QUALITY EVALUATION OF THE NATIONAL TOPOGRAPHIC MAP 1 : 50,000

OCENA KAKOVOSTI DRŽAVNE TOPOGRAFSKE KARTE V MERILU 1 : 50 000

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ABSTRACT

The establishment of the National Topographic Map of Slovenia 1: 50,000 was finished in 2005. The map represents an important achievement of Slovenian cartography; some innovative methods on a world-wide scale were used in the procedure of establishment. But, the quality of the map is of most importance to users. A-priori quality estimation was made in the editorial plan prior to the map production. After finishing all sheets of the map another quality evaluation was performed. The map content was compared to the real situation in the terrain, captured by using field measurements and observations. The quality evaluation followed the requirements of ISO standards: ISO 19113:2002 GI defining quality principles and ISO 19114:2003 GI defining procedures for quality evaluation.

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IZVLEČEK

V letu 2005 se je zaključila izdelava Državne topografske karte v merilu 1 : 50 000. Karta predstavlja velik dosežek slovenske kartografije, saj je izdelana po nekaterih v svetovnem merilu inovativnih postopkih, rezultatih slovenskega znanja. A za uporabnike je najpomembnejša njena kakovost. Ta je bila najprej ocenjena s predhodno oceno kakovosti v fazi priprave redakcijskega načrta. Po končanju izdelave je sledila še dejanska ocena kakovosti na osnovi primerjave na karti prikazanega stanja s podatki, pridobljenimi s terenskimi meritvami in ogledi na izbranem listu. Ocena kakovosti je bila opravljena na osnovi ISO-standardov ISO 19113:2002 GI – kakovostna načela in ISO 19114:2003 GI – postopki za ocenjevanje kakovosti, ki opredeljujeta poenoteni kakovostni model in metodologijo za določanje kakovosti prostorskih podatkov.

KLJUČNE BESEDE

topografske karte, ocena kakovosti, model kakovosti

KEY WORDS

topographic maps, quality evaluation, quality model

1 INTRODUCTION

Despite the growing expansion of topographic databases, topographic maps remain an important source and way of representing spatial data. Because of visual representation, comprehensiveness and simplicity of use, they are the basis for many space-related activities. In comparison to topographic databases, topographic maps require of the user less knowledge and less understanding of origin (source) of data, direct quality parameters of particular data, and they can be used without adaptations to computer hardware and software. Also, owing to a consistent level of generalization of all the elements shown and due to depiction in different scales, topographic maps represent a mutually aligned mapping basis with a certain level of detail, while with topographic databases this has to be created by the user.

However, all of this holds true only when an appropriate quality of the topographic map is achieved. The International Organization for Standardization (ISO) defines quality as a set of characteristics and attributes of a product or service, which support its ability to fulfil the expressed or inherent needs. It is important for the data user to know the quality of the map, which enables him/her to determine whether the particular map is of sufficient quality before the actual use. In general, quality of maps can be delineated by (Šumrada, 2005):

- level of completeness,
- adequacy to fit the user's requirements and needs,
- applicability to a certain use.

The quality of a map depends on objective and subjective reasons. It is thus influenced by (Petrovič et al., 2001): quality of the geodetic bases and mathematical elements, quality of semantic completeness and geographic real-world accuracy, currency of content, transparency and clarity of presentation, geometric accuracy and graphic quality; many of these attributes result from adequacy and commitment to the work performed.

Quality of topographic maps can be determined in two ways, that is, by preliminary, *a priori* evaluation and actual, subsequent (*a posteriori*) evaluation, respectively. Preliminary accuracy evaluation is done prior to the making of a topographic map. It is obtained through the analysis of particular errors that occur in map production. The evaluation then represents the restrictions that we must adhere to in order to achieve the desired quality. The actual accuracy evaluation is performed after the map production by comparing the data obtained during field investigation or by other quality source and the data from the map. In this way, the *a priori* evaluation is being validated (Peterca et al., 1974).

After Slovenia's declaration of independence in 1991, the geodetic service allocated considerable funds into setting up and development of different spatial databases, including topographic maps. The databases were being set up quickly; however, they often failed to ensure adequate and suitable quality. During preparation of setting up particular databases, *a priori* quality evaluations were performed, but the results were mostly metadata on database quality, which were intended for the user. Subsequent quality evaluations that could verify or disprove the a *priori* evaluations were seldom performed. In some cases, it was the users that first brought attention to the poor quality of databases, which proved to be different than the one indicated, or even unacceptable.

Data quality is defined by elements of quality, which make up a quality model. Besides the definition of the quality model, the selection of a methodology for determination of quality of geographic data is of relevance. In the selection three phases are of importance (Šumrada, 2005):

- development and definition of a proper standard set of criteria or indicators for the definition of quality of geographic data (standard quality model),

- development and definition of suitable methods for testing and definition of geographic data and relationships between them (methodology), and
- definition of suitable methods for presentation and display of quality of geographic data (standard report) and graphic representation of elements of quality.

2 NATIONAL TOPOGRAPHIC MAP 1 : 50,000

The National Topographic Map at a scale of 1 : 50,000 (NTM 50) is the most recent topographic map of the Republic of Slovenia and the most significant achievement of Slovenian cartography after Slovenia's declaration of independence. Preparations for the making of NTM 50 started in 1996. At the time, the production of sheets of the National Topographic Map at a scale of 1: 25,000 (NTM 25, 1995–1999) was intensively underway, however, it was clear that it would fail to meet all the needs of the users. Namely, NTM 25 was produced with the classic, analogue cartographic technology and with limited content-related updates to the original source. Also, it did not comply with the standards of the NATO Pact and was therefore of limited use for the Slovenian Army. The decision to produce NTM 50 was conditioned by the following criteria: compliance with the NATO standards to ensure ready-to-use application in the Slovenian Army, application of state-of-the-art computer technology and complete renewal as to content. Having in mind the reduction of production cost and quality provision, the former Yugoslav's military Topographic map 1: 50,000 (TM 50 VGI) was identified as the most adequate source, however, there were only printed sheets available in Slovenia, which contained geometrical errors. Notably, the removal of geometrical deformations and colour separation of content from the colour image was an innovative method at a world-wide scale, introduced by DFG Consulting, company

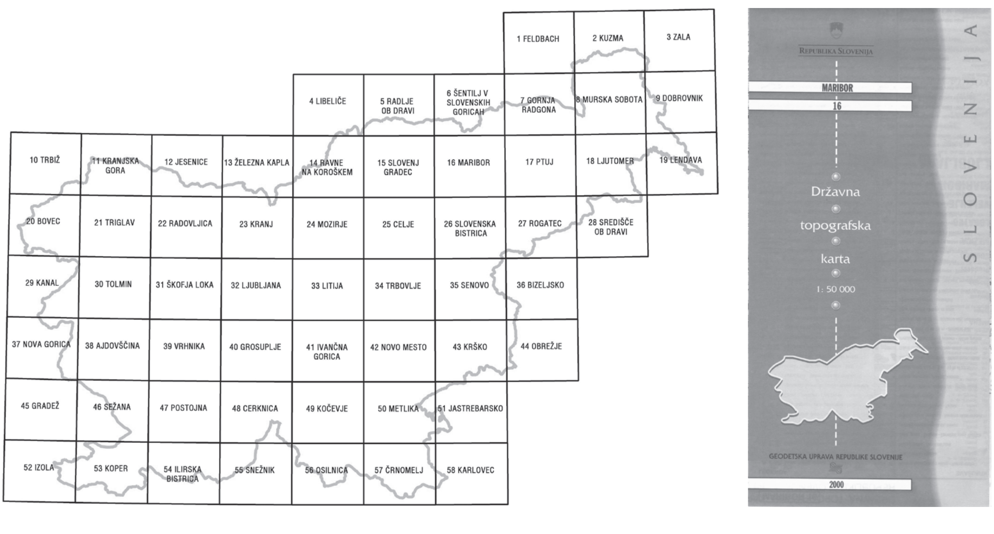

***Figure 1:** Division of the National Topographic Map 1 : 50,000 (NTM 50) into 58 sheets and title page of a sheet.*

with the co-operation of the then Institute for Geodesy and Photogrammetry (Rojc et al., 1997). The editorial plan for NTM 50 was completed between 1997 and 2001, and a few test sheets were made during the time to check the adequacy of editorial decisions and suitability of the production method. Among other things, the *a priori* quality evaluation was included in the editorial plan.

The regular production of the topographic map at a scale of 1: 50,000 started in 2000. The map is composed of 58 sheets of a size of 20′ × 12′, shown in Figure 1. The sheets are produced based on the UTM map projection, using the WGS 84 ellipsoid, and represent the first database of the national geodetic service, which does not correspond to the existing national system, i.e. Gauss-Krueger projection on the Bessel ellipsoid. The production of the map was funded by the Surveying and Mapping Authority of the Republic of Slovenia and the Ministry of Defence. The production was supported by experts from DFG Consulting, Geodetski zavod Slovenije, and Geodetic Institute of Slovenia. Next to the fundamental source, i.e. the topographic map TM 50 VGI, the corrections and updates were acquired with photogrammetric capture of stereopairs of Cyclic Aerial Survey and field survey (accessed by car). Other available databases of topographic data were used, while the geographical names were revised by the Geographical Institute of the Scientific Research Centre of the Slovenian Academy of Sciences and Arts. After the symbolization and generalization of corrections and updates, the map was in the final production phase and ready to be printed in two versions: a national map (NTM) and a military (MTM) map. The versions differ in the colour indication of roads, co-ordinate grids, and in marginal content; the NTM version contains an additional hillshading relief presentation method of half-tone representation (Figure 2). MTM 50 completely complies with the binding provisions of NATO, while the NTM 50 is adapted to the needs of the Slovenian users.

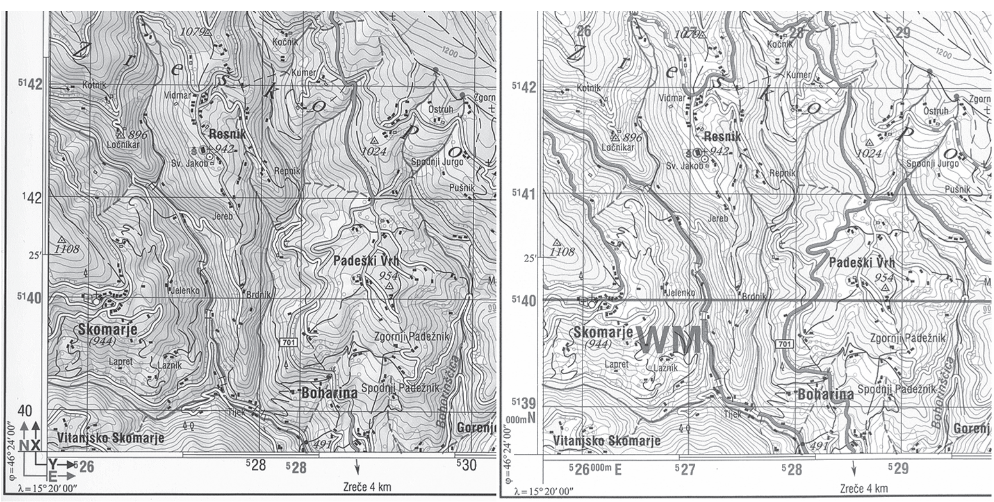

Figure 2: *Extracts from the National Topographic Map and Military Topographic Map 1: 50,000 (NTM/MTM 50), Surveying and Mapping Authority of the Republic of Slovenia and the Ministry of Defence.*

The last sheets were printed in June 2005, and the official launch ceremony of NTM/NTM 50 was on 22 November 2005. The MTM 50 was intended for the use within the Ministry of Defence, and the NTM 50 was intended for all users, that is, as printed sheets or as raster images of separate or combined layers with a resolution of 300 dpi. The first fifth of the sheets is being updated in 2006.

3 PRELIMINARY QUALITY EVALUATION

In the preliminary quality evaluation (*a priori*) of a topographic map based on the planned sources and procedures of production, the expected quality of the end product, i.e. map, is defined. In general, the map quality can be defined as:

- geometrical (locational) accuracy in the sense of the deviation in position of the structure or phenomenon in the map with its real-world position, and
- semantic accuracy of objects and phenomena shown in the map, such as the number of incorrect names of settlements and incorrectly classified structures.

In general, as to content the accuracy depends on the adequacy of classification, interrelations, completeness and temporal accuracy. The main problem is the fact that the parameters of semantic accuracy cannot be mathematically defined and thus objectively measured, and that quality evaluation is thus essentially linked to the subjective estimate of posterior statistical processing, which helps to determine, for example, the number of incorrect data related to the number of all data of the same kind (e.g. the number of incorrect geographical names, unsuitable cartographic symbols ...) (Peterca et al., 1974). As a rule, the preliminary accuracy evaluation is therefore limited to the estimation of geometrical accuracy of a map.

The basic components of geometrical accuracy of a map are (Peterca et al., 1974):

- horizontal accuracy related to the accuracy of points, lines and contours of objects in the horizontal plane, and
- height (vertical) accuracy related to the accuracy of contours and elevations representing the height above the sea in the map. The geometrical accuracy depends upon (Peterca et al., 1974): quality of geodetic basis (geodetic network), surveying method (terrestrial, photogrammetric, satellite imagery etc.), type and quality of the instruments and tools used (computer programs, scanner), type and quality of materials used (foil, printing paper), method of production, cartographic procedures (classic procedures – engraving, masking, transferring, computer procedures – scanning, map processing in vector and raster format), reproduction and printing procedures (copying, film exposure, printing, completion), medium deformations carrying the map (paper, plastic sheets), and methods, tools and procedures for map measurement .

If the map is not produced from originally performed surveying and thus the existing map is used as the source, the effects of surveying errors are replaced by errors of the cartographic source (Petrovič et al., 2001). The common geometric accuracy is determined by taking into consideration all causes for the errors. All errors, which occur in different procedures of map production, are analysed. The final estimation of preliminary accuracy is obtained by the sum of all errors in accordance with the rules of transfer of errors.

$$m = \pm\sqrt{\sum_{i=1}^{n} m_i^2}$$

m_i = mean error of phase (i) in the cartographic/reproduction procedure

m = mean error of the entire cartographic/reproduction procedure

n = number of phases in the cartographic/reproduction procedure

The horizontal geometrical accuracy of the NTM system is influenced by the following errors of single phases of cartographic/reproduction procedures:

- error of mathematical basis,
- own error of the original of the basic cartographic source,
- error of generalization of the additional cartographic source,
- error of colour match,
- error of paper deformation, and
- error of map measurement.

The preliminary evaluation of horizontal positional accuracy of NTM 50 is 19.8 m (Petrovič et al., 2001).

The elevation accuracy of topographic maps depends on the way of representation of terrain. In topographic maps, terrain is mostly represented by contours and height spots. The height accuracy is estimated by mean square error of positioning of contours and mean error of height points in relation to the surrounding points of the geodetic basis. In geometrical accuracy of representation of contours, there occur errors of position, height, shape, curvature, direction, length and gradient. However, only the errors of position, height and shape can be estimated *a priori* (Petrovič et al., 2001a). In the basic source, i.e. sheets of TM 50 VGI, the height was well represented with contours and elevation points. Since the changes in terrain are small, no considerable changes were expected in terms of height. Therefore, the *a priori* accuracy evaluation could be taken from the data of accuracy evaluation of VGI, which was, for slopes, between 10% and 100%: $M_h = \pm$ 1.9 m to ±14.5 m (Peterca et al., 1974).

4 SUBSEQUENT QUALITY EVALUATION

The actual quality evaluation is made after the map production, by performing a comparison between field investigation or other quality source, and the data acquired from the map. The evaluation helps to either verify or disprove the suitability of the *a priori* accuracy evaluation. Considering the extent and quantity of data shown in the topographic map, it can be well understood that a total control is not possible, and that it can only be replaced by a sample control check.

4.1 Quality model

The quality model contains the definition of criteria for assessing the quality of a certain product. In Slovenia, the SIST standard has been applicable, which was adopted based on the ISO 19113:2002 standard, establishing a unified model of spatial data. The quality elements that form the ISO standard quality model are grouped in three descriptive (qualitative) elements of quality:

- purpose,
- usage, and
- lineage,

and five principal (quantitative) elements of quality:

- positional accuracy, which includes horizontal and vertical accuracy,
- thematic (attribute) accuracy,
- temporal accuracy,
- completeness, and
- logical consistency.

The principal elements of quality are composed of specific subelements, which provide a more detailed definition of data quality in a dataset (Šumrada, 2005).

Positional accuracy of a map is given as the mean square error of plane co-ordinates m_x and m_y, and mean square error of height m_v and with the highest deviation of plane co-ordinates and height. The term of mean square error is expressed as:

$$m = \pm\sqrt{\frac{\varepsilon_1^2 + \varepsilon_2^2 + \ldots + \varepsilon_n^2}{n}} ,$$

where

$\varepsilon_{1,2,\ldots n}$ ... error (difference between the value obtained in the field and the value on the map), and

n ... the number of errors.

Thematic accuracy could be defined as the degree to which the description of a feature in a map matches its actual description in the real world. It gives the reliability of classification, precision of quantitative attributes and correctness of semantic (qualitative) attributes and it may contain the following sub-elements:

- correctness of classification of features, yielding the reliability of the compared classification of features in specific groups in relation to the feature catalogue used,
- quantitative precision, giving the reliability of numerical values of descriptive attributes, and
- qualitative correctness, giving consistency of non-numerical values of descriptive attributes.

Temporal accuracy establishes the accuracy of temporal attributes and temporal relations between structures and may contain the following three subelements:

- accuracy of time measurements, giving the correctness or discrepancy of temporal data on spatial phenomena and structures,
- temporal consistency, giving the consistency of distribution of ordinal data, and
- temporal validity, setting out the conformance and durability of data in relation to the time span.

In logical consistency, relations and connections between objects are investigated, while the completeness of data investigates the presence or omission of objects, attributes and relations in a dataset, i.e. in a map.

4.2 Selecting the sample and capture of reference data

Because of the many objects and phenomena represented in a map, only sample quality estimation can be used. The sample is usually represented by a randomly chosen final subset of objects. It is the field in the part of population where the investigation of (all or selected) data assumptions is carried out. The decision on the size and way of selecting the representative sample is of high importance, particularly when considering locational features, spatial distribution and other particularities of spatial data, such as completeness and consistency. Objects shown in a map are highly diverse, therefore, instead of the probability analysis, we have chosen the method of sample determination based on evaluation. First, we delineated the area for performing the sample checks. NTM 50 is composed of 58 sheets. All 58 sheets were produced by the same methodology and by the same producers. Based on these facts, we chose one sheet, which was produced in the middle of production, which contained various landscape features, many and frequent encroachments upon the environment, and which was easy-of-access. All the conditions were met by sheet 32 Ljubljana.

In the sheet »Ljubljana« we selected sample points where we would compare the quality parameters. Different objects in a map are presented with a different level of quality, accuracy in particular, and so the elements displayed in the map can be classified into three groups:

- Group I: trigonometric points which are determined by maximum accuracy, ± (0.01–0.02) mm in the scale of the map; elevation is determined by geodetic surveying;
- Group II: important orientation points and characteristic features, such as crossroads and traffic routes, watercourses, relief extremes (peaks), accuracy of mapping ± (0.2–0.3) mm, indication of heights, and
- Group III: borders of traffic routes, independent features, and vegetation, which are, because of dimensions of mapping symbols, usually shifted and only their positional interaction is preserved (accuracy of mapping up to ± 0.6 mm at the scale of the map and the height of points is only indirectly determinable based on the contours) (Peterca et al., 1974).

Figure 3: *Distribution of 77 sample points in sheet NTM 50 Ljubljana.*

That is why we chose sample points from all three groups; they were equally distributed in the sheet area and allocated according to the geographic features of the area shown. Altogether 77 points were selected (Figure 3) and for each point the discrepancy between the situation in the map and the real-world situation was being investigated in terms of the five elements of quality that were reasonable for a given point (Pivc, 2005).

The reference data were captured by field investigation and observation performed at the end of 2004. With the map at a scale of 1 : 50,000 the co-ordinates of points in the map could be read with 0.5 mm accuracy, which is 25 m in nature. The previous evaluation of horizontal accuracy is ± 19.8 m, and estimation of vertical accuracy ± 14.5 m, respectively. The accuracy of measurement between ± 5 m and ± 10 m sufficed for the estimation of the actual accuracy of the map, which could be achieved with the half-static method of surveying, using the manual GPS receiver. Two receivers were used, i.e. Garmin GPSMAP 60CS and Trimble Geoexplorer 2. The latter enables postprocessing correction of results of observation, which, however, was not used. Nevertheless, during the measurement we checked the accuracy of GPS measurements by comparing the measured values in the trigonometric points with the data from the geodetic points' database (Surveying and Mapping Authority of the Republic of Slovenia). The mean square error of the GPS receiver Trimble Geoexplorer 2 was: m_y = ± 1.260 m, m_x = ± 1.268 m and m_v = ± 1,142 m, and the mean square error of the GPS receiver Garmin GPSMAP 60CS was: m_y = ± 1.75 m, m_x = ± 1.03 m and m_v = ± 5.97 m. Both accuracies were considerably better than the expected accuracy of the map, and due to the simplicity of use we opted for the Garmin GPSMAP 60CS GPS receiver. Out of 77 selected points, 19 points were excluded due to unreliable interpretation in the field or poor reception of the GPS signal, and thus 58 points of all three groups were considered in the final analysis (Pivc, 2005).

4.3 QUALITY ANALYSIS

The analysis of positional accuracy was performed for each group of the features shown in the map separately. In the first group, 7 trigonometric points were analysed. Based on the differences between the selected positions in the map and data of the Database of Geodetic Points (Table 1) we calculated the following values of positional accuracy:

- mean square error on co-ordinate axes: m_y = ± 6.4 m and m_x = ± 5.3 m,
- maximum deviation on co-ordinate axes: o_y = 10.9 m and o_x = -8.7 m, and
- maximum deviation of position: o_p = 13.9 m and mean square error of position: m_p = 8.3 m.

When estimating the heights the mean square error was obtained: m_v = ± 6 m and maximum deviation: o_v = 9 m (Pivc, 2005).

Attribute (thematic) accuracy was estimated based on the comparison between the objects shown in the map with the cartographic symbol and the object observed in nature. Among 77 points distributed in the entire sheet, only one point was incorrect in terms of thematic accuracy (1.3 %). The cemetery, which was shown in the map as an areal object, should be shown with the point

Point	Field			NTM 50			Δ y [m]	Δ x [m]	Positional error [m]	Δ H [m]
	y [m]	x [m]	H [m]	y [m]	x [m]	H [m]				
1	452425,6	115564,2	360,7	452428,0	115558,5	360	-2,4	5,7	± 6,2	1
2	452212,0	106132,6	802	452214,0	106133,0	807	-2,0	-0,4	± 2,1	-5
5	456213,4	102082,3	407	456216,0	102080,5	399	-2,6	1,8	± 3,1	8
7	46097,3	105075,9	310	460968,5	105084,5	308	10,8	-8,6	± 13,8	2
8	4671431,0	96821,7	467	467141,5	96825,0	458	-0,4	-3,3	± 3,3	9
9	467124,9	100095,8	288	467114,0	100104,5	285	10,9	-8,7	± 13,9	3
11	470834,9	110964,7	360	4780840,5	110962,5	353	-5,6	2,2	± 6,0	7

Table 1: *points of Group I – deviation of horizontal co-ordinates and height deviations.*

For points of Groups II and III the deviations were calculated based on the differences between the allocated positions in the map and positions in the real world. For 43 points presenting Group II, we chose crossroads, crossings with streams and rivers with roads and paths (bridges),

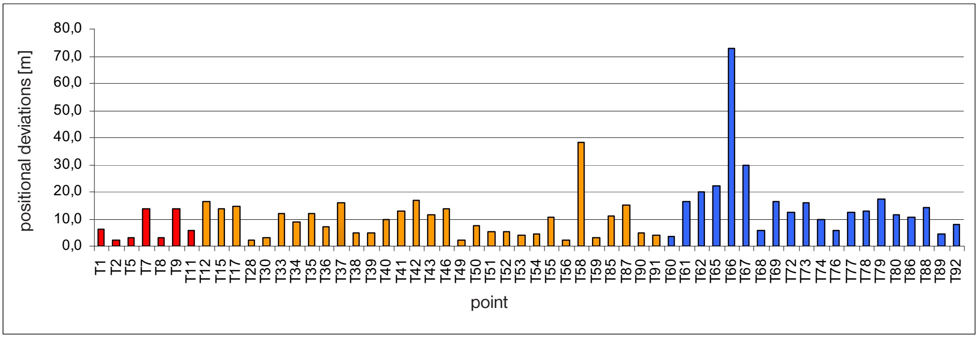

Figure 4: *Positional deviations in the selected sample points.*

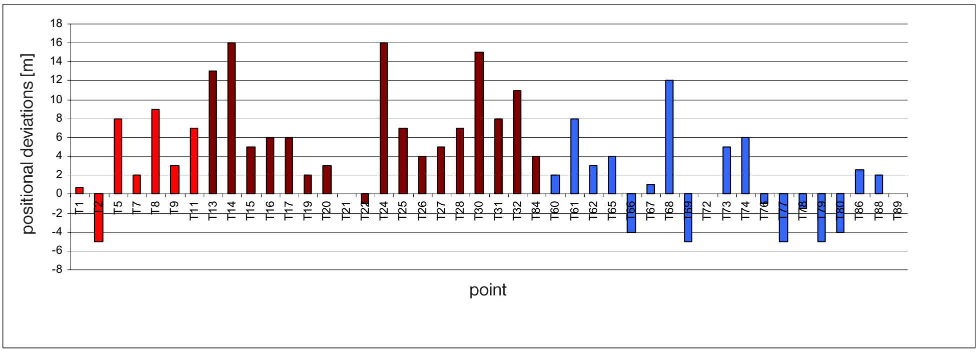

Figure 5: *Discrepancy in height in selected sample points.*

Group	No. of points	o_y	o_x	m_y	m_x	o_p	m_p	o_v	m_v
I.	7	10,9 m	-8,7 m	± 6,4 m	± 5,3 m	13,9	8,3 m	9 m	± 6 m
II.	31 (17)	37,2 m	15,7 m	± 9,7 m	± 6,9 m	38,4 m	11,9 m	16 m	± 8 m
III.	20 (19)	59,6 m	-41,9 m	± 16,2 m	± 14,4 m	72,9 m	21,7 m	12 m	± 5 m*

Table 2*: Estimation of positional and height accuracy of points in the groups.*

symbol due to its actual size in nature. However, to efficiently perform a percentage estimate, the sample of 77 points is too small, so we decided to perform a full check of thematic accuracy in a small section of the map, of a size of 4 km^2 (Figure 6). The number of all geographical data in the section was 790; after field investigation we established that three geographical data were incorrect, i.e. only 0.4%. By taking into consideration the sample points and the selected (smaller) section we assumed with great certainty that thematic accuracy is more than 98% (Pivc, 2005).

In maps, temporal accuracy is among the most problematic criteria of quality. Map production itself is a time-consuming procedure and quite often the state shown in the map is obsolete at the time of publication. The content is updated every few years at best. The Ljubljana sheet was

Figure 6: *Smaller map section that was fully checked for thematic and temporal accuracy, logical consistency and completeness; with indication of points, which deviate from the state in nature in the thematic sense.*

published in 1993, and the stereopairs of cyclic aerial survey and field survey in 2002 served as a basic source of updates and corrections. At the moment of analysis of quality, the content in relation to its source was 2 years old, also, the area covered is one of the most intensive in the country. Despite these facts, among 77 sample points, only 3 showed considerable difference between the display in the map and the state in nature due to temporal differences, and in the smaller section (Figure 6) there were no discrepancies. The unreliable estimate would mathematically indicate the temporal correctness better than 96%.

More reliable was the estimate of logical consistency. We compared the consistency or relationships between single objects in the map with the state in the field. Among 77 sample points in the sheet, there were two logical inconsistencies: in a first case the wrong relationship between the path and watercourse was identified, and in another case the memorial plate was shown in the wrong side of the road. Among 790 objects in the small section, there was one logical inconsistency – the wrong position of the chimney in relation to the surrounding structures. The proportion of inconsistencies was thus lower than 3% or, in other words, the logical consistency was at least 97%.

When evaluating the last quality criterion, i.e. completeness, we checked the presence of objects shown in the map related to the number of objects in nature, by taking into consideration the quantitative and semantical criteria of cartographic generalization. To provide an estimate on the sample of 77 selected points would not be sensible, so our investigation was narrowed down to the selected section of 4 km^2 (Figure 6), where we found 7 structures that were missing in the maps: a chapel, a small cemetery, three hayracks, a skyscraper and a dirt track in poor condition, which represented 0.9% of all structures and phenomena shown in the section. Based on the result, the data completeness of the section of NTM 50 was 99% (Pivc, 2005).

5 CONCLUSIONS

A summarised set of results of assessing the quality of NTM 50 based on the selected test sheet is shown in Table 3 (Pivc, 2005).

Quality element	Quality evaluation
Positional accuracy: - Horizontal accuracy: Gr. I / Gr. II / Gr. III - Vertical accuracy: Gr. I / Gr. II / Gr. III	 8.3 m / 11.9 m / 21.7 m 6 m / 8 m / 5 m
Thematic accuracy	98%
Temporal accuracy	96%
Logical consistency	97%
Data completeness	99%

***Table 3**: Quality evaluation of NTM 50 based on sheet 32 Ljubljana.*

We can compare the positional accuracy with preliminary evaluation, which is 19.8 m for horizontal accuracy and 14.5 for vertical or height accuracy. The results show that, in fact, the positional accuracy almost completely confirms the preliminary evaluation, however, somewhat worse is the positional accuracy of objects in Group III. The reason is that this group contains objects where the effect of cartographic generalization in relation to the map position is the greatest, and where the theoretical mapping accuracy itself is only 0.6 mm, that is, 30 m in a map at a scale of 1: 50,000. Also, these objects were often located in the forest with poor GPS signal.

Unexpectedly, the results of other quality elements are favourable, thus indicating the high quality of NTM 50. The production of NTM 50 simultaneously included a full technological transformation from the analogue into the digital format, partial change of categorization of structure types, partial change of the mode of display with cartographic symbols (new cartographic signs library) and updating the content based on the new sources. Each of these phases increases the possibility of mistakes, which add up, and only during the next content update can most of these mistakes be removed. However, we must have in mind that for most users the positional accuracy of objects and phenomena shown in the map is of secondary importance, that is, due to the theoretic limitations originating from cartographic generalization. The applicable quality of a map is in most cases estimated in terms of its thematic accuracy, temporal accuracy, logical consistency and completeness of data. Unfortunately, one single inconsistency of thematic incorrectness is often enough for a generalized negative opinion and evaluation, since the user is typically interested only in a small proportion of the many objects or phenomena shown in the map. The absolute quality that would ensure the absence of all errors, however, is theoretically achievable only with infinite time of production and infinite financial resources.

The analysis has shown that the new National Topographic Map 1 : 50,000 is not only a technological achievement of Slovenian cartography with original methods of production, but also a high quality product that is widely applicable in many fields and for various purposes.

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