

Digital Photogrammetric System

PHOTOMOD

Version 7.51

USER MANUAL

Orthorectification
(Windows x64)



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1. Purpose of the document

This document contains detailed information about orthorectification images and orthoimages creation in the *PHOTOMOD* system.

2. General information

Orthoimage is a georeferenced image prepared from a perspective photograph or other remotely-sensed data in which displacement of objects due to sensor orientation and terrain relief have been removed.



The system provides possibility of creating orthoimages by source images block. This step allows to prepare images for further processing and creating mosaic in the *Geomosaic program*.


During *orthorectification* the system corrects relief displacement, axial angle, camera distortion, etc. For images orthorectification it is necessary to specify output orthophoto cell size, select output image coordinate system and scale, specify output file format and georeference type.





Prior to create orthoimages it is necessary to adjust images block (see “[Block adjustment](#)” User Manual).

3. The “Orthorectification” toolbar

The **Orthorectification** toolbar is used for creating orthoimages.

In order to display the toolbar, choose the **Rasters › Orthorectification (Ctrl+Alt+M)** or click the  button on the main toolbar.

The following elements are displayed in the **Orthorectification** toolbar title:

- A toolbar name: **Orthorectification**;
- [optional] The “*” symbol meaning that current orthorectification settings have been changed, and hence the orthorectification project is to be saved or overwritten (, );






















If the project is not saved before orthorectification start, an appropriate info message is issued before the operation that offers to save this project (see below).

- [optional] Current orthorectification project name.



The project name is in quotes, after the window name and the “*” symbol (which, in turn, is displayed if the project has unsaved changes)

Table 1. The “Orthorectification” toolbar

Buttons	Function
	to create the new orthorectification project
	to open an orthorectification project from active profile resources
	to save an orthorectification project
	to save an orthorectification project with a new name
	to open the Images list window (see the ' Creating project ' User Manual)
	to set the orthorectification parameters
	to set the percent of trim image edges during orthorectification manually
	to specify the percent of trim image edges during orthorectification by setting the residual overlap
	to perform the accuracy control of orthorectification
	to start of orthoimages building and creation of output file for selected sheet
	to start orthoimages creation for specified active sheets considering user settings and parameters in distributed processing mode
	to start of orthoimages building in the MegaTIFF format using the distributed processing mode
	to create a separate layer with orthoimage for each of selected images (see Section 5)
	to measure a building height (see the “ Vectorization ” User Manual)
	to show general information about project (number of images channels, byte per channel, number of images and output size of mosaic)
	to move to previous image in a block scheme. The first image of the first strip opens if the block scheme 2D-window is active
	to open selected in 2D-window of a block scheme image in a separate window
	to move to next image in a block scheme. The last image of the last strip opens if the block scheme 2D-window is active
	to close all separate raster FastOrtho layers

4. Cropping source images before orthorectification

The system provides the ability not to use image margins when creating an orthophoto.



It may be necessary so that only useful part of an image was processed (e.g. while processing projects with analog imagery as source data).



In most cases, when processing digital images, cropping images is necessary in order to use only their central regions, with the smallest off-nadir angles, when creating an orthophoto.

The system provides the functionality of automatic control of residual overlaps of images, which allows to avoid “gaps” in the output orthomosaic, if the user sets an unreasonably large image margins.

Source image cropping before orthorectification can be both [manual](#) and [automatic](#) (based on customized residual overlap sizes).

The cropping is performed before orthorectification is started. Data on image crop parameters are saved in the current orthorectification project settings.


After the operation is complete the system allows for visual control of image areas involved in orthorectification in two ways:

- [optional] During image cropping, create a vector layer with polygons, displaying the areas involved in orthorectification (see below);
- [optional] After cropping, open project images in the 2D window one-by-one using  and  buttons of the **Orthorectification** toolbar.

When viewing an image in a 2D window, the areas involved in orthorectification are bounded by a green polygon with a discontinuous border.

4.1. Manual cropping of source images

To customize preliminary initial image cropping before manual orthorectification, perform the following:

1. Click  on the **Orthorectification** toolbar. The **cut images boundaries** window opens:

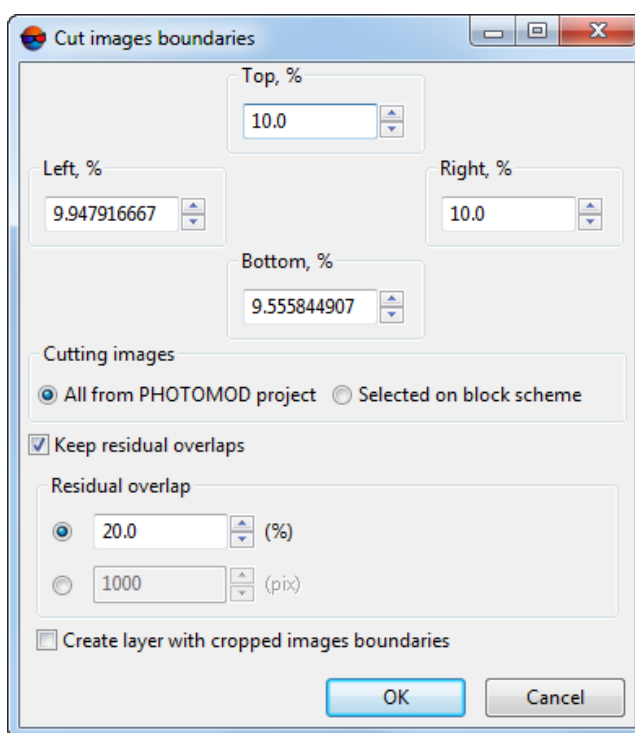


Fig. 1. The Cut images boundaries window

2. Set image margins that will not be processed, in percent;

3. [optional] To **keep residual overlaps**, set the appropriate checkbox. Specify the desired **residual overlap**, in percent or in pixels;



Checking residual overlap allows avoiding “gaps” in the output orthomosaic, if the user sets unreasonably large image margins.

Entered image margins excluded from orthophoto creation and set **residual overlap** must have the correct ratio.

It should also be noted that characteristic overlap between images within a strip and between strips can differ significantly.

4. [optional] For visual control of the areas involved in orthorectification, before building an orthomosaic, set the appropriate checkbox to **create layer with cropped images boundaries**;
5. Click OK. Image cropping options are assigned to the current orthorectification project. A vector layer is created that contains polygons representing the areas involved in orthorectification, if the appropriate checkbox was set.

4.2. Automatic cropping of source images

Automatic cropping of images allows for using only their central parts with the smallest off-nadir angles when creating an orthophoto, while maintaining, however, areas that provide overlap between images in order to avoid “gaps” in the output orthomosaic.

To customize preliminary cropping of source images before automatic orthorectification (based on customized residual overlap sizes), perform the following:

1. Click  панели инструментов **Orthorectification**. The **Automatic cut images boundaries** window opens:

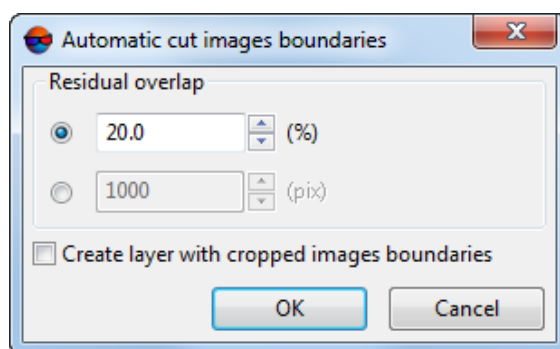


Fig. 2. The Automatic cut images boundaries window

2. Specify the required **residual overlap**, in percent or in pixels;



It should also be noted that characteristic overlap between images within a strip and between strips can differ significantly.

3. [optional] For visual control of the areas involved in orthorectification, before building an orthomosaic, set the appropriate checkbox to **create layer with cropped images boundaries**;
4. Click OK. Image cropping options are assigned to the current orthorectification project. A vector layer is created that contains polygons representing the areas involved in orthorectification, if the appropriate checkbox was set.

5. “FastOrtho” displaying

The system provides possibility to quick display and create of orthoimages “*FastOrtho*” separately for each of selected images.

FastOrtho is used to display orthoimage, created “on fly” by adjustment results. At that the pyramid level of image is used, depending on current zoom. These orthoimages allows to preliminary (rough) estimate data quality.



FastOrtho could be created only on a block with adjustment in geodetic coordinate system.

Orthorectification images “in fly” is used to display orthoimage in 2D-window for any selected image of project.

Perform the following actions to create orthoimages “on fly”:

1. Perform the block adjustment in a geodetic coordinates (see the “[Block adjustment](#)” User Manual).
2. [optional] Select images for *FastOrtho* in 2D-window (more details see in the *Vector objects selection* chapter in the “[Vectorization](#)” User Manual).
3. [опционально] В случае если в блоке было выделено одно изображение, открывается окно, позволяющее ввести **имя слоя FastOrtho**:

[optional] If one image is selected in the block, the window opens where the **FastOrtho layer name** can be input.

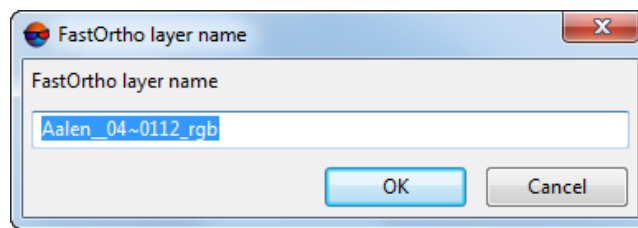



Fig. 3. The FastOrtho layer name window

Enter **FastOrtho layer name** in the appropriate input field and click OK.


If more than one image was selected in the block, this step is skipped, and the created raster layers are automatically named according to the following template:

<Name_image> (FastOrtho)

4. Click the  button of the **Orthorectification** toolbar. Separate raster *FastOrtho* layer creates for each of selected images. Orthoimage displays in 2D-window.

6. Orthoimages creation

Perform the following actions to create orthoimages:

1. Adjust the source images block (see the “[Block adjustment](#)” User Manual);
2. [optional] To create orthoimages in distributed processing mode, perform the following actions:
 - Set and run the distributed processing server/client (see the “Distributed processing” chapter in the “[General information](#)” User Manual);
 - Set the mode allowing to perform all distributed processing task automatically (see the “Distributed processing” chapter in the “[General information](#)” User Manual).
3. [optional] Select images for orthorectification in 2D-window (see in the “The “Block editor” chapter of “[Creating project](#)” User Manual);
4. Choose the **Rasters › Orthorectification**. The **Orthorectification** toolbar opens;
5. Click the  button. The **Orthoimages parameters** window opens;

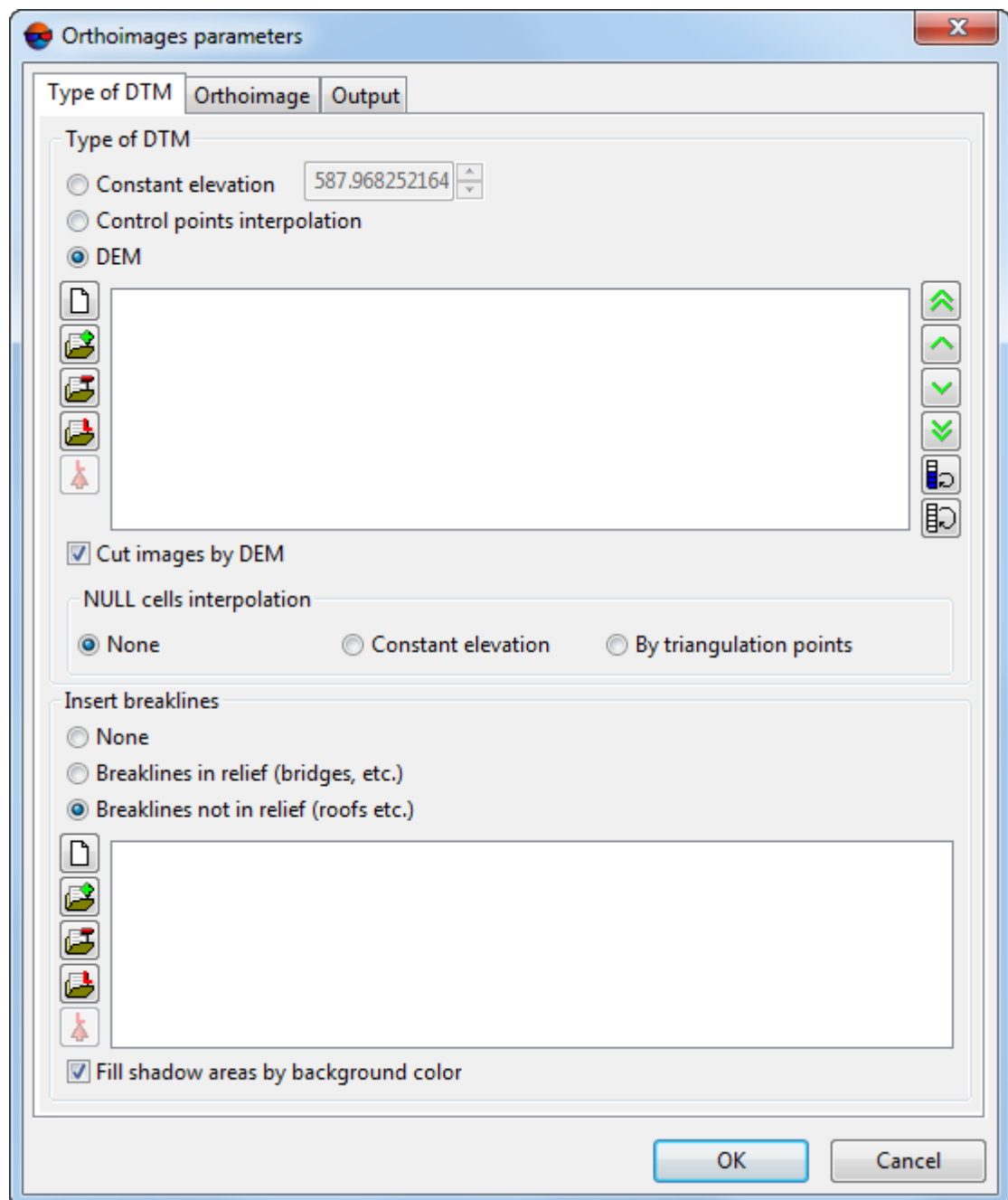



Fig. 4. The Orthorectification parameters

6. Set the [orthorectification parameters](#);
7. Click OK to save parameters and close the **Orthoimages parameters** window;
8. [optional] Click the  of the **Orthorectification** toolbar to save the orthoimages project. Otherwise – the appropriate message window opens before the orthorectification operation starts:

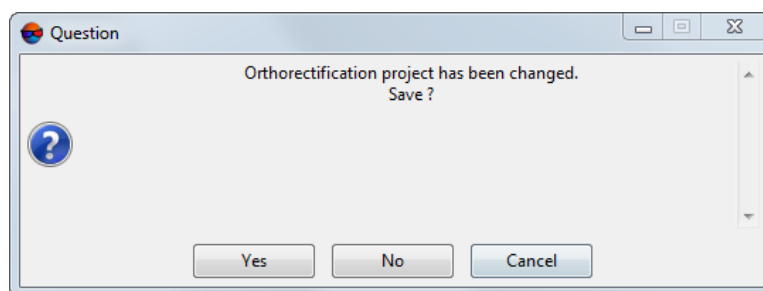





Fig. 5. The message window

9. Perform one of the following actions:

- [optional] Click the  button of the **Orthorectification** toolbar, to start the orthorectification in default mode;
- [optional] For orthorectification in distributed processing mode, click the  button;
- [optional] For orthorectification in MegaTIFF format in distributed processing mode, click the  button.

10. The **Output** window opens. Configure or confirm preconfigured parameters of orthoimage saving.



Preliminary access to the **Output** window is possible by clicking the **Output data** button in the **Output** tab of the **Orthoimages parameters** window (see items 5 – 7 above). When starting the orthorectification, the **Output** window opens for final confirmation of settings.

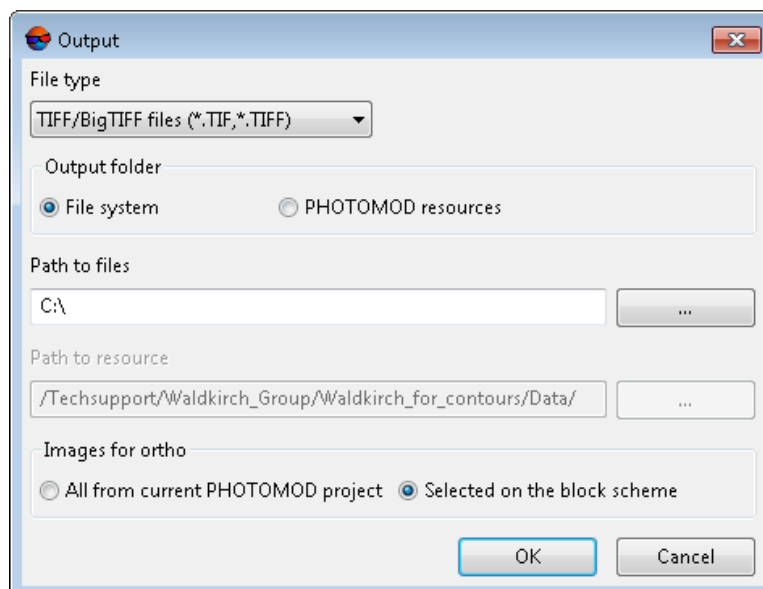





Fig. 6. Output parameters

Set the following parameters:

- Choose **File type** for output orthoimages from drop-down list.
 - **TIFF / BigTIFF files** (*.tiff, *.tif);
 - **Windows Bitmap** (*.bmp);
 - **Panorama raster** (*.rsw);
 - **ERDAS IMAGINE** (*.img);
 - **NITF** (*.nitf);
 - **JPEG** (*.jpg, *.jpeg);
 - **PNG** (*.png);
 - **Microstation** (*.gfn);
 - **PCIDSK** (*.pix);
 - **JPEG2000** (*.jp2);
 - **PHOTOMOD MegaTIFF** (*.prf) – in case when the orthorectification in MegaTIFF format in distributed processing mode () was chosen (see the paragraph 9 above);
 - **ECW** (*.ecw);
 - **Файлы WebP** (*.webp).
- Select an **output folder** location:
 - [optional] in **file system**;
 - click the  button to specify the **path to files**.
 - [optional] in **PHOTOMOD resources**.
 - click the  button to specify the **path to resource**.
- [optional] If some images are selected on a block scheme, choose **Images for ortho**:
 - **All from current PHOTOMOD project**:
 - **Selected on the block scheme**.

Click OK to start process of orthorectification.

11. [optional] If the **Panorama raster (*.rsw) File type** was chosen in **Output** window (see paragraph 10 above), the **Panorama map selection** window opens:

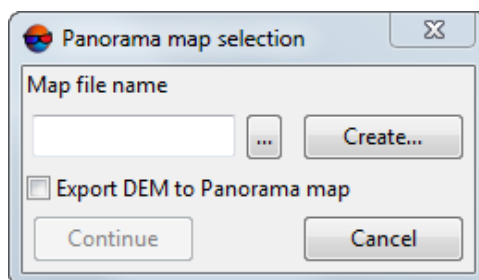


Fig. 7. Parameters of Panorama map export

Set name and path for the map file with one of the following ways:

- click the **...** button to export the map *.sit-file;
- click the **Create** button to create a new Panorama map (*.sit), input filename and click the **Save** button;
- to export DEM that is used in orthomap creation, set on the **Export DEM to Panorama map** checkbox.

12. [optional] in case when:

- the orthorectification in MegaTIFF format in distributed processing mode (🌐) was chosen (see the paragraph 9);
- the any **File type**, except **PHOTOMOD MegaTIFF**, was chosen in **Output** window (see paragraph 10).

the appropriate warning message opens:

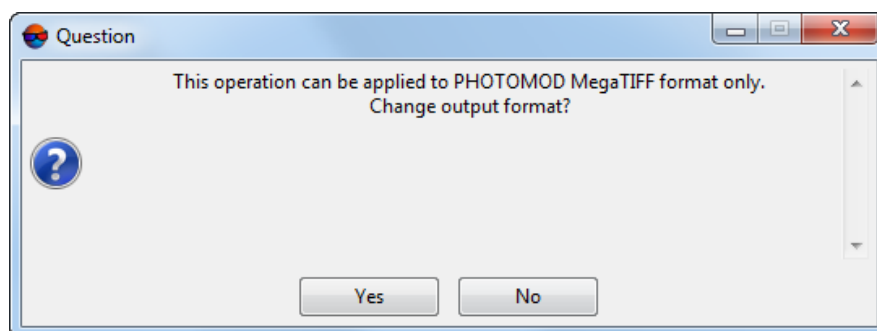


Fig. 8. The warning message

Set the correct **File type (PHOTOMOD MegaTIFF)** to continue the orthorectification in MegaTIFF format in distributed processing mode (🌐).

13. The orthoimage and georeference files are created in the project's folder in chosen formats, as well as the file with *.prj extension, with information about coordinate system in OGC WKT format.



The WKT (well known text) format is a common text format of coordinate system description developed according to *ISO* standards (International Standardization Organization) and standards of *Open Geospatial Consortium*, an international organization committed to making quality open standards for the global geospatial community.

6.1. Settings of orthorectification parameters

6.1.1. Type of DTM

The **Type of DTM** tab allows to choose method of using DTM and breaklines during the orthoimages creating.

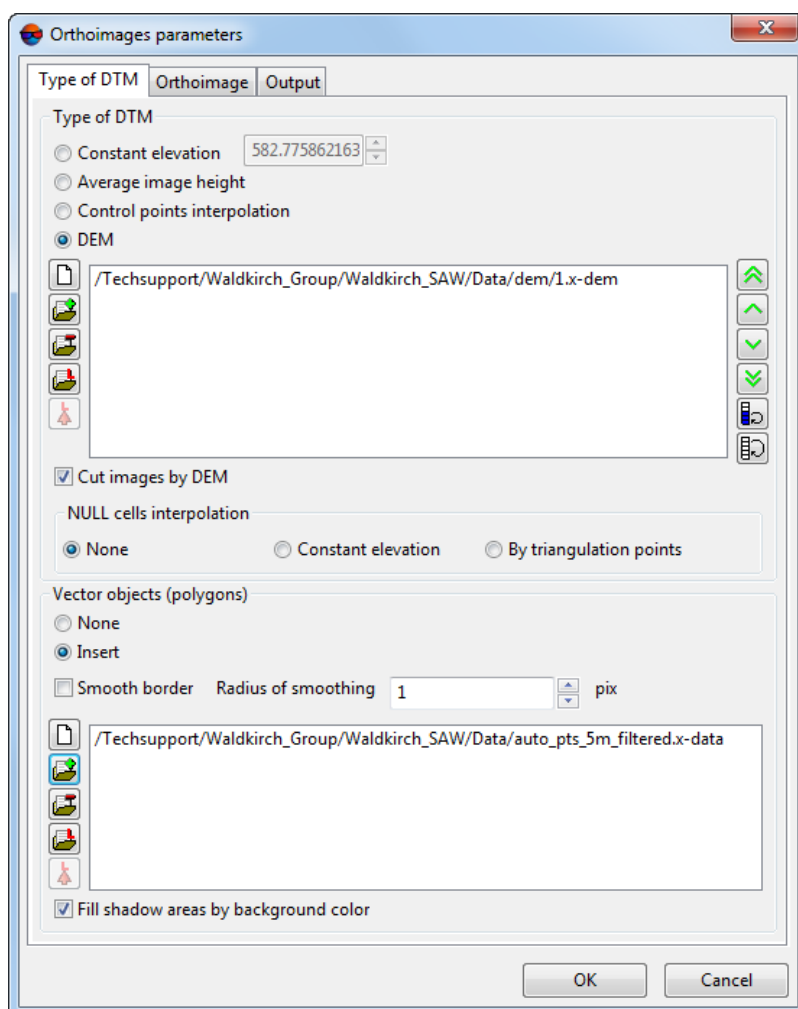


Fig. 9. The orthorectification parameters on the 'Type of DTM' tab

The **Type of DTM** section allows to set the following parameters of DTM using:

- **Constant elevation** – allows to use constant relief elevation during the orthoimages creating and fit elevation in one value from the input field;



Default value is mean elevation value calculated from all source images block.





- **Average image height** – when creating an orthoimage, the average elevation value calculated separately for each image by triangulation points is used;



If there are no triangulation points in the image, the average elevation for the given image is calculated on the base of **Relief elevation** difference specified in *Project properties* (see the “[Creating project](#)” User Manual).

- **Control points interpolation** – smooth polynomial model calculated by ground control and tie points is used in orthorectification process (see the “[Block adjustment](#)” User Manual);
- **DEM** – allows to use information from DEM (see the “[DTM Generation](#)” User Manual).

To form the list of DEM there is a toolbox, which contains the following buttons:


-  – allows to clear the DEM list;
-  – allows to add DEM in the list;
-  – allows to remove DEM from the list;
-  – allows to add to the list *only* DEMs loaded to the current project.













The **Layers selection** window is opened. It contains all DEM layers loaded to the current project. You can select multiple DEMs at once to be added to the list.

-  – allows to create a new layer with copy of DEM selected in the list.




Select *only one* file with DEM data in the list and click the **Open in a new layer** button ().

-  – allows to move selected DEM at the head of the list;
-  – allows to move selected DEM up the list;
-  – allows to move selected DEM down the list;
-  – allows to move selected DEM at the end of the list;


-  – allows to invert selected DEM in the list;
-  – allows to reverse the DEM order.
- The **Cut images by DEM** checkbox allows to create orthoimages by rectangle border considering using DEM and without considering the rest area of image.
- The **NULL cells interpolation** allows to define area out of DEM:
 - **None** – NULL cells are not used in orthorectification process;
 - **Constant elevation** – allows to use constant elevation out of DEM during the orthoimages creating and fit elevation in one value from the input field;
 - **By triangulation points** – smooth polynomial model calculated by triangulation points is used in orthorectification process (see the “[Block adjustment](#)” User Manual).
- The **Vector objects (polygons)** allows to set the following parameters of using vector objects:
 - **None** – orthoimages are creating without using vector objects;
 - **Insert** – an orthoimage is created taking into account structure polygons towering above the terrain (bridges, roofs, and other similar objects) which are not included in the DEM used for orthoimage creation in case if the DEM is the *digital terrain model*;
 - [optional] set the **Smooth border** checkbox to smooth borders of used structure polygons and set **Radius of smoothing** in pixels.
- To form the list of vector files there is a toolbox, which contains the following buttons:
 -  – allows to clear the file list;
 -  – allows to add vector file in the list;
 -  – allows to remove vector file from the list.
 -  – allows to add to the list *only* vector data loaded to the current project.



You can select multiple layers with vector data at once to be added to the list.

-  – allows to create a new layer with copy of vector data.



Select *only one* file with vector data in the list and click the **Open in a new layer** button ().

- The **Fill invisible areas by background color** checkbox is set in the system by default. If the checkbox is off, shadow areas which become 'visible' after rectification, are filled in due to interpolation of color values of adjacent pixels.

6.1.2. General orthoimages creation parameters

The **Orthoimage** tab of the **Orthoimages parameters** window purposes to setup main options of orthoimages creating.

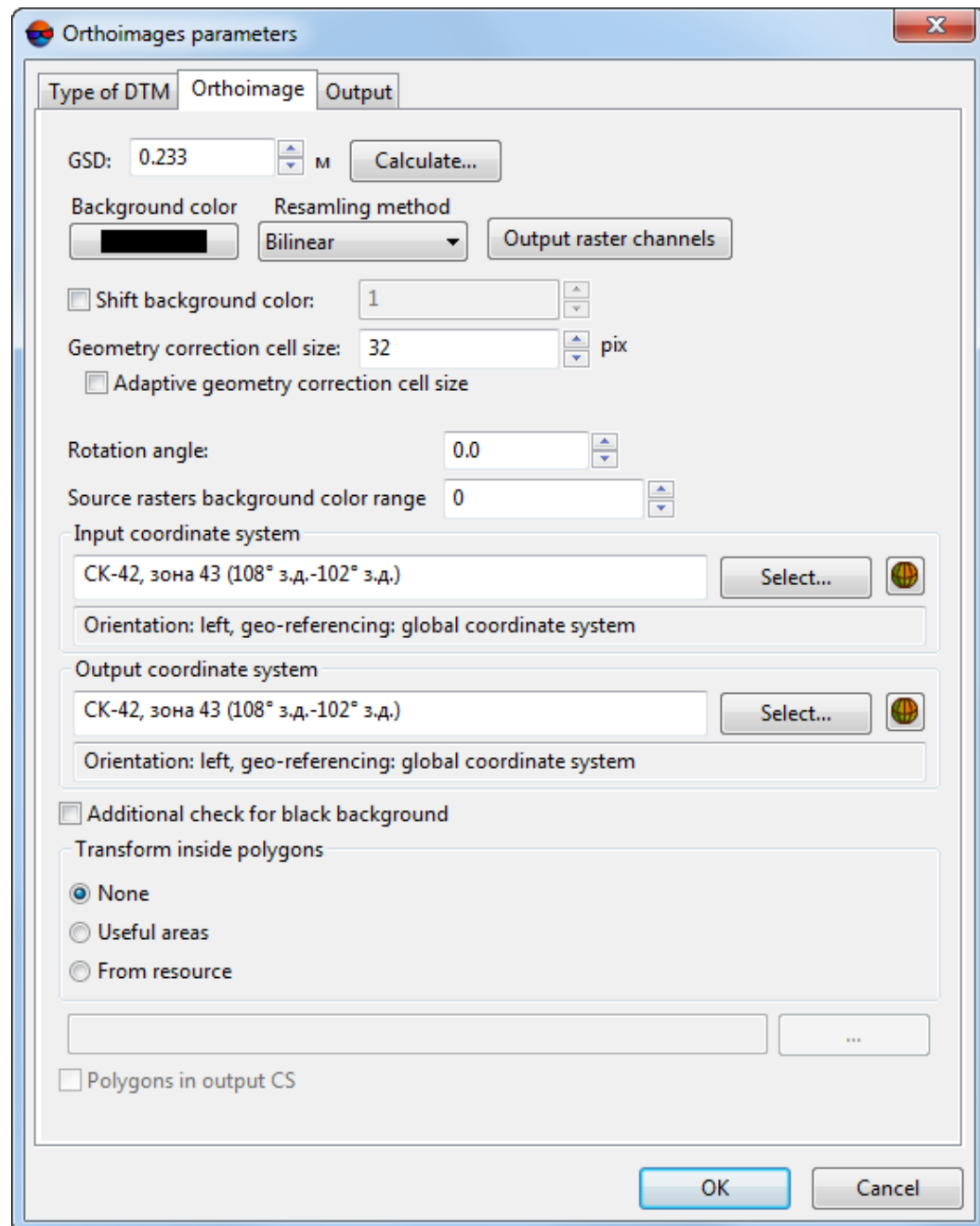


Fig. 10. General orthoimages parameters

The **Orthoimage** tab is used for setting the following parameters of output orthoimages:

- **Cell size** – allows to specify the size of output orthoimage cell on the terrain. The cell size by default is equal to the cell size of the first image of project.



The cell size is set in measurement units equal to units of ground control points in the adjustment step (see the “[Block adjustment](#)” User Manual).



The **Compute** button allows to set general size of orthoimage in pixels and recalculate the cell size according to set parameters.

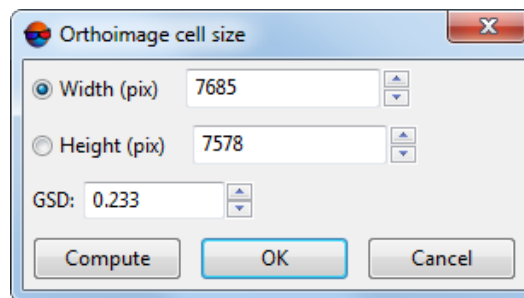


Fig. 11. Orthoimage cell size

- **Background color** – allows to set an output colour for orthoimages background, since output orthoimages always inscribes into a rectangular of this color.
 - **Shift background color** – allows to specify a shift of colour, for some pixels on the substantial part of image, if color of these pixels coincides with defined colour of output orthoimages background, after the orthotransformation.



During an orthophoto creation, images are subjected to geometric transformations and resampling. As a result of such operations, the color of some informative pixels of the raster image may by chance precisely match the chosen output image background color.

- **Resampling method** – allows to choose the brightness interpolation mode during orthomosaic creation: **bilinear**, **cubic** or **nearest neighbour**;
- **Geometry correction cell size** (in pixels) is the size of an image fragment, projected onto the corresponding (in meters) DEM section, interpolated by the bilinear interpolation method .



If **Geometry correction cell size** is equal to one, each pixel of a used image is projected onto the DEM in the course of orthorectification, what provides the maximum accuracy of mosaic creation at, often, practically unacceptable time expenditures.

Introducing such a parameter as the **Geometry correction cell size** allows the user to choose the optimal ratio of the data processing speed and the quality of the output orthoimage. Thus, for example, the default **Geometry correction cell size** equal to 32 pixels (with an average image pixel size on the terrain equal, for example, 0.1 m) means that image fragments with

3.2x3.2 m terrain sizes will be projected onto the DEM. Within this terrain size the DEM (having its own cell size) will be subjected to bilinear interpolation.

Taking into account the abovementioned, it should be noted that the decrease in the accuracy of the orthoimage (which results in the increased **Geometry correction cell size**, which significantly increases the processing speed) is not uniform and directly depends on the angle of deviation from the nadir and the degree of relief roughness in a particular area of the image.

For areas with weak and medium ruggedness of relief, the default **Geometry correction cell size** (equal to 32 pixels) is optimal in most cases. A sharply broken relief itself increases the probability of distortion during orthorectification and may require a significant reduction of the **Geometry correction cell size** to ensure sufficient accuracy of the results.

- **Adaptive geometry correction cell size** – allows to adjust the **Geometry correction cell size** automatically, according to the topographic features, increasing the speed of orthoimages creation and the accuracy of the areas with rugged topography;
- **Output raster channels** – opens the window **Output image parameters**, used for specifying the following parameters:



By default quantity and structure of channels are defined by first added image.

- **Use radiometric form RMC-files** – is used when create orthoimages if in the *Raster Converter* module was preliminary performed the radiometric correction (see the “[General information](#)” User Manual);
- **Channels list** – contains list of source (left) and selected for using in orthorectification channels (right);



Quantity and structure of channels are forming with buttons of the **Channels list** section.



When processing data that contain any bands except for Red, Green, and Blue (RGB), keep in mind that original names of such extra bands (after orthorectification) can remain unchanged only if [output data](#) is saved in **PHOTOMOD MegaTIFF** (*.prf) format.

If correct original names of extra bands in output data are critical (e.g. for further processing those data in *PHOTOMOD Geomosaic*), choose **File type** – **PHOTOMOD MegaTIFF** (*.prf) files in the **Output** window. Otherwise, all extra bands (except for Red, Green, and Blue) will be saved named as Special 1, Special 2, Special 3, etc.

- **Data format** – allows to choose the format of image: **8 bit** or **16 bit**;
- **Monochrome output** – allows to create output file with one grayscale channel.

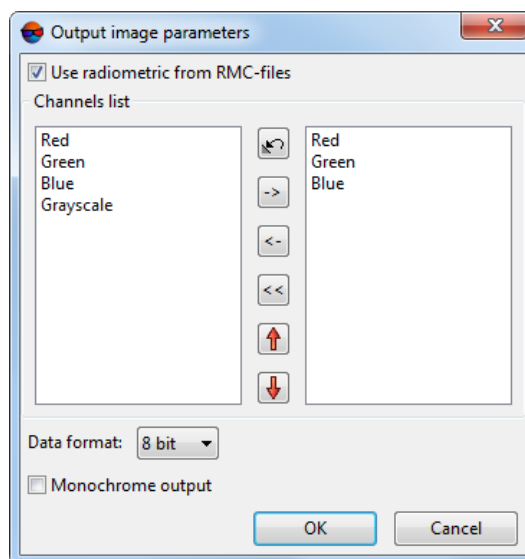


Fig. 12. Output channels parameters

- **Rotation angle** – allows to setup a rotation angle (in degrees) of orthoimages.



This option is used if a block of initial images has elongated shape and it is necessary to remove over background area in rectangular window of created orthoimages.

- **Source rasters background color range** – allows to set a deviation from background color: to specify a range of color, that consider as background in initial images (see the “[Orthophotomaps creation](#)” User Manual);
- The **Additional check for black background** checkbox allows to consider the areas of source imagery with black background as transparent and fill them with output background color in output mosaic;
- **Transform inside polygons** – allows to set the area of orthorectification:
 - **None** – the whole image is transformed;
 - **Useful areas** – area of orthorectification is set by *useful areas*. Useful areas are represented as vector polygons. Useful areas along with other information, are located in image description files, in the same folder with the images. Files with image description have *.x-feat extension (see the “Creating areas without background (useful areas)” chapter of the “[Creating project](#)” User Manual).



To load *Useful areas* as vector polygons or verify their existence choose **Block › Useful areas › Load**.

- **From resource** – area of orthorectification is set by arbitrary polygons from a vector file. Choose a file with polygons in active profile resources.



Set the **Polygons in output CS** checkbox, if the polygons were created in the output coordinate system.

Also the **Orthoimage** tab allows to choose **Input** and **Output coordinate systems**.

6.1.3. Output orthoimages parameters

The **Output** tab of the **Orthoimages parameters** window purposes to setup output options of orthoimages creating.

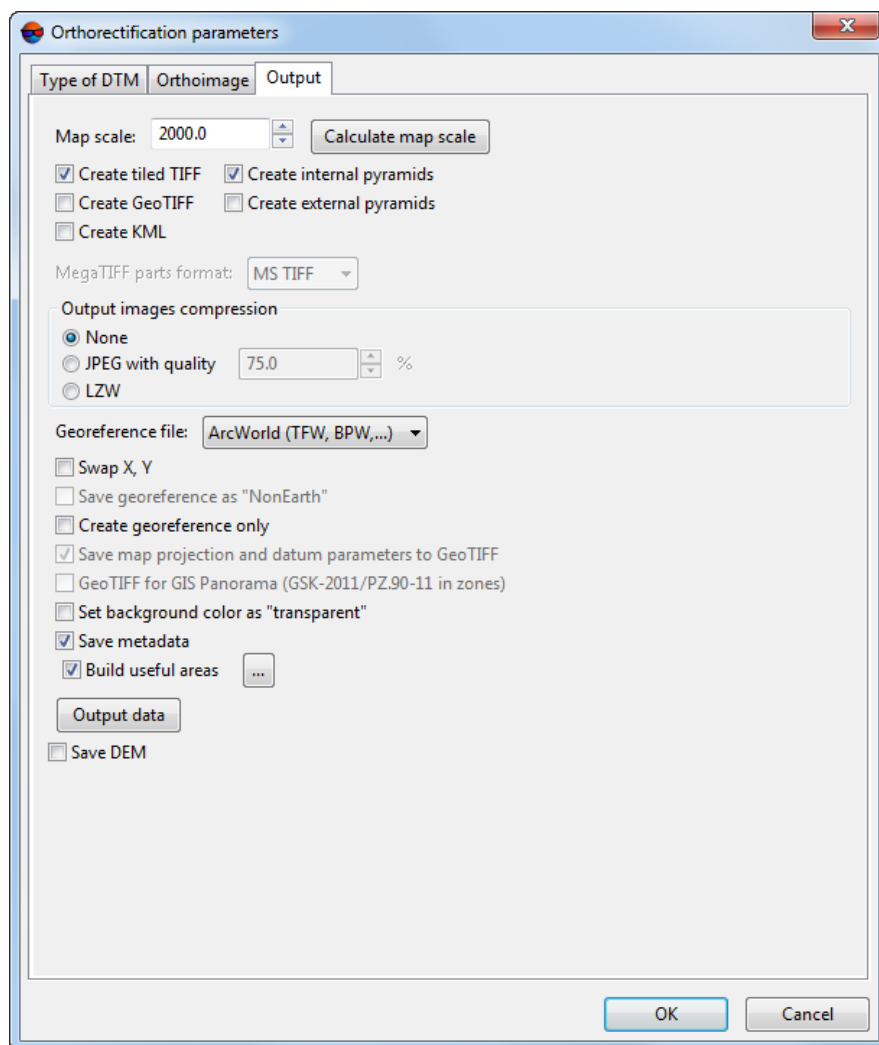


Fig. 13. Output orthoimages parameters

The **Map scale** field allows to set the scale of output orthoimages.

The **Calculate map scale** button allows to calculate a scale and map sheet size (in meters) and print resolution.



Information on the printing resolution of an output image (*dpi*, *dpm*) is recorded in the metadata of *.tiff and *.bmp images, respectively. *DPI* is dots per inch and *DPM* is dots per millimeter.

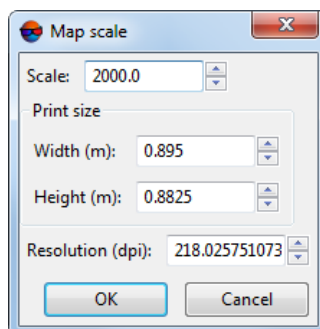


Fig. 14. Map scale

When creating an orthoimage, various additional data can also be created depending on the input **File type**. For this, set or clear the following checkboxes:

- **Create tiled TIFF** – an orthoimage will be created as a TIFF file splitted into tiles;



Creation of tiled TIFFs is available only if **TIFF/BigTIFF** (*.tiff, *.tif) **File type** was preselected in **Output** window.



If the **Create tiled TIFF** checkbox is cleared – a *.TIFF file is created with a standard line data record format.

- **Create internal pyramids** – allows for creating pyramids inside TIFF output images for quick redrawing of images on the screen in case of changing the viewing scale.



To use internal pyramids, the viewer must support such option.

- **Create external pyramids** – allows for creating pyramids as additional files saved in a separate folder;



It is recommended to create external pyramids for large orthoimages in case when the TIFF format with internal pyramids is not used for orthoimage recording (**Create tiled TIFF** and **Create internal pyramids** checkboxes are cleared).

- **Create GeoTIFF** – output orthoimages created in GeoTIFF format with pyramids;



Creation of GeoTIFF is available only if **TIFF/BigTIFF** (*.TIF, *.TIFF) **File type** was preselected in **Output** window.

- **Create KML** – allows to create additional file in *.kml format, e.g. to show results in the *Google Earth*;



It is necessary to choose global coordinate system as output to create file in *.kml format.



*.kml-files are creating both for all block and each image individually.

[optional] Select the **MegaTIFF parts format**, **MS-TIFF** or **JPEG 2000** if **PHOTOMOD MegaTIFF** (*.prf) files were selected as **File type** in the **Output** window.



MS-TIFF –tiled TIFF with internal pyramids.

The **Output images compression** allows to set up the compression parameters of output orthoimages files:

- **None** – files are creates without compression;
- **JPEG with quality .. %** – files are creates with set quality of JPEG-compression;



Default compression level is 75 %, that provides the 5-7 times compression of initial image volume.

- **LZW** – files are creates with LZW-compression;
- **Deflate** – files are creates with deflate compression.

Also the **Output** tab allows to set the following parameters of saving files during orthorectification:

- **Georeferenced file** – allows to select the format of the additional file created;
- **Swap X, Y** – allows to swap X,Y coordinates to obtain output orthoimages;
- **Save georeference as “NonEarth”** – allows you to save georeference In NonEarth coordinate system, when saving the resulting orthoimages in *MapInfo TAB* program;



Used if *MapInfo* system does not support coordinate system of mosaic project.

- **Create georeference only** – allows to create just georeference files of orthoimages without orthorectification (i. e. without files creation);
- **Save map projection and datum parameters to GeoTIFF** – allows to save seven parameters of coordinate system to meta data of TIFF-file;



Used if it was decided to **Create GeoTIFF**.

- **GeoTIFF for GIS Panorama (GSK-2011/PZ90.11 in zones)** – allows to save the appropriate parameters of coordinate system to metadata of TIFF-file;



Used if it was decided to **Create GeoTIFF**, for the further processing in *Panorama* software.

- **Set background color as “transparent”** – allows to set the output background color which is shown in *MapInfo* and *GIS Map 2011* systems, as transparent, when saving the resulting orthoimage in *MapInfo* or *GIS Map 2011* formats, chosen in the **File type** list in the **Output** window (see the **Output data** button below);



To save an orthophoto in the *MapInfo* format, choose the **File type** used by this program in the **Output** window and set the **Georeferenced file** that is to be **MapInfo TAB**.



To save an orthophoto in the *GIS Map 2011* format, choose **Panorama raster (*.rsw)** in the **File type** list in the **Output** window.

- **Save metadata** – allows to save images metadata in the *.x-feat-file: background colour, number of channels and its settings;
- **Build useful area** – allows to create useful areas and save them in the folder containing a previously built orthophoto (click the **...** button to set the **Parameters** of useful area creation):

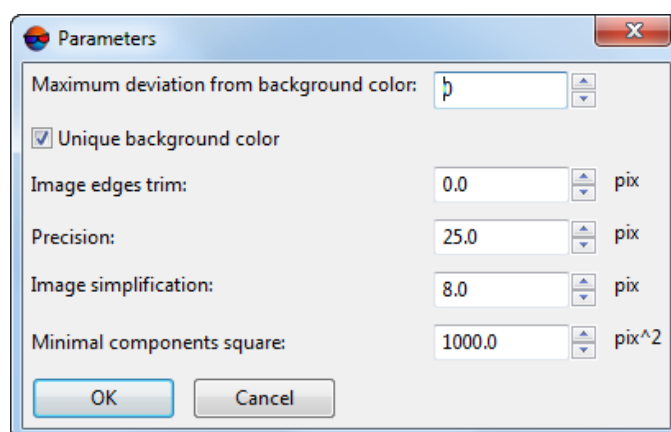


Fig. 15. Useful areas parameters

- [optional] in case of areas on images with color equal to background color, set on the **Unique background color** checkbox and set the **Maximum deviation from background color** to define a range of color, which presents in background of source images;

- Set the **Image edges trim** value to setup offset distance from background boundary and the image substantial area (in pixels);
- Set the **Precision** of calculation of areas boundaries (this value influences on number of nodes in polygon to be created);
- **Image simplification**, in pixels;



Preliminary simplification of images makes it possible to reduce the time spent on constructing the boundaries of useful areas and reduce the number of their vertices, thus avoiding unjustified complexity of their configuration.



Specific optimum values of simplification are to be chosen individually for each project, depending on the project type and geometry of initial data.

It is not recommended to reduce default values for UAS and central projection projects, that have quite large image overlapping.

When processing satellite scanner survey projects that have small image overlapping, reducing this parameter can be feasible for the purpose of increasing the quality of boundary construction.

When setting this parameter, it is recommended to take into account the previously set **Precision** of calculation of areas boundaries (see above). The **Precision** and **Image simplification** values that differ by several orders of magnitude, are not advisable



Preliminary **image simplification** before the construction of useful areas' boundaries is to be performed only if the **unique background color** checkbox is set (see above).

- Set the **Minimal components square** to specify image area value, that will be used as area minimal threshold for useful areas creation.



Further application of useful areas is described in "[Orthophotomaps creation](#)" User Manual.


- **Save DEM** – allows to save the DEM file to the output path.

The **Output data** button allows to choose output **file type** of orthoimage in **Output** window and set path to files.

7. Accuracy control

The system allows to perform accuracy control of orthoimages creation.

Visual displaying of residuals vectors is used for that. Residuals vector on point is a difference of the same point position, calculated from different images for used DEM.

To display residuals on a block scheme, click the  button of the **Orthorectification** toolbar. The **Display options** and **Triangulation points** windows open. Residuals are displayed in a 2D-window considering to a specified parameters.

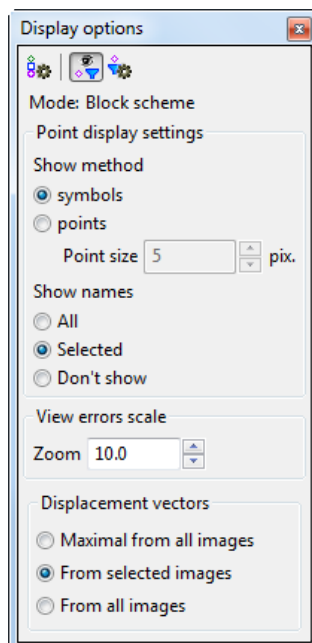





Fig. 16. Parameters of triangulation points display

The **Display options** window contains the toolbar with buttons used to perform the following operations:

-  – allows to display list of symbols of point on a block scheme (see the “[Block adjustment](#)” User Manual);
-  – allows to set on/off the filter of triangulation points display;
-  – allows to set filter of triangulation points display (see the “[Block adjustment](#)” User Manual).

In the Mode field is displayed chosen mode of block scheme, It depends on active 2D-window – Block scheme or Image.



Triangulation points are not displayed in the stereopair 2D-window.

The **Point display settings** section allows to setup the following parameters:

- The **Show method** of points:
 - **symbols** – points are displayed by selected symbols;
 - **points** – **point size** is specified in pixels.

• **Show names** the following points in 2D-window:

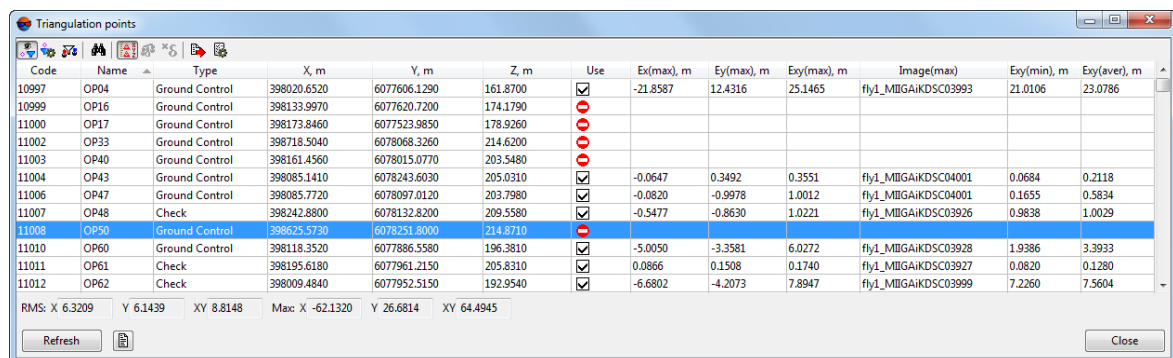
- **All** points;
- **Selected** points;
- **Don't show** points names on a block scheme.

The **View error scale** section allows to define scale of residuals on a block scheme. **Zoom** of scale – size of residual vector is equal to a scheme scale. At that vectors are zoom in/out during zooming in/out of block scheme.

Error vector creates in regard to a point's position on each image with point's coordinates.

The **Displacement vectors** section allows to choose what quantity of vectors for what type of points are displayed on a block scheme:

- **Maximal from all images** – maximal error vector for each point displays;
- **From selected images** – all error vectors for points on selected image display;
- **From all images** – all error vectors for all points display.









Code	Name	Type	X, m	Y, m	Z, m	Use	Ex(max), m	Ey(max), m	Ez(max), m	Image(max)	Ey(min), m	Ey(aver), m
10997	OP04	Ground Control	398020.6520	6077606.1290	161.8700	<input checked="" type="checkbox"/>	-21.8587	12.4316	25.1465	fly1_MIBGAIKDSC03993	21.0106	23.0786
10999	OP16	Ground Control	398133.9970	6077620.7200	174.1790	<input checked="" type="checkbox"/>						
11000	OP17	Ground Control	398173.8460	6077523.9850	178.9260	<input checked="" type="checkbox"/>						
11002	OP33	Ground Control	398718.5040	6078068.3260	214.6200	<input checked="" type="checkbox"/>						
11003	OP40	Ground Control	398161.4560	6078015.0770	203.5480	<input checked="" type="checkbox"/>						
11004	OP43	Ground Control	398085.1410	6078243.6030	205.0310	<input checked="" type="checkbox"/>	-0.0647	0.3492	0.3551	fly1_MIBGAIKDSC04001	0.0684	0.2118
11006	OP47	Ground Control	398085.7720	6078097.0120	203.7980	<input checked="" type="checkbox"/>	-0.0820	-0.9978	1.0012	fly1_MIBGAIKDSC04001	0.1655	0.5834
11007	OP48	Check	398242.8800	6078132.8200	209.5580	<input checked="" type="checkbox"/>	-0.5477	-0.8630	1.0221	fly1_MIBGAIKDSC03926	0.9838	1.0029
11008	OP50	Ground Control	398625.5730	6078251.8000	214.8710	<input checked="" type="checkbox"/>						
11010	OP60	Ground Control	398118.3520	6077886.5580	196.3810	<input checked="" type="checkbox"/>	-5.0050	-3.3581	6.0272	fly1_MIBGAIKDSC03928	1.9386	3.3933
11011	OP61	Check	398195.6180	6077961.2150	205.8310	<input checked="" type="checkbox"/>	0.0866	0.1508	0.1740	fly1_MIBGAIKDSC03927	0.0820	0.1280
11012	OP62	Check	398009.4840	6077952.5150	192.9540	<input checked="" type="checkbox"/>	-6.6802	-4.2073	7.8947	fly1_MIBGAIKDSC03999	7.2260	7.5604

RMS: X 6.3209 Y 6.1439 XY 8.8148 Max X -62.1320 Y 26.6814 XY 64.4945


Refresh Close

Fig. 17. The Triangulation points window

Table 2. Toolbar of the Triangulation points window

Buttons	Function
	to set on/off the filter of triangulation points display
	to setup the filter of triangulation points display
	to display all/selected points in the table
	to search for an image by name (part of name)
	to display GC/check points initial coordinates – X, m, Y, m, Z, m (see the “ Aerial triangulation ” User Manual)
	to export the table content to text file with *.csv extension

For refreshing data in the list and on a block scheme about project state after changes the **Refresh** button is used.

The  button allows to display accuracy control report of orthoimages creation in a print forms, and also to save the report as text, export or print it.

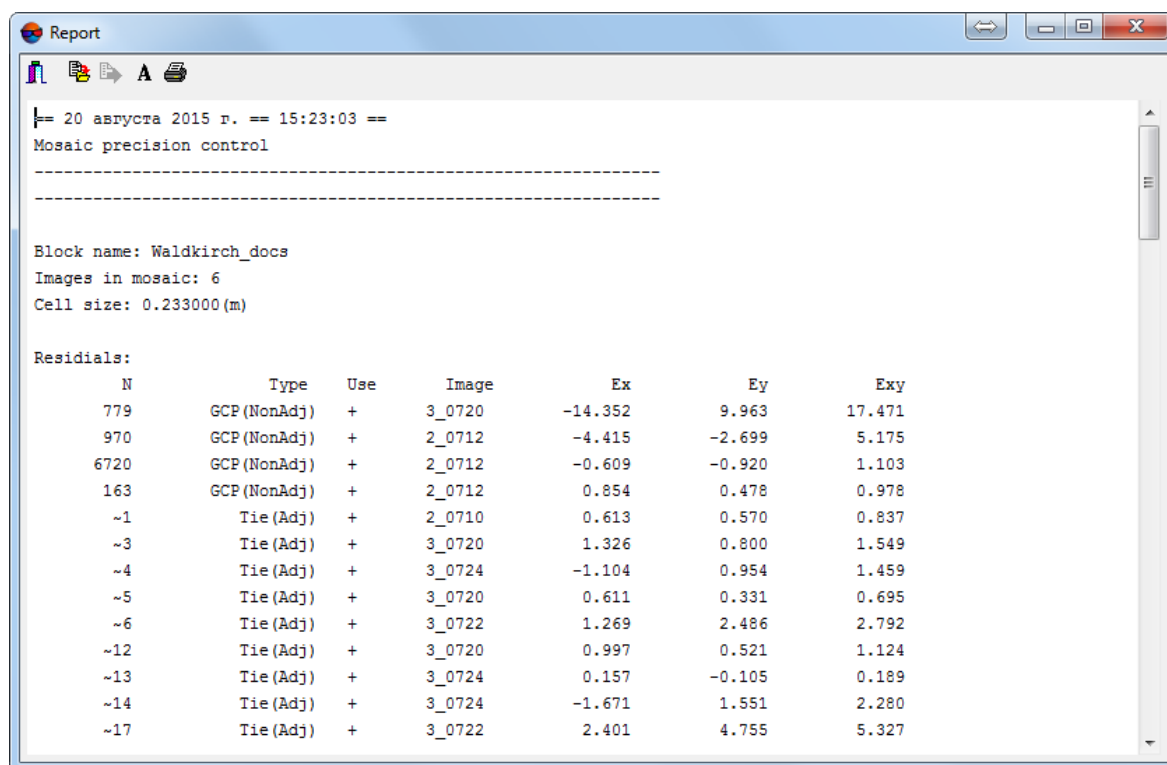




Fig. 18. Accuracy control of orthoimages creation

The list of triangulation points is a table with the following columns:

- Code of the point;
- Image name;
- Type – tie, GCP, check, excluded;
- X, m, Y, m, Z, m – GC/check points initial coordinates (click the  button to display);
- Use – data about point use for calculating of DEM deviation by Z-coordinate:
 - ☒ – the triangulation point was used;
 - ☐ – the triangulation point was not used;
 -  – the triangulation point cannot be used, since it was not used for adjustment.

- $Ex(max), m$ – maximal coordinate discrepancy on X;
- $Ey(max), m$ – maximal coordinate discrepancy on Y;
- $E_{xy}(max), m$ – maximal error of plane point position (the square root of X and Y errors sum);
- $Image(max)$ – a name of an image where a point is shifted in XY-plane during orthorectification as much as possible in relation to its own adjusted coordinates;
- $E_{xy}(min), m$ – minimal error of plane point position (the square root of X and Y errors sum);
- $E_{xy}(aver), m$ – average error of plane point position (the square root of X and Y errors sum).

In the status bar is displayed the **RMS** value and maximum error (**Max**) as points position and coordinate discrepancy on X and Y.

The **Triangulation points** window is synchronized with 2D-window: when point selecting in 2D-window it is also selects in the table.

Double-click on point's name in the table allows to open the **Points measurement** module for edit point's position.