

# GEO-INTERPRETATION CAPABILITIES AND PRECISION OF AN ORTHOPHOTOMAP OBTAINED FROM CARTOSAT IMAGES

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### ABSTRACT:

Orthophotomaps obtained from satellite images are one of the basic products used by geousers. The paper describes in detail the whole process of orthorectification and triangulation of satellite images from Cartosat. The impact of the number and distribution of GCPs on the results of triangulation is presented. The paper includes the values of orthorectification accuracy obtained for various DEMs. A large number of Check points evenly distributed on the scene shows the accuracy changes for various DEMs and numbers of GCPs. Additionally, accuracy analysis of the orthophotomap final product is shown. It is based on comparison of distances measured in terrain and on the orthophotomap. Geo-interpretation capabilities of the product are analyzed on the basis of Cartosat orthophotomaps application possibilities to topographic maps updating.

## 1. INTRODUCTION

New Indian satellite CARTOSAT-1 was designed for cartography applications. Satellite is placed on the polar Sun Synchronous Orbit on high 618 km from Earth. CARTOSAT-1 has two high resolution panchromatic sensors recording stereo images in the visible radiation. The recording swath on the Earth is about 30 km. Pixel size is 2.5 m.

The sensors in satellite are acquiring stereoscope pairs from the one orbit. Pictures are taken forward and backward in the same time by two sensors. As terrain resolution is more than two times better than previous Indian satellite IRS and radiometric resolution is also better. It seems that products of Cartosat will be more useful in various GIS and mapping application.

The best way to define possibilities of application of these images in cartography a fragment of digital orthophotomap has been elaborated. Accuracy and interpretability of topographic objects has also been investigated.

### Set of data

Two stereo panchromatic scenes of the Rawa Mazowiecka (26.5 km x 29.5 km) region in Poland (51° 42,5 ' N; 20° 23' E).

The date of acquisition: 25.02.2006 (winter time in Poland)

Scenes are cloud free

The quality of pictures: very good / good

Remarks: winter scene with partly snow still on the ground.

## 2. ELABORATION OF STEREO CARTOSAT DATA

### 2.1. Triangulation, orientation

36 natural GCP's well distributed and well identified have been measured with GPS technique with accuracy  $M_{x,y} < 0.10$  m, and  $M_z < 0.15$  m. Due to snow some of the GCP's have to be placed on corners of surrounds, which is shown on the Figure 1.

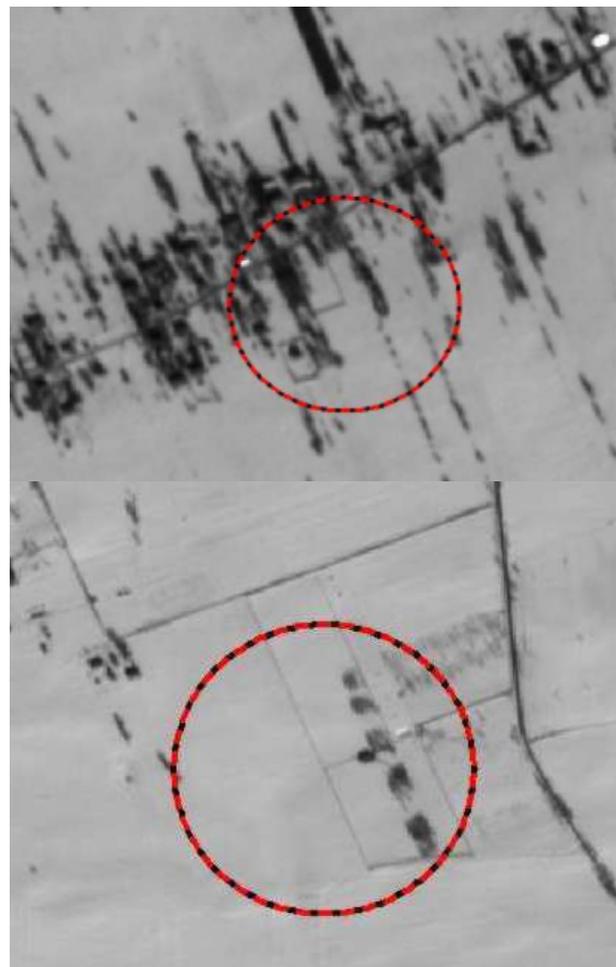


Figure 1. The example of some of GCP's

When it was possible GCP's were chosen certainly crosses of narrow, straight roads, but considering possible interpretation

errors it was too difficult and therefore 2 GCP's were not used to the elaboration. Triangulation of scenes was made with 4 various distributions of GCP's. The results are shown in Table 1.

	A	B	C	D
Number of control / check points	19/14	15/18	12/21	9/24
$\sigma_0$ [pixel]	1.24	1.41	1.49	1.41
RMSE GCP's				
Ground X [m]	1.01	1.00	0.84	0.50
Ground Z [m]	0.85	0.89	0.74	0.57
Ground Y [m]	1.02	1.11	0.67	1.27
Image x [pixel]	0.48	0.47	0.37	0.28
Image y [pixel]	0.29	0.30	0.25	0.19
RMSE CHK's				
Ground X [m]	2.00	2.22	2.05	1.88
Ground Z [m]	1.83	1.75	1.78	1.93
Ground Y [m]	2.29	2.35	2.40	1.71
Image x [pixel]	0.91	1.02	0.99	0.93
Image y [pixel]	0.69	0.67	0.77	0.67

Table 1. Results of orientation of stereo scenes

Analyzing of table 1 is seen that most favorable variant it is when 9 GCP's on scene are used for orientation. However looking at errors occurring on Check points, which are below GSD for Cartosat one may state that the number of 9 GCP's on scene are sufficient for precise orientation of the scenes with the use of RPC method. On the other hand increasing the number of GCP's doesn't significantly improve the accuracy of orientation.

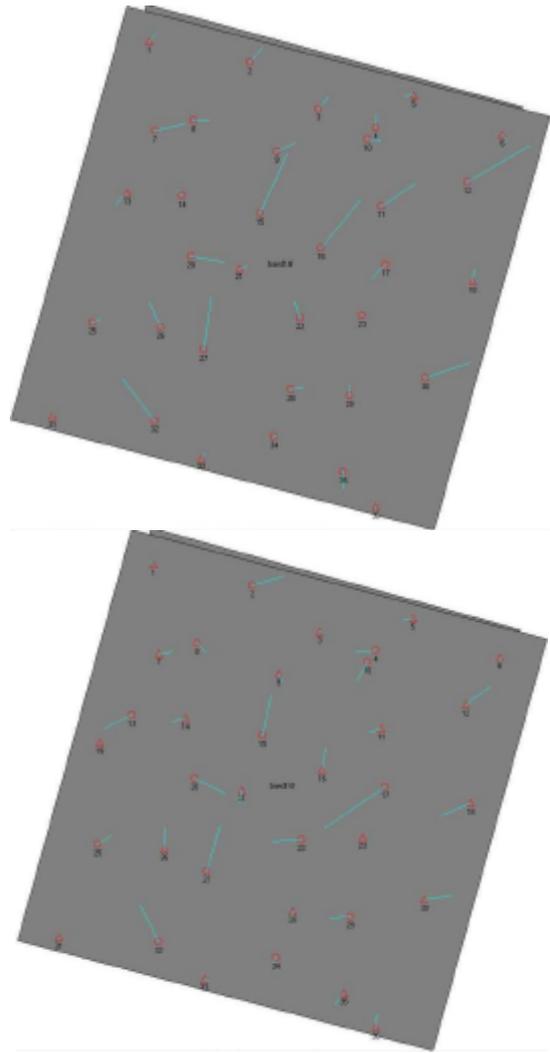


Figure 2. The distribution residuals on scene – variant 9/24 and 19/14 GCP's/CHK's.

The scale of the vector residual 2000%.

The characteristic aspect of the distribution of the largest residuals on GCP's and CHK's are in central part of the scene, which is probably due to wrong Meta data.

## 2.2. Orthorectification

To orthorectification process necessary DEM was generated from the stereopair of Cartosat with grid 20 m by 20 m and DTED level 2. Bilinear interpolation method was applied for orthorectification with the pixel size 2.5 x 2.5m. The difference between orthoimage and original scene from Cartosat is shown on Figure 3.

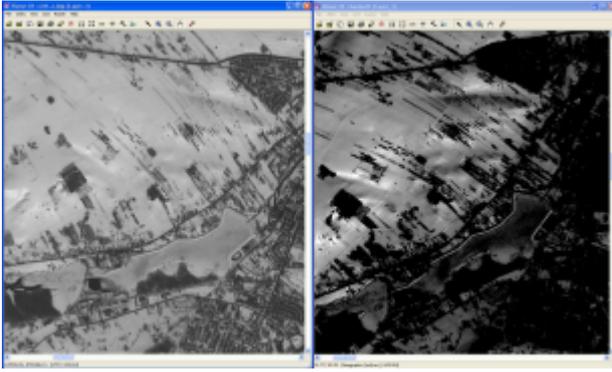


Figure 3. Orthoimage on the left, original image band-A on the right

For estimation of the accuracy of orthoimage 6 distances more than 20 km each were measured on orthoimage and calculated from coordinates. The result is shown in Table 2.

CHK's	$\Delta$
12-32	7.24
8-29	2.01
7-35	-0.88
25-4	-0.06
3-34	-0.62
2-30	2.59

Table 2. Accuracy achieved from the distances

Calculated differences between achieved value (measured on the orthoimage) and theoretical value (calculated from the coordinates). The average value is 1.71 m. So large error in the line 12-32 is due to less accurate of DEM.

Another assessment of accuracy of the orthophoto has been done with the use of 6 measured distances in the field with Total Station Topcon GTS- 212. Results are shown in table 3.

No.	$\Delta$
1	2.34
2	2.84
3	-0.90
4	3.58
5	1.73
6	-0.29

Table 3. The differences in distances measured on ortho and on the terrain

The average value is 1.84 m. These results are only 1.5 times more than achieved in a similar experiment made with the Ikonos data (*Literatura*).

### 2.3 Interpretability

The orthophotomap elaborated from Cartosat may be used for updating existing maps or they may be the sources for precise topographic mapping as a input to GIS. Some problems occur with the shadow due to the season of acquisition of the data (February). In south part of the scene some blur is seen and where error exceeds 3m. It is visible on first image shown on Figure 4.



Figure 4. Fragment of orthoimage  
3. CONCLUSION

Data from Cartosat seems to be very good and can be used for topographic maps updating in the scales 1:10,000 and 1:25,000. The accuracy orientation of stereoimages with 1.4 pixel is satisfactory even that data were acquired in winter season. The price of the data may be probably competitive to HRS SPOT 5 data.

### 4. REFERENCES

Kaczynski R., Ziobro J., 1998. Digital Aerial Triangulation for DMT and Orthophoto Generation. International Archives of Photogrammetry and Remote Sensing, Vol.32, part 4, Stuttgart, pp. 281-283.