# An objective analysis and ranking of cities on environmental and social factors

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## 1. Introduction

In Hungary, 236 cities accounting for 65.7 percent of the country's population, were registered on January 1, 2001. Environmental factors in cities such as housing, transportation, air quality and public green space, etc., are important to the quality of life. But which cities have cleaner air, more urban parkland, or more pleasant climate? Which do a better job at organising traffic systems, waste management or public sanitation? Which cities are wasteful in their use of water or energy? To answer these questions, at least at a preliminary level, the so-called "Green Cities Index" which ranks cities on several environmental criteria, was developed (Cutter, S.L., 1992).

Ranking cities according to their environmental quality and level of environmental awareness is not a simple task. Over the years, many quality-of-life rankings comparing countries or cities, have appeared in special literature (Kerényi, A., 1995), although few have focused on environmental criteria (e.g. Cutter, S.L., 1992; Kerényi, A., 1995). In this study, 25 environmental indicators were initially considered for each of the 236 Hungarian cities. Indicators, which were not shared by all cities were subsequently omitted. As well, the cities were ranked by population and population density. However, these two parameters were not included for ranking according to the Green Cities Index, since larger and more densely populated cities do not necessarily have poorer environmental quality. Because environmental regulations in many cities have become increasingly more stringent, part of the data used in this study may be obsolete by publication date. Consequently, Green Cities Index rankings should be viewed as a measure of environmental quality and concern at a given point in time.

The data basis for the study are drawn from the statistical yearbooks of Hungarian counties and Budapest for 2000.

## 2. Environmental indicators

Seven different categories of environmental indicators ranging from water consumption to air quality were included in the Green Cities Index. Specific measures within each category were selected on the basis of data availability. Some related measures were combined to yield new, composite measures. Altogether 25 indicators were considered initially but only 19 were retained. The seven categories and their 19 indicator elements, are listed in Table 1.

Data on all 19 indicators are available for only 88 of the 236 cities in the data base. Hence, further analyses are based on those 88. Though these indicators are neither perfect nor exhaustive, they enable an overall comparison among the relevant cities.

Table 1.
Categories and Indicators Used for Compiling the Green Index
for Hungarian Cities and Counties

| CATEGORIES | INDICATORS | | |
|---|---|---|---|
| | Serial number | Elements | Units |
| **Water Consumption** | 1 | Water use | $m^3$ / capita / year |
| **Energy Consumption** | 2 | Gas consumption | $m^3$ / household / year |
| | 3 | Electric energy consumption | kWh / household / year |
| | 4 | Degree days | sum of heating and cooling degree days |
| **Public Utilities Supply** | 5 | Ratio of households connected to gas conduit network | percent |
| | 6 | Ratio of dwellings connected to drinking water conduit network | percent |
| | 7 | Ratio of dwellings connected to public sewerage system | percent |
| | 8 | Public sewerage system | m / km drinking water conduit |
| **Traffic** | 9 | Supply with passenger car | inhabitants per passenger car |
| **Waste management** | 10 | Drained-off waste water total | $m^3$ / capita / year |
| | 11 | Total waste removed | $m^3$ / capita / year |
| | 12 | Ratio of dwellings connected to regular waste removal system | percent |
| **Settlement amenities factors** | 13 | Public green area | $m^2$ / capita |
| | 14 | Ratio of constructed inner roads | percent |
| | 15 | Ratio of constructed public surfaces cleaned regularly | percent |
| | 16 | Housing | occupants / dwelling |
| **Air Quality** [ξ] | 17 | Average concentration of particulates deposited | g / $m^2$ / 30 days |
| | 18 | Average concentration of sulphur-dioxide | μg / $m^3$ |
| | 19 | Average concentration of nitrogen-dioxide | μg / $m^3$ |

[ξ] Based on average of non-heating half-year (200.04.01 – 2000.09.01) and average of heating half-year (2000.10.01 – 2000.03.31). Heating (cooling) degree-days are defined as the number of days when the mean temperature is above (below) 18°C, with each day weighted by the number of degrees above (below) 18°C. This parameter can be used as a measure of energy use for space heating (cooling) (Cutter, S,L. 1992). 18°C is considered the optimum temperature.

## 3. The Green Cities Index

### 3.1. Method

The Green City Index is derived as follows

(a) The statistics on each indicator for each city was compiled from the Year books

(b) Each indicator element is represented with a serial number (1 – 19). See column 2 of Table 1.

(c) For each indicator element, cities were ranked from the most environmentally friendly (1) to least friendly (88) based on their statistics as determined in step (a). These ranks represent city scores on each indicator. The scores are listed in Table 2 under the identifying serial number.

(d) The rank scores achieved for each city over the 19 indicator elements were averaged. The resulting figure is the City Green Index (column 3, Table 3).

(e) Finally, the Green City Indices were ranked to yield the Final Sequence (column 2, Table 3). The Final Sequence (FS) places the cities in rank order from the best (1) to the worst (88) based on step (d). FS is a rank of ranks.

It is noted that the indicator elements were not weighted to reflect their relative importance to environmental quality or overall contribution to making a city liveable. Rather, they illustrate how each city fared when compared to others.

Human activities are the greatest source of contaminants in the environment. Thus, population and population density might be important environmental factors. But their implications to environmental quality are freqently contradictory since increases in the size of either variables or both, do not automatically indicate a tendency towards poorer environmental quality. For example, compact and highly centralised cities with high population densities, have the advantage of decreasing passenger car traffic between city centre and the suburbs thus contributing to lower air pollution loads. However, such advantage may be mitigated by more concentrated sources of pollution and waste, and more congestion. On the other hand, cities that sprawl and are dispersed, resulting in lower population densities, may have a harder time providing mass transit, but they may have more open space. On balance, large centralised cities tend to have greater difficulty achieving the same level of environmental quality than smaller cities. To test the impact of population and population density on the Green Index, a second set of Final Sequence (modified sequence) based on 21 indicator elements – the nineteen original ones, plus population and population density – was derived.

Table 2.
Green cities rankings on the environmental indicators considered
(1 = best, 88 = worst)

| City | Environmental indicators | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. |
| Ajka | 40 | 60 | 49 | 76 | 79 | 43 | 24 | 81 | 48 | 52 | 41 | 67 | 28 | 67 | 18 | 49 | 61 | 73 | 24 |
| Baja | 71 | 41 | 31 | 41 | 23 | 46 | 54 | 36 | 26 | 73 | 28 | 64 | 11 | 55 | 73 | 16 | 86 | 20 | 27 |
| Balassagyarmat | 9 | 70 | 75 | 80 | 59 | 52 | 43 | 57 | 55 | 70 | 13 | 48 | 79 | 71 | 58 | 76 | 44 | 74 | 70 |
| Balatonalmádi | 82 | 49 | 15 | 61 | 71 | 41 | 44 | 37 | 10 | 43 | 84 | 86 | 38 | 81 | 51 | 2 | 12 | 53 | 18 |
| Balatonboglár | 73 | 38 | 52 | 13 | 30 | 63 | 25 | 16 | 3 | 49 | 42 | 83 | 18 | 37 | 1 | 6 | 17 | 4 | 13 |
| Balatonföldvár | 87 | 20 | 14 | 12 | 53 | 71 | 1 | 8 | 2 | 86 | 80 | 87 | 4 | 11 | 9 | 1 | 17 | 4 | 14 |
| Balatonfüred | 65 | 63 | 62 | 61 | 74 | 1 | 57 | 24 | 7 | 53 | 81 | 81 | 6 | 82 | 29 | 21 | 12 | 53 | 19 |
| Balatonlelle | 83 | 36 | 26 | 14 | 63 | 1 | 28 | 13 | 7 | 57 | 66 | 82 | 1 | 56 | 31 | 10 | 17 | 4 | 15 |
| Bátonyterenye | 4 | 37 | 33 | 81 | 45 | 66 | 68 | 73 | 83 | 7 | 37 | 63 | 27 | 29 | 13 | 25 | 22 | 64 | 40 |
| Békés | 23 | 35 | 37 | 58 | 20 | 58 | 83 | 68 | 80 | 6 | 21 | 50 | 72 | 70 | 16 | 33 | 77 | 86 | 26 |
| Békéscsaba | 30 | 23 | 23 | 56 | 19 | 73 | 63 | 80 | 44 | 77 | 34 | 15 | 42 | 54 | 33 | 21 | 43 | 80 | 30 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bonyhád | 15 | 52 | 67 | 6 | 37 | 48 | 15 | 15 | 24 | 29 | 25 | 1 | 55 | 16 | 56 | 73 | 78 | 26 | 23 |
| Budaörs | 86 | 64 | 58 | 60 | 7 | 80 | 35 | 2 | 1 | 87 | 68 | 37 | 75 | 84 | 64 | 82 | 24 | 9 | 65 |
| Budapest | 88 | 15 | 45 | 49 | 67 | 32 | 11 | 7 | 9 | 88 | 49 | 1 | 26 | 60 | 1 | 3 | 37 | 84 | 83 |
| Cegléd | 11 | 44 | 35 | 52 | 46 | 61 | 75 | 85 | 72 | 17 | 24 | 75 | 78 | 79 | 61 | 63 | 23 | 2 | 61 |
| Csongrád | 43 | 24 | 4 | 44 | 38 | 77 | 78 | 83 | 76 | 11 | 44 | 84 | 32 | 76 | 30 | 4 | 7 | 68 | 75 |
| Debrecen | 36 | 32 | 24 | 69 | 44 | 33 | 38 | 34 | 58 | 79 | 17 | 19 | 68 | 68 | 26 | 38 | 50 | 61 | 20 |
| Dombóvár | 31 | 71 | 72 | 4 | 81 | 75 | 67 | 72 | 59 | 18 | 52 | 73 | 30 | 53 | 22 | 33 | 56 | 24 | 22 |
| Dorog | 17 | 83 | 85 | 23 | 76 | 1 | 1 | 65 | 62 | 35 | 45 | 12 | 53 | 25 | 35 | 35 | 45 | 36 | 78 |
| Dunakeszi | 64 | 67 | 68 | 50 | 1 | 49 | 65 | 59 | 13 | 33 | 43 | 49 | 82 | 86 | 17 | 65 | 1 | 10 | 42 |
| Dunaújváros | 78 | 1 | 12 | 37 | 4 | 36 | 10 | 4 | 73 | 71 | 76 | 68 | 9 | 40 | 25 | 27 | 88 | 72 | 52 |
| Eger | 63 | 26 | 18 | 75 | 26 | 50 | 23 | 30 | 34 | 68 | 83 | 45 | 41 | 47 | 11 | 15 | 38 | 52 | 29 |
| Esztergom | 14 | 85 | 70 | 24 | 78 | 40 | 53 | 44 | 48 | 32 | 15 | 23 | 74 | 74 | 40 | 61 | 6 | 38 | 88 |
| Fonyód | 85 | 29 | 6 | 10 | 73 | 1 | 16 | 86 | 6 | 56 | 75 | 76 | 3 | 66 | 21 | 14 | 17 | 4 | 16 |
| Gárdony | 84 | 33 | 3 | 39 | 56 | 47 | 5 | 50 | 15 | 45 | 86 | 72 | 15 | 7 | 87 | 71 | 33 | 83 | 66 |
| Göd | 74 | 81 | 69 | 51 | 18 | 38 | 82 | 60 | 25 | 8 | 4 | 21 | 87 | 88 | 64 | 83 | 1 | 10 | 43 |
| Gyöngyös | 62 | 31 | 46 | 70 | 55 | 65 | 62 | 14 | 23 | 69 | 35 | 74 | 40 | 30 | 52 | 11 | 30 | 56 | 12 |
| Győr | 19 | 6 | 34 | 33 | 9 | 67 | 32 | 31 | 21 | 84 | 79 | 9 | 14 | 28 | 10 | 43 | 76 | 62 | 76 |
| Gyula | 66 | 21 | 22 | 57 | 15 | 69 | 58 | 58 | 52 | 64 | 39 | 78 | 19 | 42 | 41 | 19 | 39 | 79 | 10 |
| Hajdúnánás | 37 | 48 | 61 | 74 | 46 | 83 | 85 | 77 | 87 | 21 | 8 | 11 | 76 | 65 | 47 | 57 | 48 | 29 | 6 |
| Hajdúszoboszló | 20 | 43 | 10 | 68 | 25 | 1 | 86 | 74 | 68 | 31 | 65 | 79 | 77 | 18 | 63 | 47 | 16 | 34 | 31 |
| Hatvan | 41 | 59 | 57 | 65 | 14 | 1 | 84 | 84 | 51 | 14 | 88 | 40 | 31 | 22 | 71 | 30 | 62 | 44 | 9 |
| Jászberény | 18 | 51 | 59 | 64 | 43 | 58 | 74 | 42 | 44 | 19 | 73 | 71 | 67 | 30 | 85 | 17 | 9 | 23 | 8 |
| Kalocsa | 54 | 46 | 60 | 45 | 22 | 87 | 50 | 23 | 40 | 55 | 82 | 62 | 44 | 8 | 57 | 45 | 66 | 21 | 11 |
| Kaposvár | 47 | 14 | 38 | 1 | 21 | 24 | 29 | 29 | 36 | 44 | 70 | 39 | 52 | 45 | 7 | 40 | 40 | 19 | 38 |
| Kazincbarcika | 24 | 3 | 5 | 87 | 48 | 41 | 13 | 40 | 84 | 24 | 47 | 14 | 33 | 21 | 20 | 47 | 73 | 85 | 39 |
| Kecskemét | 29 | 25 | 21 | 46 | 32 | 72 | 66 | 66 | 18 | 60 | 27 | 43 | 70 | 78 | 34 | 31 | 84 | 27 | 59 |
| Keszthely | 56 | 39 | 54 | 22 | 52 | 51 | 30 | 1 | 14 | 41 | 53 | 41 | 50 | 57 | 68 | 21 | 83 | 31 | 2 |
| Kistelek | 39 | 22 | 50 | 41 | 27 | 82 | 88 | 87 | 77 | 3 | 60 | 88 | 45 | 80 | 53 | 4 | 42 | 66 | 77 |
| Kisvárda | 21 | 68 | 73 | 72 | 39 | 78 | 76 | 20 | 60 | 80 | 11 | 1 | 81 | 14 | 50 | 81 | 55 | 59 | 73 |
| Komárom | 57 | 76 | 76 | 40 | 68 | 21 | 48 | 39 | 42 | 63 | 61 | 26 | 34 | 64 | 79 | 41 | 54 | 35 | 54 |
| Komló | 16 | 47 | 48 | 21 | 86 | 15 | 4 | 12 | 82 | 22 | 12 | 55 | 13 | 13 | 70 | 27 | 63 | 32 | 68 |
| Kőszeg | 34 | 54 | 78 | 47 | 71 | 44 | 18 | 38 | 63 | 47 | 56 | 54 | 17 | 24 | 49 | 76 | 40 | 1 | 32 |
| Lenti | 58 | 9 | 39 | 26 | 34 | 17 | 72 | 55 | 22 | 26 | 29 | 1 | 62 | 43 | 59 | 43 | 87 | 33 | 1 |
| Lőrinci | 12 | 74 | 83 | 66 | 42 | 86 | 87 | 88 | 81 | 4 | 7 | 46 | 88 | 1 | 38 | 45 | 28 | 49 | 3 |
| Mátészalka | 27 | 69 | 74 | 78 | 60 | 21 | 69 | 10 | 39 | 61 | 20 | 52 | 66 | 17 | 43 | 73 | 53 | 70 | 81 |
| Miskolc | 35 | 10 | 7 | 85 | 28 | 17 | 21 | 17 | 79 | 48 | 10 | 13 | 29 | 59 | 46 | 25 | 32 | 82 | 57 |
| Mohács | 13 | 42 | 25 | 5 | 74 | 55 | 46 | 71 | 73 | 51 | 55 | 44 | 48 | 9 | 76 | 12 | 70 | 25 | 41 |
| Mór | 32 | 77 | 77 | 38 | 58 | 1 | 50 | 63 | 47 | 34 | 63 | 66 | 46 | 77 | 77 | 76 | 82 | 88 | 63 |
| Mosonmagyaróvár | 68 | 75 | 84 | 36 | 77 | 60 | 49 | 19 | 26 | 78 | 72 | 33 | 54 | 44 | 55 | 61 | 71 | 77 | 86 |
| Nagykanizsa | 60 | 7 | 2 | 30 | 15 | 17 | 22 | 5 | 32 | 50 | 5 | 30 | 43 | 35 | 54 | 36 | 79 | 41 | 5 |
| Nagymaros | 75 | 88 | 27 | 29 | 80 | 26 | 73 | 45 | 75 | 16 | 62 | 85 | 86 | 23 | 88 | 17 | 1 | 10 | 44 |
| Nyíregyháza | 53 | 40 | 29 | 73 | 39 | 36 | 40 | 43 | 30 | 46 | 19 | 59 | 21 | 73 | 19 | 76 | 68 | 46 | 82 |
| Orosháza | 33 | 53 | 16 | 48 | 30 | 85 | 77 | 70 | 71 | 54 | 50 | 65 | 65 | 75 | 44 | 7 | 58 | 81 | 28 |
| Oroszlány | 5 | 80 | 66 | 28 | 87 | 1 | 6 | 3 | 70 | 36 | 18 | 27 | 35 | 12 | 8 | 41 | 69 | 55 | 60 |
| Ózd | 1 | 12 | 11 | 82 | 50 | 79 | 70 | 78 | 86 | 9 | 2 | 56 | 8 | 15 | 77 | 36 | 49 | 76 | 49 |
| Pápa | 61 | 28 | 64 | 34 | 33 | 44 | 55 | 69 | 65 | 82 | 38 | 10 | 64 | 41 | 72 | 64 | 51 | 37 | 58 |
| Pásztó | 2 | 55 | 65 | 79 | 35 | 29 | 79 | 82 | 57 | 1 | 54 | 76 | 83 | 32 | 74 | 31 | 36 | 63 | 48 |
| Pécs | 42 | 13 | 41 | 16 | 49 | 24 | 17 | 53 | 34 | 39 | 14 | 58 | 10 | 58 | 75 | 21 | 65 | 57 | 74 |
| Pilisvörösvár | 52 | 87 | 55 | 25 | 10 | 62 | 80 | 9 | 42 | 5 | 23 | 47 | 2 | 85 | 64 | 87 | 1 | 10 | 45 |
| Sajószentpéter | 3 | 61 | 30 | 88 | 29 | 84 | 71 | 26 | 88 | 27 | 59 | 34 | 71 | 19 | 62 | 84 | 85 | 87 | 71 |
| Salgótarján | 59 | 45 | 19 | 86 | 57 | 1 | 36 | 76 | 66 | 75 | 3 | 35 | 57 | 27 | 14 | 8 | 63 | 75 | 51 |
| Siklós | 50 | 66 | 88 | 1 | 88 | 54 | 59 | 79 | 46 | 12 | 1 | 61 | 22 | 1 | 1 | 52 | 45 | 30 | 47 |
| Siófok | 77 | 30 | 20 | 27 | 54 | 55 | 34 | 32 | 4 | 59 | 74 | 57 | 16 | 39 | 27 | 9 | 17 | 4 | 17 |
| Sopron | 45 | 16 | 42 | 19 | 13 | 1 | 12 | 33 | 28 | 81 | 51 | 1 | 37 | 51 | 23 | 57 | 80 | 67 | 85 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sümeg | 28 | 57 | 51 | 3 | 66 | 1 | 61 | 62 | 41 | 10 | 32 | 80 | 85 | 69 | 82 | 80 | 67 | 45 | 55 |
| Százhalombatta | 67 | 4 | 71 | 59 | 1 | 30 | 45 | 25 | 11 | 62 | 85 | 16 | 25 | 32 | 1 | 66 | 8 | 17 | 33 |
| Szécsény | 6 | 78 | 86 | 83 | 61 | 15 | 56 | 51 | 64 | 15 | 87 | 18 | 47 | 32 | 69 | 52 | 25 | 60 | 72 |
| Szeged | 81 | 5 | 17 | 17 | 8 | 23 | 42 | 52 | 50 | 83 | 67 | 20 | 51 | 61 | 32 | 12 | 27 | 69 | 87 |
| Székesfehérvár | 72 | 8 | 31 | 35 | 3 | 31 | 18 | 28 | 12 | 76 | 58 | 28 | 23 | 20 | 42 | 55 | 56 | 78 | 84 |
| Szekszárd | 44 | 50 | 43 | 7 | 69 | 17 | 13 | 27 | 17 | 66 | 31 | 60 | 59 | 52 | 45 | 38 | 52 | 18 | 50 |
| Szentendre | 80 | 84 | 56 | 9 | 41 | 57 | 39 | 56 | 5 | 42 | 69 | 69 | 56 | 62 | 81 | 66 | 15 | 16 | 67 |
| Szentlőrinc | 26 | 79 | 79 | 11 | 83 | 76 | 37 | 49 | 69 | 23 | 33 | 51 | 73 | 1 | 84 | 86 | 59 | 42 | 34 |
| Szigetvár | 8 | 73 | 82 | 8 | 84 | 1 | 63 | 48 | 54 | 28 | 6 | 42 | 39 | 1 | 39 | 71 | 75 | 28 | 64 |
| Szolnok | 70 | 17 | 13 | 55 | 24 | 35 | 31 | 18 | 55 | 85 | 78 | 38 | 7 | 45 | 60 | 20 | 47 | 22 | 7 |
| Szombathely | 48 | 18 | 36 | 43 | 11 | 39 | 8 | 46 | 20 | 58 | 26 | 31 | 63 | 36 | 1 | 49 | 26 | 10 | 56 |
| Tapolca | 22 | 34 | 47 | 30 | 64 | 1 | 47 | 64 | 37 | 20 | 36 | 29 | 36 | 38 | 24 | 70 | 11 | 48 | 25 |
| Tata | 46 | 82 | 80 | 15 | 70 | 74 | 60 | 54 | 28 | 40 | 9 | 24 | 5 | 50 | 48 | 55 | 10 | 38 | 35 |
| Tatabánya | 10 | 86 | 28 | 18 | 85 | 34 | 20 | 11 | 61 | 38 | 16 | 1 | 24 | 6 | 12 | 27 | 74 | 58 | 80 |
| Tiszaújváros | 55 | 2 | 9 | 84 | 35 | 26 | 3 | 6 | 33 | 72 | 77 | 24 | 20 | 48 | 1 | 49 | 12 | 50 | 21 |
| Tiszavasvári | 25 | 56 | 63 | 71 | 51 | 68 | 81 | 67 | 85 | 2 | 40 | 1 | 58 | 83 | 83 | 85 | 34 | 47 | 62 |
| Vác | 49 | 27 | 40 | 53 | 5 | 26 | 27 | 47 | 38 | 74 | 57 | 32 | 61 | 72 | 37 | 59 | 31 | 3 | 69 |
| Várpalota | 51 | 62 | 53 | 32 | 82 | 1 | 7 | 75 | 67 | 37 | 64 | 22 | 60 | 26 | 15 | 52 | 72 | 71 | 36 |
| Veresegyház | 79 | 72 | 1 | 53 | 6 | 70 | 52 | 22 | 31 | 13 | 46 | 53 | 80 | 87 | 64 | 88 | 1 | 10 | 46 |
| Veszprém | 69 | 19 | 44 | 63 | 12 | 63 | 33 | 41 | 18 | 65 | 48 | 36 | 69 | 63 | 28 | 66 | 60 | 51 | 53 |
| Záhony | 38 | 58 | 87 | 77 | 62 | 88 | 9 | 21 | 78 | 25 | 22 | 16 | 84 | 1 | 86 | 59 | 35 | 65 | 79 |
| Zalaegerszeg | 76 | 11 | 8 | 20 | 17 | 53 | 41 | 35 | 15 | 67 | 30 | 1 | 12 | 10 | 36 | 73 | 81 | 40 | 4 |
| Zirc | 7 | 65 | 81 | 67 | 65 | 81 | 26 | 61 | 53 | 30 | 71 | 70 | 49 | 49 | 80 | 66 | 28 | 43 | 37 |

### 3.1. Ranking the Cities – Final Sequence Results

The final sequence of the cities shows some surprising results (Table 3.) Nagykanizsa, near the Hungarian-Croatian border, is the highest-ranked city. Though ranks achieved in concentration of deposited particlates (79), water consumption (60), ratio of cleaned public area total (54) and waste water drainage (50) are relatively poor, the city's high rank placing in gas and electric energy consumption (ranked 7, and 2, respectively), development of the public sewerage system (5) and waste removal total, enables it to win its coveted position as the most environmentally friendly city in the country. Nagykanizsa is followed by settlements around Lake Balaton: Balatonföldvár (2), Balatonboglár (3) and Balatonlelle (4). Among the major cities, Szombathely (5), Zalaegerszeg (7) and Kaposvár (8) are stand out (Table 3.).

Mosonmagyaróvár (88), Mór (87) and Balassagyarmat (86) are the worst ranked cities (Table 3) inspite of their relatively good placing in a number of indicators. Mosonmagyaróvár is 19$^{th}$ ranked in development of public sewerage system and 33$^{rd}$ in the the ratio of dwellings connected to regular waste removal system. Mór is ranked 1$^{st}$ in both the ratio of households connected to the public water conduit network and its per capita water consumption. Balassagyarmat is 9$^{th}$ in per capita water consumption and 13$^{th}$ in waste removal total. Summing up, no city is found consistently either at the top or the bottom half of the rankings on all environmental indicators. All cities in Hungary are characterised by a mix of favourable and less favourable environmental quality.

Environmental quality of Hungarian cities is best in the western and southern parts of Transdanubia, where Green Cities Index values are smallest. There are no clear regional patterns in the rest of the country (Fig. 1.).

### 3.2. Examining the potential impact of population on the Green Index

The possible consequence of including population and population density in the Green Index was examined by comparing the rankings obtained with the inclusion of the two variables (modified Final Sequence) and those calculated without them (original Final Sequence). The Spearman's rank correlation coefficient, which was utilized for this purpose,

yielded a value of of 0.94 significant at the 99.9% confidence level. This means that there is a significant connection between the original and modified groups of indicators. We would be in error once in 1000 cases. Hence, the original final sequence is not substantially influenced by not considering population and population density. This result indicates that, although not perfect, the Green Cities Index, as calculated, is a reasonably fair method of providing an environmental rating for cities in Hungary.

## 4. The Green Counties Index

The 19 Hungarian counties were also ranked from the most environmentally friendly to the worst. The same environmental indicators used for the cities were applied. The so-called Green Counties Index values are the average of the scores achieved by all cities within the county. The average scores on each of the 19 indicator elements are tabulated in Table 4. The Green Counties Index, similar to the cities, is effectively a rank of ranks. Low numbers indicate better environmental quality.

The final rank order of the counties also shows some interesting results (Table 5). Somogy is the greenest county of Hungary. Though it is almost the most wasteful in water consumption (ranked 18) and average in waste removal (13), its favourable ranking in public green area total (1), average sulphur dioxide concentration (1), energy requirement and electric energy consumption (2 and 4, respectively), regularly cleaned constructed public surfaces (3) and average concentration of particulates deposited (3) make it the most environmentally county in the nation. Somogy is followed by Zala and Vas respectively. Both Zala and Vas score well in environmental factors related to infrastructural and social developments and to a lesser extent, in physical factors such as air quality and green areas. The Green Counties Index is a good measure of the general development of the counties. It well reflects the fact that the western part of the country, namely Transdanubia, is much more environment-sensitively developed than eastern Hungary.

The seven counties, which did the best are all found in Transdanubia (Somogy, Zala, Vas, Komárom-Esztergom, Veszprém, Baranya and Győr-Moson-Sopron) while the five counties, which did the worst, are all found in the Great Hungarian Plain: Szabolcs-Szatmár-Bereg, Hajdú-Bihar, Békés, Bács-Kiskun and Heves (Table 5). Szabolcs-Szatmár-Bereg, Hajdú-Bihar and Békés, however, do well in some indicators. For example, in Szabolcs-Szatmár-Bereg county, waste removal total (ranked 2), waste water drainage (4) and management of public sewerage system (5) are all very favourable. In Hajdú-Bihar county, per capita water consumption (2), waste removal (3) and the average nitrogen-dioxide concentration (4) rank well. In Békés county, the number of inhabitants per dwelling (2), electric energy consumption per capita (3), dwellings connected to gas conduit (5) and the average nitrogen-dioxide concentration (6) are among the best in the country.

As in cities, no one county is found consistently at either at the top or the bottom half of the rankings on all indicators. In general, Transdanubian counties enjoy better placement than counties in eastern Hungary (Fig. 2).

## 5. Objective classification of the cities and counties

### 5.1. Method

Objective classification of the cities and counties examined was made with the help of cluster analysis. The aim was to group cities and counties objectively based on similarity in environmental conditions. The basis for the classification is to maximise the homogeneity of cities and counties within the clusters and maximise the heterogeneity among them. The database for the analysis consisted of city (county) scores in each of the 19 environmental indicators measured in 2000.

Table 3.
Average of rankings of the environmental indicators considered; namely, the Green Cities Index, and the final sequence of the cities (1 = best, 88 = worst)

| City | Final sequence | Green Cities Index |
|---|---|---|
| Nagykanizsa | 1 | 29.89 |
| Balatonföldvár | 2 | 30.58 |
| Balatonboglár | 3 | 30.68 |
| Balatonlelle | 4 | 32.11 |
| Szombathely | 5 | 32.89 |
| Tiszaújváros | 6 | 33.00 |
| Zalaegerszeg | 7 | 33.16 |
| Kaposvár | 8 | 33.32 |
| Siófok | 9 | 34.32 |
| Százhalombatta | 10 | 34.63 |
| Fonyód | 11 | 34.74 |
| Bonyhád | 12 | 34.79 |
| Tapolca | 13 | 35.95 |
| Tatabánya | 14 | 36.26 |
| Miskolc | 15 | 36.84 |
| Komló | 16 | 37.16 |
| Oroszlány | 17 | 37.21 |
| Lenti | 18 | 37.68 |
| Szolnok | 19 | 38.26 |
| Győr | 20 | 38.58 |
| Sopron | 21 | 39.05 |
| Kazincbarcika | 22 | 39.37 |
| Budapest | 23 | 39.74 |
| Székesfehérvár | 24 | 39.89 |
| Szekszárd | 25 | 39.91 |
| Pécs | 26 | 40.00 |
| Keszthely | 27 | 40.32 |
| Eger | 28 | 40.74 |
| Dunaújváros | 29 | 41.21 |
| Pilisvörösvár | 30 | 41.63 |
| Siklós | 31 | 42.26 |
| Szeged | 32 | 42.32 |
| Vác | 33 | 42.47 |
| Dorog | 34 | 42.74 |
| Debrecen | 35 | 42.84 |
| Szigetvár | 36 | 42.88 |
| Bátonyterenye | 37 | 43.00 |
| Baja | 38 | 43.26 |
| Tata | 39 | 43.32 |
| Mohács | 40 | 43.95 |
| Gyöngyös | 41 | 44.05 |
| Békéscsaba | 42 | 44.21 |
| Kőszeg | 43 | 44.37 |
| Ózd | 44 | 44.53 |

| City | Final sequence | Green Cities Index |
|---|---|---|
| Gyula | 45 | 44.63 |
| Balatonfüred | 46 | 44.79 |
| Salgótarján | 47 | 44.89 |
| Jászberény | 48 | 45.00 |
| Hajdúszoboszló | 49 | 45.05 |
| Dunakeszi | 50 | 45.47 |
| Hatvan | 51 | 45.63 |
| Veresegyház | 52 | 46.00 |
| Balatonalmádi | 53 | 46.21 |
| Kalocsa | 54 | 46.27 |
| Várpalota | 55 | 46.58 |
| Kecskemét | 56 | 46.74 |
| Nyíregyháza | 57 | 46.95 |
| Gárdony | 58 | 47.21 |
| Csongrád | 59 | 47.26 |
| Veszprém | 60 | 47.42 |
| Esztergom | 61 | 47.74 |
| Göd | 62 | 47.78 |
| Dombóvár | 63 | 48.16 |
| Békés | 64 | 48.37 |
| Lőrinci | 65 | 48.84 |
| Nagymaros | 66 | 50.00 |
| Cegléd | 67 | 50.74 |
| Hajdúnánás | 68 | 50.84 |
| Pápa | 69 | 51.05 |
| Szentendre | 70 | 51.14 |
| Sümeg | 71 | 51.32 |
| Szécsény | 72 | 51.42 |
| Komárom | 73 | 51.47 |
| Ajka | 74 | 51.58 |
| Pásztó | 75 | 51.63 |
| Mátészalka | 76 | 51.74 |
| Budaörs | 77 | 52.00 |
| Záhony | 78 | 52.11 |
| Szentlőrinc | 79 | 52.37 |
| Orosháza | 80 | 53.16 |
| Kisvárda | 81 | 53.26 |
| Zirc | 82 | 54.16 |
| Kistelek | 83 | 54.26 |
| Tiszavasvári | 84 | 55.89 |
| Sajószentpéter | 85 | 56.79 |
| Balassagyarmat | 86 | 58.05 |
| Mór | 87 | 58.68 |
| Mosonmagyaróvár | 88 | 59.21 |

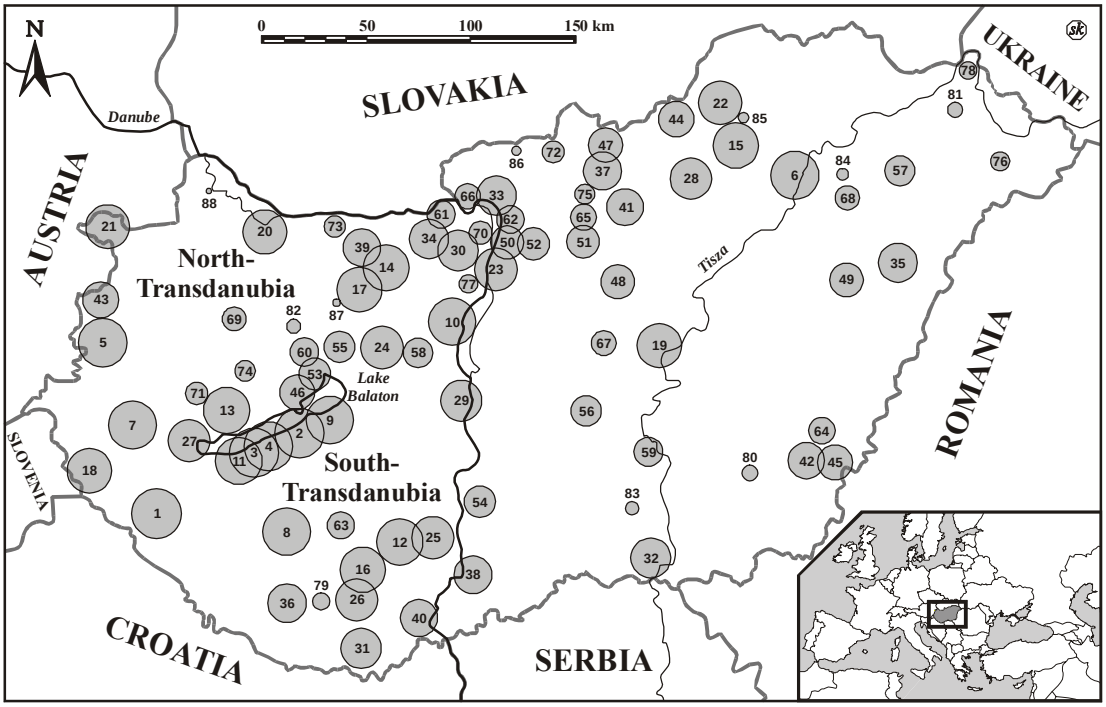


Fig. 1.
Environmental quality of cities according to their Green Cities Index.
[High values (circles with large area) = favourable;
Low values (circles with small area) = disadvanted]
The numbers indicate the final sequence of the cities
(1 = best, 88 = worst; see Table 3)

Table 4.
Green counties rankings on the environmental indicators considered
(1 = best, 19 = worst; the numbers indicate the counties)

| County | Environmental indicators | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. |
| Bács-Kiskun | 15 | 6 | 5 | 10 | 10 | 19 | 18 | 19 | 5 | 10 | 3 | 19 | 18 | 13 | 13 | 3 | 18 | 6 | 8 |
| Baranya | 11 | 13 | 17 | 1 | 17 | 9 | 6 | 6 | 10 | 3 | 6 | 13 | 2 | 9 | 17 | 7 | 15 | 7 | 12 |
| Békés | 10 | 5 | 3 | 12 | 5 | 18 | 17 | 18 | 16 | 13 | 7 | 17 | 14 | 18 | 8 | 2 | 12 | 19 | 6 |
| Borsod-Abaúj-Zemplén | 1 | 17 | 8 | 19 | 12 | 14 | 10 | 4 | 19 | 2 | 3 | 5 | 16 | 4 | 11 | 11 | 13 | 18 | 11 |
| Csongrád | 16 | 2 | 2 | 8 | 2 | 15 | 15 | 15 | 14 | 18 | 16 | 11 | 9 | 12 | 7 | 1 | 2 | 16 | 18 |
| Fejér | 14 | 10 | 7 | 7 | 3 | 2 | 8 | 2 | 9 | 14 | 17 | 7 | 10 | 2 | 15 | 17 | 17 | 17 | 15 |
| Győr-Moson-Sopron | 13 | 11 | 18 | 6 | 6 | 5 | 3 | 9 | 1 | 19 | 19 | 1 | 5 | 8 | 1 | 15 | 16 | 15 | 19 |
| Hajdú-Bihar | 2 | 9 | 11 | 15 | 14 | 12 | 19 | 16 | 17 | 15 | 3 | 10 | 19 | 17 | 12 | 15 | 7 | 9 | 4 |
| Heves | 7 | 14 | 12 | 16 | 7 | 13 | 12 | 14 | 11 | 17 | 18 | 14 | 17 | 6 | 9 | 4 | 8 | 11 | 3 |
| Jász-Nagykun-Szolnok | 4 | 7 | 6 | 14 | 9 | 10 | 16 | 13 | 18 | 8 | 8 | 18 | 13 | 14 | 19 | 6 | 4 | 4 | 2 |
| Komárom-Esztergom | 5 | 19 | 14 | 5 | 19 | 3 | 2 | 3 | 12 | 9 | 11 | 2 | 8 | 3 | 5 | 10 | 10 | 10 | 17 |
| Nógrád | 3 | 16 | 13 | 18 | 15 | 1 | 9 | 17 | 15 | 16 | 15 | 6 | 12 | 7 | 4 | 5 | 9 | 14 | 14 |
| Pest | 17 | 18 | 9 | 11 | 1 | 16 | 13 | 10 | 2 | 1 | 1 | 16 | 3 | 19 | 18 | 19 | 1 | 3 | 13 |
| Somogy | 18 | 3 | 4 | 2 | 11 | 8 | 4 | 8 | 4 | 5 | 13 | 8 | 1 | 11 | 3 | 8 | 3 | 1 | 5 |
| Szabolcs-Szatmár-Bereg | 8 | 12 | 16 | 17 | 13 | 17 | 14 | 5 | 13 | 4 | 2 | 15 | 11 | 16 | 10 | 18 | 14 | 13 | 16 |
| Tolna | 6 | 15 | 19 | 4 | 18 | 11 | 11 | 12 | 7 | 7 | 11 | 12 | 15 | 10 | 16 | 9 | 11 | 4 | 7 |
| Vas | 9 | 4 | 15 | 9 | 8 | 4 | 5 | 7 | 6 | 11 | 13 | 4 | 6 | 5 | 2 | 12 | 5 | 2 | 10 |
| Veszprém | 12 | 8 | 10 | 13 | 16 | 6 | 1 | 11 | 8 | 6 | 9 | 9 | 7 | 15 | 6 | 12 | 6 | 12 | 9 |
| Zala | 19 | 1 | 1 | 3 | 4 | 7 | 7 | 1 | 3 | 12 | 9 | 3 | 4 | 1 | 14 | 12 | 19 | 8 | 1 |

Table 5.
Average of rankings of the environmental indicators considered;
namely, the Green Counties Index, and the final sequence of the counties
(1 = best, 19 = worst; the numbers indicate the counties)

| County | Final sequence | Green Counties Index |
|---|---|---|
| Somogy | 1 | 6.32 |
| Zala | 2 | 6.79 |
| Vas | 3 | 7.21 |
| Komárom-Esztergom | 4 | 8.79 |
| Veszprém | 5 | 9.26 |
| Baranya | 6 | 9.53 |
| Győr-Moson-Sopron | 7 | 10.00 |
| Pest | 8 | 10.05 |
| Fejér | 9 | 10.16 |
| Jász-Nagykun-Szolnok | 10 | 10.16 |
| Borsod-Abaúj-Zemplén | 11 | 10.42 |
| Csongrád | 12 | 10.47 |
| Tolna | 13 | 10.79 |
| Nógrád | 14 | 11.00 |
| Heves | 15 | 11.21 |
| Bács-Kiskun | 16 | 11.47 |
| Békés | 17 | 11.58 |
| Hajdú-Bihar | 18 | 11.89 |
| Szabolcs-Szatmár-Bereg | 19 | 12.32 |

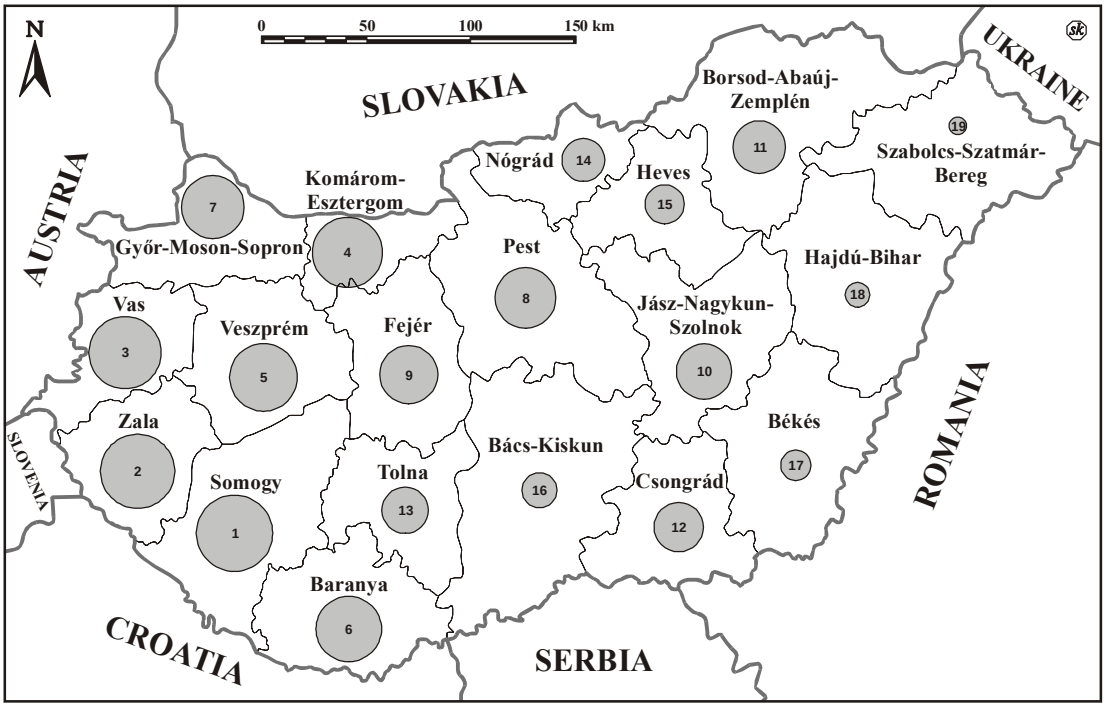


Fig. 2.
Environmental quality of counties according to their Green Counties Index.
[High values (circles with large area) = favourable;
Low values (circles with small area) = disadvanted]
The numbers indicate the final sequence of the counties
(1 = best, 19 = worst; see Table 5)

## 5.2. Results

### 5.2.1. Cities

The 88 cities were divided into 6 groups. Three groups (Groups 2, 4 and 5) have few cities within them (Fig. 3). Group 2 contains three settlements in Zala county (Nagykanizsa, Zalaegerszeg, Lenti), as well as Bonyhád, Keszthely and Dunaújváros. Four cities in Group 4 are located in the Lake Balaton region (Balatonalmádi, Balatonlelle, Fonyód, Balatonföldvár), the remaining two, Csongrád and Kistelek, lie east. Group 5 cities cluster around Budapest (Göd, Veresegyház, Pilisvörösvár, Dunakeszi). Three groups contain more than ten cities each; 14 in Group 1, 30 in Group 2 and 28 in Group 6.

The 6 groups of the cities, considered to be the most homogenous ones according to the cluster analysis, do not form a comprehensive (contiguous) spatial system. All the 14 cities of Group 1 are found either in eastern or northern Hungary, indicating considerable dispersion. Group 2 consists of 6 Transdanubian settlements, 4 are located in the southwestern part of Transdanubia, while the other two are far from them. The 30 cities of Group 3 also exhibit considerable spatial dispersion. Here, two distinct sub-groups are found; one in the southern part of Transdanubia and the other in the northern part. Four cities in Group 4 are found around Lake Balaton, while the other two are in the southern part of the Great Hungarian Plain. All the 4 cities of Group 5 are found around Budapest. Though settlements belonging to Group 6 (28 cities) show density junctions in the middle part of Transdanubia, south of Budapest and Northern Hungary, they are considerably dispersed (Fig. 3).

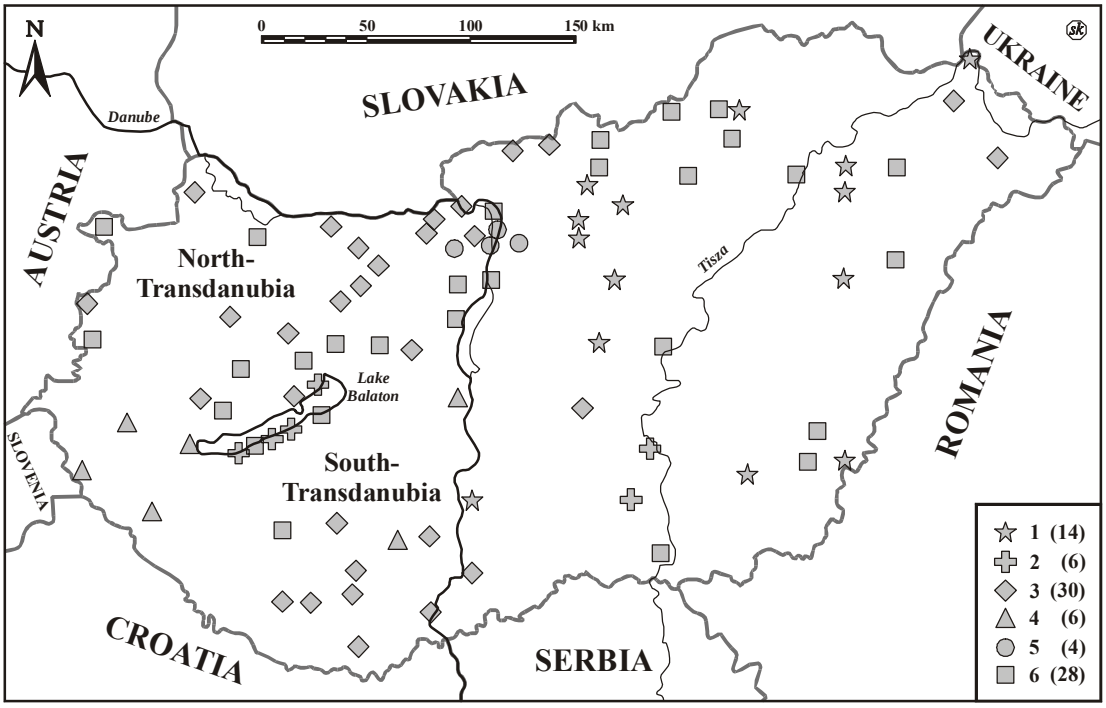


Fig. 3.
Spatial distribution of cities, with symbols of their 6 clusters produced by using cluster analysis. [Right and down the sign, serial number of the cluster and the number of cities in the cluster (in parenthesis) are found.]

### 5.2.2. Counties

Environmental indicators for the counties, as basic data, were created by averaging scores for the cities belonging to each county. As a result, 6 groups of the counties were determined. Group A consists of Baranya, Tolna, Vas, Veszprém and Komárom-Esztergom counties; Group B comprises Fejér, Zala and Somogy counties. Group C involves only Győr-

Moson-Sopron county. Group D includes the counties of the southern part of the Great Hungarian Plain (Békés, Csongrád and Bács-Kiskun counties). While Group E, the largest one, contains six counties (Heves, Nógrád, Hajdú-Bihar, Jász-Nagykun-Szolnok, Borsod-Abaúj-Zemplén and Szabolcs-Szatmár-Bereg), Group F, has only one – Pest.

The grouping of counties by using cluster analysis, separated regions more clearly. The southern part of the Great Hungarian Plain (Bács-Kiskun, Csongrád and Békés counties) is well defined. The middle part of the Great Hungarian Plain and Northern Hungary (Jász-Nagykun-Szolnok, Hajdú-Bihar, Nógrád, Heves, Borsod-Abaúj-Zemplén and Szabolcs-Szatmár-Bereg counties) stand out as well. Zala, Somogy and Fejér counties form a distinct region as do regions representing Vas, Veszprém and Komárom-Esztergom counties; Baranya and Tolna; Győr-Moson-Sopron and Pest.


Fig. 4.
Spatial distribution of counties, with symbols of their 6 clusters produced by using cluster analysis. [Right and down the sign, serial number of the cluster and the number of cities in the cluster (in parenthesis) are found.]

## 6. Conclusion

The aim of the study was to rank and classify Hungarian cities and counties according to their environmental quality and level of environmental awareness.

The top 5 most environmentally friendly cities are, in descending order, Nagykanizsa, Balatonföldvár, Balatonboglár, Balatonlelle and Szombathely. The bottom five are, starting with the worst, Mosonmagyaróvár, Mór, Balassagyarmat, Sajószentpéter and Tiszavasvári. Cities situated in the western and southwestern part of Transdanubia have the best environmental quality. In the rest of the country, cities with either favourable or unfavourable positions, are mixed, forming no comprehensive regional patterns.

Whereas the top 3 counties are Somogy, Vas and Zala; Szabolcs-Szatmár-Bereg, Hajdú-Bihar and Békés counties are the most disadvantaged. Environmentally most friendly counties occur in Transdanubia clearly separated from the most unfriendly ones found in eastern Hungary.

While the 6 groups of cities, considered most homogenous, do not form comprehensive spatial patterns, the classification of the counties according to cluster analysis defines six clear regions.

***Acknowledgement***

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