AHEAD

ACTION FOR HEALTH AND EQUITY
ADDRESSING MEDICAL DESERTS

Methodological approach for medical desertification index calculation

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Table of contents

Medical desertification

In the initial stages of the AHEAD project, we carried out a literature review to better define the concept of 'medical desertification'. Based on a thorough review of scientific studies (more than 100), we have concluded that the complex concept requires a set of definitions to understand its multidimensional perspective. From the literature review, we derived a working definition to inform the development of research tools and validated this definition through the results of these tools. Below is the final version of the medical desertification definition, from AHEAD consortium:

Definition

Short definition

A medical desert is the end point of a complex process called 'medical desertification', that implies continuous and increasing inability of a given population to access health services in a timely and contextually relevant manner.

Further explanation

The regions likely at risk of becoming a medical desert can be identified and based on the factors commonly used for describing the three dimensions of access to health care, and could be categorized as barriers.

Specific definitions of the terms used:

Context: the context entails the local, regional and national levels, which should be investigated based on the available standards and (social) norms.

Given population: a population in a specific area (e.g. municipality; region) or isolated area (e.g. hard to reach, rural locations) or population groups with specific needs and/or vulnerabilities (e.g. Roma, migrants, the elderly).

Dimensions: the physical access, social and policy dimensions are interrelated and dependent on each other in varying degrees and modalities.

F*actors*: each dimension can be investigated by a range of factors, such as (see below - not an exhaustive list):

Physical access factors

- Availability of (1) general-practitioner, (2) community health centers, (3) emergency services, (4) hospitals, (5) pharmacists
- Distance to primary healthcare facilities

- Average time to reach the health facility or the patient, using the emergency services.

Social factors

- Cultural sensitivity and context-appropriateness of the care that is being offered
- Expectations of the population (e.g. supply vs. demand, met vs. unmet needs, and expectation of the population on isolation based on location, are among the factors to be considered during investigation).

Policy factors

- Regional and rural development strategies
- Human resources for health strategies – policy decisions on the availability and distribution of primary health care personnel; renumeration methods; regulation, including strategies for licensing and continuous professional development
- Strategies for primary health care facilities and their management
- Strategies for specialist services (such as distribution of specialised hospitals, services provided, etc.).
- Cost of services to the patient and financing the health system.

The factors can be identified using qualitative and quantitative research tools. These tools are a guideline of the approach and should be contextualised to each research objective.

The quantitative factors should result in a database that can be used to compute a medical desertification index (see below), which provides an insight into whether this area is at risk of becoming a medical desert.

The qualitative factors should be used to further understand the realities of potential medical deserts.

Medical desertification index:

A research team can decide to adapt the research and index calculation methodology to the specific objective and context.

The index provides a snapshot of the situation, and thus must be investigated further and analysed over time to definitively conclude whether the area is indeed going through desertification or has reached the end of the process.

Once the key factors are investigated, understood (and compared to national standards) and where possible, computed into a set of indexes, one can make a conclusion on the stage of the process of

medical desertification.

Table 1 depicts the main operational conclusions. They stress the need to consider both demand and supply. Demand is manifested by differentiations within age group of local population. 'Local' population includes both the ones living in the locality, but also the ones in the nearby, which may access the services in the locality under scrutiny. 'Supply' includes general-practitioners (GPs), pharmacies, hospitals, other type of medical staff, but it also refers to the nearby localities. All these principles translate into computing indexes of access to medical services that are depicted in the following section.

Table 1. An overview of the conclusions from literature review. The table reproduces part of the report on literature review.

Main conclusions

- The term is used in the literature inconsistently, it is measured differently depending on the availability of data and or nuances in the point of view about it, and overlaps with other terms.
- The easiest way to find a definition is most likely to start from an operational one but keeping in mind the main conceptual considerations.
- Overlapping terms include rurality, rural/urban inequalities of access, isolated communities, etc.
- Measurement is also tricky. It needs deciding upon what type of indicators to consider, how to measure each of them, if one needs to combine them in a single measure or to consider a multidimensional approach, and how to combine them in a single index or in several indexes:
  - What indicators to consider. Examples:
    - Density of health care staff per patient in the catchment area of reference;
    - Distance to health care (on public roads);
    - Distance to health care expressed as time.
  - How to measure them:
    - Which is the catchment area/referral hospital/point;
    - Which levels of health care to consider (emergency, specialized, what types of specialized intervention);
    - How to compute time (e.g. what average speed we consider).
  - How to combine the indicators:
    - How one can decide about the relative importance of each indicator
    - Do they receive equal weights?
    - How we test for reliability/validity?

Computing the medical desertification indicators: methodological specifications

When computing medical desertification indexes, one needs to consider on one hand at least three types of providers of medical services (GPs, pharmacies, and hospitals), along with the population adjusted by its structure, and the context given by the nearby localities. In the following, we address all these elements and explain how the indexes were computed for Romania, as a case study example.

Steps in computation

Step 1. Adjusting population by demand

Principle: some population groups need more frequent medical care. Such groups include infants, preschool children, elderly. Therefore, they should receive higher weight when considering demand for medical service.

We have used the following formula:

$$\textbf{\textit{AdjPop}} = \textbf{\textit{pop0004}}*1.27 + \textbf{\textit{pop0509}}*0.65 + \textbf{\textit{pop1014}}*0.55 + \textbf{\textit{pop1519}}*0.51 + \textbf{\textit{pop2024}}*0.54 + \textbf{\textit{pop2544}}*0.695 + \textbf{\textit{pop4564}}*1.08 + \textbf{\textit{pop6579}}*1.775 + \textbf{\textit{pop8000}}*2.77$$

where *popXXYY* is total population with ages between XX and YY, and *AdjPop* stands for "adjusted population"[1].

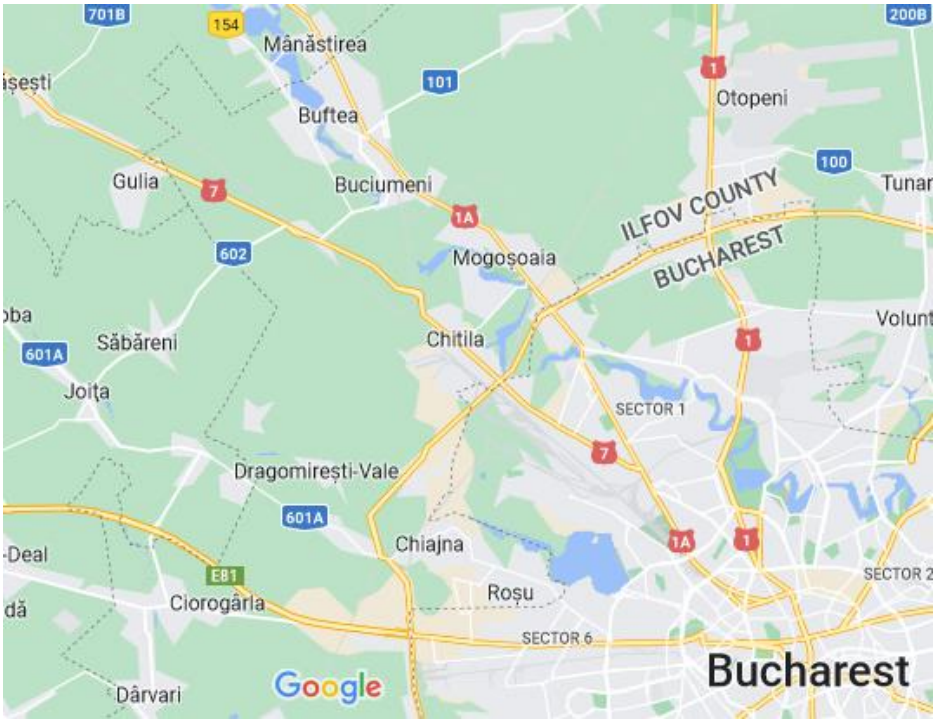
For each locality, population is adjusted according to the above formula.

Step 2. Adjusting population by distance

Let's imagine that we have a GP working in Buftea. Look at the map below. The GP will serve those in Buftea and some of those in the neighboring localities, such as Săbăreni. Therefore, the population that should be considered when assessing whom the GP serves, should also include those in Săbăreni. Note that the road distance between Săbăreni and Buftea is 11.4 km.

[1] Weights adapted based on the model used by Lucas-Gabrielli et al, 2016 (Lucas-Gabrielli, V., Nestrigue, C., & Coldefy, M. (2016). Analyse de sensibilité de l'Accessibilité potentielle localisée (APL). *IRDES [Internet])*

Therefore, when considering the population in Buftea, we will sum up the adjusted Buftea population with the one in Săbăreni and other neighboring localities (such as Mogoșoaia, Gulia, Crevedia, etc.). Nevertheless, those in Săbăreni are less likely to go to a GP in Buftea (in particular if they have another GP closer to home). However, think of someone living in Săbăreni, and working in Buftea, where kids are also going to school: they will have enough incentives to choose a GP in Buftea. The same applies to any provider of medical-related services, including pharmacies and hospitals.



Consequently, when summing up the reference population for Buftea, the ones in Săbăreni will count less.

The population of each locality was adjusted in two scenarios:

- considering a 20 km catchment area
- considering a 30 km catchment area

In the first scenario, for each locality, all people that were living in the locality or in a 5 km area received the same weight (1), each living between 5 and 10 km outside the locality (in other localities) received the weight of 0.7, and each living between 10 and 20 km outside the locality counted for 0.5. If considering a 30 km catchment area, this means that:

- an individual that lives in the locality or in another locality at maximum 10 km distance is counted as such (he/she/ze receives the weight of 1)
- an individual living in another locality located between 10 and 20 km distance from the center of the locality for which we compute the adjusted population receives the weight of 0.7 (he/she/ze is seen as being 0.7 persons)
- if living at 20 to 30 km from locality the weight is 0.5
- if living more than 30 km away, the weight is 0 (that person is not taken into consideration)

Step 3. Adjusting the number service providers

GPs, hospitals, and pharmacies are estimated using the same formula as in **step 2**.
Reasons:

- a service located in another locality at some reasonable distance, can provide service to those in the surrounding area as well, not only to those residing in the locality where the practice is located.
- The probability to serve those at higher distance is decreasing with the distance.

Step 4. Final computation

The adjusted number of service providers is divided by adjusted population.
Four indexes were computed for each type of medical service (GPs, pharmacies, hospitals), as described in **table 2**.

Table 2. Types of indexes depicting access to medical services

Completely unadjusted: Providers/Population	Estimated number of providers by unadjusted population (this index does not take into consideration the differences in demand by age, and the existence of neighbouring localities)
Adjusted for local demand: Providers/Population adjusted by age	Estimated number of providers by population adjusted by age (this index does not take into consideration the existence of neighbouring localities)
Adjusted for demand and supply in 30 km catchment area Providers/Population adjusted by age (both adjusted with figures for neighboring localities)	This index considers both the providers and population in a surrounding area of 30 km, and adjusts the figures according to distance
Adjusted for demand and supply in 20 km catchment area Providers/Population adjusted by age (both adjusted with figures for neighbouring localities)	This index considers both the providers and population in a surrounding area of 20 km, and adjusts the figures according to distance

Results

General-practitioners (GPs)

Legal provision indicates some normative for the minimal number of GPs. They indicate an optimal number of patients per GP equal to 1800 (the piece of legislation is: HG 140/2018, Anexa 2, Art. 4 - (2)).

One can start from this normative threshold and derive the following classification:

- If there are less than 1800 patients per GP in a certain locality, we can label that locality as not deserted.
- More than 1800 patients but less than double the normative (3600), means we can label that locality as being deserted
- Over 3600 patients per GP means one can say it is a severe medical desert.

Using such categories, we can show how localities distribute on the indexes computed for medical desertification based on numbers of GPs, as illustrated in **table 3**.

For each locality we have three indexes. The first one does not adjust for population structure and for the context provided by the nearby localities (unadjusted, no neighbors); the second adjusts population like in **step 1** but does not take into consideration the neighboring localities; the third one adds population and GPs from localities on a radius of 30 km distance, as explained in **step 4**.

Table 3. Simulated distribution of localities starting from the normative GP threshold.

		Index		
		unadjusted index, no neighbors	adjusted demand, no neighbors	fully adjusted index
Category	no medical desertification	31%	31%	0%
	normative, but not severe	54%	55%	62%
	severe medical desertification	15%	14%	38%
	Total	100%	100%	100%

One can observe that the number of severe medical deserts changes when changing the type of measurement.

To solve the imprecision, we have decided to consider as medical desert the localities that sum up low scores (meaning high desertification) on every single index. That is, we consider the stance of desertification as being grave when reverse Matthew effect is observed, that is when cumulative disadvantages manifest through being labeled as deserted by all the measures that we have encompassed in the analysis.

Table 4 shows the resulting distribution. Considering the principle stated in the previous paragraph, the 249 localities in the bottom-left corner are the ones that are the most deserted considering the presence of GPs in the locality or in the nearby.

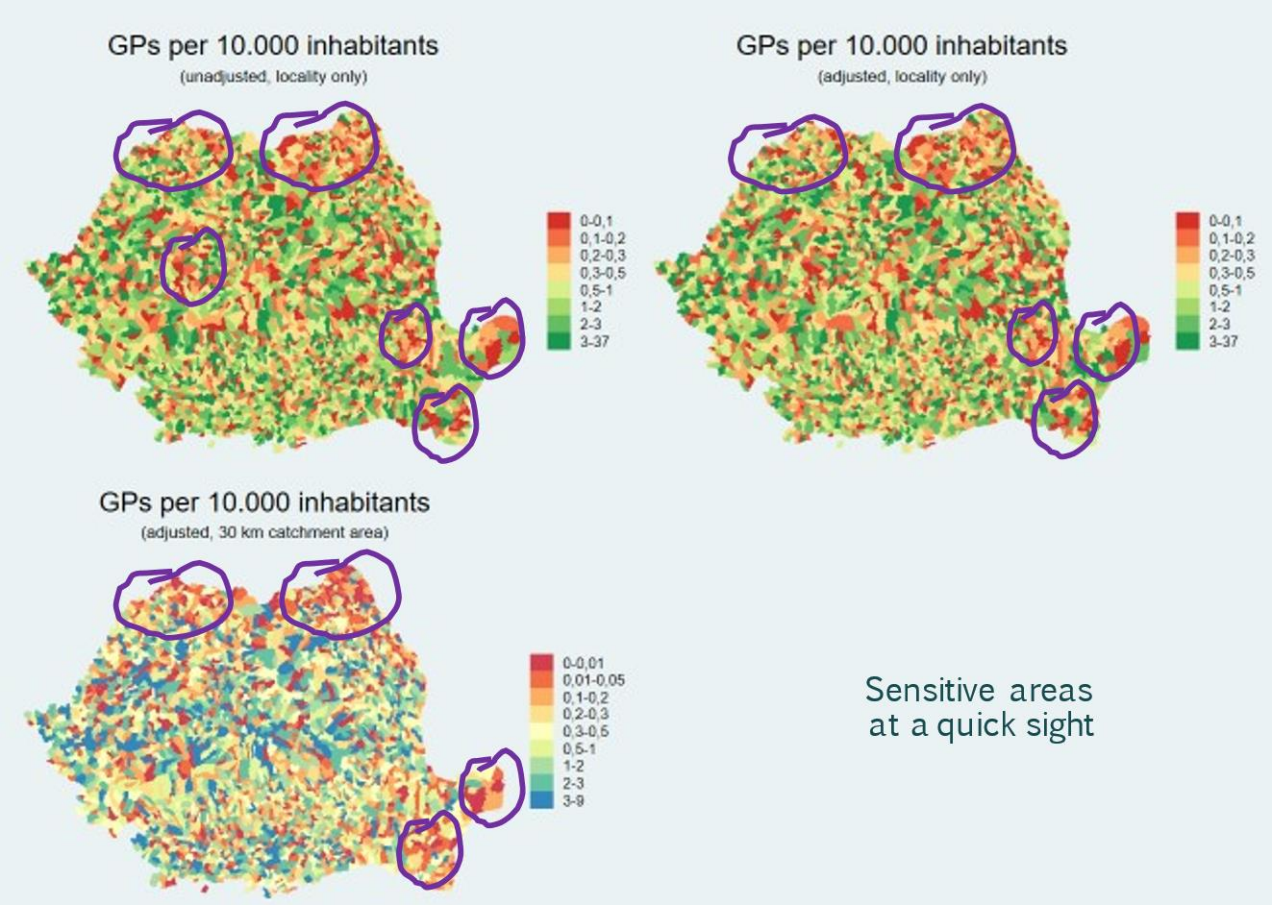
Table 4. Distribution of Romanian localities depending on how often (out of three GP-related indexes); they were labelled as "medical deserts", respectively" severe medical deserts"

		Number of labeling as „desert", but not „severe"				
		0	1	2	3	Total
How many times the locality was labeled as „severe desert"	0	6	728	104	929	1767
	1	181	49	727	0	957
	2	2	211	0	0	213
	3	249	0	0	0	249
Total		438	988	831	929	3186

Figure 1 goes further and combines all this information by county. **Figure 2** illustrates the variation across country of the desertification indexes. One may see that, irrespective of which indexes we choose, the regional concentration of deserts remains almost the same.

Figure 1. Distribution of counties depending on severity of desertification by locality, considering GPs

Figure 2. Desertification maps for GPs.



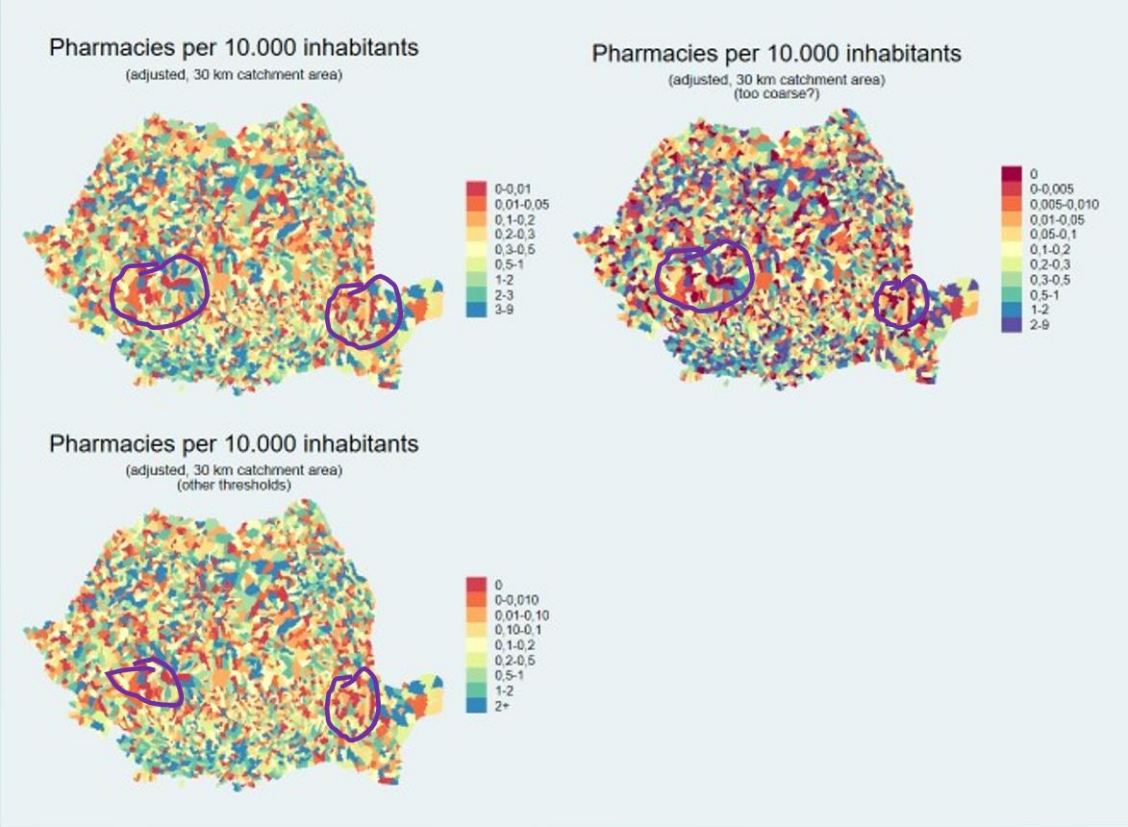
Pharmacies

A similar regulation states the optimal number of pharmacies at one for 4000 inhabitants. Following a similar logic as in the case of GPs, we set up a threshold for severe desertification at 4000×2=8000, and we derive the figures from **table 5**. They led to the map depicted in **figure 3**, which has quite a good overlapping with the corresponding map for desertification based on numbers of GPs (**figure 2**).

Table 5. Distribution of Romanian localities based on pharmacy-based medical desertification

	unadjusted index, no neighbors	adjusted demand, no neighbors	fully adjusted index
no medical desertification	20%	20%	0%
normative, but not severe	30%	31%	24%
severe medical desertification	50%	49%	75%
Total	100%	100%	100%

Figure 3. Desertification maps for pharmacies



Hospitals

Hospitals are rare and located mainly in urban areas. We decided to focus on rural areas and to take into consideration only GPs and pharmacies.

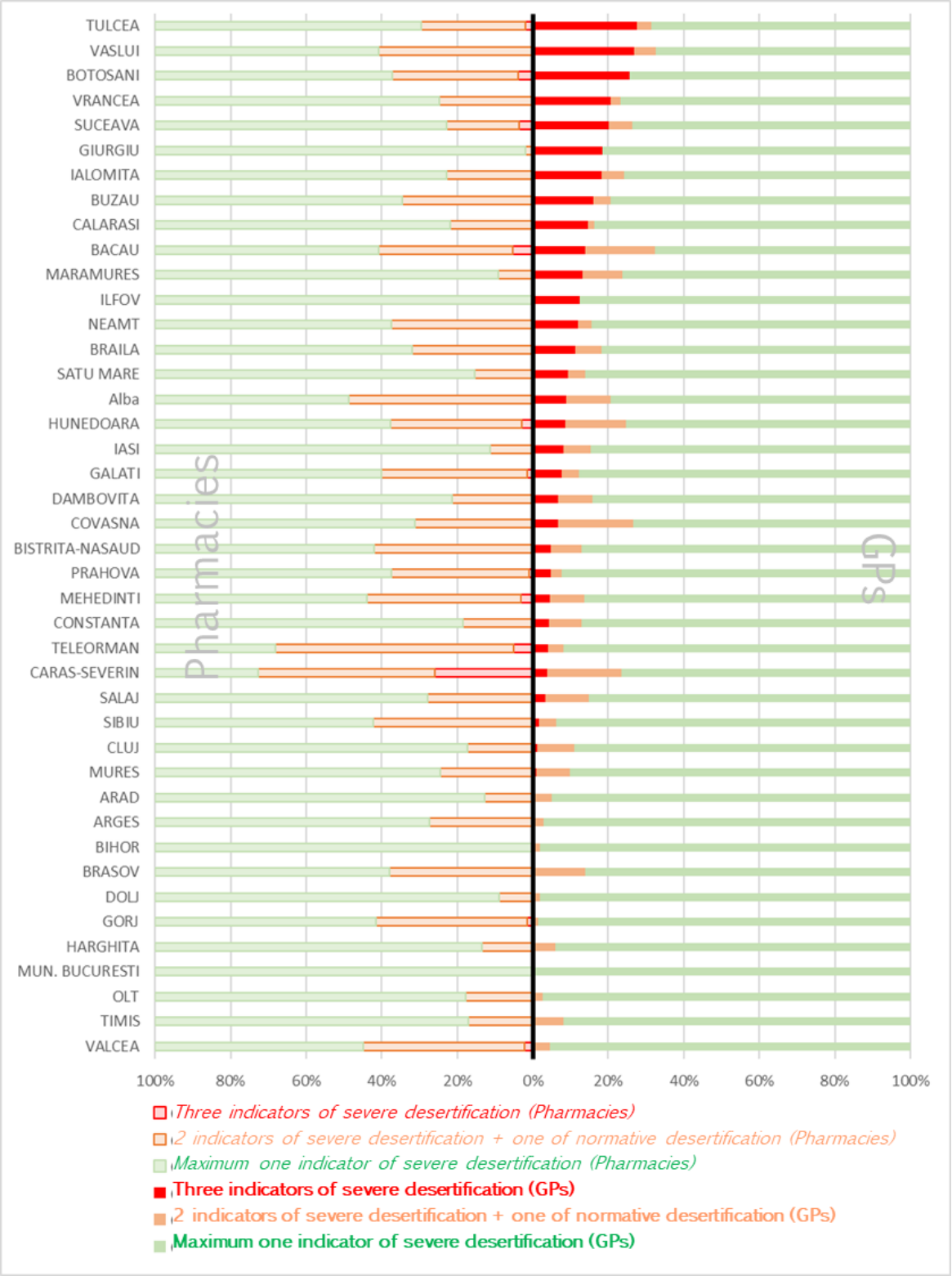
Overall desertification

Figure 4 shows distribution of counties depending on how many localities are deserted. The left pane shows the desertification considering pharmacies. The right pane shows it based on general practitioners.

We decided to look for the most deserted counties.

In order to do so, we have considered the proportion by county of the localities that have either 3+3 indicators of severe desertification (that is they have three „severe desertification" indicators for GPs and 3 for pharmacies), or have any combination of 3 indicators of severe desertification and (2 "severe" +1 "normative") desertification. In other words, to be considered deserted, a locality should have at least 5 out of 6 indicators stating that it is in a severe medical desert, while the last indicator states either "severe desertification", or at least "normative desertification".

Figure 4. Distribution of localities within counties depending on GP and pharmacy desertification



Under such provision, the Tulcea county has 16% of its localities in a situation that could be labeled as medical desert. It is followed by Caraș-Severin (12%), Buzău (12%), Vrancea (11%), Vaslui (11%), Botoșani (9%), Hunedoara (9%). In all other counties, this specific desertification rate is under 8%.

Tulcea becomes the main target for selecting a case study. Among the other four counties in top 5 counties by desertification rate, three (Buzău, Vaslui, and Vrancea) are part of the Romanian South-East NUTS-2 Region, a region that also includes Tulcea. For reasons related to the severity of desertification related to GPs, Vrancea was chosen for being the second county from which to select a case study.

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