# CITY POPULATION MOVEMENT AND ITS CARTOGRAPHIC VISUALIZATION

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**Abstrakt.** Projekt se zabývá pohybem městské populace a možnostmi jeho kartografické vizualizace. Na počátku realizace projektu přitom byly tři hlavní cíle – na třech vybraných lokalitách v Olomouci vysledovat pohyb městské populace, statisticky tento pohyb vyhodnotit v různých časových intervalech a zhodnotit možnosti jeho kartografické vizualizace. Vybrané metody tematické kartografie vhodné pro vizualizaci pohybu populace pak byly v rámci naplnění cílů realizovány v mapách. Bylo nutné srovnat možnosti kartografické vizualizace s možnostmi současně dostupného softwaru. Také bylo velmi zajímavé porovnat existující rozdělení vyjadřovacích metod tematické kartografie od odborníků na kartografii a geoinformatiku z celého světa. Práce mimo jiné také dokumentuje metody používané pro vyjádření pohybu ve starších materiálech. Na závěr je uvedeno shrnutí a doporučení, jak lze vytvářet mapy znázorňující pohyb městské populace korektním způsobem a vyhodnocení internetového dotazníku. Projekt byl realizován v rámci bakalářské práce.

**Klíčová slova:** pohyb populace, vizualizace, vyjadřovací prostředky, kartografie

**Abstract**. This thesis is dealing with city population movement and its cartographic visualization. There were three goals: trace the movement of city population in three localities examined, statistically analyse this movement and in the cartographic part assess the possibilities for its cartographic visualization. A practical realization of assessed methods and a creation of sample maps, which is an essential part of this research, are also included in this thesis. It was necessary to compare possibilities of cartographic visualization with abilities of software and also various dividing of methods in thematic cartography was very interesting to study and compare. The thesis also addresses visualization possibilities of used methods for movement in the past. At the end is made the full summary of the results and analysis and presentation how to make maps of city population movement correctly. This project was realized as a bachelor's thesis.

**Keywords:** population movement, visualization possibilities, cartography

## 1 Introduction

There are many researches on population movement in various scales. For example visualization of transcontinental flights in the scale of the world, visualization of commuting to work in the scale of countries or visualization of transport in the city scale. But there is not any research on city population movement in so large scale to visualize population movement on the square, in the shopping centre or in the blocks. All researches in those scales were done just for immediate usage during construction works and the like. But it is hard or sometime impossible to use cartographic methods used in small scales to an area of few square kilometres. Because of that, this work tries to be an inspiration for everybody who is looking for the possibilities of cartographic visualization of city population movements on small areas. After analyses of collected data, this thesis should be an inspiration to social, demographic or philosophic interpretation of reasons and effects of this movement. Usage of this research is very wide.

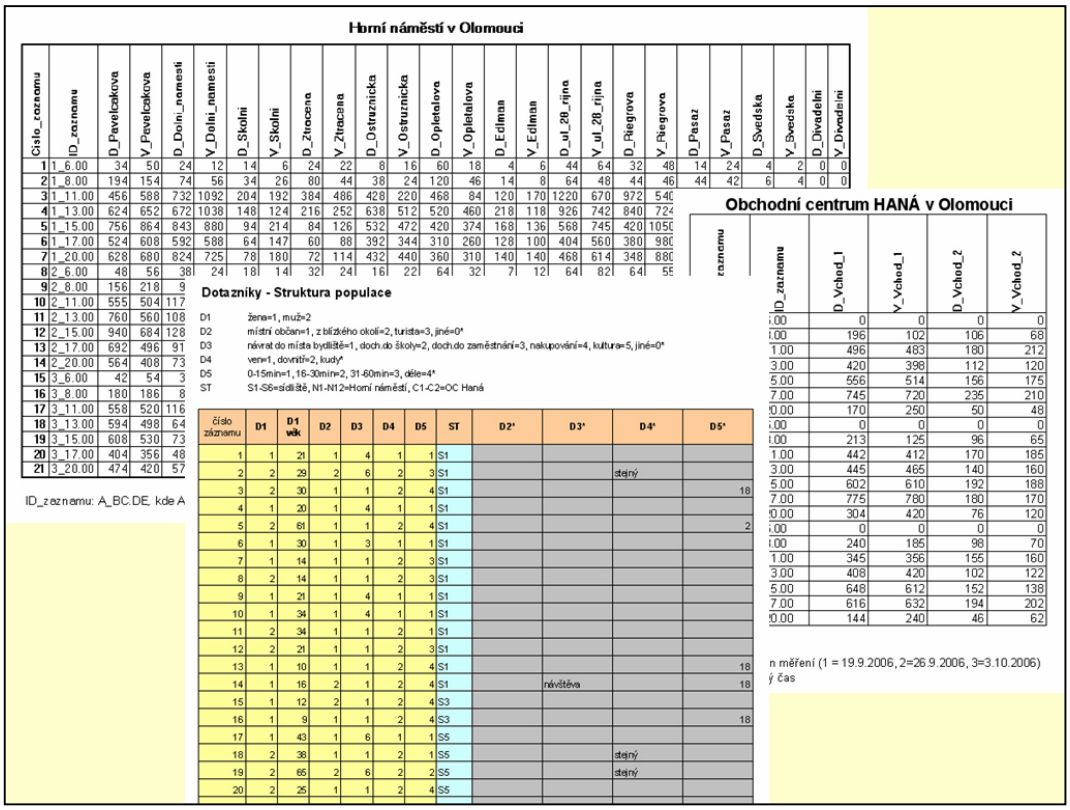
## 2 City population movement and cartographic visualization

At the present time, this question is really highly actual topic. It is interesting to the utility services like advertising or propagation as well as in combat of terrorism, when terrorists are trying to attack places, where the city population has natural centres. In the same way a person who wants to prevent terrorist attacks is looking for a population movement in time scale. And there are not just terrorists who can cause the danger for population. There are also natural disasters and unexpected accidents that demand knowledge of evacuative capacity of neighbourhoods and localities in explicit time. That is why monitoring and interpretation of city population movement is so important topic. With regard to absence of standardization in the thematic cartography many creators of maps (and not only cartographers) do not know suitable possibilities for visualization of city population movement. And it is the main aim of this thesis to help in this question.

### 2.1 Collecting information and data

During the work on this project it was necessary to go through specific literature sources dealing with city population movement and movement in general, consult specialists and contact various institutions of different branches to analyse the study questions. There has been contacted about fifty specialists to improve the background research. It was necessary to find possible methods of cartographic visualization and compare them with software possibilities. With the conclusion of this part there were determined suitable possibilities for visualizing of city population movement.
Then, there were set rules for collecting of data. It was a challenging part of this work. The collecting of data has taken four weeks and about 400 hours of measuring. After consultations there were examined three localities in the city – square of Horní náměstí, OC Haná shopping centre and neighbourhood of Černá cesta. The creation of sample maps, which was an essential part of this research, was next step.
An indisputable part of the thesis is a statistic analysis of the result of measuring and collecting of data dealing with city population movement. There were set hypothesis and they were analysed with application of data from developed database.

**Picture 1.** Collecting of data.



Horní náměstí v Olomouci

| Číslo_zaznamu | ID_zaznamu | D_Pavelcakova | V_Pavelcakova | D_Dolni_namesti | V_Dolni_namesti | D_Skolni | V_Skolni | D_Ztracena | V_Ztracena | D_Ostruznicka | V_Ostruznicka | D_Opletalova | V_Opletalova | D_Edlman | V_Edlman | D_ul_28_rijna | V_ul_28_rijna | D_Riegrova | V_Riegrova | D_Pasaz | V_Pasaz | D_Svedska | V_Svedska | D_Divadelni | V_Divadelni |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1_6.00 | 34 | 50 | 24 | 12 | 14 | 6 | 24 | 22 | 8 | 16 | 60 | 18 | 4 | 6 | 44 | 64 | 32 | 48 | 14 | 24 | 4 | 2 | 0 | 0 |
| 2 | 1_8.00 | 194 | 154 | 74 | 56 | 34 | 26 | 80 | 44 | 38 | 24 | 120 | 46 | 14 | 8 | 64 | 48 | 44 | 46 | 44 | 42 | 6 | 4 | 0 | 0 |
| 3 | 1_11.00 | 456 | 588 | 732 | 1092 | 204 | 192 | 384 | 486 | 428 | 220 | 468 | 84 | 120 | 170 | 1220 | 670 | 972 | 540 | | | | | | |
| 4 | 1_13.00 | 624 | 652 | 672 | 1038 | 148 | 124 | 216 | 252 | 638 | 512 | 520 | 460 | 218 | 118 | 926 | 742 | 840 | 724 | | | | | | |
| 5 | 1_15.00 | 756 | 864 | 843 | 880 | 94 | 214 | 84 | 126 | 532 | 472 | 420 | 374 | 168 | 136 | 568 | 745 | 420 | 1050 | | | | | | |
| 6 | 1_17.00 | 524 | 608 | 592 | 588 | 64 | 147 | 60 | 88 | 392 | 344 | 310 | 260 | 128 | 100 | 404 | 560 | 380 | 980 | | | | | | |
| 7 | 1_20.00 | 628 | 680 | 824 | 725 | 78 | 180 | 72 | 114 | 432 | 440 | 360 | 310 | 140 | 140 | 468 | 614 | 348 | 880 | | | | | | |
| 8 | 2_6.00 | 48 | 56 | 38 | 24 | 18 | 14 | 32 | 24 | 16 | 22 | 64 | 32 | 7 | 12 | 64 | 82 | 64 | 55 | | | | | | |
| 9 | 2_8.00 | 156 | 218 | 9 | | | | | | | | | | | | | | | | | | | | | |
| 10 | 2_11.00 | 555 | 504 | 117 | | | | | | | | | | | | | | | | | | | | | |
| 11 | 2_13.00 | 760 | 560 | 108 | | | | | | | | | | | | | | | | | | | | | |
| 12 | 2_15.00 | 940 | 684 | 128 | | | | | | | | | | | | | | | | | | | | | |
| 13 | 2_17.00 | 692 | 496 | 91 | | | | | | | | | | | | | | | | | | | | | |
| 14 | 2_20.00 | 564 | 408 | 73 | | | | | | | | | | | | | | | | | | | | | |
| 15 | 3_6.00 | 42 | 54 | 3 | | | | | | | | | | | | | | | | | | | | | |
| 16 | 3_8.00 | 180 | 186 | 8 | | | | | | | | | | | | | | | | | | | | | |
| 17 | 3_11.00 | 558 | 520 | 116 | | | | | | | | | | | | | | | | | | | | | |
| 18 | 3_13.00 | 594 | 498 | 64 | | | | | | | | | | | | | | | | | | | | | |
| 19 | 3_15.00 | 608 | 530 | 73 | | | | | | | | | | | | | | | | | | | | | |
| 20 | 3_17.00 | 404 | 356 | 48 | | | | | | | | | | | | | | | | | | | | | |
| 21 | 3_20.00 | 474 | 420 | 57 | | | | | | | | | | | | | | | | | | | | | |

ID_zaznamu: A_BC.DE, kde A

**Dotazníky - Struktura populace**

D1 žena=1, muž=2
D2 místní občan=1, z blízkého okolí=2, turista=3, jiné=0*
D3 návrat do místa bydliště=1, doch.do školy=2, doch.do zaměstnání=3, nakupování=4, kultura=5, jiné=0*
D4 ven=1, dovnitř=2, kudy*
D5 0-15min=1, 16-30min=2, 31-60min=3, déle=4*
ST S1-S6=sídliště, N1-N12=Horní náměstí, C1-C2=OC Haná

| číslo záznamu | D1 | D1 věk | D2 | D3 | D4 | D5 | ST | D2* | D3* | D4* | D5* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 21 | 1 | 4 | 1 | 1 | S1 | | | | |
| 2 | 2 | 29 | 2 | 6 | 2 | 3 | S1 | | | stejný | |
| 3 | 2 | 30 | 1 | 1 | 2 | 4 | S1 | | | | 18 |
| 4 | 1 | 20 | 1 | 4 | 1 | 1 | S1 | | | | |
| 5 | 2 | 61 | 1 | 1 | 2 | 4 | S1 | | | | 2 |
| 6 | 1 | 30 | 1 | 3 | 1 | 1 | S1 | | | | |
| 7 | 1 | 14 | 1 | 1 | 2 | 3 | S1 | | | | |
| 8 | 2 | 14 | 1 | 1 | 2 | 3 | S1 | | | | |
| 9 | 1 | 21 | 1 | 4 | 1 | 1 | S1 | | | | |
| 10 | 1 | 34 | 1 | 4 | 1 | 1 | S1 | | | | |
| 11 | 2 | 34 | 1 | 1 | 2 | 1 | S1 | | | | |
| 12 | 2 | 21 | 1 | 1 | 2 | 3 | S1 | | | | |
| 13 | 1 | 10 | 1 | 1 | 2 | 4 | S1 | | | | 18 |
| 14 | 1 | 16 | 2 | 1 | 2 | 4 | S1 | | návštěva | | 18 |
| 15 | 1 | 12 | 2 | 1 | 2 | 4 | S3 | | | | |
| 16 | 1 | 9 | 1 | 1 | 2 | 4 | S3 | | | | 18 |
| 17 | 1 | 43 | 1 | 6 | 1 | 1 | S5 | | | | |
| 18 | 2 | 38 | 1 | 1 | 2 | 1 | S5 | | | stejný | |
| 19 | 2 | 65 | 2 | 6 | 2 | 2 | S5 | | | stejný | |
| 20 | 2 | 25 | 1 | 1 | 2 | 4 | S5 | | | | |

Obchodní centrum HANÁ v Olomouci

| raznamu | ID_zaznamu | D_Vchod_1 | V_Vchod_1 | D_Vchod_2 | V_Vchod_2 |
|---|---|---|---|---|---|
| | :00 | 0 | 0 | 0 | 0 |
| | :00 | 196 | 102 | 106 | 68 |
| | 1.00 | 496 | 483 | 180 | 212 |
| | 3.00 | 420 | 398 | 112 | 120 |
| | 5.00 | 556 | 514 | 156 | 175 |
| | 7.00 | 745 | 720 | 235 | 210 |
| | 0.00 | 170 | 250 | 50 | 48 |
| | :00 | 0 | 0 | 0 | 0 |
| | :00 | 213 | 125 | 96 | 65 |
| | 1.00 | 442 | 412 | 170 | 185 |
| | 3.00 | 445 | 465 | 140 | 160 |
| | 5.00 | 602 | 610 | 192 | 188 |
| | 7.00 | 775 | 780 | 180 | 170 |
| | 0.00 | 304 | 420 | 76 | 120 |
| | :00 | 0 | 0 | 0 | 0 |
| | :00 | 240 | 185 | 98 | 70 |
| | 1.00 | 345 | 356 | 155 | 160 |
| | 3.00 | 408 | 420 | 102 | 122 |
| | 5.00 | 648 | 612 | 152 | 138 |
| | 7.00 | 616 | 632 | 194 | 202 |
| | 0.00 | 144 | 240 | 46 | 62 |

n měření (1 = 19.9.2006, 2=26.9.2006, 3=3.10.2006)
ý čas

**Picture 2.** Output of the collecting of data – tables included in the database.

## 2.2 Possibilities of cartographic visualization

There are many possibilities how to visualize city population movement. But in general, there are two main groups of methods. The first group are static maps and the second group are dynamic maps or static maps with dynamic symbols. Methods that are used for static maps can be always used for dynamic maps. On the contrary it is mostly hard or impossible. Just because that the thesis is mainly speaking about methods for static maps. By the computer cartography, it can be upgraded and variegated by dynamic symbols, movies, animations, music, etc.

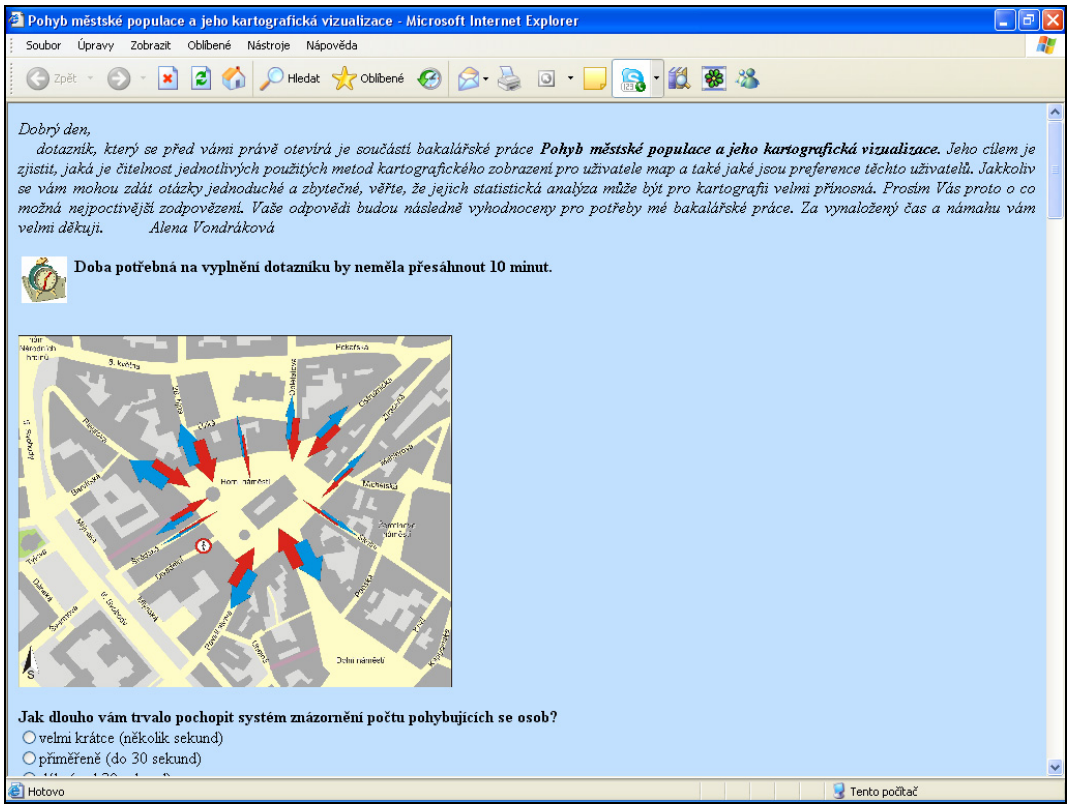

**Picture 3.** Possible methods of cartographic visualization according to famous cartographers.

Visualizing the city population movement means visualization of qualitative and quantitative characteristics as well. Data that were collected by measuring and collecting as a part of this project are located to one point – standing place or to the area – monitored localities. The easiest way how to visualize collected data are point-located methods or point-located diagrams. There are many of them, but the basic ones are column diagrams, square diagrams, circular diagrams, semicircular diagrams, triangle diagrams and figurate diagrams. Always one or more parameters of the symbol represent the value.

There can be also used line-located methods and diagrams. We use them on a larger area, for example to visualize the utilization of traffic or streets. The last group are area-located methods and diagrams, which represents data of polygons. Also these types were used during creation of sample maps.

Modern technologies offer using of GIS – geographic information systems for spatial analyses, for example to interpolate collected values or statistical tools to analyse the theoretical fragmentation, etc.

Unfortunately, thematic cartography has been never standardized and there is no chance to the future to do that. Because of that, there will be always many opinions and theories what method is the best and what other methods can be improved. Because this thesis is just the study, there was a big hazard to cover up subjectivism into the results. In order to eliminate any possible subjectivity in the thesis there was created an on-line research conducted among users of maps in order to acquire information about their preferences. During 45 days there were 141 respondents that filled up questions and the result was covered into the conclusion of this research. Of course the number of respondents was too low, but it was good demonstration how it can work.




**Picture 5.** Index of on-line research.

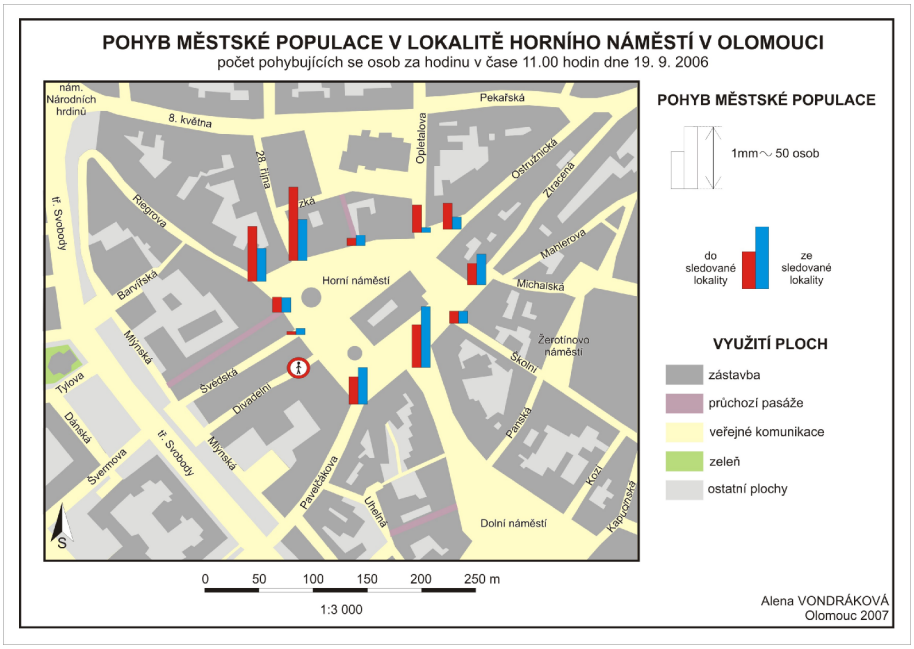
And what usage does this thesis have? In the extend, it has been realised, the town council of Olomouc used it to have a model how to prepare collecting of data and also the analyses, that were done on the examined localities, were used for changing the stand places of rescue workers during possible evacuation. One advertising agency used it for improving impact factors in these localities and the thesis was offered to people that were interested in the topic.

## 3 Conclusion

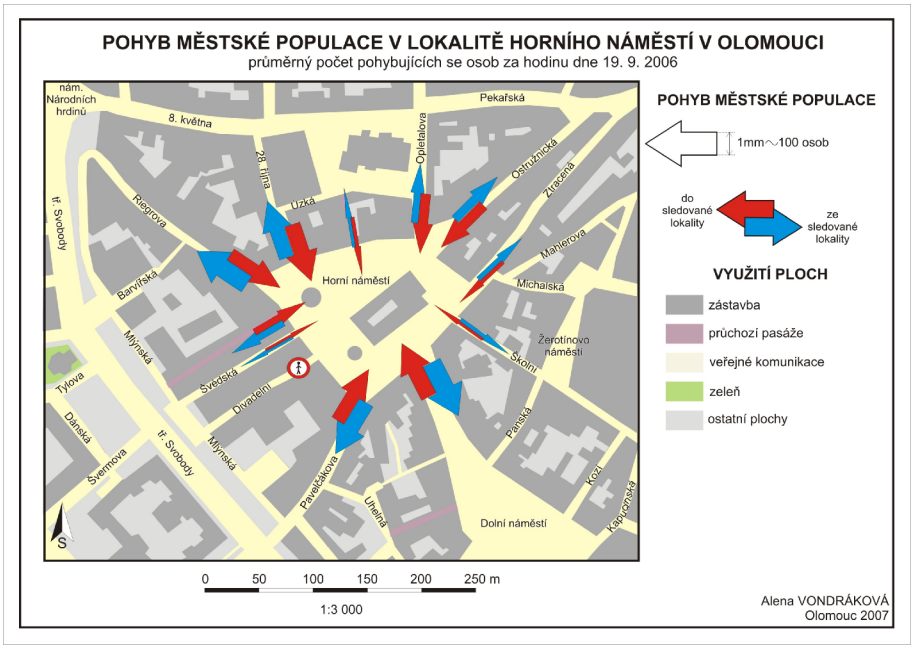
The possibilities of making thematic maps dealing with city population movement are mainly dependant on collected data and their structure and quality. To pass the requirements of the thesis task, there has been sufficient measuring for four weeks. Of course, for making correct analyses, there is a need of much bigger data collection. Also there can not be said, that there are described all the possible methods. On the contrary, there are just examined assessed methods, which are mostly used. It is a base for next studies and research. At the end of the thesis there is a full summary of the results and analyses and a presentation how to make maps of city population movement correctly.

This project was realized as a bachelor's thesis. It was presented on the student conference GISáček and has won the first prize in the bachelor's degree thesis competiton. The poster of the thesis (in English) was submitted into HERODOT Student Poster Competition and also has won. Thanks to that, the thesis was presented on the HERODOT and ESRI conferences in September 2007 in Stockholm.

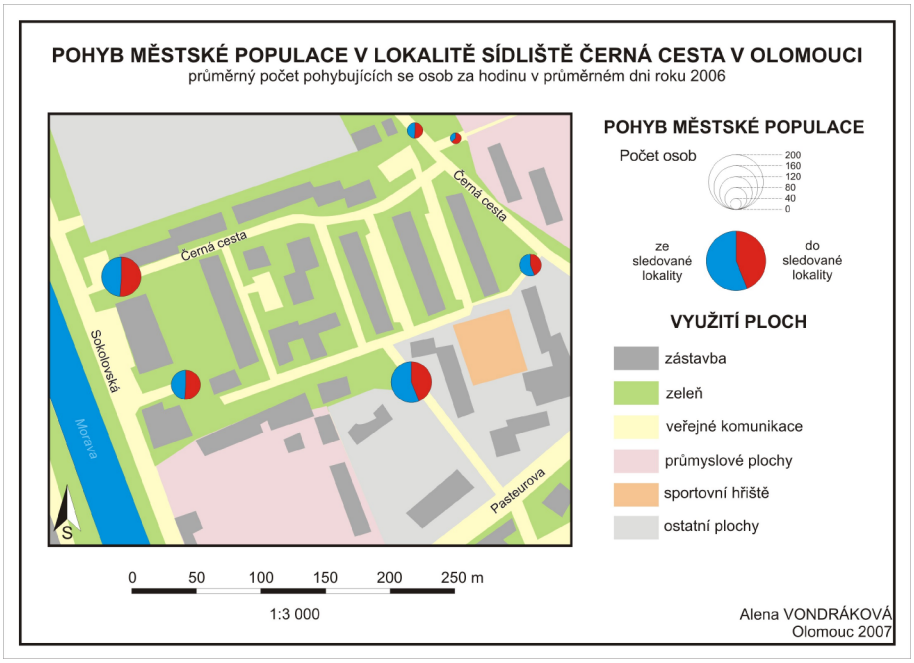
## 4 Gallery of sample maps



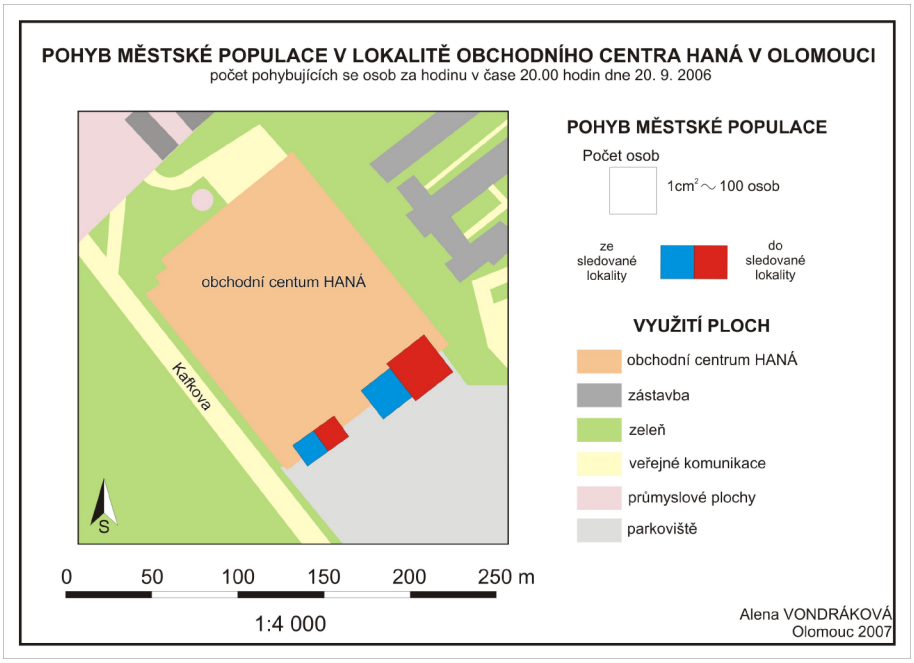

**Map 1.** Column diagrams.



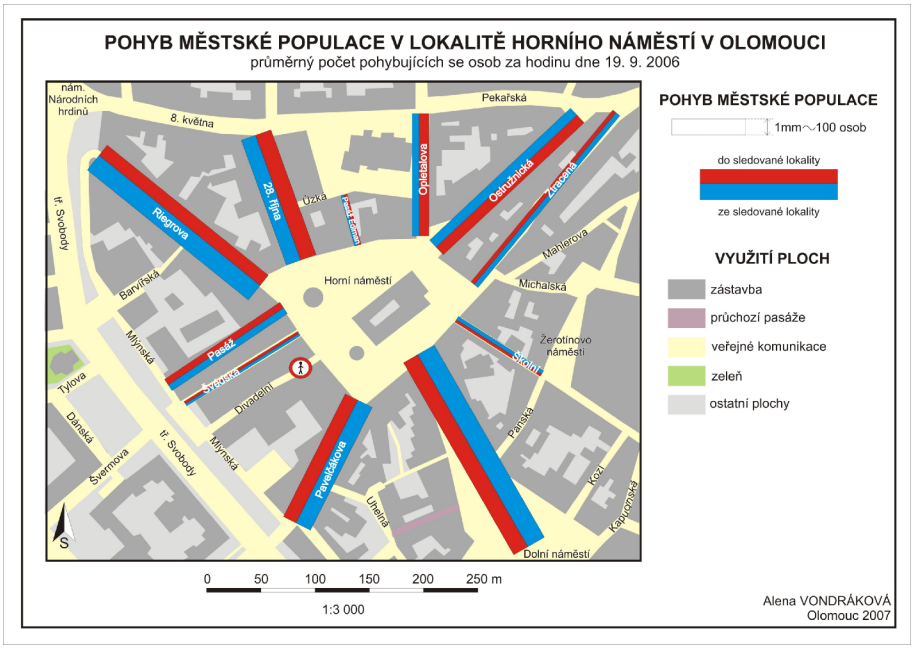

**Map 2.** Polygon diagrams - darts.




**Map 3.** Circular diagrams.




**Map 4.** Square diagrams.




**Map 5.** Line diagrams – "ribbons".

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