric		
Geodetic	Geodetic		
Local Cartesian	Local Cartesian		
Projected	Projected		
Topocentric	Topocentric		
Choose Cancel			

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;

G Editing the coordinate system	
General information	Parameters
Name	Type Geodetic
Short name	Prime meridian
Description	Ellipsoid Ingitude
	Units Designations: Latitude φ longitude λ Positive longitude direction
	Height Units Designation h
Show Transformations Export	Vertical datum
	OK Cancel

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 <u>units</u> 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.

G Editing the coordinate system	X
General information	Parameters
Name	Type Geocentric
	Prime meridian
Short name	☑ Datum
	Units
Description	Axes names
	X X Y Y Z Z
Show	
Transformations Export	
	OK Cancel

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 <u>button</u> to select the datum from the list;

- 4. Click the <u>___</u> 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.

G Editing the coordinate syste	m
General information	Parameters
Name	Type Local Cartesian
	Units
Short name	Orientation Coordinates designations
	Right X x Y y Z z
Description	© Left
Show	
Transformations Export	
	OK Cancel

Fig. 10. Creating the Cartesian coordinate system

- 2. Click the <u>___</u> 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.

G Editing the coordinate system	x
General information	Parameters
Name	Type Projected
	Prime meridian
Short name	O Datum
	O Ellipsoid
Description	Plane coordinates
	Projection
	Units
	Axes names ,
	Height
	Units Axis name H
	Vertical datum
Show	
Transformations Export	
	OK Cancel

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 <u>____</u> 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 <u>units</u> 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;

Ga Editing the coordinate system			×
General information	Parameters		
Name	Type Topocentric		
	The basic coordinate system	Origin coordinates	
Short name	Prime meridian	Latitude	Latitude and longitude units
	O Datum	Longitude	
Description	🔘 Ellipsoid 🛛 📖	Height (above Ell.)	Height units
	Coordinate axis		
	Azimuth	Orientation Des	signations
		C Left X	x Yy Zz
	Azimut units	Right Coo	ordinat units
Show			1
Transformations Export			
			OK Cancel
1			

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 <u>____</u> 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 $\frac{1}{100}$ 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 here 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 \blacktriangleright 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 > Coordinate systems types**) 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.

Garage Types of coordinate systems	×
i	
Search	×
Name	Description
Geocentric	Geocentric
Geodetic	Geodetic
Local Cartesian	Local Cartesian
Projected	Projected
Topocentric	Topocentric
	Cancel

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:

	4		
earch			
Name	Description	EPSG Code (Geotiff)	Mapinfo code
Abidjan 1987	Fundamental Point: Abid	0	NULL
Abidjan 1987[1]	Fundamental Point: Abid	0	NULL
Abidjan 1987[2]	Fundamental Point: Abid	0	NULL
Adindan	Fundamental Point: Stati	0	NULL
Afgooye	EPSG	0	NULL
Ain el Abd 1970	Fundamental Point: Ain E	0	NULL
Amersfoort	Fundamental Point: Ame	0	NULL
Antigua 1943	Fundamental point: stati	0	NULL
Arc 1950	Fundamental Point: Buff	0	NULL
Arc 1960	Fundamental Point: Buff	0	NULL

Fig. 14. The Datum window

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

🚱 Datum editing	×
General information Name	Parameters Ellipsoid
Short name	Recalculation to WGS 84
Description	
Show export	
	OK Cancel

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 <u>button rightward to the **Ellipsoid** field to choose reference-ellipsoid from the list (see the Section 7.2);</u>
- 5. Click the <u>___</u> 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:

earch		>
Name	Description	
AGD84 to WGS 84	Australia. Australian Surveying and Land Information Group - www.auslig.gov.au/geodesy	
Adindan to WGS 8	Sudan. U.S. Defense Mapping Agency TR8350.2 December 1987. EPSG	
Afgooye to WGS 8	Somalia. U.S. Defense Mapping Agency TR8350.2 December 1987. EPSG	
Ain el Abd to WGS	Saudi Arabia. U.S. Defense Mapping Agency TR8350.2 revision of August 1993. EPSG	
Amersfoort to WG	Netherlands. Nederlandse Commissie voor Geodesie publication 30; 1993. EPSG	
Antigua 1943 to W	Antigua. Ordnance Survey of Great Britain EPSG	
Arc 1950 to WGS 8	Zimbabwe. U.S. Defense Mapping Agency TR8350.2 December 1987. EPSG	
Arc 1960 to WGS 8	Tanzania. U.S. National Imagery and Mapping Agency TR8350.2 revision of October 1997;	
Batavia to WGS 84	Indonesia (Sumatra). U.S. Defense Mapping Agency TR8350.2 December 1987. EPSG	
Bermuda 1957 to	Bermuda, U.S. Defense Mapping Agency TR8350.2 December 1987, EPSG	

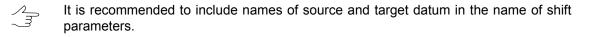
Fig. 16. Default datum transformation parameters presets

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

G Datum transformation parameters	×
General information	Parameters
Name	Transformation type
Short name	
Description	
Show export	OK Cancel

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;



- 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

G Datum transformation parameters			X
General information Name	Parameters Transformation typ Parameters	pe Helmert	
Short name	Shift X	Rotation X	Scale correction
Description	Y Z Units	Y Z Units	Units
	Nonlinear trans	sformation	
Show export		ОК	Cancel

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.

 $\mathcal{I}_{\overline{\exists}}$ Click is 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

G Datum transformation parameters	X
General information	Parameters
Name	Transformation type Molodensky
	Shift by X Shift by Y Shift by Z
Short name	
	Unit
Description	
Show export	
	OK Cancel

Fig. 19. The Molodensky transformation

- 2. Shift shift units and Tx, Ty, and Tz values;
 - $\mathcal{A}_{\mathcal{A}}$ Click is to select **units** of shift from the list.

The Molodensky-Badekas (Helmert) transformation

🚱 Datum transformation pa	arameters			×
General information	Parameters]
Name	Transformation type	Molodensky-Bade	ecas (Helmert)	
	Parameters			
Short name	Origin coordinates	Shift	Rotation	Scale correction
	x	X	x	
Description	Y	Y	Y	
	z	z	z	
	Units		Units	Units
Show export				
			ОК	Cancel

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.

 $\mathcal{I}_{\mathcal{I}}$ Click is to select **units** of shift, rotation, or scale from the list.

The Molodensky-Badekas (rotate-shift-scale)

G Datum transformation	parameters			×
General information	Parameters]
Name	Transformation type	Molodensky-Bad	ecas (Rotate-shift-s	cale)
	Parameters			
Short name	Origin coordinates	Shift	Rotation	Scale correction
	x	x	x	
Description	Y	Y	Y	
	z	z	z	
	Units		Units	Units
Show export				
			ОК	Cancel

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.

 $\mathcal{I}_{\mathcal{I}}$ Click is to select **units** of shift, rotation, or scale from the list.

Rotation-Shift-Scale

G Datum transformation parameters			X
General information Name	Parameters Transformation typ Parameters	pe Rotate-shift-sca	ale
Short name	Shift	Rotation X	Scale correction
Description	Y Z Units Nonlinear trans	Y Z Units	Units
Show export		ОК	Cancel

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.

 $\mathcal{I}_{\overline{\exists}}$ Click is 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.

G Types of transformation of datums	×
A	
Search	
Name	Description
Helmert	Datum rotation Bursa-Wolf
Molodensky	Shift by 3 axis
Molodensky-Badecas (Helmert)	Datum rotation Bursa-Wolf
Molodensky-Badecas (Rotate-shift-scale)	Datum rotations used in the Russian Federation
Rotate-shift-scale	Datum rotations used in the Russian Federation
	Cancel

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:

<u>₩</u> 🕄 🗗 🗙 (
Search				
Name	Description	EPSG Code (Geotiff)	Mapinfo code	
Clarke 1866	US Army Map Service Tec	7008	NULL	
Clarke 1866 Michigan	USGS Professional Paper #	7009	NULL	(
Clarke 1880	"\"Ellipsoidisch Parameter	7034	NULL	
Clarke 1880 (Arc)	EPSG Adopts Clarke's valu	7013	NULL	
Clarke 1880 (Benoit)	EPSG Adopts Clarke's valu	7010	NULL	
Clarke 1880 (IGN)	EPSG Adopts Clarke's valu	7011	NULL	
Clarke 1880 (RGS)	Empire Survey Review #32	7012	NULL	
Clarke 1880 (SGA 1922)	EPSG Used in Old French	7014	NULL	

Fig. 24. The list of default ellipsoids in database

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

Ga Ellipsoid	×
General information	Parameters
Name	Major semiaxis
	Spheroid
Description	O Minor semiaxis
	Flattening
	Unit
Show export	
	OK Cancel

Fig. 25. Reference ellipsoid parameters

- 3. Define the Name and Description of the reference ellipsoid in the fields;
- 4. Specify the following ellipsoid parameters:

- Major semiaxis;
- [optional] Minor semiaxis or flattening (or create the Spheroid).
- 5. Click the <u>button</u> 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:

🕼 Prime meri	dians	x
<u>1</u> 🔊 🛙	ħ 🗙 Φ ♠ ħ	
Search		X
Name	Description	*
Jakarta	EPSG	
Lisbon	Instituto Geografico e Cadastral; Lisbon EPSG	
Madrid	EPSG	
Oslo	Statens kartverk - Geodesi dividsion EPSG Formerly known as Kristiana and Christiana.	
Paris	Institut Geographique National (IGN); Paris EPSG Value adopted by IGN (Paris) in 193	=
Rome	EPSG	
Stockholm	EPSG	-
t	Cancel	

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

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

🚱 Prime meridian	X
General information Name	Longitude of the prime meridian Longitude
Description	Unit
Show export	OK Cancel

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 <u>button</u> 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:

🚱 Linear units	×
<u>17</u> 😴 🗗	a 🗙 🔄 🔁 🗈
Search	
Name	Description
Meter	
US survey foot	EPSG Used in USA.
metre	ISO 1000. Also known as International metre.
metre[1]	ISO 1000. EPSG Also known as International metre.
metre[2]	
метр	ISO 1000
	Cancel

Fig. 28. The Linear units window

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

🚱 Linear un	its 🛛 🗶
-General info	rmation
Name	
Short name	
Description	
Transformat	tion coefficients
	m =
Show exp	
	OK Cancel

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:

Gale units	
<u>1</u> 🔁 🖻	🗙 🔄 糩 🗈
Search	
Name	Description
parts per million	EPSG
ppm	
unity	EPSG
unity[1]	
единица	
L	
	Cancel

Fig. 30. The Scale units window

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

🚱 Scale units			×
General information	n		
Name			
Short name			
Description			
Transformation co	officients		
I ransformation co			
	=		
Show export			
		ОК	Cancel

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:

<u>1</u> 🖓 🖻 🗙 🚯 🗗		
earch		
Name	Description	
DMSH	degree minute second hemisphere EPSG Format: degrees (integer)	
DMSH[1]	degree minute second hemisphere EPSG Format: degrees (integer)	
DMSH[2]	degree minute second hemisphere EPSG Format: degrees (integer)	
Degree		
arc-second	EPSG 1/60th arc-minute. =(pi/180) / 3600	
arc-second[1]		
centesimal second	http://www.geodesy.matav.hu/xgonmil.htm EPSG "1/100 of a cent	
degree	EPSG = pi/180	
degree[1]		
grad	EPSG "=pi/200. In France also abbreviated as \"gr\"."	

Fig. 32. The Angular units window

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

General information Name Short name Description Transformation coefficients Format Deacial Show export	🚱 Angular u	nits			×
Short name Description Transformation coefficients Format Deacial	General info	rmation			Ì
Description Transformation coefficients Format Deacial	Name				
Transformation coefficients Format Deacial	Short name				
Format Deacial	Description				
Format Deacial					
Format Deacial					
Format Deacial					
Format Deacial					
Format Deacial					
Format Deacial					
Format Deacial					
Format Deacial					
Format Deacial		ion coefficients			
Deadal			rad =		
	Format				
Show export	Deacial				
	Show exp	ort			
OK Cancel			(ОК	Cancel

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.

Angular formats	X
i	
Search	
Name	Description
Deacial	Format: [+/-] nnn.nnnnnnnnnnnnn
Degrees-minutes-seconds	Format: [+/-] GGG mm SS.SSSSS; For input values, it is also permissible [+/-] GGG. GGGGGGGGGG and [+/-] GGG mm mmmmmmm
Degrees-minutes-seconds-Hemisphere	Format: GGG MM SS.SSSSSS [n/e/s/w], where N - northern, e - eastern, s - southern, w - Western The hemisphere, respectively
Degrees-minutes-seconds-par of seconds	Format: [+/-] GGG. MMMSSSSSSS; Equivalent [+/-] GGG mm SS.SSSSSS
	Cancel

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:

🚱 The values of param	eters of cartographic projections	×
☆寥 ₪ ×	(i) 🏚 🗈	
Search	/	×
Name	Description	*
Gauss-Kruger zone 23	132deg East to 138deg East; northern hemisphere. EPSG Original transformation by Gaus	
Gauss-Kruger zone 24	138deg East to 144deg East; northern hemisphere. EPSG Original transformation by Gaus	
Gauss-Kruger zone 25	144deg East to 150deg East; northern hemisphere. EPSG Original transformation by Gaus	
Gauss-Kruger zone 26	150deg East to 156deg East; northern hemisphere. EPSG Original transformation by Gaus	
Gauss-Kruger zone 27	156deg East to 162deg East; northern hemisphere. EPSG Original transformation by Gaus	
Gauss-Kruger zone 28	162deg East to 168deg East; northern hemisphere. EPSG Original transformation by Gaus	
Gauss-Kruger zone 29	168deg East to 174deg East; northern hemisphere. EPSG Original transformation by Gaus	
Gauss-Kruger zone 3	12deg East to 18deg East; northern hemisphere. EPSG Original transformation by Gauss	
Gauss-Kruger zone 30	174deg East to 180deg; northern hemisphere. EPSG Original transformation by Gauss-Kr	
Gauss-Kruger zone 31	180deg to 174deg West; northern hemisphere. EPSG Original transformation by Gauss-K	-
	c	ancel

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

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

G Projection	×
General information	Projection parameters
Name	Projections types
	Parameter Value Units
Short name	
Description	
	Linear units Angular units Scale units
	Coordinate axes
	First axis direction East First axis name
	Second axis direction North Second axis name
Show export	
	OK Cancel

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.

 $\int_{-\frac{3}{2}}$ 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.

 $\mathcal{I}_{\mathfrak{I}}$ 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.

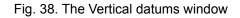
earch		
Name	Description	
Mercator 2 standart parallels	Mercator 2 standart parallels	
New Zeland map grid (NZMG)	New Zeland map grid (NZMG)	
Oblique Mercator	Oblique Mercator	
Oblique stereographic	Oblique stereographic	
Orthographic	Orthographic	
Polar Stereographic	Polar Stereographic	
Polyconic	Polyconic	
SK63	SK63	
Transverse Mercator	Transverse Mercator	
Transverse Mercator wide zone	Transverse Mercator wide zone	

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.

Ga Vertical	datums 📃	x
∃ĭ ×		
Search		×
Name	Description	
EGM 2008	Earth Gravitational Model 2008	
EGM 96	Earth Gravitational Model 1996	
	Cancel	
	Cancer	



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 (PHOTOMOD8.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).

7.6.2. Creating custom height system

The system provides for creating a user height system with preset parameters.

To do this, perform the following:

1. Choose the **Database > Height system** in the main window of the program. The **Vertical datums** window opens:

🚱 Vertical	Vertical datums			
ЪХ 🗙	(i)			
Search				
Name	Description			
EGM 2008	Earth Gravitational Model 2008			
EGM 96	Earth Gravitational Model 1996			
	Cancel			

Fig. 39. The Vertical datums window

2. Click the 🛅 button. The **Vertical datum** window opens:

General informatio	n Parameters				
Name	Coordinate system				
Short name	DEM				
	Bounds				
escription	Units:				
		North	0.0		
	West 0.0			East 0.0	
			0.0		
	Height 0.000				
	Width 0.000				
				ОК	Cancel

Fig. 40. The "Vertical datum" window

- 3. Set the general vertical datum parameters:
 - **Name** arbitrary name;
 - Short name arbitrary short name;
 - **Description** arbitrary description it's additional information to identify height system in the list.

- 4. In the **Parameters** section, click the <u>button</u> button to select the **coordinate system**:
- 5. In the **Parameters** section, click the <u>____</u> button to select the **DEM**. In the **North**, **West**, **East**, **South**, **Height** and **Width** fields the system displays calculated DEM size and size of DEM border in meters;
- 6. Click the **OK** button. Created height system is shown in the list with defined name and description.

To use the custom vertical datum in *PHOTOMOD* system, click the **W** button that allows to choose geoids from a list or cancel the using of the geoid.

WGS 84 / UTM zone 32N (6deg East to 12deg East; northern he Select, 🥘	
Orientation: right, geo-referencing: global coordinate system	No geoid
OK Distributed processing Can	EGM 2008 EGM 96
	custom

To delete the custom vertical datum the \mathbf{X} is used. The system vertical datums **EGM 96** and **EGM 2008** could not be deleted.

7.7. Deleting coordinate system elements

To delete coordinate system elements, use the \times button in the toolbar of the window intended for viewing and managing the list of corresponding entities (CS elements). Confirm this operation in the following box:

Question			
Delete?			
Yes No			

Fig. 41. Deleting an entity from the coordinate system database dialog box

To confirm the deletion, click **Yes**.

Since the database of coordinate systems and their elements has an hierarchic structure, the deletion of child elements of any entity (for example, a set of parameters for shifting the datum that is a child of another datum) may cause database errors.

Thus, before deleting any entity from a database, an automatic check of the links between the objects that the database operates on is performed. If it is not possible to

delete the selected object, the **Relative database objects** window opens, listing the objects that depend on the one being deleted (see **The listed objects depend on the deleted** section):

G Relative database objects						
The listed objects of	The listed objects depend on the deleted:					
Туре	Name	Description				
Datums	Auto Пулково					
		Clos	se			

Fig. 42. The Relative database objects window

To ensure correct database operation, first remove parent objects from the database that are placed on the upper level of the hierarchy (coordinate system), and then, if needed, delete the coordinate system elements remaining in the database if there are any.



When deleting coordinate systems and their elements, note that the *GeoCalculator* (coming with *PHOTOMOD*) database is shared with *PHOTOMOD*. Thus, *GeoCalculator* coordinate systems can be used for processing *PHOTOMOD* projects.



The solution in the main *GeoCalculator* toolbar opens the PhCoordSys.db database provided by default (without database reset).



The solution in the main *GeoCalculator* toolbar allows you to reset the coordinate system database. The current database will be closed, the PhCoordSys.db database supplied with the program will be returned to its original parameters and opened as the current database.

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

Transf	formation						
Add	Browse	Delete	Delete all	Export	Set export	Import	Set import
							
L							

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:

G Transformation	×
General information	Transforming parameters
Name	Transformation type
Description	
	OK Cancel

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.

Ga Transformation	×		
General information	Transforming parameters		
Name	Transformation type		
	Affine transformation of plane coordinates		
Description			
	Y ¹ = X Y +		
	Return Identity. Inverse		
	OK Cancel		

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.

Ga Transformation	×
General information	Transforming parameters
Name	Transformation type
	Plane coordinates shift
Description	X' Y Y 0 Y' Y 0 0 Return Identity. Inverse
	OK Cancel

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.

G Transformation	×
General information	Transforming parameters
Name	Transformation type
	Height shift
Description	H'=H+ 0
	Return Identity. Inverse
	Unit
	OK Cancel

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.

G Types of transformations	
A	
Search	
Name	Description
Affine transformation of plane coordinates	
Height shift	
Plane coordinates shift	
L	
	Choose Cancel

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.

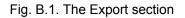
The system allows:

- 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 (\Box , \Im). The **Export** section opens:

Export		
GeoTIFF (EPSG)	0	
MapInfo	0	🗷



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:

Export		
GeoTIFF (EPSG)	0	
MapInfo	0	

Fig. B.2. The Export section

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

Ga EPSG Datum code	s	X
<u> 1</u> 😵 🗗 💙	🔇 4) 🐴 🖺	
Search		
Name	Description	
		Choose Cancel

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:

EPSG code e	ditor 🗾
-General infor	mation
Name	
Description	
Export code	
	Check the code
	OK Cancel

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:

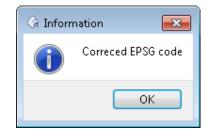


Fig. B.5. The info message

 [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.

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+l	Searching for incorrect points
Ctrl+D	Delete incorrect points
Ctrl+E	Delete empty lines
Ctrl+U	Swap point lists

Table C.1. Hotkeys

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 **Settings** button on the main toolbar.

Ga Settings	x
Recalculation	
Display transform statistics	
English	•
OK Return the original	Cancel

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 *PHOTO-MOD 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 *PHOTO-MOD* documentation kit).

Appendix F. Calculating datum transformation parameters

Calculating datum shift means refining the transformation parameters between two spatial coordinate systems. This allows, using two sets of identical points (at least three points in a set), to determine the parameters to transform the first set points' coordinates to the second set coordinate system.

The transformation parameters include: **scaling**, **three axis rotation angular elements**, and **three linear elements** of the coordinate system center shift. Such transformations

are necessary, for example, when referring the received GPS measurement data to the stations of the state geodetic network.



When processing data, it may be necessary to compare two sets of identical points on the earth's surface, measured at different times, using different methods, and recorded in different coordinate systems.

When converting coordinates of points from one coordinate system to another and subsequently analyzing the results, the need to clarify the transformation parameters between two spatial coordinate systems may arise due to many possible factors, from measurement errors to changes in the terrain itself, as a result of natural and anthropogenic processes.

Calculating datum shift parameters is available using the *GeoCalculator* software provided with *PHOTOMOD*, as well as using a separate *Seven-Parameter Calculation* application available for downloading from the **Racurs** Company website racurs.ru.

The *GeoCalculator* program (provided with *PHOTOMOD*) allows for immediate use of refined transformation parameters by automatically generating a user coordinate system, with a custom datum that includes a datum transformation parameter set that use the refined **rotation-shift-scaling** parameters.

A user coordinate system saved in *GeoCalculator* database can be further used when processing a project directly in *PHOTOMOD* (see "Coordinate systems" in the "Creating project" User Manual, *PHOTOMOD* documentation)

F.1. Preparing data sets

To determine transformation parameters between two coordinate systems, first prepare two data sets: two TXT files with point coordinates. One file must contain points in one coordinate system only.

The data in the files must meet the following criteria:

- The number of lines in both files must be the same;
- Point coordinates in each file must be entered in the following order:



If there are errors in sequence, incorrect data may be obtained.

1,6235070.742,12520067.725,100.000,

Where 1 - is the point name, 6235070.742 - is the point coordinate (**northward** coordinate axis), 12520067.725 - is the point coordinate (**eastward** coordinate axis), 100.000 - is the Z-coordinate.

- Each file must contain no less than three lines;
- The order of coordinates in both files must be the same;
- In Gauss-Krüger projection files, the coordinate values must include the zone number;



Point coordinates in the *Gauss-Krüger projection* (on the territory of the Russian Federation) are to be recorded as follows: point_name, **X** coordinate, **Y** coordinate; since Gauss-Krüger abscissa (**X**) is northward and ordinate (**Y**) is eastward.

• в файле с проекцией UTM (Universal Transverse Mercator) координаты точек должны соответствовать номеру зоны;

In UTM projection (Universal Transverse Mercator) files, point coordinates *must correspond to the zone number*;



UTM point coordinates are to be recorded as follows: point_name, **Y** coordinate, **X** coordinate; since UTM abscissa (**X**) is eastward and ordinate (**Y**) is northward.

- Gauss-Krüger and UTM files must contain data for the ellipsoid divided into 60 6°zones;
- The following characters must be used as separators:
 - The separator between X and Y coordinates is a comma,
 - The decimal separator is a period.

If coordinates are presented as degrees-minutes-seconds, the separators are to be:

- The separator between degrees and minutes (and minutes and seconds as well) is a space,
- The decimal separator is a period.

😑 Local	_coordinate_system.txt 🗵
1	1,4955381.037,141467.417,-141.358
2	2,4957273.061,136682.518,-127.944
3	3,4962455.190,140516.577,-141.424
4	4,4960094.892,146255.044,-102.993
5	5,4944062.214,146256.320,-105.844
6	6,4947368.126,138264.536,-133.132
7	7,4951135.503,144658.537,-129.094
8	8,4966696.866,147210.165,-111.355
9	9,4966232.640,136697.274,-139.366
10	10,4969056.198,141478.133,-134.744
11	11,4969536.426,135110.786,-137.924
12	12,4940764.585,139855.786,-112.620
13	13,4952092.885,133160.695,-140.182
14	14,4957268.011,151041.646,-123.013
15	15,4968585.708,151349.412,-112.592
16	16,4962006.499,129038.594,-155.379

Fig. F.1. An example file with point coordinates

🔚 Geodetic_(Lat,Long,Height).txt 🛛

1	1,47 33 28.92857,1 34 46.07143,84.000
2	2,47 34 33.21429,1 30 45.00000,97.500
3	3,47 37 30.00000,1 33 57.85714,84.000
4	4,47 36 9.64286,1 38 47.14286,122.327
5	5,47 27 3.21429,1 38 47.14286,119.357
6	6,47 28 55.71429,1 32 5.35714,92.214
7	7,47 31 4.28571,1 37 26.78571,96.184
8	8,47 39 54.64286,1 39 35.35714,114.000
9	9,47 39 38.57143,1 30 45.00000,86.143
10	10,47 41 15.00000,1 34 46.07143,90.714
11	11,47 41 31.07143,1 29 24.64286,87.633
12	12,47 25 10.71429,1 33 25.71429,112.653
13	13,47 31 36.42857,1 27 48.21429,85.276
14	14,47 34 33.21429,1 42 48.21429,102.214
15	15,47 40 58.92857,1 43 4.28571,112.714
16	16,47 37 13.92857,1 24 19.28571,70.214



F.2. Loading data sets

1. Load two prepared point coordinate sets in the right and left parts of the *GeoCalculator* windows using buttons. Use **Choose** buttons to specify the coordinate systems corresponding to them.

The program calculates the parameters of transformation from the first coordinate system (data on the *left*) to the second coordinate system (data on the *right*). When calculating the transformation parameters, the formulas given in the reference book are used *Map projections: A working manual* [J.P. Snyder, 1987].

Database H	Help						
မာ 🍧	🛉 🧉 🗳) 🔁 🖻) 📭 🔗 🛐 📓	\$			
Coordinate sy	stem		Choose	Coordinate sy	stem		Choose
	esian Geocentri esian Geocentri		centric)) to 6deg East herlands offsh		orth Sea); Germany United Kingdom (UKCS)
			🔚 🗙 X=Y 🌩	🔶 🗲	🔒 🗙)	(≠ γ	
Point name	Х	γ	Z	Point name	E	N	Н
1	4701473.199	4299708.919	302432.649	1	5267520.192	393268.003	219.289
2	4700627.445	4300928.011	298527.475	2	5269599.107	388268.442	232.649
3	4697573.694	4304032.832	301524.736	3	5274980.774	392398.053	219.145
4	4698675.981	4302553.348	306210.775	4	5272391.537	398392.175	257.643
5	4707597.289	4292763.103	306534.509	5	5255523.011	398098.129	254.955
6	4706071.799	4294859.389	299998.568	6	5259148.410	389750.469	227.572
7	4703711.771	4297088.478	305098.541	7	5262994.486	396547.277	231.620
8	4694952.453	4306558.004	306848.352	8	5279320.045	399518.930	249.224
9	4695628.659	4306379.214	298365.754	9	5279025.729	388449.290	221.136
10	4693861.666	4308044.952	302171.439	10	5281908.245	393531.623	225.766
11	4693853.927	4308409.177	297020.965	11	5282531.141	386841.069	222.533
12	4709694.954	4290816.551	301416.324	12	5252171.190	391303.187	248.164
13	4703645.750	4297800.160	295777.705	13	5264213.629	384467.424	220.436
14	4700031.141	4300760.185	310136.352	14	5269329.027	403376.147	237.688
15	4693722.630	4307658.368	310151.863	15	5281230.898	403908.808	247.999
16	4698280.600	4303883.968	292257.778	16	5274720.488	380313.057	205.108

Fig. F.3. Main program window showing loaded data

2. [Optional] Click in the main *GeoCalculator*. The **Web-map** window opens, that allows you to estimate at-a-glance whether it is required to refine transformation parameters between the two coordinate systems:

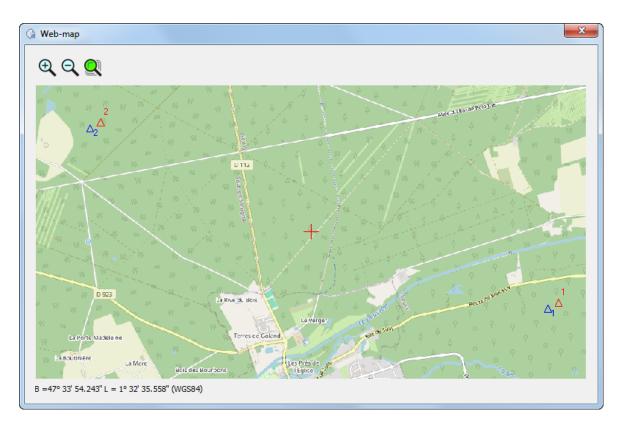


Fig. F.4. The Web-map window (refined rotation-translation-scaling datum transformation parameters are not in use)

This window contains layers with loaded point sets as well as the geographic *OpenStreetMap*. Points loaded in the *left* part of the *GeoCalculator* window are shown in *red*. Points loaded in the *right* part of the *GeoCalculator* window are shown in *blue*. Current marker coordinates (WGS84) are shown in the bottom of the window.

OpenStreetMap (OSM) is a non-profit web resource with a free geographic world map. To download the *OpenStreetMap* map, your workstation must be connected to the Internet.

The **Web-map** toolbar contains the following buttons

- A allows to zoom in an image by one step (*);
- A allows to zoom out an image by one step (/);
- 🔍 allows to fit to page data of opened layers (Alt+Enter).
- 3. Click in the main *GeoCalculator* toolbar, to open the **Calculate Datum parameters** window.

F.3. Calculating datum transformation parameters

		T.										
Point name	Ŷ	x	Y	Z	E	N	н	Ex	Ey	Ez		
1	1	4701473.199	4299708.919	302432.649	5267520.192	393268.00	3 219.289					
2	1	4700627.445	4300928.011	298527.475	5269599.107	388268.44	2 232.649					
3	1	4697573.694	4304032.832	301524.736	5274980.774	392398.05	3 219.145					
ļ .	1	4698675.981	4302553.348	306210.775	5272391.537	398392.17	5 257.643					
i	1	4707597.289	4292763.103	306534.509	5255523.011	398098.12	9 254.955					
5	1	4706071.799	4294859.389	299998.568	5259148.410	389750.46	9 227.572					
	1	4703711.771	4297088.478	305098.541	5262994.486	396547.27	7 231.620					
3	1	4694952.453	4306558.004	306848.352	5279320.045	399518.93	0 249.224					
)	1	4695628.659	4306379.214	298365.754	5279025.729	388449.29	0 221.136					
LO	1	4693861.666	4308044.952	302171.439	5281908.245	393531.62	3 225.766					
1	1	4693853.927	4308409.177	297020.965	5282531.141	386841.06	9 222.533					
12	V	4709694.954	4290816.551	301416.324	5252171.190	391303.18	7 248.164					
13	V	4703645.750	4297800.160	295777.705	5264213.629	384467.42	4 220.436					
14	V	4700031.141	4300760.185	310136.352	5269329.027	403376.14	7 237.688					
alculated par	amete	rs				Б	rrors					
Parameter	name	Parameter	/alue							X, m	Y, m	Z, m
Scale, unity						1	laximum		[
X-offset, m						1	4ean abs. v	alue				
Y-offset, m						F	RMS					
Z-offset, m												
X-rotation,	sec											
Y-rotation,	sec											
Z-rotation,	sec											

Fig. F.5. The Calculate Datum parameters window

The Calculate Datum parameters window contains the following interface elements:

- A panel displaying information about the user-specified coordinate systems of two loaded sets of point coordinates:
 - Reference coordinate system is the coordinate system of the point set loaded into the left part of the *GeoCalculator* window;
 - Additional coordinate system is the coordinate system of the point set loaded into the right part of the *GeoCalculator* window.



The program calculates the parameters of transformation from the reference coordinate system to the additional one.

• A summary table containing information about the loaded sets of point coordinates and including the following columns:

- Point name column;
- A column containing checkboxes to include or exclude certain point pairs from the calculation of Datum transformation parameters;
- Three columns containing the point coordinates from the left-hand GeoCalculator coordinate set;
- Three columns containing coordinates of the point that corresponds to the left-hand one from the right-hand *GeoCalculator* coordinates;
- Three columns containing Ex, Ey and Ez discrepancy data (to be displayed after the calculation is complete).
- Main Calculate Datum parameters toolbar to manage records in the table. The system allows either temporarily excluding specific point pairs from the calculation of Datum transformation parameters, or deleting a point pair from the user-loaded sets. The toolbar contains the following buttons

 - deselect all pairs of points;
 - □ invert the selection of pairs of points;
 - \circ \mathbf{m} delete the selected pair of points from the loaded sets.



Changes made to the table are displayed in the **Calculate Datum parameters** window only. To return to the originally loaded point sets, close this window and open it again by clicking in the main *GeoCalculator* toolbar.

The buttons of the main toolbar are partially duplicated by the checkboxes in the second column of the table described above, as well as by the items of the context menu that opens when you right-click on the corresponding row of the table. The menu contains the following items:

- To Delete selected point button is to delete the selected point from both loaded sets;
- **Exclude selected point** from calculations;
- Return selected point into calculations;
- Seturn all include all pairs of points in calculations.
- A table in the lower left part of the window containing the Calculated parameters of transformation between two spatial coordinate systems, scaling, three axis rotation

angular elements, and **three linear elements** of the coordinate system center translation (will be displayed after the calculations are completed);

• A table in the lower right part of the window displaying the calculated **Errors** (will be displayed after the calculations are completed).

To **calculate** the refined transformation parameters between the spatial coordinate systems, click the appropriate button. The calculation results are displayed in two tables below: **Calculated parameters** and **Errors** (and also in the Ex, Ey and Ez columns of the main table). Seven shift parameters (scaling, X, Y, Z-translation, and X, Y, Z-rotation) are displayed in the lower left table, and errors and residual discrepancy in the lower right one).

		nate system: E											
Point name	Ŷ	x	Y	Z	E	N	н	Ex	Ey	Ez			
L		4701473.199	4299708.919	302432.649	5267520.192	393268.0	03 219.289	0.0018	-0.0025	-0.0009			
2	V	4700627.445	4300928.011	298527.475	5269599.107	388268.4	42 232.649	0.0005	-0.0011	0.0103			
3	V	4697573.694	4304032.832	301524.736	5274980.774	392398.0	53 219.145	-0.0032	2 0.0032	0.0012			
Ļ	V	4698675.981	4302553.348	306210.775	5272391.537	398392.1	75 257.643	-0.0004	1 0.0022	-0.0114			
5	V	4707597.289	4292763.103	306534.509	5255523.011	398098.1	29 254.955	0.0105	-0.0107	-0.0116			
j.	V	4706071.799	4294859.389	299998.568	5259148.410	389750.4	69 227.572	0.0072	-0.0085	0.0064			
1	V	4703711.771	4297088.478	305098.541	5262994.486	396547.2	77 231.620	0.0055	-0.0056	-0.0077			
3	V	4694952.453	4306558.004	306848.352	5279320.045	399518.9	30 249.224	-0.0052	2 0.0072	-0.0129			
)	V	4695628.659	4306379.214	298365.754	5279025.729	388449.2	90 221.136	-0.0064	4 0.0058	0.0105			
LO	V	4693861.666	4308044.952	302171.439	5281908.245	393531.6	23 225.766	-0.0080	0.0084	-0.0002			
1	V	4693853.927	4308409.177	297020.965	5282531.141	386841.0	69 222.533	-0.0089	0.0083	0.0135			
12	V	4709694.954	4290816.551	301416.324	5252171.190	391303.1	87 248.164	0.0120	-0.0137	0.0023			
13	V	4703645.750	4297800.160	295777.705	5264213.629	384467.4	24 220.436	0.0037	-0.0045	0.0177			
4	V	4700031.141	4300760.185	310136.352	5269329.027	403376.1	47 237.688	0.0015	-0.0002	-0.0218			
alculated par	amete	rs				I	Errors						
Parameter	name	Parameter	/alue						Х, г	n	Y, m	Z, m	
Scale, unity		1.000008839					Maximum		0.0120		0.0137	0.0274	
X-offset, m		143.4592					Mean abs. v	alue (0.0018		0.0020	0.0037	
Y-offset, m		131.5107					RMS		0.0037		0.0040	0.0079	
Z-offset, m		0.3224											
X-rotation,	sec	-0.2793											
Y-rotation,	sec	-0.2342											
Z-rotation,	sec	5.1083											

Fig. F.6. The results of Datum parameter calculations

To create a user-copy of the additional coordinate system with a custom Datum that includes the set of datum transformation parameters using the *rotation-translation-scaling* **Calculated parameters**, click **Save datum**.

The following information box appears:

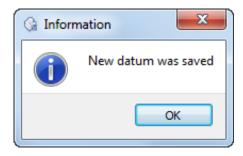


Fig. F.7. An information message

To view the created user coordinate system in the *GeoCalculator* window, click OK. The information message and **Calculate Datum parameters** window will be closed. Do not close the *GeoCalculator* window with loaded point sets.

Database H	Help									
n 🍧	j 🧳 🦂) 🔁 🔁) 🕒 🔗 🚮 🛙	}						
Coordinate sy	stem		Choose	Coordinate system Choose						
	sian Geocentri sian Geocentri		centric)) to 6deg East herlands offsh		orth Sea); Germany United Kingdom (UKCS)			
			🔚 🗙 X=Y 🌩	🔶 🗁	🔒 🗙)	(≠ Y				
Point name	Х	Y	Z	Point name	E	N	Н			
1	4701473.199	4299708.919	302432.649	1	5267520.192	393268.003	219.289			
2	4700627.445	4300928.011	298527.475	2	5269599.107	388268.442	232.649			
3	4697573.694	4304032.832	301524.736	3	5274980.774	392398.053	219.145			
4	4698675.981	4302553.348	306210.775	4	5272391.537	398392.175	257.643			
5	4707597.289	4292763.103	306534.509	5	5255523.011	398098.129	254.955			
6	4706071.799	4294859.389	299998.568	6	5259148.410	389750.469	227.572			
7	4703711.771	4297088.478	305098.541	7	5262994.486	396547.277	231.620			
8	4694952.453	4306558.004	306848.352	8	5279320.045	399518.930	249.224			
9	4695628.659	4306379.214	298365.754	9	5279025.729	388449.290	221.136			
10	4693861.666	4308044.952	302171.439	10	5281908.245	393531.623	225.766			
11	4693853.927	4308409.177	297020.965	11	5282531.141	386841.069	222.533			
12	4709694.954	4290816.551	301416.324	12	5252171.190	391303.187	248.164			
13	4703645.750	4297800.160	295777.705	13	5264213.629	384467.424	220.436			
14	4700031.141	4300760.185	310136.352	14	5269329.027	403376.147	237.688			
	4693722.630	4307658.368	310151.863	15	5281230.898	403908.808	247.999			
15										

Fig. F.8. The main GeoCalculator window with loaded data

F.4. Viewing the user coordinate system Info

To view the information about the user coordinate system created, perform the following:

1. Click **Choose** in the right part of the *GeoCalculator* window. The **Coordinate systems** window opens:

earch		
Name	Description	
Arc 1960 / UTM zone 35N	Uganda north of equator and west of 30 deg East. EPSG	
Arc 1960 / UTM zone 35S	Tanzania - west of 30 deg East; Uganda south of equator and west	
Arc 1960 / UTM zone 36N	Kenya - north of equator and west of 36 deg East; Uganda north of	
Arc 1960 / UTM zone 36S	Kenya - south of equator and west of 36 deg East; Tanzania - 30 to	
Arc 1960 / UTM zone 37N	Kenya - north of equator and east of 36 deg East. EPSG	
Arc 1960 / UTM zone 37S	Kenya - south of equator and east of 36 deg East; Tanzania - east o	
Auto ED50 / UTM zone 31N	Auto Europe - 0deg to 6deg East - Denmark (North Sea); Germany	
Barbados 1938	Barbados EPSG	
Barbados 1938 / Barbados National Grid	Barbados Ordnance Survey of Great Britain EPSG Supersedes Barba	
Barbados 1938 / British West Indies Grid	Barbados Ordnance Survey of Great Britain EPSG Superseded by Ba	

Fig. F.9. The window with coordinate systems listed

 Find and select the created user coordinate system in the list. The name of the user coordinate system is generated automatically, according to the following template: Auto <parent_coordinate_system_name> (the coordinate system selected in the *right* side of *GeoCalculator* window). Click . The **Editing the coordinate system** window opens

Game Editing the coordinate system	x
General information	Parameters
Name	Type Projected
Auto ED50 / UTM zone 31N	Prime meridian Greenwich
Short name	O Datum opean Datum 1950
	Ellipsoid
Description	Plane coordinates
Auto Europe - Odeg to 6deg East - Denmark (North Sea):	Projection UTM zone 31N
Auto Europe - Odeg to 6deg East - Denmark (North Sea); Germany offshore; Netherlands offshore;	Units metre
Norway; United Kingdom	Axes names E , N
(UKCS) offshore. EPSG	Height
	Units metre Axis name H
Show Transformations I Export	Vertical datum
Export	
GeoTIFF (EPSG) 23031	
•	•
	OK Cancel

Fig. F.10. The Editing the coordinate system window

The **Datum** field displays the name of the custom datum created together with the user coordinate system.

The custom datum name is generated automatically according to the following template: Auto <parent_datum_name> (corresponding to the parent coordinate system).

3. To view custom datum parameters click ____ next to the **Datum** field. The **Datum** window opens:

🚱 Datum	×
🕂 🖓 🗈 🗙 🔅 🎙 🕒	
Search	
Name	A
Afgooye	EPSG
Ain el Abd 1970	Fundamental Point: Ain El Abd. Latitude: 28 deg 14 min 06.171 sec N;
Amersfoort	Fundamental Point: Amersfoort. Latitude: 52 deg 09 min 22.178 sec N;
Antigua 1943	Fundamental point: station A14. Ordnance Survey of Great Britain. EPS
Arc 1950	Fundamental Point: Buffelsfontein. Latitude: 33 deg 59 min 32.000 sec :
Arc 1960	Fundamental Point: Buffelsfontein. Latitude: 33 deg 59 min 32.000 sec :
Australian Geodetic Datum 1966	Fundamental Point: Johnson Memorial. Latitude: 25 deg 56 min 54.551
Australian Geodetic Datum 1984	EPSG
Auto European Datum 1950	Fundamental Point: Potsdam (Helmert Tower). Latitude: 52 deg 22 mir 👻
<	4
	Choose Cancel

Fig. F.11. The Datum window

4. Find and select the custom datum (see the previous item). Click 🛐. The **Datum** editing window opens:

🚱 Datum editing	x
General information	Parameters
Name	Ellipsoid
ito European Datum 1950	International 1924
Short name	Recalculation to WGS 84
ED50	generated datum params
Description	
Tower). Latitude: 52 deg 22 min 51.450 sec N; Longitude: 13 deg 3 min 58.740 sec E (of	
Show	
additionally very export	
Export	
GeoTIFF (EPSG) 0	🖾
MapInfo 0	🗷
<	4
	OK Cancel

Fig. F.12. The Datum editing window

The **Recalculation to WGS 84** field displays the name of the custom datum parameter set created along with the custom datum and coordinate system.

The name of the custom datum parameter set is generated automatically according to the following template:

Auto generated datum params;

Auto generated datum params[1];

Auto generated datum params[2], etc. (according to the order of creating user sets of transformation parameters).

5. To see the custom set of datum parameters, click ____ next to the **Recalculation to WGS 84** field. The **Datum transformations** window opens:

arch	
Name	Description
AGD84 to WGS 84 (2)	Australia. Australian Surveying and Land Information Group - www.auslig.g
Adindan to WGS 84 (7)	Sudan. U.S. Defense Mapping Agency TR8350.2 December 1987. EPSG
Afgooye to WGS 84 (1)	Somalia. U.S. Defense Mapping Agency TR8350.2 December 1987. EPSG
Ain el Abd to WGS 84 (2)	Saudi Arabia. U.S. Defense Mapping Agency TR8350.2 revision of August 19
Amersfoort to WGS 84 (1)	Netherlands. Nederlandse Commissie voor Geodesie publication 30; 1993. E
Antigua 1943 to WGS 84 (1)	Antigua. Ordnance Survey of Great Britain EPSG
Arc 1950 to WGS 84 (9)	Zimbabwe. U.S. Defense Mapping Agency TR8350.2 December 1987. EPSG
Arc 1960 to WGS 84 (3)	Tanzania. U.S. National Imagery and Mapping Agency TR8350.2 revision of
Auto generated datum params	Auto
Batavia to WGS 84 (1)	Indonesia (Sumatra), U.S. Defense Mapping Agency TR8350.2 December 198

Fig. F.13. The Datum transformations

6. Find and select the desired Auto generated datum params (see above). Click 😹. The **Datum transformation parameters** window opens:

G Datum transformation parame	eters	x
General information	Parameters	
Name	Transformation type Rotate-shift-scale	
Auto generated datum params	Parameters	
Short name	Shift Rotation Scale corre	ection
	X 143.4592 metre[2] X 0.2793 arc-second[2] -8.8394 p	opm[1]
Description	Y 131.5107 metre[2] Y 0.2342 arc-second[2]	
Auto	Z -0.3224 metre[2] Z -5.1083 arc-second[2]	
	Units Units Units	
	metre[2] arc-second[2] ppm[1]	
	Nonlinear transformation	
Show export		
	ОКС	ancel

Fig. F.14. The Datum transformation parameters window

The **parameters** section displays calculated datum transformation parameters, i.e. **scale**, **three axis rotation angular elements**, and **three linear elements** of the coordinate system center shift.

7. Go back to **Coordinate systems** (see item 1) closing the relevant windows. Select the user coordinate system and click **Choose**.

The **Coordinate systems** window will be closed. The selected user coordinate system will be displayed on the right side of the *GeoCalculator* program window.

8. Click in the main *GeoCalculator* toolbar. The **Web-map** window opens. Here you can evaluate at-a-glance the results of using the refined parameters of shift between two coordinate systems:

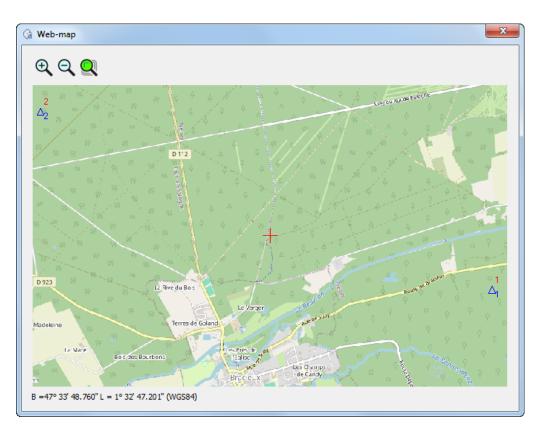


Fig. F.15. The Web-map window (refined rotation-translation-scaling datum transformation parameters are applied)

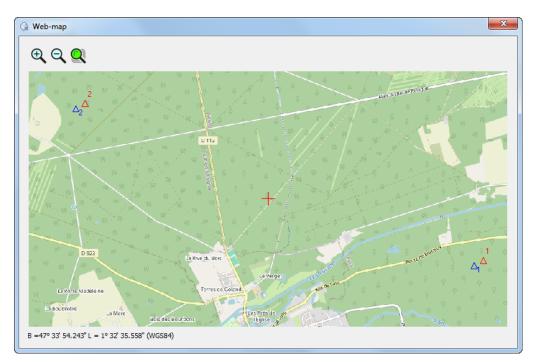


Fig. F.16. The Web-map window (refined rotation-translation-scale datum transformation parameters are not applied, see Section F.2)

F.5. Transformation sequence

The calculation of shift between two coordinate systems is according to the following scheme:

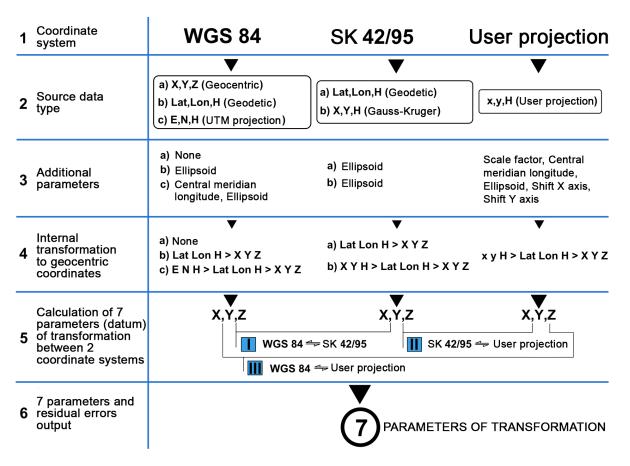


Fig. F.17. Calculating shift between two coordinate systems

F.5.1. Checking input data errors when calculating parameters of transformation between coordinate systems

Let us consider the features of calculating the parameters of transformation between two coordinate systems with an error in the input data using the following example:

1. There is an elevation error in the fourth file line.

The system allows you to manually correct the loaded data in the main *GeoCalculator* window. There is no such feature in the **Calculate Datum parameters** window.

Database H	Help										
n 🥞	i 💣 🗳	b 🔁 🔁) 📭 🔗 📬 🛙	.							
Coordinate sy	stem		Choose	Coordinate system Choose							
	esian Geocentri esian Geocentri		centric)) to 6deg East herlands offsh		orth Sea); Germany United Kingdom (UKCS)				
			🔚 🗙 X=Y 🌩	+ 🗁		(≓ Y					
Point name	Х	Y	Z	Point name	E	N	Н				
1	4701473.199	4299708.919	302432.649	1	5267520.192	393268.003	219.289				
2	4700627.445	4300928.011	298527.475	2	5269599.107	388268.442	232.649				
3	4697573.694	4304032.832	301524.736	3	5274980.774	392398.053	219.145				
4	4698675.981	4302553.348	30621.775	4	5272391.537	398392.175	257.643				
5	4707597.289	4292763.103	306534.509	5	5255523.011	398098.129	254.955				
6	4706071.799	4294859.389	299998.568	6	5259148.410	389750.469	227.572				
7	4703711.771	4297088.478	305098.541	7	5262994.486	396547.277	231.620				
8	4694952.453	4306558.004	306848.352	8	5279320.045	399518.930	249.224				
9	4695628.659	4306379.214	298365.754	9	5279025.729	388449.290	221.136				
10	4693861.666	4308044.952	302171.439	10	5281908.245	393531.623	225.766				
11	4693853.927	4308409.177	297020.965	11	5282531.141	386841.069	222.533				
12	4709694.954	4290816.551	301416.324	12	5252171.190	391303.187	248.164				
13	4703645.750	4297800.160	295777.705	13	5264213.629	384467.424	220.436				
14	4700031.141	4300760.185	310136.352	14	5269329.027	403376.147	237.688				
15	4693722.630	4307658.368	310151.863	15	5281230.898	403908.808	247.999				
16	4698280.600	4303883.968	292257.778	16	5274720.488	380313.057	205.108				

Fig. F.18. Original data with an elevation error

2. When calculating the transformation parameters between two coordinate systems, coordinates with an error are taken into account. As a result, the transformation parameters are calculated incorrectly: the residual discrepancies at a given point exceed the allowable values.

In case of very large residual discrepancies, an appropriate information message is issued.

S		T	D50 / UTM zon	2.214								
Point name	Ŷ	x	Y	Z	E	N	н	Ex	Ey	Ez		
L	V	4701473.199	4299708.919	302432.649	5267520.192	393268.003	219.289	-1527.6477	1685.7932	-44.2313		
2	~	4700627.445	4300928.011	298527.475	5269599.107	388268.442	232.649	-683.4360	468.8510	3854.0131		
3	~	4697573.694	4304032.832	301524.736	5274980.774	392398.053	219.145	2364.8110	-2630.5226	862.0791		
4		4698675.981	4302553.348	30621.775	5272391.537	398392.175	257.643	1263.7002	-1153.1356	-4308.0435		
5	V	4707597.289	4292763.103	306534.509	5255523.011	398098.129	254.955	-7640.6618	8619.4015	-4138.8243		
6	V	4706071.799	4294859.389	299998.568	5259148.410	389750.469	227.572	-6117.9513	6526.8101	2385.5184		
7	1	4703711.771	4297088.478	305098.541	5262994.486	396547.277	231.620	-3762.1663	4301.6262	-2705.3960		
•		4694952.45	G Warning									
5	V	4034332.43	Que Hanning									
-	V	4695628.65										
9					rs level after D	atum paran	neters det	ermination.	Check the s	ourse		
9 10	V	4695628.65		oo high erroi ata.	rs level after D	atum paran	neters det	ermination.	Check the s	ourse		
9 10 11	v	4695628.65 4693861.66			rs level after D	atum paran	neters det	ermination.	_			
8 9 10 11 12 13	✓ ✓	4695628.65 4693861.66 4693853.92			rs level after D	latum paran	neters det	ermination.	_	ourse OK		
9 10 11 12		4695628.65 4693861.66 4693853.92 4709694.95 4703645.75	A To	ata.	rs level after D			ermination.	_			
9 10 11 12 13 14		4695628.65 4693861.66 4693853.92 4709694.95 4703645.75 4700031.141	A To	ata.			257.088			ок		
9 10 11 12 13	V V V V V V	4695628.65 4693861.66 4693853.92 4709694.95 4703645.75 4700031.141	4500/00.185	ata.		405570.147	257.088			ок	Z, m	
9 10 11 12 13 14 Calculated pa	Image: Constraint of the second se	4695628.65 4693861.66 4693853.92 4709694.95 4703645.75 4700031.141	4300/00.183	ata.		403370.147	257.088		030.3090 X, m	ОК	Z, m 10112.5864	
9 10 11 12 13 14 Calculated pa	V V V V v ramete	4695628.65 4693861.66 4693853.92 4709694.95 4703645.75 4700031.141 rs Parameter	4300700.183 value	ata.		405570.147	237.088 Drs	-88.1032 9734	030.3390 X, m 55574	ОК -7734.2006 Y, m		
9 10 11 12 13 14 Calculated pa Parameter Scale, unity	v v v v v v v v	4695628.65 4693861.66 4693853.92 4709694.95 4703645.75 4700031.141 rs Parameter 0.001786720	4300700.183 value	ata.		405570.147	257.088 ors aximum ean abs. va	-88.1032 9734	x, m 5574 8153	OK -//34.2008 Y, m 10562.5440	10112.5864	
9 10 11 12 13 14 Calculated pa Parameter Scale, unity X-offset, m	ramete	4695628.65 4693861.66 4693853.92 4709694.95 4703645.75 4700031.141 rs Parameter 0.001786720 4691836.032	4300700.183 value	ata.		405570.147 Err Ma Ma	257.088 ors aximum ean abs. va	-88.1032 9734 alue 1378	x, m 5574 8153	OK -//34.2000 Y, m 10562.5440 1513.8891	10112.5864 1364.7036	
9 10 11 12 13 14 Calculated pa Parameter Scale, unity X-offset, m Y-offset, m	ramete	4695628.65 4693861.66 4693853.92 4709694.95 4703645.75 4700031.141 rs Parameter 0.001786720 4691836.032 4293765.852	4300700.183 value	ata.		405570.147 Err Ma Ma	257.088 ors aximum ean abs. va	-88.1032 9734 alue 1378	x, m 5574 8153	OK -//34.2000 Y, m 10562.5440 1513.8891	10112.5864 1364.7036	
9 10 11 12 13 14 Calculated pa Parameter Scale, unity X-offset, m Y-offset, m Z-offset, m	v v v v v v v v v v v v v v v v v v v	4695628.65 4693861.66 4693853.92 4709694.95 4703645.75 4700031.141 rs Parameter 0.001786720 4691836.032 4293765.852 301857.4205	4300700.183 value	ata.		405570.147 Err Ma Ma	257.088 ors aximum ean abs. va	-88.1032 9734 alue 1378	x, m 5574 8153	OK -//34.2000 Y, m 10562.5440 1513.8891	10112.5864 1364.7036	

Fig. F.19. The result of calculating parameters with an error in the source data

- 3. [optional] Click OK to close the warning;
- 4. In order to exclude a point with erroneous coordinates from calculations, right-click on the desired row (in the corresponding table) and select **Exclude selected point** in the context menu that opens.

		T										
Point name	Ŷ	x	Y	z	E	N	н	Ex	Ey	Ez		-
1	V	4701473.199	4299708.919	302432.649	5267520.192	393268.00	3 219.289	-1527.6477	1685.7932	-44.2313		
2	1	4700627.445	4300928.011	298527.47	5269599.107	388268.44	2 232.649	-683.4360	468.8510	3854.0131		
3	V	4697573.694	4304032.832	301524.73	5 5274980.774	392398.05	3 219.145	2364.8110	-2630.5226	862.0791		
4		- Dalata	selected poir	5	5272391.537	398392.17	5 257.643					
5	1	_		D	9 5255523.011	398098.12	254.955	-7640.6618	8619.4015	-4138.8243		
5	1		e selected po	bi	3 5259148.410	389750.46	59 227.572	-6117.9513	6526.8101	2385.5184		
7	1	 Return 	selected poir	nt p	5262994.486	396547.27	7 231.620	-3762.1663	4301.6262	-2705.3960		
8	V	Return	all	5	2 5279320.045	45 399518.93	30 249.224	4981.3373	-5151.2685	-4452.0800		
9	1	4695628.659	4306379.214	298365.75	4 5279025.729	388449.29	0 221.136	4306.3208	-4972.7769	4015.4590		
10	1	4693861.666	4308044.952	302171.43	5281908.245	393531.62	23 225.766	6070.1367	-6635.5963	216.5334		
11	1	4693853.927	4308409.177	297020.96	5 5282531.141	386841.06	59 222.533	6077.8424	-6999.1716	5357.8644		
12	V	4709694.954	4290816.551	301416.324	\$ 5252171.190	391303.18	37 248.164	-9734.5574	10562.5440	970.2701		
13	V	4703645.750	4297800.160	295777.70	5 5264213.629	384467.42	24 220.436	-3696.2996	3591.2136	6598.8946		
14	1	4700031.141	4300760.185	310136.35	2 5269329.027	403376.14	237.688	-88.1652	636.3590	-7734.2558		
Calculated para	amete	rs				E	rrors					
Parameter r	name	Parameter	value						X, m	Y, m	Z, m	
Scale, unity		0.001786720)				Maximum	9734	.5574	10562.5440	10112.5864	
X-offset, m		4691836.032	26				Mean abs. v	alue 1378	.8153	1513.8891	1364.7036	
Y-offset, m		4293765.852	21				RMS	2838	.8440	3099.3272	2870.9183	
Z-offset, m		301857.4205	5									
X-rotation, s	sec	-213.5386										
Y-rotation, s	sec	-348.6430										
Z-rotation,	sec	7.2755										

Fig. F.20. The result of calculating parameters with an error in the source data

5. Click **Calculate** again. When the point containing erroneous coordinates is excluded, the parameters are calculated correctly (residual discrepancies at all remaining points are within tolerance).

		T											
Point name	Ŷ	x	Y	z	E	N	н	Ex	Ey	Ez			_
1	1	4701473.199	4299708.919	302432.649	5267520.192	393268.00	03 219.289	0.0017	-0.0023	-0.0016			
2	1	4700627.445	4300928.011	298527.475	5269599.107	388268.44	42 232.649	0.0005	-0.0011	0.0097			
3	V	4697573.694	4304032.832	301524.736	5274980.774	392398.0	53 219.145	-0.0031	0.0032	0.0004			
ļ.		4698675.981	4302553.348	30621.775	5272391.537	398392.17	75 257.643						
5	1	4707597.289	4292763.103	306534.509	5255523.011	398098.12	29 254.955	0.0101	-0.0101	-0.0122			
5	1	4706071.799	4294859.389	299998.568	5259148.410	389750.40	59 227.572	0.0070	-0.0082	0.0059			
1	V	4703711.771	4297088.478	305098.541	5262994.486	396547.2	77 231.620	0.0053	-0.0052	-0.0085			
3	V	4694952.453	4306558.004	306848.352	5279320.045	399518.93	30 249.224	-0.0051	0.0073	-0.0140			
9	V	4695628.659	4306379.214	298365.754	5279025.729	388449.29	90 221.136	-0.0063	0.0057	0.0097			
10	V	4693861.666	4308044.952	302171.439	5281908.245	393531.62	23 225.766	-0.0078	0.0083	-0.0012			
11	1	4693853.927	4308409.177	297020.965	5282531.141	386841.00	59 222.533	-0.0086	0.0081	0.0127			
12	1	4709694.954	4290816.551	301416.324	5252171.190	391303.18	37 248.164	0.0116	-0.0132	0.0019			
13	V		4297800.160						-0.0044	0.0173			
14	V	4700031.141	4300760.185	310136.352	5269329.027	403376.14	47 237.688	0.0014	0.0001	-0.0229	_		
Calculated para	amete	rs				——— E	rrors						_
Parameter r	name	Parameter	value						Х, г	n	Y, m	Z, m	
Scale, unity		1.000008802					Maximum	(0.0116		0.0132	0.0270	
X-offset, m		143.6279					Mean abs. v	alue (0.0018		0.0020	0.0038	
Y-offset, m		131.6779					RMS	(0.0037		0.0040	0.0081	
Z-offset, m		0.3879											
X-rotation, s	sec	-0.2745											
Y-rotation, s	sec	-0.2321											
Z-rotation, s	sec	5.1089											

Fig. F.21. The result of calculating the parameters without taking into account the error in the source data