

ANALYSIS FOR FACSIMILE OF CADASTRAL MAP OF VARAZDIN

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The cadastral map of Varazdin dating from 1860 is a nice coloured map and still is in official use of the State geodetic administration. During its usage the map is substantially damaged and there is a need to protect the original and, at the same time, to make a map that will replace the original, the facsimile of Varazdin. In order to make the facsimile of Varazdin cadastral map, this paper gives results of the research of the methodology of the map making, the map content, used colours, paper and added map content.

Available sources are the original cadastral map which is coloured and additional sources in form of line-art cadastral map and field cadastral sketches. The original and line-art map were scanned using a DeSkanExpress low-cost scanning system for large formats. The system scans portions of map in several strips which are merged into the single image using our own software. The terrain cadastral map were scanned by flatbed UMAX Mirage scanner of A3 format.

The original map is made on high-quality drawing paper with watermark visible at natural sunlight. During the time the paper became light yellow. The map content is inside thin black ink drawn map frame. Outside the frame are meta-data: map-sheet signature, map-sheet number, cadastral area name and so on.

The map content consists of parcel borders, its numbers and land use; buildings, distinguished by its colours and public ones with their names; street and square names with its numbers and some point signatures such as alone trees. The list of street names is outside the map frame. Buildings differ upon its colour: red (public and houses), light and dark pink and yellow ones. The rest of the content is black ink drawn and then watercoloured.

During 150 years of regular maintenance new parcels with its numbers were drawn with red ink. Some signs and numbers are added with lead-pencil. At the map borders the paper is physically damaged. Some parts of paper are missing on the edge, some torn off pieces are joined with tape. Under tape paper became dark brown.

The colour separation method is rejected in the start, because the map is made by hand. The paper discusses possibility of copying and inserting missing parts from additional map sources, changing the colour of the paper with white or some other colour, removal of the map content added with red ink and lead-pencil and so on. The discussion is based on practical examples on the digital image. The conclusion suggests image processing methods for optimal result of the facsimile of Varazdin cadastral map.

KEYWORDS

Map Content, Map Digitizing, Image Processing.

1. BACKGROUND AND OBJECTIVES

The cadastral map from 1860 shows the Town of Varazdin. The map is damaged during long period of usage and partly because it has not been stored right. The paper researches and suggests ways of making the facsimile of cadastral map of Varazdin. For the research is applied an image processing software Adobe Photoshop CE 7.0 designed for processing of photographs in the first place.

1.1. Background

The map is hand made, black ink drawn and and colored with water-colors at the high quality drawing paper. The map reconstruction with digital simulation of reproduction originals cannot result with a good facsimile. Damages are warned edges, dark brown areas of a tape, missing parts of the map and spots. The paper discusses contents added with lead-pencil and red ink added lines and parcel numbers during regular cadastral map maintenance.

The map content analysis results with the strategy for map damage reparation. The paper researches reconstruction of the map content described in the abstract through reconstruction examples using the strategy briefly described in the paper continuation.

1.2. Objectives

The result of the Facsimile of Cadastral Map of Varazdin is the look on the beginning of its usage: with whole edges, the whole map content and without spots on the paper, and optionally without red ink and pencil drawn map content.

Reconstructed digital raster image picture we can view in some raster image viewer software, plot on the paper or some other media, transform into contemporary coordinate system (cartographic projection) and use it in a GIS software for spatial analysis.

2. APPROCHES AND METHODS

Digital reconstruction of the cadastral map original will process digitally scanned map original in colors (map A, Figure 1). The line-art map (map B, Figure 2) and the terrain cadastral map (map C, Figure 3) are auxiliary sources with equal spatial frame and a little different map content, they will reconstruct some parts of the map A.



Figure 1: The coloured cadastral map original, map A.



Figure 2: The line-art cadastral map original, map B.



Figure 3: The terrain cadastral map original, map C in four parts.

Natural choice of methodology is the map A damage reconstruction using similar samples without damage from the same map. The basis for the digital Facsimile of Cadastral Map of Varazdin is scanned map A. For the reconstruction of damages and missing parts of the map A we copy good parts of the map A at the separate layer that will mask damage. For example, a part of missing line we copy from the part of the map A where exist a similar line at the near part of the map A. In the case where part of the map is missing, we take the area from one or both auxiliary sources the map B and the map C.

2.1. Approaches

The research of reconstruction of all kinds of noticed damages of the map A are at three samples:

Sample 1: Muhl Gasse i Ungarn Gasse.

Sample 2: Biškupečka ulica.

Sample 3: The list of street names.

2.1.1. Sample 1: Muhl Gasse i Ungarn Gasse

The sample 1 is the middle upper part of the map A containing street names Ungar Gasse and Muhl Gasse where the map is torn. At the sample 1 we research reconstruction of the typical damages (Figure 4): 1. torn edge of the map, 2. connecting torn lines: the black ones and the thick red lines of the buildings, 3. reconstruction of the colored and uncolored areas: filling torn area using similar color, 4. the area signature reconstruction, 5. parcel number reconstruction, 6. point signature reconstruction: the tree drawing with its shadow, 7. removing a lead-pencil content: lines, circled parcel numbers and other, and 8. spot removal.



Figure 4: Sample 1: Mühl Gasse i Ungar Gasse with its damages: 1-8 (left), and reconstructed sample 1 (right).

2.1.2. Sample 2: Biškupečka ulica

The lower middle part of the map A is missing, probably because of its long-term use and the map users held the map at that (missing) part of the map. For the research of reconstruction of the missing part of the map A we suggest use of the auxiliary sources the map B and the map C:



Figure 5: The missing part of the map A, Sample 2: Biškupečka ulica.

During 150 years of regular maintenance new parcels with its numbers were drawn with red ink. At the sample 2 we research removal of the red ink content.



Figure 6: Damaged map surface upper right from the parcel number 841.

2.1.3. Sample 3: The list of street names.

The list of street names is outside the map frame in the lower left part of the map A in five columns, each street name with its red number. The list contains 21 street names in Croatian and each street name has the corresponding street name in German with the same red number inside the frame of the map A. The list is damaged substantially (Figure 7) and we suggest research of reconstruction of the list of street names in the lower left part of the map A.



Figure 7: Sample 3: The list of street names.

2.2. Methods

Hardware for scanning main and auxiliary sources and software for preparation of digital sources for reconstruction of the map A and research of possibilities for Facsimile of Cadastral Map of Varazdin

The original (map A) and line-art map (map B) were scanned using a DeScanExpress low-cost scanning system for large formats. The system scans portions of map in several strips which are merged into the single image using our own software (Tutić and Lapaine 2010).



Figure 8: Scanned strips of the map A which are merged into the single image.

The terrain cadastral map (map C) was scanned by flatbed UMAX Mirage scanner of A3 format in 300 dpi in 48 colors.

3. RESULTS

For reconstruction of damaged parts of the map, we use good (undamaged) parts of the map A, for example the sample 1. For reconstruction of larger missing parts of the map A we use auxiliary sources the maps B and C, in the sense that we took some content or larger parts of the maps B or C for the map A reconstruction, for example the samples 2 and 3. For the reconstruction of the samples of the map A are used Photoshop tools described in the paper continuation.

3.1. Reconstructions on the sample 1

The reconstruction of the line break used the selection shape of the line break area made using Polygonal Lasso Tool, then the selection was moved to similar part of the sample where the line is undamaged, and copied in separate layer to the position where this part is damaged, that covers damaged part of the map. All damages we reconstructed that way. Sometimes the masked line break had position that mask make visible step of one pixel. This reconstruction was not good, and we repeated procedure, we made new mask a little further along the line on the map and the result was good. The reconstruction of the damage on the left and the right of the line break we made in the same step (Figure 9).



Figure 9: A the line break, B the mask for the line break: similar near sample for the reconstruction, C masked line break.

Reconstruction of the first figure 5 (that is damaged) of the parcel number (5650) is reconstructed by copying undamaged figure 5 from the same parcel number. The shadow of the tree reconstruction in the lower part at the parcel 126 we made the same way, by copying the shadow tree on the upper part of the parcel.

Somewhere, torn part of the map A damaged the map that content is missing, for example buildings and parts of parcels 129 and 130. The reconstruction of the mentioned parts used sample of the map B. Selection with Magic Wand Tool were all areas among lines of the map B. Selection-Inverse selected only the lines, then the selection we copied at the separate layer in the map A, then we moved and rotated this selection on the right place of the map A using Edit-Free Transform tool. Then the colored area is copied using previously described procedure for line break.

3.2. Reconstruction of missing part of the sample 2

The second part researches reconstruction of the missing part of the map A. The missing part we copied from the map B to the map A at the separate layer and situated using the neighboring content of the map A and B.

The triangular shape selection on the map B a little larger than the missing part of the map A was made using Polygonal Lasso Tool, the selection was saved and then copied using Edit-Copy, then pasted (Edit-Paste), then moved and rotated (Edit-Free Transform). The mask, the triangular part of the map B copied to the separate layer in the map A, we trimmed more precise with inverse selection (Select Inverse-Clear).

The triangular part from the map B (moved and rotated with Free Transform) cannot be situated ideally into the map A, discrepancies are visible, the one or two line weights. The discrepancy avoiding (Figure 10) is possible using more complex transformation of the copied triangular part from the map B that uses neighboring map content.



Figure 10: Visible discrepancies between the map A and moved and rotated the triangular part of the map B.

After reconstruction of the missing part of the map A with the map B, the black ink line-art content is on the right place. The red ink content we should mask the previously described way.

The missing part of the map A is reconstructed with the map B that has not parcel numbers displayed and has different land use area signatures than those used on the map A (on the map A buildings are in yellow and pink, backyards and gardens are in green with its area signatures). The missing land use and parcel numbers we can read from lower left and lower right part of the map C. On the map C there are black and red parcel numbers, the right parcel numbers are written in red but with different font. The parcel number reconstruction should be done from figures of the map A using red parcel numbers from the map C. Land use areas should be reconstructed the same way using undamaged part of the map A.

Technically, the first layer is the background image, the second layer is the colored areas (that have sharp edges) and the next layer is the line art content (that covers sharp area edges like these kinds of content on the map A). Parcel numbers we should reconstruct using the method of masking layers. Red ink and lead-pencil content was not removed but masked (covered) with parts of the clean parts of the map A.

The sample 2 we were reconstructed geometrically using auxiliary source the map B and then we read parcel numbers and land use from the map C and reconstructed them using undamaged parts of the map A.

3.3. The list of street names reconstruction on the sample 3

The list of street names is physically damaged and defective. Missing street names from on the list of street names in Croatian, we found using red street number inside the frame of the map A in German, and then the street names were compared with street names on the map B in Croatian. The list of street names in Croatian is supplemented using the map B, except for the Wiesen Gasse which translation in Croatian is Livadska ulica.

1	6 Mesnička ulica	11 Kazališna ulica	16 ? ulica	21 Jalkovečka ulica
2	7 Uzka " "	12 Streljastna " "	17 "	
3	8 _ečnička " "	13 Nova " "	18 "	
4	9 Gradska " "	14 Zelena " "	19 "	
5	10 Kovačka " "	15 Postarska " "	20 "	

Table 1: The list of street names in Croatian on the map A.

1 Florianska ulica	6 Mesnička ulica	11 Kazališna ulica	16 Opatička ulica	21 Jalkovečka ulica
2 Cintorska ulica	7 Uzka " "	12 Streljstna " "	17 Dučanska ulica	
3 Mlinska ulica	8 Večnička " "	13 Nova " "	18 Šetalistna ulica	
4 Livadska	9 Gradska " "	14 Zelena " "	19 Vidovska ulica	
5 Dravska ulica	10 Kovačka " "	15 Postarska " "	20 Užarska ulica	

Table 2: Reconstruction of the list of street names in Croatian for the map A.

1 Florian Gasse	6 Fleischhauer Gasse	11 Theater Gasse	16 Nonnen Gasse	21 Jalkovecer Gasse
2 Friedhof Gasse	7 Schmale Gasse	12 Schies Statt Gasse	17 Gervolber Gasse	
3 Mühl Gasse	8 Rathaus Gasse	13 Neue Gasse	18 Promenade Gasse	
4 Wiesen Gasse	9 Schloss Gasse	14 Grüne Gasse	19 Veits Gasse	
5 Drau Gasse	10 Schmid Gasse	15 Post Gasse	20 Seiler Gasse	

Table 3: Reconstruction of the list of street names in German for the map A.

The list of street names in the lower left part of the map A is in Croatian, the street names inside the map frame are in German. There are several suggestions for reconstruction of the list of street names:

1. Copying street names in German from the map A inside the map frame, to the list of street names of the map A.
2. Copying street names in Croatian from the map B inside the map frame, to the list of street names of the map A.
3. Copying street names in Croatian from the map C, to the list of street names of the map A.

The street names on the map B use different font then the font used in the list of street names at map A. By adding missing street names from the map B the list of street names would have all the street names in Croatian, but in two different fonts, furthermore the list would be uneven that means not neat and nice. The list of street names we could do using all the names from the map B, but this font is different and is not used on the map A.

The physical damage of cardboard of the terrain cadastral (map C) is substantial. Letters of the street names are damaged, its background is darker then the background of the map A and the street names have spots. Reconstruction of the list of street names from the map C was rejected, because it needs substantial post-processing.

Our choice is suggestion 1, reconstruction of the list of street names in German using street names inside the frame of the map A. Result differs from original but cartographically is acceptable: the new list of street names uses the same font, and the legend is in use the same language as the map content (German). Street names we copied at the lower left part outside the map frame, and then rotated and scaled as needed (Figure 11).



Figure 11: The list of street names in German made using the street names from the map A content, inside the map frame.

There were some difficulties of putting relatively long street names in German in the first line of the each column of the list. In the second to the fifth line of the each column, the word Gasse could replace quotation marks like in the original list in Croatian. The pink background of the copied street names in German we should remove. Upper left part of the map frame is undamaged and it was mirror copied in the lower left part of the map A, sample 3. Street names are written along the street and some of them should be aligned letter by letter (6), some of them should be enlarged (5, 7, 17), and some of them reduced (3, 4, 21).

The same category of damage is damaged map number (21) in the upper right corner of the map A. We can replace it with the map number (21) in the upper middle part of the map B that use very similar font.



Figure 12: Damaged map number 21 and reconstructed map number 21 taken from the map B.

The last step is control of the masking layer order of the each sample, and then integration of the produced image into one unique raster image using Image-Apply. We did the operation for each sample.

4. CONCLUSION AND FUTURE PLANS

The paper presents three map samples before and after reconstruction. Repaired map content is better but colors are not perfect. The samples are nicer and they are more usable and informative than before reconstructions.

The software Adobe Photoshop 7.0 was usable and grateful for the map reconstruction using masking method. It is simple and intuitive application software with instructive help. Locked background image and layers with masks on separate layers is not strange to cartographers and because of it, it could be acceptable.

4.1. Conclusion

This research included digital reconstruction at the three samples of almost all kinds of the damages of the map A. Reconstructions in the paper are not perfect, but with more careful selection of masking samples the result would be little better. Reconstructed samples look almost excellent, because they were physically very damaged or missing.

4.2. Future Plans

The facsimile of the cadastral map of Varazdin we could do in reasonable time, using researched methods for the needs defined in the objectives of the paper. The Photoshop application software can convert easily digital made facsimile in RGB color system for displaying devices, into CMYK color system for printing devices (Vlašić 1999).

The digital facsimile of Varazdin we can transform into contemporary cartographic projection coordinate system using transformation parameters based on coordinates of the four corner of the map A into Gauß-Krüger (Transverse Mercator) coordinate system for spatial analysis needs. The most official cartographic materials in Croatia still use the Gauß-Krüger coordinate system, but we accepted the new cartographic projection HTRS 96 (Croatian Terrestrial Reference System).

Some unsuccessful attempts of reconstruction of the map A was selecting damaged area, than coloring the selection with a convenient color. Coloring with selected uniform color would not look like an old map, so we should use an old map color. Furthermore, resulting color depends on a selected color and a color of the background. The coloring digital facsimile method can research some other paper.

Some parts of the map A we cannot reconstruct, because there is no authentic copy. For example, lower right part of the map A, outside the frame contains author's signatures and probably same other pieces of data. Mentioned part of the map and parts of that kind we could reconstruct in artistic manner. Cartography is the branch of technical science but in historical cartographic materials are often artistic works.

5. REFERENCES:

- Husak, M. (2005): Izrada faksimila katastarskog plana Varazdina iz 1860. godine. seminarski rad, Geodetski fakultet Sveučilišta u Zagrebu, Zagreb.
- Tutić, D., Lapaine, M. (2010): Digitization of Old Maps Using Deskan Express 5.0. u: Livieratos, E., Gartner, G (ed.): Proceedings of the 5th International Workshop on Digital Approaches in Cartographic Heritage, Vienna, Research Group Cartography, Vienna University of Technology, 597-603.
- Vlašić, K. (1999): Adobe Photoshop u 10 koraka. Kristal Print, Zagreb.