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Spatial aspects of the ambulance service in Hungary

Introduction

The investigation of the structural components of human life quality (both spatial and temporal) has yielded substantial results in recent times (Bácsy & Vizi 1998, Fekete 2006, Hankiss & Manchin & Füstös 1978, Kopp & Kovács 2006). The relevance of this issue in current day Hungary is ensured by the fact that the political-social transition is prolonged and is accompanied by strengthening social and spatial polarisation. Experts in spatial planning and development have gradually recognised the importance of knowledge in this field, and the creators of concepts and plans now rely on these results. Correlations between life quality, life expectancies, health conditions, and place of residence are becoming increasingly acute; their recognition by people other than just the small community of professionals is because of the need for spatial rationalisation, which is a determining element in the structural reform of health services, and for equal opportunities. In the present study, the authors provide an account of the spatial differences in the availability of the ambulance service, this field representing a special segment of health services. Within the health system, it is a specific area in which highly appreciated changes have already taken place; the quality of services has improved, cost-efficiency has increased, and the availability of equal opportunities has strengthened.

Preliminaries and methods

Hungary's largest health service organisation of the time, the Hungarian National Ambulance and Emergency Service (HNAES; Országos Mentőszolgálat – OMSZ) was established soon after World War II, in 1948. Following a recommendation by the Economic Advisory Committee, the government decided to bring the existing historic ambulance services – the Budapest Voluntary Ambulance Society and the National Ambulance Society of Counties and Municipalities – under governmental possession, and ordered this measure to be implemented in Governmental Decree 4980/1948.

As established by the decision, a centralised ambulance service was created that had country wide competence, was funded by the state, and was operated along uniform principles. At the same time, a decree by the competent Health Minister was also issued (217.760/1948), in which the main goal of the society, determining also the then current method of operation and development, was already formulated: "*gradually organises and establishes ambulance stations and first-aid spots throughout the country*" (Cselkó 1987).

* '*Science Please!*' Innovative research team (TÁMOP–4.2.2/08/1/2008–2011).

On 1st February 2010, the HNAES had 228 ambulance stations, with 772 organised ambulance vehicles (mobile units) in service. The service network development before 1990 aimed to provide ambulance availability in a 30 km radius from each station (Debrődi 2003). Today, the basis of the improvement concept for the ambulance network is to ensure arrival anywhere in the country within 15 minutes from the emergency phone call, which is a generally accepted standard in Europe, allowing the best survival chances for ER patients.

For the South-Transdanubian Health Development Council and later for the HNAES itself, the Institute of Geography at the University of Pécs performed several studies (1999, 2002, 2005, 2009), analysing the spatial pattern of hospital and ambulance service availability, as an output of which regional and later national service availability maps and network developmental recommendations were produced. The authors believe that it is a particularly fortunate situation that these recommendations could be realised – such a direct relationship is very rare, almost unique in Hungarian spatial development *sensu lato*. In our study, we provide an analysis of the current situation and the results of improvements, as well as attempting to provide new recommendations, sometimes re-grouping certain settlements among the ambulance districts, or creating new service formations, in order to further improve the standards of ambulance services, and through that, the life quality of citizens.

As part of our analysis, emergency ambulance response times were calculated, based on the district division made available by the HNAES, using route-planning software. The advantage of this GIS-based method is that the 15-minute isochron lines drawn from the input data are based on true travelling speeds applicable for particular road sections, and are thus supposed to be highly realistic. The program made its calculations in "normal" passenger car mode, (i.e. it did not consider the time gain that is the case with the travelling response unit using its emergency signals) practically making up for the time lost between receiving the emergency call and launching the response unit. In several of the European countries, the 15-minute response time standard is calculated as: 2 minutes departure response interval plus 13 minutes travelling time (Veen et al. 2001). Most certainly, the speed advantage arising from the use of emergency signals of the response unit travelling larger distances or between settlements will result in precious minutes and kilometres, thus effectively expanding the size of the supplied area. However, there is a factor of error in the calculations, in that ambulance arrival times were calculated from the exact address of ambulance stations to the centre of the settlements. For that reason, quite substantial differences could arise between calculated values and the actual response times measured, when accessing certain settlement parts or streets.[1] In our analysis, we were not able to tackle this problem, as setting up a street-based database is beyond our current resources and capabilities. Thus, we can assume that the population reached by the emergency medical service within less than 15 minutes is actually smaller than that is indicated in the database. It is particularly so in the case of the larger settlements, especially cities and villages with extensive peripheral zones

1 In several developed countries, practical databases are maintained relying on daily ambulance rescue activities. Actual response time is recorded upon the arrival of the unit to the rescue scene, and service districts are formulated based on such data input.

where such an effect should be considered. We can assume but cannot support with factual data that the two types of errors with opposite directions balance each other, meaning that response and availability figures are exact, if not for each and every settlement, but certainly for larger area units (country, regions, maybe counties as well).

Spatial aspects of ambulance availability and response

Currently there are 228 ambulance stations in Hungary, of which 13 are in Budapest, and 215 in the rest of the country. The districts supplied by these stations cover the entire country, with each of the settlements being allocated to one of them. Ambulance stations are normally located in urban environments: about 200 of them operate in towns, 10 in large villages, and 18 in villages. When establishing a new ambulance base, normally the more important, developed settlements have priority; the majority of which are large villages with a large population, or an important attraction zone. The creation of new bases also has a certain type of urbanisation effect as the settlement will have yet another central role; one that is highly influential on people's lives. In many cases, the existence of an ambulance station is one of the arguments in the process of town rank acquisition.

The extent of the districts supplied by a single ambulance station is highly dependent on the geographic environment, but many other aspects also play a role. The most highly populated districts, are of course those of large cities (such as Debrecen, Miskolc and Pécs, in order of size), where the inhabitants of villages and small towns linked to them add another 50–60 thousand people to the population that has to be supplied. (This figure, in itself, exceeds the population of several districts in the countryside, and is certainly much higher than the populations of any newly planned ones.) The highest number of settlements are also found in more or less the same districts: the Zalaegerszeg district supplies 81 settlements, Pécs supplies 86, Kaposvár 88, and in the capital cities or small towns (e.g. Lenti, Dombóvár) of counties with small villages, districts with 40–60 settlement units are also typical. The opposite extremes are to be found in the eastern parts of Hungary: Hajdúböszörmény in itself, Hajdúnánás with Hajdúdorog, Gyula with Kétegyháza and Elek, Egyek with Tiszacsege and Újszentmargita making up single ambulance districts.

On regional and county level, the picture of emergency ambulance services with the currently operating stations is shown in Table 1. Among these indicators the most important and most expressive one is the proportion of people (relative to the total population of the unit) living in settlements reached within 15 minutes. In this respect, the figures on a county level – apart from Budapest – range from Békés county with 71.4% and Somogy county with 71.5%, to the counties of Pest, Komárom-Esztergom, Veszprém, and Nógrád just exceeding 88%.

Table 1

Population and settlement data of ambulance/emergency medical service availability, 2009

Capital, county, region	Settlements reached within 15 minutes:				Settlements reached in more than 15 minutes			
	number	proportion, %	population size	proportion in population, %	number	proportion, %	population size	proportion in population, %
Budapest	1	100.0	1 696 128	100.0	0	0.0	0	0.0
Pest	141	75.4	1 036 799	88.1	46	24.6	139 751	11.9
Central Hungary	*142*	*75.5*	*2 732 927*	*95.1*	*46*	*24.5*	*139 751*	*4.9*
Győr-Moson-Sopron	107	58.8	371 295	83.9	75	41.2	71 372	16.1
Vas	147	68.1	230 084	87.4	69	31.9	33 167	12.6
Zala	116	45.1	233 906	79.7	141	54.9	59 537	20.3
West-Transdanubia	*370*	*56.5*	*835 285*	*83.6*	*285*	*43.5*	*164 076*	*16.4*
Fejér	69	63.3	352 825	81.9	40	36.7	78 181	18.1
Komárom-Esztergom	52	69.3	275 705	88.2	23	30.7	37 036	11.8
Veszprém	143	65.9	320 517	88.1	74	34.1	43 189	11.9
Central-Transdanubia	*264*	*65.8*	*949 047*	*85.7*	*137*	*34.2*	*158 406*	*14.3*
Baranya	69	25.5	294 836	74.4	202	74.5	101 425	25.6
Somogy	95	38.8	235 017	71.5	150	61.2	93 479	28.5
Tolna	66	60.6	191 517	79.5	43	39.4	49 449	20.5
South-Transdanubia	*230*	*36.8*	*721 370*	*74.7*	*395*	*63.2*	*244 353*	*25.3*
Borsod-Abaúj-Zemplén	198	55.3	605 254	84.3	160	44.7	112 929	15.7
Heves	75	62.0	247 859	77.7	46	38.0	71 061	22.3
Nógrád	93	71.0	187 422	88.0	38	29.0	25 608	12.0
Northern Hungary	*366*	*60.0*	*1 040 535*	*83.2*	*244*	*40.0*	*209 598*	*16.8*
Hajdú-Bihar	58	70.7	477 132	87.5	24	29.3	68 329	12.5
Jász-Nagykun-Szolnok	48	60.8	337 277	83.4	31	39.2	67 298	16.6
Szabolcs-Szatmár-Bereg	141	82.0	473 249	87.6	31	18.0	67 298	12.4
Northern Great Plain	*247*	*74.2*	*1 287 658*	*86.4*	*86*	*25.8*	*202 925*	*13.6*
Bács-Kiskun	61	51.7	392 512	74.1	57	48.3	137 421	25.9
Békés	39	52.0	272 138	71.4	36	48.0	109 180	28.6
Csongrád	30	50.0	352 793	83.3	30	50.0	70 958	16.7
Southern Great Plain	*130*	*51.4*	*1 017 443*	*76.2*	*123*	*48.6*	*317 559*	*23.8*
Hungary	1 749	57.1	8 584 265	85.7	1 316	42.9	1 436 668	14.3

Source: edited by the authors, based on data of HNAES.

A cartographic chart (Figure 1) indicating the currently operating ambulance stations and the response times calculated for various settlements is intended to assist a more detailed spatial analysis. Differences between county level and regional statistical data appear quite spectacularly in the graphical chart, too. Here the scale, instead of having only two levels, is more differentiated when showing response times, since it is obvious that the difference between 14- and 16-minute response times is much less significant than between 20 and 30 minute times.

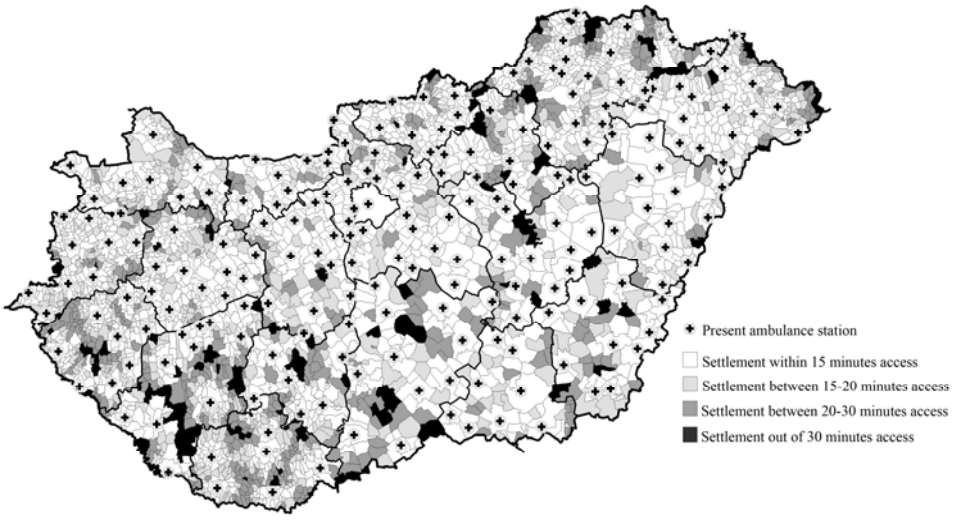
The settlement, which is in the worst situation of all, is Kálmáncsa in Somogy county, with a response time of nearly 60(!) minutes, reached from Kaposvár. Arrival times beyond 30 minutes, which can often easily exclude the possibility of survival, is what can be expected by about 100 000 people living in 127 settlements. The majority of these long response time cases could be improved by means of some type of re-arrangement, or re-grouping; such suggestions will be made later in the study.

The location of regions with accessibility problems is more or less in line with what one could expect from spatial meso- and micro-structures. It is mostly the spaces with a looser structure (Tóth 2004), typically the outer and inner peripheries that appear boldly in the picture. Life quality in this respect, too, is the worst in spaces characterised by a deficiency of towns, or at least urban deficit in a functional sense (Tolna hills, Ormánság area, Zemplén mountains, Cserehát regions), and in many cases in regions along county borders. Not only in emergency medical rescue are such shadow zones typical, research in recent years has revealed some areas that are critical in this respect, leading to re-grouping in certain cases. Such is the Baranya hills, more precisely the Sásd micro-region, which was originally supplied with ambulance service from the town of Komló, but after a re-organisation, the majority of medical emergency service duties were given to Dombóvár (i.e. a different county). Although such measures were successful in reducing poor response times, in most of the cases the situation remained just beyond the critical level.

Within the ambulance service, outer peripheries appear only along certain boundaries, illustrated quite sharply in Szabolcs-Szatmár-Bereg county, particularly in the Bereg area. Although less marked, the periphery effect is also present along part of the Hungarian-Romanian border (e.g. around Battonya), as well as along the Hungarian–Croatian state border section.

Figure 1

Spatial structure of the ambulance service, 2009



Source: edited by the authors.

The situation of Bács-Kiskun county is quite special in that the problems in ambulance response there appear mostly in the central areas. Nearly 100 000 people in 38 settlements live outside the 20-minute isochron, including Lajosmizse with 11 000 inhabitants, the second largest town with response times beyond the 15-minute standard. The situation is similar in Békés county; the similarity is a result of low settlement density and the extensive, yet functionally weak network of small towns.

Current issues of network development

Having given an account of the situation prevailing in the country, the following recommendations have been formulated in order to reduce the extensive "white patches" on the map (shown in grey in our figures). In order to solve the problems experienced in ambulance availability, HNAES has planned a project that is intended to be an important element of the ambulance service network development; its funding provided by the TIOP[2]_EÜIF_V_4 scheme. The 11.5 billion HUF budget of the TIOP 2.2.1 distinguished funding scheme entitled "Development of emergency services – ambulance and air rescue" can be used, among others, for the improvement of the network of ambulance stations. Following preliminary activities in 2007–2008, the exact planning of network development started in spring 2009 (Figure 4).

According to our calculations, the planned 23 new ambulance stations would significantly improve the emergency services for a quarter of a million people. The figures of weighted response times[3] calculated for the involved settlements will improve by 56%, improving by not only some minutes, but also changing categories: the decreased 14.6 minute average response time by settlement generally means that the villages (sometimes towns) move from the 20–25 minute range to the 10–15 range.

The involved districts are usually small-village regions, the mean settlement size just exceeding 1 000 individuals. Naturally, such spatial fragmentation is not beneficial for improving efficiency: the average population size of ambulance districts is 11 000 individuals, with only the region of Sárospatak standing out with its 28 000 inhabitants. Low figures of average population size are accompanied by a low total population size. According to the plans, Aggtelek would provide an ambulance service for altogether 7 villages with an average population size of 310 individuals; the district of Igal includes 14 settlements with 6 800 people, including the centre, which has already become a town. In the district of Zalalövő, there are 15 settlements and in that of Sásd, 16 settlements with an average population size around 500. The smallest one of all the newly planned district centres is Krasznokvajda, with a population of 541; the 17 settlements supplied by this centre have a total population size just exceeding 4 000.

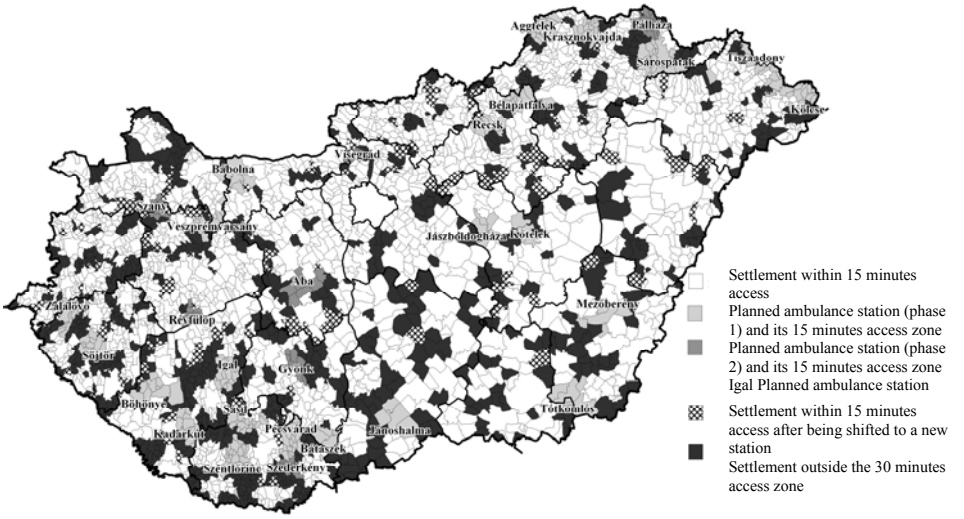
The majority of response problems and the highest number of new centres are in the small-village regions of South-Transdanubia: there will be seven new stations altogether aimed at improving the situation, three of them in Baranya, three in Somogy and one in Tolna county.

2 TIOP: Operative Programme for Society and Infrastructure.

3 Weighted response time: average response time (or its decrease) multiplied by the population size of the particular settlement (unit: minutes × individuals).

Figure 4

Improvements of the ambulance network, as planned by HNAES, with recommendations by the authors



Source: edited by the authors, based on data from the HNAES.

There will be two new stations in Zala county, and one in Győr-Moson-Sopron county, both located in West Transdanubia. Unlike in the previously mentioned new centres, where it was mostly the large districts of county seats that were cut into smaller units; there will also be peripheral centres here, with their districts divided up into smaller areas (e.g. Őriszentpéter, Tét).

In the region of North Hungary, five new stations will be created, of which the ones in Heves county (Recsk, Bélapátfalva), in practice will result in the dissection of the Eger district, ensuring minutes of improvement in response times for a population of 10 000 people each. In Borsod county, the centres in Aggtelek and Krasznokvajda should ease the situation in the Cserehát mountain region, an area with small villages, a poor general public health situation, and bad accessibility. In this area, the town of Sárospatak should also be mentioned, which used to be the largest Hungarian settlement without an ambulance station. Although it is located within the 15-minute response time zone of the neighbouring Sátoraljaújhely (this town also having a hospital), its size justifies the setting up of an own ambulance centre which can also serve settlements further to the south of the district.

Improvements in the Great Plain region are of a different nature. It is only Kölcse and Tiszaadony, the two stations in Szabolcs-Szatmár-Bereg county, whose creation can be explained with the same strategy as for the formerly mentioned ones (i.e. providing an ambulance service for small-villages and peripheral regions with poor response times). Jászboldogháza and the nearby Kőtelek in the Jászság region mean improvements for only three and five settlements, respectively, although these improvements are quite substantial. In Békés county, the settlements Tótkomlós and Mezőberény are those each

given a new ambulance station, yet a significant breakthrough could be achieved only if the elements of the current network had been relocated and totally re-organised.

It appears from the data, that even a considerable improvement of the network (from which the region of Central Hungary was left out due to project-technical reasons of the TIOP funding scheme) cannot provide a remedy for all the problems.

In addition to the plans specified in the TIOP-project, in our research we have proposed recommendations for establishing further possible ambulance districts (Table 2).

The districts included in these recommendations are small: with one exception (Aba), their total populations do not reach 10 000 each, but even the smaller ones are at least twice as large as the new Aggtelek district. The weighted response times calculated for these districts are higher (63%) than those of the ones planned in the TIOP project. Average population size is yet smaller (meaning that we further progressed towards smaller settlement networks), and the recommended improvement affects a total of 52 000 people in 57 settlements.

Among the recommended new units, both in the case of Visegrád and Révfülöp, there is a new factor that has not been emphasised so far: their tourism attraction potential means that the population temporarily present there, as well as other visitors and hikers significantly increases the number of potential emergency rescue cases. Furthermore, the weighted response time value would also improve, even if the affected population were not significantly large.

Table 2

Further improvements and their possible results

Centre of the planned new ambulance district	County	District from where settlements would be taken over (number of settlements to be taken over)	Number of settlements in the district	Total population of the district	Average population size of the settlements	Average response time, minutes			Decrease of the weighted response time, thousand	Rate of decrease in the weighted response time, %
						currently	with the new district	difference, decrease		
Aba	Fejér	Sárbogárd (4), Székesfehérvár (2)	6	17 546	2 924	22.0	11.3	10.7	1 122.9	48.5
Gyönk	Tolna	Szekszárd (6), Simontornya (1), Tamási (1)	8	4 573	571	35.0	9.4	25.6	937.5	73.2
Pálháza	Borsod-Abaúj-Zemplén	Sátoraljaújhely (13)	13	4 675	359	24.3	6.6	17.7	1 075.3	72.8
Révfülöp	Veszprém	Tapolca (7), Nagyvázsony (1)	8	4 479	559	21.9	6.8	15.1	542.0	69.1
Szany	Győr-Moson-Sopron	Csorna (6), Pápa (1)	9	5 776	641	21.3	8.2	13.1	681.6	61.5
Szederkény	Baranya	Pécs (5), Mohács (5)	10	9 540	954	17.4	6.6	10.8	1 030.3	62.1
Visegrád	Pest	Szentendre (2), Esztergom (1)	3	6 134	2 044	20.3	5.3	15.0	276.0	73.8
		Total	57	52 723	925	23.3	7.7	15.6	5 665.5	62.9

Source: calculated and edited by the authors.

Due to study length limitations, we cannot go into details about every planned new district, but we can point out a few. One is Szederkény, the zone sandwiched between the Mohács and Pécs districts, beside the newly opened highway; although this station would

bring considerable improvement to the ambulance service of the involved settlements, it is questionable economically. The only way to improve ambulance availability in Baranya – a county with a special settlement structure – would be to revise the locations of the currently existing stations. Sellye is the historic centre of the Ormánság (South Baranya) region, yet its ambulance station is unable to reach substantially large areas within the time standard. A possible new station in Vajszló, another centre in the same region with a traffic node function as well, would mean considerable overlap with the Sellye district, thus it is not justified to create one there under the current circumstances. An ideal distribution could be achieved if new ambulance stations were created, instead of Sellye, in Drávafok and Vajszló, and another two in Harkány and Villány to replace the one in Siklós (in this case, building one in Szederkény would be pointless).

The situation of Gyönk is quite special, for the following reasons. The large district of Szekszárd is like those of the other county seats, characterised with a geographically quite asymmetric shape, stretching along road No. 63 in a north-western direction. It is here in this region of the Tolna hills, where we find settlements with the worst ambulance response time values maybe in the entire country, and often served by the Szekszárd ambulance centre even when Hőgyész would be a more rational solution. In our opinion, the currently very bad response time indicators would certainly justify establishing a new ambulance centre in Gyönk, a settlement having received town rank in the meantime. As shown in the above table, this would mean an average of 25 minutes (!) improvement in response times in the case of eight settlements, this difference being the second highest value among all the plans and recommended changes that we have introduced so far.

Finally, the prospective ambulance station of Aba[4] would be the one on our list whose creation is the least questionable. A population of 17 000 people, formerly belonging mostly to the Sárbogárd district, would be served from here in the southern part of Fejér county; this number undoubtedly justifying the establishment of a new centre.

By providing an analysis of the recommended new ambulance stations we intended to demonstrate how difficult it is to further develop the ambulance service: ultimately it is almost impossible to achieve spectacular results without relocating some of the currently existing stations to different places (generally less central, but more advantageous from a traffic network point of view). Such an investment, due to the extra costs (new stations have to be built) is a difficult path, not to mention the conflict of interests in the case of existing stations to be eliminated. We are currently working[5] on a computer software tool that could assist in designating "mobile" ambulance stations. Based on access information and the demographic data of different settlements, the application could calculate the ideal location where ambulance unit(s) could be positioned temporarily (e.g. during high traffic periods or in the case of extreme weather), along highways, in larger shopping centres or at the vacant side of a petrol station.

There is yet another possibility the authors have looked at, namely the re-grouping of certain settlements from one district to another (Figure 4). The majority of such cases could be handled in a way that the transformed districts cross county borders, especially

4 During the time that has passed between preparing the original study and its English version, Aba became involved in the TIOP project, which already has reached a stage where there are signed contracts for establishing new ambulance stations.

5 'Science Please!' Innovative research team (TÁMOP–4.2.2/08/1/2008–2011).

in the case of Heves, Jász-Nagykun-Szolnok, Pest, Nógrád, Győr-Moson-Sopron, Somogy and Fejér counties. There are altogether 178 settlements in which a re-grouping would (theoretically) bring the response time to below the 15-minute limit, and a considerable decrease would occur in ambulance service time. Although quite a few of them would not meet a number of other professional requirements required for emergency medicine, approximately half probably would, making them worth considering.

Summary

There is a plan, relying on a more or less professional consent, for creating 23 new ambulance stations, with the prospect of becoming a reality in the near future, and aiming to improve the life quality of about 253 000 people. By completing these plans with our recommendations (7 new stations serving 52 000 people), and also calculating with another 90 000 people that will fall within the 15-minute response time limit if some settlements are re-categorised between districts, the results will be impressive. If the improvement figures of the life quality of these nearly 400 000 people (about 4% of Hungary's population) are added to the corresponding figures of Table 1, the difference projected for the total population will be almost 90%. Although the authors are admittedly unaware of the minimum size of a cost-effectively operated ambulance district and station, the traditional strategy relying on network development thus comes close to its realistically achievable maximum. Human life is, of course, an absolute value, yet because of the limited capacity of the country and the state health system, together with the need to also fulfil other health related political duties, it is necessary to set realistic limits.

As uninvolved researchers having dealt with the current issue for years, the authors are convinced that HNEAS understands the problem that has been dealt with for 15 years in a complex, spatially well thought out manner, not regarding it solely as an emergency rescue issue, and that this direction of thinking is worth following. HNAES has succeeded in communicating that the outdated, rigid concepts (settlement hierarchy, county borders, district boundaries) can be overwritten, and that the ambulance service can be handled in a flexible way, thus an existing structure can and should be transformed. If, by publishing our thoughts about this issue, as geographers, we have been able to contribute to improving the situation, and are delighted and proud to have wandered beyond the boundaries of traditional disciplines.

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