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Inspire Policy Making with Territorial Evidence

Functional rural areas in Romania

A methodological investigation

Final Report / June 2022

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Introduction

The workflow needed for the delineation of the functional rural areas is based on the implementation of a specific set of activities, starting with the exploration of the theoretical background and finishing with the proposal of a set of policy recommendations that encompass the potential interventions from the public actors and decision takers. The intermediate steps, such as the data collection, the analysis of the rural space from a functional perspective and the projections of the natural threats and risks for the functional rural areas, demanded a sound management of different set of indicators and geometries, in a particular context – the pre-census period. In this case, even if the official datasets (mainly the NSI and the Ministry of Development databases) were largely mobilized for the tasks, we were forced to collect information from some auxiliary sources (APIA, Ministry of Finances and transportation websites), in order to advance in the analysis of the Romanian rural space.

The first part of the work done for the delineation was dedicated to the exploration of the methodological and conceptual background, bounding the scientific basis of our investigation. The main challenge of this task was to profit from the multiple semantic layers of the term functional area, especially when it used as a label for the rural spaces. At the same time, we estimated that our delineation should not double the work already proposed by the Romanian Ministry of Development, Public Works and Administration on the topic of territorial cohesion (Disparități teritoriale în România - studiu de fundamentare[1], 2021), avoiding the description of the rural spaces as a sum of territorial disadvantages only. As a matter of fact, the economic and demographic recent dynamics of the Romanian rural spaces suggest that elements of territorial functionality are solidly embedded in the local spatial structures, needing general and efficient policies to become resilient and sustainable. The theoretical background in the field of rural studies and policy design for rural spaces indicated that one possible direction for the delineation of the functional rural areas is given by their assimilation to a *space of local sharing of specific territorial features*.

In our opinion, the Romanian functional rural areas might occupy a spatial *niche* where elements defining both the French concepts of *pays and bassin de vie* and the *operational frames of intervention intersect* (INSEE, 2012). Compared to the concept of functional urban areas that already benefit from a consistent amount of empirical and theoretical studies, the Romanian functional rural areas might be better defined in terms of local homogeneity, rather by tools based on spatial interaction. Seeking for this local homogeneity, as a base for a policy intervention frame and for a potential "*bassin de vie*", had consequences on the elaboration of the spatial database used in the study, the second task in our workflow.

The collection of data and indicators was organized as a function of three objectives: (1) providing an image of the economic dimension of the Romanian rural spaces, (2) building a dataset that enables the exploration of the elements of territorial functionality, by using multivariate analysis, and (3) developing a general frame of delineation for the Romanian functional rural areas. In order to measure the sensitivity of the functional rural areas to different natural risks and threats, an exploratory data acquisition task was added to the three main objectives mentioned. The implementation of this task had to deal with a set of challenges related to the data format (climate data, soil data and descriptors, land use and erosion etc.), the data preparation and validation for Romania, and to the geographical transformation of the coordinates systems. Finally, all the indicators were subordinated to a selection process and, as a function of the geographical and policy relevance, they were included in the delineation model of the functional rural areas. The selection process was dictated by a multi-thematic approach, this approach being based on the inclusion of at least one physical descriptor (like the altitude), accessibility analysis of services of general interest and cities, ability of the rural LAU to attract funding and demographic trends.

Once the project's spatial database was created and the exploratory analysis of the Romanian territory was set, the workflow continued with the third task – the delineation process. The first step or the main activity related to this task consisted in defining the basic spatial and territorial constraints acting as a guideline for the algorithms of rural LAU aggregation in functional areas. The spatial criterion used as constraint consisted in the necessity to build functional rural areas considering that the contiguity between

[1] https://www.mdlpa.ro/uploads/articole/attachments/618cf3596cc0c316310799.pdf

the participating LAU is compulsory. This constraint will eliminate the risk to assist to the apparition of spatially fragmented functional rural areas. From the territorial point of view, the potential FRA should be hierarchically dependent on the same NUTS3 as the participating rural LAU. Basically, no aggregation of spatial units belonging to different NUTS3 was allowed. To these two sets of constraints, a third one was added, regarding this time the maximization of the internal homogeneity of the potential functional rural areas. Given the multi-thematic approach used for the selection of the indicators participating in the delineation process, a statistical constraint was imposed – avoiding the use of statistically correlated indicators. At the same time, even if one will found a sufficient number of independent descriptors, a supplementary precaution is needed in order not to overload the model with irrelevant indicators for the task, artificially decreasing thus the degree of local homogeneity of the functional rural areas. The flexibility of the geostatistical model built for the delineation gave us the opportunity to test it in two different contexts, including or excluding groups of rural LAU, in the case where a competing policy on the metropolitan areas will technically interfere with the objective of the project. Finally, one version of the delineation was selected, and an assessment of their sustainability was produced, taking into account the various exposures to different risks and natural threats, such as soil erosion or climate change.

Compared to the data and indicators usually used to assess the economic and demographic sustainability of the functional regions, when dealing with the natural exposure, one will have to identify the proper way to stock and capitalise the available information. This information is usually stocked in raster format, complicating the routines of calculus and indicators derivation. However, given the fact that the main economic activity characterizing the Romanian rural LAU is agriculture, identifying, mapping and discussing the range of the potential natural threats is a topic of major interest for the sustainability of the potential functional rural areas. Given the scale of analysis (national level), efforts were made to preserve the best data resolution and to detect patterns and trends that present a clear interest for policy and administrative decision. For example, in some cases, like the net annual soil erosion map, it is arguable if the national scale suits better the implementation of policies or specific interventions, compared to the regional NUTS2 one. But, when facing climate changes effects, even if the models employed and the scenarios derived are not congruent on the future temperatures increase, the functional rural areas will need to be included in a general, national frame of solutions.

The data analysis together with the mapping process systematically extracted a set of policy recommendations and a key finding, set that was thematically declined. The delineation of the functional rural areas also emphasized the need to address two linked objectives: maintaining the level of territorial cohesion, at rural scale, and developing more competitive metropolitan areas, in a complementary form. The simple example provided by how the shape of the future metropolitan area will impact on the capacity of the rural LAU to join a functional area is an illustration of why these two approaches should be combined. From our point of view, using the functional rural areas as a frame of intervention and policy design, at local scale, is not a purpose per se, it is just a milestone in a longer trajectory of the Romanian rural spaces, already announced by the set of long-term strategies of national spatial planning. For the moment, their functionality should be considered in a pragmatic way, as potential adjustments and geometry changes could be recurring as the strategies shift on the long run. The main policy recommendations are synthesized in a dedicated final part of this study, but we considered necessary to indicate the relevant findings for policy design at the end of each major chapter.

The structure and the results presented in this report are the output of an approach that investigates the methodological background of the concept and the relevant and accessible datasets needed for the analysis. The conceptual inquiry and the data integration are followed by a more in-depth exploration of the economic and territorial elements of rural functionality, at the scale of the Romanian LAU. Finally, based on the three previous points, a technical presentation of the functional rural areas is proposed in a separate chapter. This chapter includes two potential working versions of the functional rural areas methodological investigation, emphasizing their potential for policy design and planning interventions.

1 Methodological background

This part of the study was dedicated to the identification of a conceptual and methodological background for the potential delineation of the Romanian functional areas, reviewing a diversified set of definitions and territorial approaches of the concept. Our strategy of investigation derives from a genetic perspective, aiming to highlight some of the milestones in the concept's evolution, at different scales – EU and OECD space and member states interested in the instrumentalization of this delineation (among others). The elements of reference have various sources, some of them are purely technical visions of the functional rural areas, while others detain an academic and research background that provides added value to the potential definitions.

In some cases, the research managed to identify only elements of rural functionality, as described by studies and papers focusing on this topic. For example, the accessibility component is seen as an important indicator in some Spanish studies, especially useful to better understand the general limits of the rural space, in general (Sanchez-Mateos, 2018). In other cases, like the Czech bibliography on rural areas and functional regions, the interest is shifting from spatial indicators to more precise interrogations regarding the differences between the urban and the rural spaces, from a technical and quantitative point of view (Pechrova M., Simpach O, 2016). In Hungary, some studies focus on the typologies of the rural spaces based on sound empirical detailing and providing interesting results about the state of the economic functionality of the rural areas (Perger E., Farkas J.Z., Kovacks A.D., 2016).

When addressed from a planning perspective, one of the most interesting experiences in the transformation of the functional rural areas in a tool for policy interventions and funding comes from France. The definition of the French *pays* in the late `90 is a good example of how the policy vision can shift from polarization based on functional regions to functional areas defined by internal territorial cohesion and local homogeneity. The two laws consecrating the French pays as a tool of territorial planning in the already complicated and over-zoned French space (Loi d'orientation pour l'aménagement et le développement du territoire – 1995 and Loi d'orientation pour l'aménagement et le développement durable du territoire – 1999) give specific attributes to these basic forms of functional rural areas – a shared territory with stable interactions, interests, challenges and potential. Together with Poland's recent experience in delineating areas of strategic intervention in the territorial planning, the French model remains at the core of our approach in defining the potential functional rural areas in Romania.

1.1 Lineage of the functional rural areas concept in the EU and the OECD areas of intervention

In 2020, DG AGRI (Migas and Zarzycki, 2020) for the first time at EU level, synthesized the need to elaborate a definition and the ideal content of the concept of FRA - Functional Rural Area. This first theoretical investigation was seen as „a need to have a common, EU-wide, functional definition of rural areas, in order to be able to: a) carry out the efficient agricultural and territorial (with rural focus) policy and b) compare / analyse issues related in rural areas at the EU and cross-Member State levels". It is clear that the definition of the concept must primarily serve as a framework and foundation for up-to-bottom interventions. This perspective is already applied in the case of FUAs, with the corresponding results, but it should be discussed whether it would be equally effective in the case of FRAs, where the final beneficiaries are closer to decision makers and usually inter-relate more closely than those evolving in the anonymity of the urbanized environments. According to the two authors, the ideal definition of the concept of FRA should avoid being presented as the spatial negative imprint of the FUA and, more specifically, it should take into account some fundamental ideas: "use existing, accessible and regularly updated data; be universal, applicable and acceptable for Member States; be scalable to more detail, flexible and adaptable; strive for maximum comparability and reusability within existing definitions (statistical, territorial, Member States, rural development); 'fit for purpose' in terms of follow-up (indicators), policy decision-making, analysis and reporting ".

The ideas proposed by DG Agri were the result of internal debates launched in the European Commission in July 2019. The conclusions of these debates were presented to Member States' statistical offices and to the OECD partners, as well as tests of various criteria and data sets that could be mobilized for this purpose. Among the analysed criteria, the authors list the population number by 1 km^2 (GEOSTAT), population density on 1 km2 (DEGURBA - EUROSTAT), land coverage by 0.25 km^2 (CLC), administrative limits

of LAU (EUROGEOGRAPHICS) and propose a list of other potential criteria, including housing density, artificial surfaces, services availability, hospitals, schools, farm practices, farm infrastructure, road networks and connectivity. The main intention is to develop both a methodology for the functional rural areas delineation and to provide an operational concept.

The long-term analysis of EU documents on rural areas, whether carried out by institutions (Committee of the Regions, for example) or specific directorates (DG Regio, DG Agri), constantly calls into question the diversity of European rural areas, and therefore the difficulties of defining it. As a basis for the Rural Pact, the European Commission's Communication (2021) to the European Parliament reaffirms this diversity and summarizes the factors that generate it, being much more complex than in other territories: natural and climatic conditions, geographical features, historical and cultural evolutions, demographic and social dynamics, national and regional specificities, levels of economic prosperity and market integration. Migas and Zarzycki (2020) place the concept of functional rural areas in a broader context, essentially lead by the idea of an existing heritage, cumulated over three decades of studies, interventions and political decisions taken on their basis. Hermansons (2021) briefly summarizes both the richness of this legacy and its importance: “The preparatory study for the 17th session of the Conference of the Council of Europe of Ministers Responsible for Spatial Planning identified more than 20 types of functional areas (2017)”.

Simultaneously taking these factors into account seems to lead to the impossibility of defining all rural areas in a single way and, therefore, to the impossibility of a single framework for intervention because “… no two rural areas are alike. This diversity calls for locally designed responses and solutions corresponding to each territory’s specific needs and possibilities. It also means that territorial development strategies should address rural areas according to their individual characteristics and in relation to their environment” (European Commission, 2021, p.3). The lack of an unitary definition and its causes have been underlined for some time (European Commission, 2012, p. 15): “Although 'rural' areas have been analysed in many countries for decades, there is no single internationally accepted definition of rural as a concept. The main reasons are as follows:

> (1) The various perceptions of what is (and what is not) rural and of the elements characterizing 'rurality' (natural, economic, cultural, etc.).
>
> (2) The inherent need to have a tailor-made definition according to the 'object' analysed or the policy concerned;
>
> (3) The difficulty to collect relevant data at the level of basic geographical units (administrative unit, grid cell, plot, etc.)”.

In an attempt to define the European rurality, the SHERPA team reviews the main achievements in approaching rural areas and European rurality (Féret, Requier and Tahani, 2020). The base is made up of the three OECD typologies (1994, updated in 2011 and 2018). The 1994 typology uses two important variables (local density and the share of the population of rural communities in the region they belong to), distinguishing three types of rural areas: predominantly rural regions (more than 50% of the regional population living in rural municipalities), intermediate regions (15% to 50% of the regional population living in rural municipalities) and predominantly urban regions (less than 15% of the regional population living in rural municipalities). The 2011 update includes a new variable, which can be called functional, namely the accessibility, as defined by Dijkstra and Poelman (2008), e.g., “driving time needed for at least half of the population in a region to reach a populated centre of with 50.000 or more inhabitants (Brezzi, Dijkstra and Ruiz, 2011, p. 3). This resulted in four types of spaces: predominantly urban, intermediate, predominantly rural close to a city and predominantly rural remote. The new typology of 2018 becomes more complex, by introducing specific FUA elements that actually define urban polarization, providing three types of spaces: rural areas within a functional urban area, rural regions close to a functional urban area and rural regions far from a functional urban area. The most important element of the last typology is that it copes with the theories of the urban-rural continuum, somewhat reducing the risks of creating rigid territorial frameworks, subsequent generators of discontinuities and territorial inequalities.

Simultaneously with the first update of the OECD typology, and in direct contact with it, the ESPON-EDORA typology (EDORA - European Development Opportunities in Rural Areas) was elaborated between the 2009-2011. The typology, which used three categories of indicators (rurality and accessibility, economic restructuring and socio-economic performance), proposes, outside urban areas, four types of rural areas: agrarian, consumption countryside, diversified 1 (strong secondary sector) and diversified 2 (strong private services sector). Next, the SHERPA study lists the EUROSTAT classifications (2011-2018),

carried out in close connection with the OECD, and which are based on the use of a 1 km2 cell grid, the data source being harmonized using the NUTS system. The main typologies developed are the territorial ones (which take into account the values of 1 km2 cells (for reporting urban clusters and low rural densities), FUA elements and basic territorial units - LAUs) and the urban-rural classification (predominantly urban, intermediate and predominantly rural).

Finally, the typologies with multiple origins are also mentioned, targeting either specific areas (coastal regions, mountain regions, disadvantaged areas, area with natural constraints and marginalized rural areas), or typologies intended for methodological improvements (PeripheRurality Indicator), or due to pressing needs of study (Rural Broadband Coverage).The analysis of the inclusion of these types in other research projects, articles or policy speech shows that they tend to be used for their original purpose, as spatial frames, or arid comparison grids (OECD, 2013), rather than as living and evolving concepts. More, using these typologies only from a geometrical and administrative perspective risks to put some distance between the decision takers and the final beneficiaries, the citizens. That's precisely why the functional rural areas need to take into account their character of *bassin de vie*, in order to counter this risk.

Inserted in the background of methodological consolidation, visible through the textbooks proposed by EUROSTAT in tandem with the OECD (Angelova-Tosheva and Müller, 2019), by the OECD (2020), by the European Union in collaboration with UNO and the World Bank (UN, 2020; Dijkstra, Brandmüller et al., 2021), the conceptual dimension of existing or future rural typologies must be emphasized and disseminated. A solution must be found to make the whole amount of intelligence buried in the technical manuals and annexes more visible through the opaque classes of typological maps.

Given that in the existing typologies most of the variables used can be applied to both rural and urban areas, the presence of specific and vital elements of rural areas, already stated in EU programmatic documents (e.g., natural and climatic conditions, geographic features, national and regional specificities) must become much more intense. There are clear benefits in defining and understanding functional areas in terms of policy planning and territorial governance. The analysis of public documents related to currently accepted functional areas suggests that the conceptual dimension is at least overshadowed by their typological dimension. It is very rare to talk about concepts and very often about types. Janne Antikainen, a member of the team that formalized the FUA, stated in 2005, in one of the rare materials that addresses functional areas as a concept, that "There is no universal definition of city or urban nor for FUA. In the ESPON 1.1.1.study, the concept of FUA was vaguely defined as urban area or core municipality and adjacent commuting areas (fringe municipalities)". This has not prevented the FUA from pursuing a career… It seems that rural areas are about to follow the same trajectory: "Most European policies do not have a clear definition of rurality, yet planning authorities use typologies in their identification of areas in strategic planning and implementation of spatial policy" (Féret, Requier and Tahani, 2020).

1.2 Member states approaches of the functional rural area concept

For the new Member States, the situation is even more complicated because all the factors are reinforced by the extremely different individual trajectories assumed after the change of the political regime in the 1990s (Depraz, 2008; Maurel and Lacquement, 2007). At a slower pace, a similar situation was experienced by Western European states from the 1980s to the late 1990s, when "the analytical lens to rural phenomena […] evolved from an approach of rural as 'society' to rural as 'areas', reflecting major driving changes such as agricultural modernization, the decline of the farming population, the demographic erosion in rural areas and the diversification of rural economy" (Féret, Requier and Tahani, 2020, executive summary). It seems necessary that approaches in terms of functional areas be "scalable to more detail, flexible and adaptable" (Migas and Zarzycki, 2020). This has immediate methodological (and political) implications, especially if one takes into account the experience of defining other types of European functional areas: "national and regional approaches to defining functional areas must be taken into account" (Hermansons, 2021).

The Polish experience can be explored in this direction: since 2012, when **The National Spatial Development Concept 2030** was approved, the Polish spatial planning is operating under the concept of functional areas (including two types of functional rural areas), defined as " a compact spatial arrangement consisting of functionally related areas characterized by common conditions and expected, uniform devel-

opment objectives"(Barska and Jędrzejczak-Gas, 2016, p. 27). The official Polish definition, which combines the idea of a living basin (which already exists in situ and is functional) with the idea of a framework for action (externally set objectives) can provide the necessary flexibility for the concept of functional area. Specifically, it can function as an analysis grid that, on the backbone of a general structure (already being defined) can combine with the results of some of the six approaches to defining rurality synthesized by the research team SHERPA (Féret, Requier and Tahani, 2020,): „1) the administrative (or statutory) approach, based on legal-administrative character; 2) the morphological (or demographic) approach, based on population criteria such as population density; 3) the locational approach, based on spatial relationships between urban and rural areas; 4) the economic (or structural, and functional) approach, based on criteria such as the share of agricultural GDP or the cost of services; 5) the landscape approach, based on land-cover and climatic conditions; and 6) the combined approach, which used a combination of at least two of the other approaches ".

A practical example in this regard is provided by Kozera and Głowicka-Wołoszyn (2018) who, apart from the urban or mixed (urban-rural) LAU which have not been taken into account, obtained five types of rural functional areas: multifunctional, agricultural intensive, residential / industrial, agricultural extensive and agricultural extensive with growing residential. The results demonstrate a fairly pronounced spatial association of the communes of each type, which facilitates possible spatial planning decisions.

Also, a good start in defining functional rural areas is represented by the new French definition (D'Alessandro, Lévy and Regnier, 2021), refined with the help of the latest methodologies and which distinguishes four categories: very sparsely populated rural area, sparsely populated rural area, slightly polarized rural area and strongly polarized rural.

Again, one of the less limitative definitions of a functional rural area comes from the French experience of spatial planning (or aménagement du territoire). Addressing the problems of the rural spaces using a form of inter-communality based on the local territorial cohesion and homogeneity became a specific tool of policy intervention, especially in its spatial delineation known as *le pays*. The lifetime of this concept covers almost two decades (1995-2014), and it became somehow obsolete only because it was replaced by a new ongoing project of territorial inter-communality, at local scale – *le pôle d'équilibre territorial et rural* (2014). The successes and the limits of the *pays* as a frame of decision and policy design are intensely studied in the France (Bonnerandi, 2005), with relevant synthesis or impacting case studies.

The interest of the concept of *pays* in our attempt to delineate functional rural areas in Romania is given by its geographical content, its key features are easier to adapt in the Romanian rural specific context:

- a voluntary form of LAU association aiming to valorize the local territorial capital in a sustainable way;
- the *pays* overlay spaces of intense but spatially limited territorial interactions, being the geographical expression of a *bassin de vie;*
- the local homogeneity and territorial cohesion are embedded in local history and traditions, but they have the ability to oppose negative changes induced by spatial processes of superior scale and intensity (metropolisation, sub-urbanization or market transformations of territories).

The operational and pragmatic components in defining the French concept of the *pays* are also interesting from a methodological point of view, as they prove that a functional rural area is not necessarily defined by its linkage with the cities via polarization or gravity models. Contrary, it functions as an autonomous spatial delineation of the rural space, with a strong emphasis put on the degree of internal similarity.

1.3 Functional rural areas in Romania – three coordinates for a definition

Based on this conceptual and methodological background, the Romanian functional area might be delineated following the next coordinates:

- *it is an aggregation of rural local administrative units linked by a clear territorial feature – local homogeneity*. This homogeneity can derive from several factors combined: common natural assets and landscape, uniform distribution of rural densities and demographic trends, specific territorial problems (accessibility to services of general interest) and a basic experience in funds attraction and territorial planning, at local level. Attracting EU funds is a key point in shaping the fu-

ture policy related to the Romanian functional areas and our study will show how this experience is unevenly distributed in the territory (in terms of total amount of funding attracted by the LAU). However, it is not the inequality that concerns the functionality of the alternative spatial frame to be delineated. The common element is given by the fact that there is a local base for developing more the dimension of the funding absorption, if smart policies will be adopted in a multi-scalar decisional context.

- *its intermediate size overlays the potential elements of the bassin de vie characteristics – daily interactions, economic local relations, a sense of territorial common belonging and a shared set of advantages and disadvantages*. The fact that the urban polarization, with different rhythms and intensities, intersects these local pools of interactions is not necessarily a limitation of the definition. As a matter of fact, the proximity to cities that provide services to the rural spaces might become one supplementary feature of local homogeneity. Excluded from the participation in the metropolitan areas by their geographical position or by the low capacity of spatial polarization, the small cities might behave as service brokers for the neighbouring functional rural areas. These local rural pools of activities and daily routines are resilient and marked by local forms of functional complementarity, making them suitable for implementing policies aiming to reduce territorial dysfunctionalities. This resilience is sustained by an endogenous functionality based on similar conditions, from natural capital to economic and demographic systems or planning experience. This is the main logic that made us underline the necessity to propose a delineation of the functional rural areas based on the local similarity, rather than on local polarization. Homogeneous territories share common problems, and, by territorial cooperation, they also can find common solutions, maximizing the impact of the policies and projects implemented.

- *it is a pragmatic, flexible and adjustable spatial frame, ready to be instrumentalized as a function for planning needs and policy interventions*. In many regards, the aggregation of administrative units in intermediate geometries is a relatively recent topic in the Romanian planning initiatives, with three major directions – aggregation of NUTS3 in NUTS2 regions, local collaboration between the urban and the rural LAU at the scale of the metropolitan areas and the experience related to the cooperation between the rural LAU in the frame of the LAG (Local Action Groups). Being a cooperation framework between the LAU and private actors in the rural territory, the LAG is not a competitor of the functional rural areas because they serve to different purposes, mainly to the implementation of the local development via the LEADER (Liaison entre actions de développement de l'économie rurale) programme. Our analysis shows that almost all the rural LAU have experienced the participation in a LAG, with different outcomes and strategies implemented. The functional rural areas in Romania must fill de decisional gap between the local level (LAU) and the NUTS3 level, with a very pragmatic purpose – the implementation of national strategies and accelerating funds absorption, in the rural territory. If the Poland's National Strategy of regional Development 2030 aims maximizing the impact of the financial instruments using the concept of Area of Strategic Interest, the Romanian functional areas can be considered a complementary concept, taking form as areas of tactical intervention (ATI) for planning.

The exploration of these three coordinates demanded the implementation of a separate set of tasks, starting with the indicators collection and finishing the elaboration of technical algorithms of delineation. This part of the research, mainly the data collection, was constantly under implementation during the project's lifetime, as new indicators may randomly become available on the open-sources Romanian portals or on the official websites of the data providers.

2 The Romanian rural areas in data and indicators

The latest data that allows us to plot some demographic and socio-economic characteristics of the Romanian rural areas are provided by the NSI for 2020 (Romanian Statistic Yearbook – 2021). Given the fact that 2020 is the first year of the Covid-19 pandemic, one might question the relevance of these "out of context" indicators, but not their quality. Yet, some basic characteristics can still be extracted. In this year, 46.1 % of the Romanian population lives in the rural areas, compared to 62.4 % in 1972, 50 years ago. It took 3 generations for this ratio to be altered with almost one third, and 36 years, to experience a rural population decline to under 50 % of the total number of inhabitants (the event took place in 1986). Since then, the stock of rural population is constantly decreasing at a slow rate. The 8.89 million of rural inhabitants live in a territory of 207 842 km^2, about 87 % of the surface of Romania. Compared to the urban space, the density is significantly lower – 62 inh./km^2 vs. 522 inh./km^2 in the Romanian cities and towns. The rate of births per 1000 inhabitants reaches 10.2 in the rural areas, lower than in the urban LAU (10.4) and this situation seems to be fixed on a trend started in 2013. In terms of migratory balance, the rural areas attracted a stock of internal migrants superior to cities – 190.000 persons (almost 23.000 newcomers more than in the urban areas), in 2020.

From an economic perspective, in 2020, the rates of employment are not extremely divergent – 67.1% in the urban space and 63.8 % in the rural one, but the situation is really contrasting when these rates are associated with the educational attainment. The unemployment rates in the rural LAU are more reduced, in the case of the population with a low level of education – 6.7% compared to 14.1 %.

In terms of accessibility, on national average, we calculated that a person living in Romanian rural region will find a large city (200.000 inhabitants and more) at 87 minutes from its residence, a medium city (more than 100.000 inhabitants) in 60 minutes, a hospital endowed with emergency sections in 25 minutes and a high school in 20 minutes. This chrono-spatial hierarchy of potential interactions between the rural and the urban areas shapes the local economic performance, the demographic trends and the sum of territorial disadvantages that the rural areas might cumulate. Having more in-depth information about these processes demanded the elaboration of a dedicated database, with inherent challenges and limitations.

2.1 Rural indicators in the official databases

The description and the understanding of the Romanian rural areas are filtered by the access to the usual indicators – population, density, socio-economic datasets or nomenclatures that defines this particular type of space. The Romanian NIS delivers data that describes the local administrative units in a homogeneous way, subordinating the data access to the official national delineation that separates the urban LAU from their opposite – the *communes*. In this case, what is not urban (cities or municipalities), becomes rural space, independently from other potential typologies – economic functions, local polarization, socio-cultural patterns etc.

The definition of the Romanian rural space, according to the law (351/2001), focuses on the economic specialization of the LAU. The rural areas are defined by their strong orientation towards agriculture and, in other cases, by their level of territorial endowment (inferior to the cities). Interesting for our research, the definition of a rural commune (Romanian LAU designation for the rural spaces) insists on the fact that their territorial background should be given by the "common interests and traditions" of the populated places that compose it. This legal definition already contains one of the principles that helped us elaborate one of the main components of our vision on the Romanian functional rural areas – the fact that it is supposed to be based on a *bassin de vie*, a space of daily interactions.

Changing the administrative status for a rural LAU is also regulated and the main trend, for a long period of time (2001-2008), was to assist to the *upgrading* process (rural LAU becoming cities). In one case – the LAU of Băneasa (Constanța county), the main trend is reversed and the town of Băneasa *downgraded* to the status of rural commune. These changes are not technically interfering with the data collection process, but the ambiguous status of the recently appeared cities might have an impact on the territorial analysis process. For a large amount of these former rural LAU, meeting the needed indicators of urbanity is still a problem. The changes in administrative geometries have an impact of the management of time se-

ries needed for the analysis of the Romanian rural spaces, inviting the researcher to rather use the recent indicators.

In many regards, the collection of data describing the recent economic, demographic and social transformations of the Romanian rural spaces should be just another routine job, associated with simple tasks like indicators download, datasets join process with the working geometry and applied spatial analysis and models. A more in-depth analysis of these tasks reveals some difficulties, however, difficulties that are caused by independent factors, such as the administrative fragmentation at LAU scale, the pre-census period or the post-pandemic readjustments visible in the tissue of economic companies, in Romania. For example, the intense administrative fragmentation (237 new LAU have been registered between 2004 and 2022) denies the use of systematic time series on the indicators analysis and force the researcher to work with data harmonized after 2015, when this splitting process entered in a *ralenti* phase.

The pre-census period involves dealing with official data that has to be integrated as estimations, when not directly measured, being aware of the fact that some of the indicators might have a medium to high reliability only. The post-pandemic period is visible in the chaotic trends presented by the indicators describing the economic performance of the Romanian companies, both as a stock and as relative data. At the same time, the Romanian NIS no longer provides some strategic indicators for a better understanding of the rural space dynamics, including the structure of the employment by NACE classification or the agricultural patterns by crop in the rural LAU. Concerning the analysis of the spatial interactions at local level, we still miss an elementary database describing the commuters' flows, the services frequentation and the national migration by origin and destination (LAU coded).

If some of the problems mentioned lack a clear solution or the solution is out of the scope of the project (rebuilding the statistical time series, at local level, for example), some of the data access issues can be partially solved using proxy indicators. For example, during the project's lifetime, we have been able to precisely geo-locate the companies only for the Macroregion 2 (NUTS1 – RO2), by batching companies addresses in packs of 2500 lines, together with the financial indicators (number of employees, gross turnover, profit and losses in the interval 2017-2020). Cleaning the data and having a curated version could have taken an unavailable amount of time, so the process has been halted, despite its major interest for the analysis of the rural areas and the functional regions delineation.

As data on the spatial interactions is out of the researcher's reach in Romania, a dataset containing the estimated road flows for the public transportation was used instead. A transportation aggregator of road trips was used for this purpose, www.autogari.ro. The flows dataset used for the assessment of the rural connectivity should be considered as a large sample of spatial interactions between the Romanian LAU, we are aware that some of the links might be missing, but we are not able to estimate its proportion. The size of the sample is larger than 11800 links, validating under some circumstances the observations derived during the mapping process.

As no official database on road network is freely available for use in the research field associated to spatial planning in Romania, a combination between two network datasets was created, one containing the basic elements (local roads, county roads, national roads), the other one containing the highways segments. The source of both networks is Eurogeographics, only the editing scale being different. Despite this snapping between two different road networks, the results are highly reliable, and they become a specific component of the projects spatial database. An alternative solution would have been the use of an open-source dataset, but the cumulated expert opinion of the research group suggested a total avoidance of this kind of solution for insurmountable issues – connectivity, road segment labelling, editing scale etc.

Even if these details might look extremely technical, they were a part of a decision chain during the study and had an impact on the functional rural areas' delineation. In the same logic of technical recommendations, it is not lacking in interest to develop a methodological frame of time and length distance evaluation, at local scale. The use of distance calculation APIs for this purpose (Here, Google Maps, Azure etc.) might be a starting point for obtaining a confidence interval on the different distance matrixes used for accessibility calculus – but this is out of the scope of the project. Finally, for the analysis of the cultivation patterns, the APIA (Romanian Agricultural Payments and Intervention Agency) database was used. The size of the database forced us to proceed to a simplification of the indicators, using a grid of 5 km size for the integration of the major cultures (corn, wheat, colza, sunflower, forage, potatoes and vegetables).

The rest of the indicators were collected from the official sources, the Romanian National Institute of Statistics (NIS), the Romanian Territorial Observatory and the GISCO Eurostat database. The evaluation of

the potential risks and natural threats on the sustainability of the functional rural areas has multiple sources, including Joint Research Centre, as well as the internal data repository of the Faculty of Geography and Geology, Alexandru Ioan Cuza University of Iasi. As some of the analysis implemented demanded the use of network distances, an ad-hoc solution was found for the inherent measurements.

Due to a lack of data describing the Romanian territory, the challenge of delineating the functional rural areas is not only conceptual, is also an attempt to overcome a set of statistical deficiencies that has a clear impact on the study development. In this research, we propose a methodological, conceptual and technical approach of the functional rural areas. One of the objectives of the study is to project the functionality of these regions in the future, using geo-physical indicators. We consider that the sustainability of the functional rural areas is also a matter of constant surveying and observing the internal trends and dynamics. For the moment, given the statistical datasets available for research, this surveying task is a problem of geometry choice (LAU, populated places grid) and indicators harmonization.

The main data sources that can be mobilized for the surveying tasks are heterogeneous and present a mix of availability scales – populated places, LAU, grid data or geo-located geographical objects. The Table 1 is a synthesis of these potential spatial datasets and indicators collections.

Spatial resolution	General description	Source	Potential problems
Grid data	Romanian demographic grid for 2011. The census data for 2011 is integrated in a 1 km. grid and it contains basic demographic data: total population declined by gender and age.	http://geo-spatial.org/vechi/download/romania-seturi-vectoriale	The link to the basic geometry is no longer active (the EFGS grid).
Grid data	European Union and neighbour states. GIS techniques allow extracting only the data regarding Romania. The chronological extent covers 2006, 2011 and 2018.	https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/grids	No issues observed.
LAU delineation	The Territorial Observatory of the Ministry of Development, Public Works and Administration. A sound database coming into 2 formats - a geodatabase containing geometries and indicators and an archive consisting only in tabular data (.xlsx). The indicators are grouped thematically and have a clear policy support destination. It covers demographic, economic and social indicators, sometimes with large chronological extents.	https://ot.mdrap.ro/website/maps/	Not necessarily a limitation, the metadata should be checked directly at the source (NSI mainly). Given the high heterogeneity of data sources, minor harmonization must be implemented by the user.
Vector topographic maps	Two versions of recent topographic maps, at NUTS3 scale. They contain useful information, such as the location of the green energy projects, administrative buildings or generalized transportation networks (for illustration purposes only). Data provided as geodatabase.	https://geoportal.ancpi.ro/portal/home/	The data is downloadable NUTS3 by NUTS3 and it is possible that some of the information is not available at the demanded scale (1:50000, for example).

Spatial resolution	General description	Source	Potential problems
Statistical data only (LAU)	The National Statistical Institute provides a large number of updated indicators, with a classic thematic grouping: social statistics, economic statistics etc. A part of the data is provided for the LAU delineation, together with the Romanian coding system (national code or SIRUTA).	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table	The data collection is optimized for quick visualization, rather than datasets creation. The metadata includes sound definitions, but it is expedient regarding the special cases. Also, the download involves a NUTS3-by-NUTS3 approach, no national option being listed.
Statistical data only - local geometries, including LAU	The constantly updating Romanian Open Data project. It is supposed to be a multi-lingual platform sharing different datasets provided by the Romanian public institutions. It is a good starting point in collecting information about companies or detailed data about financial transfer, at local level.	https://data.gov.ro/dataset	Most of the data is in tabular format and, in some cases, lacking a systematic coding system for geographical analysis. The geolocation tasks are on the user's effort.

Table 1 Potential data sources for the investigation of the Romanian functional areas.

Our main recommendation is to create a thematic database capable to implement a constant description of the functional rural areas in the future. This database should be organized on at least two intersecting levels: a core set of indicators at the scale of the populated places (villages) and a systematically updated dataset, at LAU scale. The core set of indicators is already available, in different public datasets, but it lacks spatial descriptors (no official spatial coding system present). The upgradable dataset might be regarded, in the beginning, as an attempt to recover and update different official databases that fades into oblivion, once the projects financing them exhaust the resources. It is the case, for example, of the RORisk database, a large inventory of different hazard potentially affecting the Romanian LAU. The feasibility of this monitoring database increases in a context of active cooperation between policy makers, academic environment and the IT market.

2.2 Complex indicators describing the functionality of the rural areas

This part of the study focuses on identifying alternative datasets that can bring added value to the understanding of the Romanian rural areas, from a thematic perspective. In many regards, a large part of this information already exists, but it is relatively difficult to integrate it in the common research as the corresponding geographical objects (educational infrastructure, for example) are not yet linked to the indicators, in a ready to use GIS frame. The results of our exploration are provided in the table below.

Thematic	Dataset and description
Economy: agriculture	Data regarding the spatial distribution of the economic actors active in NACE sector A (Agriculture, forestry and fishing). The spatial resolution of the data can be imagined at the level of geolocated address, supporting integration in superior spatial frames (grid, populated places or LAU). The RECOM (Register of Commerce) and the Ministry of Finances provide this data in open access, with a fair level of data coverage –on the companies' turnover, the number of employees, the profit and losses and many others. Moreover, the data is available as time series, so trends and dynamics can be extracted and identified, with a true potential to zoom-in specific functional rural areas.

Thematic	Dataset and description
Economy: services to enterprises in the rural space.	As the main economic specialization of the rural space is agriculture, the tertiary support of this activity present interest in the understanding of the local functionality of the companies' networks. We detected at least two NACE Sectors that can be integrated in a potential database – the wholesale of phytosanitary products and the wholesale of fertilizers. The sale of these products is regulated and the logic of spatial distribution of these commercial activities is a proxy for the market integration of the agricultural spaces. Again, a geolocation at address level is possible.
Economy: tertiary activities	The level of services endowment in the rural space is relatively well-known for the public services of general interest, but it lacks a proper exploration of the territorial repartitions of private activities – retail, banking and insurances or notary services. The integration of these descriptive indicators (location mainly) will build a more structured image on the territorial disadvantages in terms of accessibility. The spatial resolution might be satisfactory at the level of the populated places (localities).
Economy: industrial activities	Possibly, one of the least explored dimensions of the Romanian rural space. Even if the main specialization of the rural space is agriculture, recent trends of industrial location are visible, and they diversify the portfolio of local activities. This data integration can rely on the information provided by the RECOM and Ministry of Finances or on the companies' data aggregators.
Digitalization fracture and TIC penetration in the rural space	The access to the Internet in the rural space is highly ignored, at local level. For the moment, measuring the digital fracture between the rural and the urban spaces relies on the datasets provided by external actors and projects like the free geolocated IP databases and the grid estimation of the download and upload speed provided by Ookla Internet Speed Dataset. Even if the coverage of the rural space is not complete, some information might be interpolated for a clearer image of the technological endowment differences between the rural and the urban areas.
Education attainment and disparities	The differences between the level of performance between the rural and the urban space became a topic of major interest recently, as the level of disparities is set on an ascendant trend. The Ministry of Education provides free datasets that can be used in order to investigate these territorial disparities, at school level. The main platforms for the data collection are : http://admitere.edu.ro/, http://bacalaureat.edu.ro/ and https://www.siiir.edu.ro/carto/. The effort of data integration should focus on two directions – mapping the educational infrastructure and finding a sound method to aggregate the educational performance indicators.
Environment and energy	The diffusion of the green energy projects in the rural space can be analysed using a triple matching between the projects location (The Romanian Geoportal), the data provided by the Ministry of Energy and the Ministry of Finances. It is a topic of major importance for the understanding of the Romanian functional areas because it depicts how these regions are coping with the recent processes of rural modernization.
Transportation and accessibility	The general picture of the rural accessibility is highly subordinated to the road transportation indicators. However, there are very few and potentially deprecated efforts to integrate accessibility and connectivity in a multi-modal transportation frame (roads and railways). Despite some technical difficulties to integrate this kind of indicators, an effort should be started with the collection of data describing the railways system, in the rural areas. The official sources (CFR – The Romanian Railways Company) is the main target for data harvesting, in this case.

Table 2 Thematic disaggregation of indicators of interest for the investigation of the Romanian functional rural areas

Box 1 Relevant findings for policy design:

1. A spatial database dedicated to monitoring the dynamics of the Romanian rural spaces is clearly needed, if one will have the intention to measure the territorial impact of the national, regional or local policies implemented in the Romanian rural space. This monitoring tool needs to differentiate itself from the rest of the data providers (Romanian NSI, MDPWA Territorial Observatory etc.). This database might focus on the very local indicators already available from different other sources (Ministry of Agriculture, Ministry of Finances or institutional databases in public access). If the delineation of the functional rural areas becomes operational, the zoom-in on the local functionality will be highly useful, especially on topics like local economy, local mobility or agricultural specialization. The datasets waiting to be integrated are, in some cases, closed to the definition of big data, so a sound technical infrastructure for this tool is a stake.

2. Overcome the lack of official datasets on the transportation network for Romania. The best solution available from the open data sources was to use Eurogeographics products. In this case, the elaboration of the indicators of spatial accessibility heavily relies on the network quality, which is really sensitive at local scale, especially for rural spaces. We also became aware of the conceptual challenges related in defining terms like accessibility or connectedness, in the context of the rural space analysis. Together with the elaboration of an official transportation network to be used at the scale of this study, a supplementary point should be the elaboration of a set of common national definitions and protocols of calculation for the indicators derived from the network analysis – accessibility, dominant route, connectedness etc. This objective will have an impact on the assessment of the transformations suffered by the functional rural areas, when changes in the territorial endowment occur.

3. The access to open data in Romania is relatively performant and the quality of the indicators is generally high. However, two issues are constantly acting as a barrier in their use – the limited amount of metadata and the erratic supply of a geo-spatial coding system for the information (spatial coordinates, national statistical code or geographical labels). If the user is external, a large amount of the data is linguistically unavailable, because the progress in translating the datasets in other languages is reduced. These aspects might not seem to be relevant or of direct importance, but their solving will create a formal frame of data curation and will bring added value to the spatial datasets describing the functional rural areas.

3 The Romanian rural space – recent economic trends and elements of local dysfunctionality

3.1 The economic dimension of the rural areas in Romania

Understanding the functionality of Romanian rural spaces needs an exploratory investigation of the main foundation that makes it locally visible, with different degrees of intensity and permanence. The pillars of this foundation are anchored in the economic, the demographic and the territorial dimension of the rural spaces, as they are described by the geo-statistical indicators. Yet, detecting all the elements of local rural functionality is out of the scope of this research. Given the today's context, where multiple potential crisis and territorial shocks are mixed, we considered that insisting on the economic dimension and the local specializations is an approach that will enable us to reveal the core of the rural functionality in Romania. Completing this primary analysis, a set of typologies addressing the issues of territorial accessibility and spatial trends regarding agricultural specializations are also proposed, in the second part of this chapter.

The datasets collectable from official sources and various platforms lead us to exploring the economic dimension of Romanian rural areas. Useful indicators such as the gross turnover and the number of employees are missing from our database and we avoided using old data, as the variations and the dynamics of the financial indicators denies their use as a proxy for the current situation. The general picture of the economic landscape of the rural LAU is a combination of outputs deriving from at least three drivers – the accumulation companies' stock, the economic specialization of the rural areas and the access to services of general interest.

Even if there is no obvious connection between these three research directions, a complex territorial linkage is likely to appear under the form of subtle territorial interactions. For example, the stock of some service providers in the rural space (other than the public ones) is correlated to the spatial diffusion trends of agricultural specialization. This situation is easy to observe, if one will analyse the spatial distribution of the public notaries or the location of real estate agencies. The explanation is simple, and it is related to the land re-parcelling in a context of high demand for land for large and productive farming. At the same time, there is an association between the spatial trends of companies' diffusion in the territory and the accessibility of services of general interest, the last ones heavily concentrating into cities and selected rural poles of attraction. Again, the explanation is rather simple – both the public services of general interest (already located) and the private companies are depending on the local catchment areas that can be accessed using the same networks, with the same impedances or time distances. One component of this diffusion process, the pharmacies, is a clear exemplification of mimetic behaviour in the location strategies.

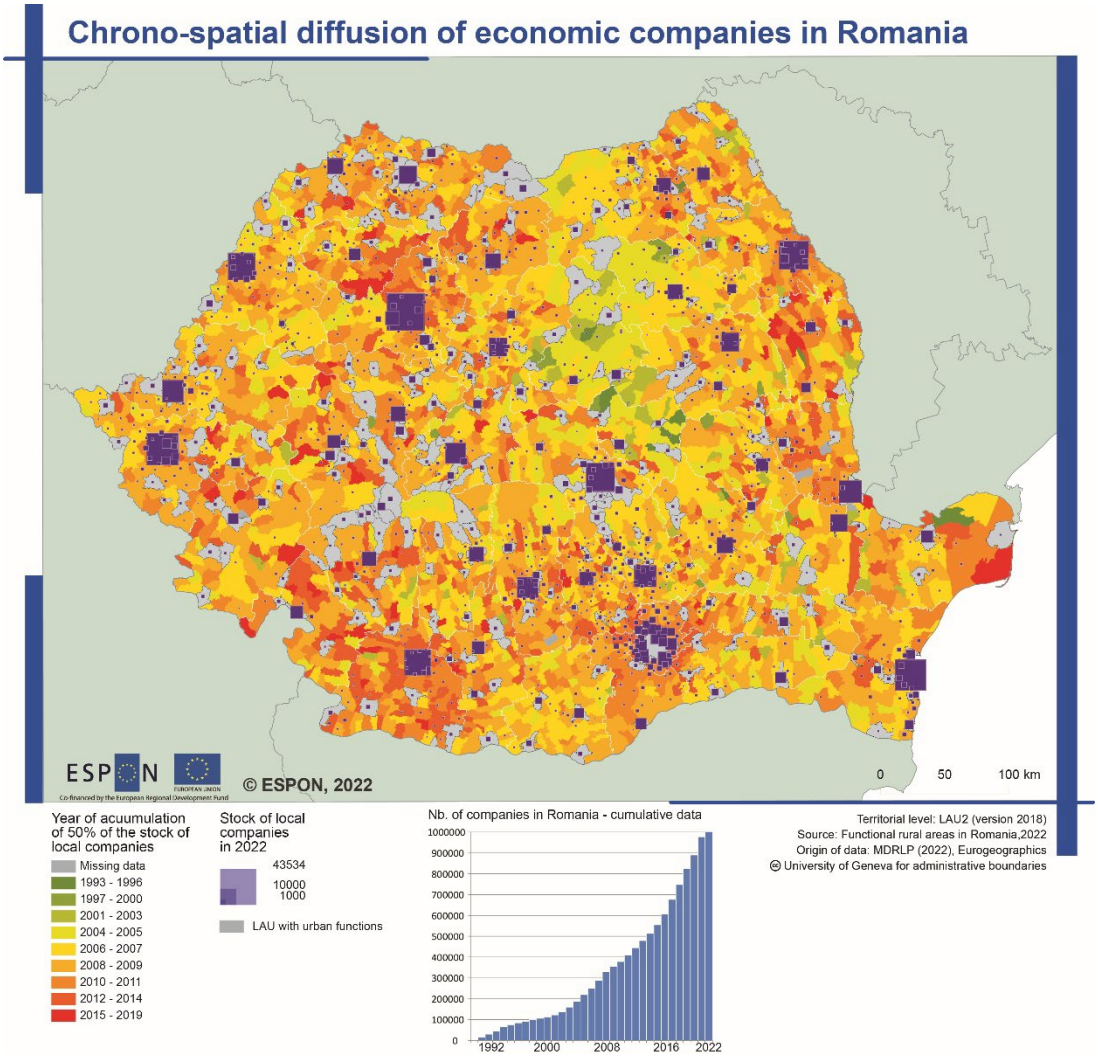
These three drivers can be contextualized by the ability of the rural communities/authorities to attract funding (indicator measured by the number of financial payments for projects related to the national frames of interventions). Generally, the reviews of the studies focusing on the economic dimension of the rural areas are convergent towards the same conclusion – there is a strong association between the territorial cohesion and the local economic performance and the intensity of this association obeys to a distance decay function from the cities (Muntele I., Groza O., Țurcănașu G., 2012).

3.1.1 Diffusion of economic modernity and agricultural specialization in the Romanian rural areas

When analysed in a multi-scalar context, the diffusion of economic modernity is adjusted by some regional or NUTS3 patterns of spatial organization of the rural areas, emphasizing the role played by the territorial resistance in the propagation of the economic innovations (companies implantation, mainly). Mapping this resistance and the trends in overcoming it was possible after the compiling of a spatial database at the scale of rural localities (villages or populated places subordinated to a rural LAU, by using partial addresses matching between the companies and the populated places centroids). As the size of the dataset was unsuitable for mapping and spatial analysis (more than 13 000 populated places), a supplementary aggregation in the LAU geometry was applied. The indicator of interest was the companies' year of implantation at local scale, without having access to other descriptors, not even the NACE code. The main observation

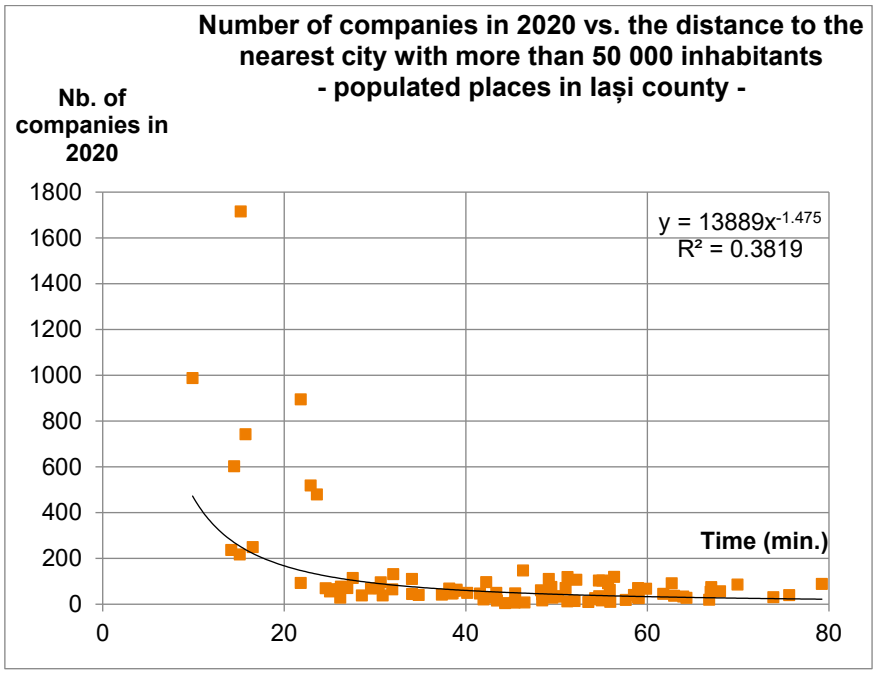
produced by the map analysis is related to the fact that the stock of companies active in the rural space is extremely low, maybe lower than expected. The level of concentration in the cities is so intense that the ratios of companies accumulation between the urban and the rural spaces is almost 2:1 (1.93, more precisely), while the demographic ratio is only 1.06:1, after excluding Bucharest from both calculations. The marginalization of the rural spaces from this accumulation process is even more intense, if one will refine the previous ratios with the situation of the metropolitan areas around the capital or around large cities like Iași, Cluj-Napoca, Constanța or Timișoara. Even if the rural LAU located in these metropolitan areas are not always extracting similar economic benefits from their proximity to the city core, the diffusion in the proximity of the entrepreneurial local advantage is visible at Miroslava, Florești or Dumbrăvița.

Measuring the relation between proximity to cities and the stock of companies is a synthetic way to describe how this diffusion mechanism works. However, this assessment makes sense at national scale, but it is even more appropriate for case studies at NUTS3 scale. In the case of the county of Iași, for example, the intensity of the relation between the distance to the nearest city with more than 50.000 inhabitants in 2020 and the number of companies in 2020, located in a rural LAU, has the shape of a classic power function, with a slope of -1.47 and a coefficient of determination of 0.38, high enough to sustain the existence of this association. Applying the same case study for a county like Constanța provides different coefficients: a slope of -1.55 and a coefficient of determination of 0.63. The parameters for Constanța are possibly even higher, when the outlier LAU of Limanu is excluded. These differences emphasize the need to approach this process of the territorial diffusion of the Romanian companies in the rural territory with an appropriate spatial frame of measurement (regional or NUTS3).

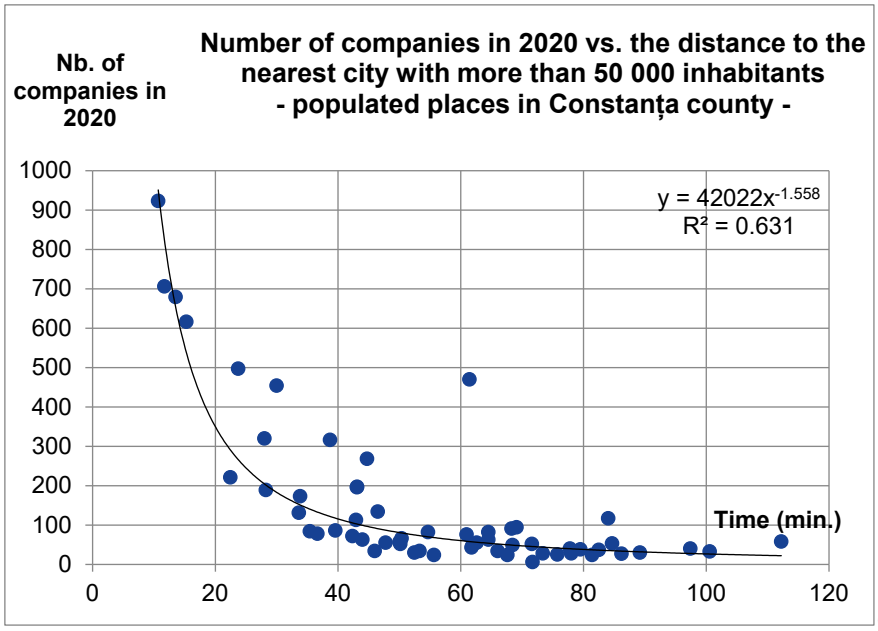


Map 1 Diffusion of the entrepreneurial behaviour in Romania – years of accumulation of 50 % of the companies stock

If these gradients are at work and they model the economic landscape of the Romanian rural areas, the policy design should be aware of the limitative impact that they detain on the accumulation of a sound stock of companies beyond a certain distance from the dynamic cities. In our opinion, counteracting the effects of the distance decay effect is possible by a better valorisation of the rural advantages, in terms of companies transfer or implantation – terrain availability for productive compartments, labour force and know-how in specific or vocational activities (agriculture). The potential functional rural areas will need to mobilize these opportunities, in a coherent frame of decisions and strategies.



G1



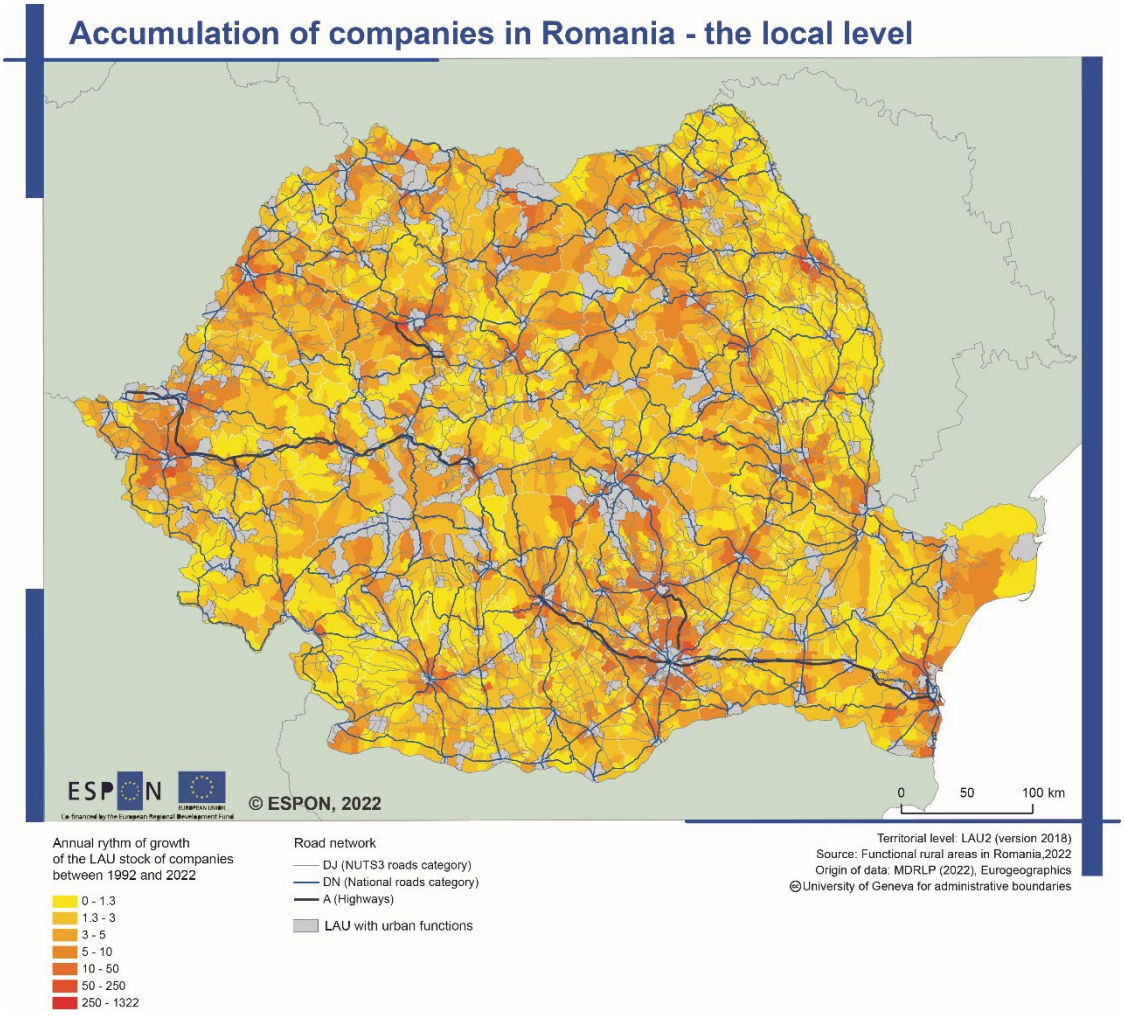
G2

Figure 1 Different effects of the cities on the accumulation of companies at LAU scale. A case study on the NUTS3 region of Iasi (G1) and NUTS3 region of Constanța (G2).

The differences between the two NUTS3 patterns are easier to explain if one will take into account the degree of urbanization of the two NUTS, in the proximity of the administrative centre – the cities of Iasi and Constanta. In the last case, the presence of a ring of small cities (Năvodari and Ovidiu) contiguous to the metropolitan core will have an impact on the companies' accumulation. As the distance increases, the dynamic rural LAU enter into action and divert a part of the concentration process, otherwise controlled by

the urban system. For Iasi, the situation is different, as no contiguous ring of small cities is present around. In this case, only the rural LAU located in the immediate proximity are able to actively participate into the accumulation process of companies. When mapped on the graph, these rural LAU create a cluster of positive residuals, grouped in the isochrone of 25 minutes around the city of Iași.

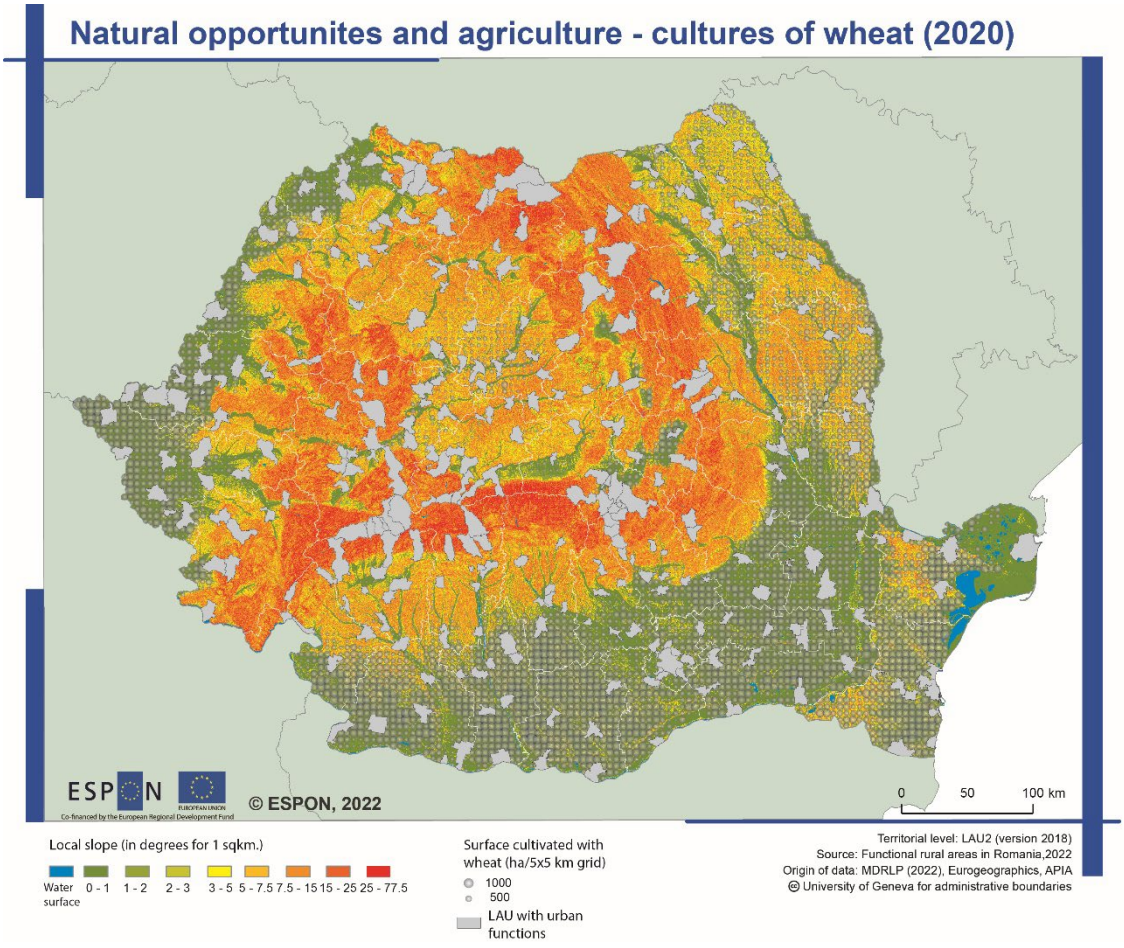
These two models emphasize the various forms of potential organization of the rural spaces, in the proximity of large cities. In the NUTS3 where the spatial relations between rural and urban LAU are less asymmetrical, the investigation of the entrepreneurial diffusion demands other logics of investigation. For example, Map no. 1 shows that at least two other patterns of accumulation might be detected in the rural areas. The first one concerns the rural LAU behaving as “early adopters of the innovation”, with a value for the year of 50% cumulative stock placed between 2001 and 2007. The mountain areas of counties like Suceava and Neamț are clear examples for this diffusion pattern, but they are also present in other parts of the Romanian territory, with lesser extent and concentration. The second category is formed by rural LAU that are characterized by more recent years of 50% accumulation. Its spatial repartition is rather associated with the rural spaces located in the inner peripheries of the urban system, especially the urban cities with advanced polarization functions (NUTS3 or regional attraction). Seen as “late adopters of the innovation”, these rural LAU are less included in the process of cumulative growth of the stock of companies, making us ask what is the morphology of the spatial association between lack of services of general interest (or lack of accessibility to them) and economic lagging. Exponents of this category can be detected in areas like Tutova’s Hills, the Plain and the Plateau of Covurlui, but also at the limit between two contrasting NUTS3, from an economic point of view. Maybe the most visible case of manifestation is at the limit between the counties of Cluj and Sălaj.



Map 2 Annual rhythm of growth of the LAU stock of companies between 1992 and 2022

As a first conclusion of our approach, the main spatial differentiation between the diffusion patterns of the entrepreneurial behaviour, in the Romanian rural areas, is given by the distance to a city with complex services (at least administrative centre of a NUTS3). This distance filter functions with different intensities, inscribed in a larger context of innovations diffusion in Romania. Depending on the local conditions, territorial endowment and comparative advantages, some of the rural LAU cope better with the networks of companies' creation and accumulation. The role played by the territorial endowment is essential in this complex equation, not only in terms of road infrastructure and connectivity, but also in terms of other territorial assets – proximity to Western border, potential for tourism, agricultural specialization. Map 2 emphasizes how strongly linked are the rhythm of growth for the companies number, at local level, and the access to a road corridor of regional or national importance. The rhythm of growth was built as the slope of the regression line between the cumulative sum of companies (Y) and the years of companies' installation (X), for each LAU. The indicator is confident at 95 %, except the LAU of Grindu (NUTS3 – Tulcea), where the confidence level is below 90 %. Again, excluding the rural LAU placed in metropolitan areas or closed to city with complex territorial functions, the spatial repartition of the indicator's values is in many cases a matter of increased spatial accessibility, via a significant road segment – E60, E85, E87 etc. At the opposite, the rural areas with a low degree of connectivity mainly induced by less important road segments (DJ – county roads) shows low values of the indicator.

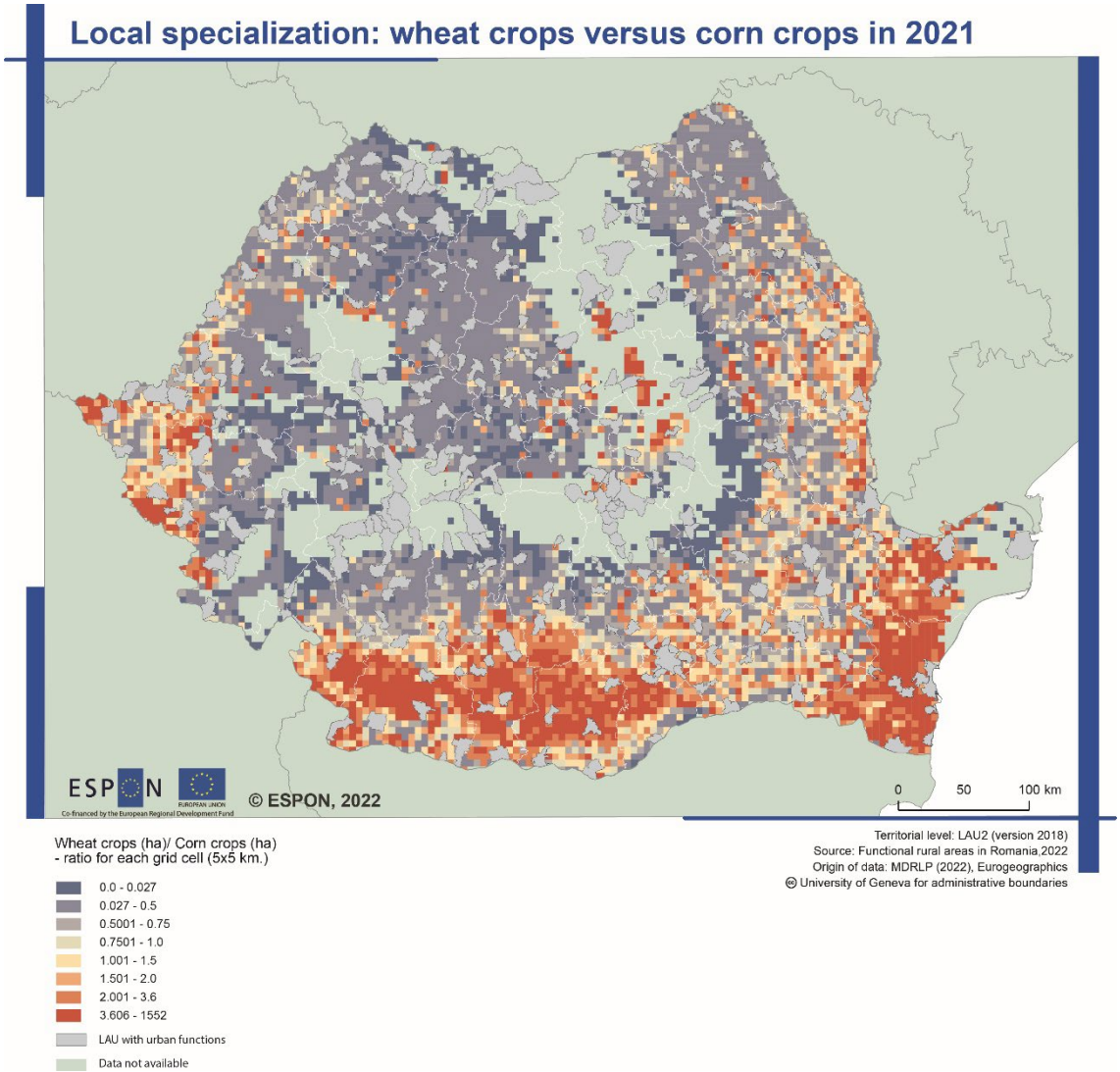
Three regional clustering of low values are of major concern, from a policy point of view: the Romanian Eastern border, the major part of the rural areas of Mehedinți and Dolj counties and a third cross NUTS3 region, overlaying the Getic Piedmont. The low level of accumulation of economic actors in these three areas is the clear sign of territorial disadvantages at work. With smaller extent and placed in other spatial situations, clusters of less integrated rural LAU are visible in other regions too. We suspect that this third category explains its presence on the map based on other mechanism – low potential of spatial interaction (Central Dobroudja), traditional marginalization of rroma communities in Southern Transylvania, tunnel effect created by the A2 highway in Ialomița county.



Map 3 Growing wheat in Romania (2021) – a matter of natural opportunities?

This contrast between the active LAU and the less integrated ones in the economic circuits is even more interesting, when placed in opposition with the territorial capital of some of the rural areas. As the main economic activity characterizing the Romanian rural areas is agriculture, linking this de facto specialization with the local territorial capital becomes an alternative path in better understanding how these regions are functioning, from an economic point of view. This local natural capital can be expressed in the form of a simple equation balancing constraints and opportunities.

The constraints and the opportunities can be expressed in terms of terrain availability, its slope and fragmentation, presence of a river network or water resources nearby, together with non-manageable factors like temperatures, precipitations and partially the soil reserves. Understanding how this natural capital is distributed in the rural areas demands methodological approaches that put an emphasis on other spatial frames of investigations (raster and grid calculus), while the classical administrative spatial references becomes complementary to the analysis. The data collected for the investigation of this aspect of the economic dimension of the Romanian rural areas is divided in two categories: APIA (Agency for Payment in the Agriculture, 2021) and geo-physical descriptors, at national scale (SRTM and river networks mainly, from GISCO).



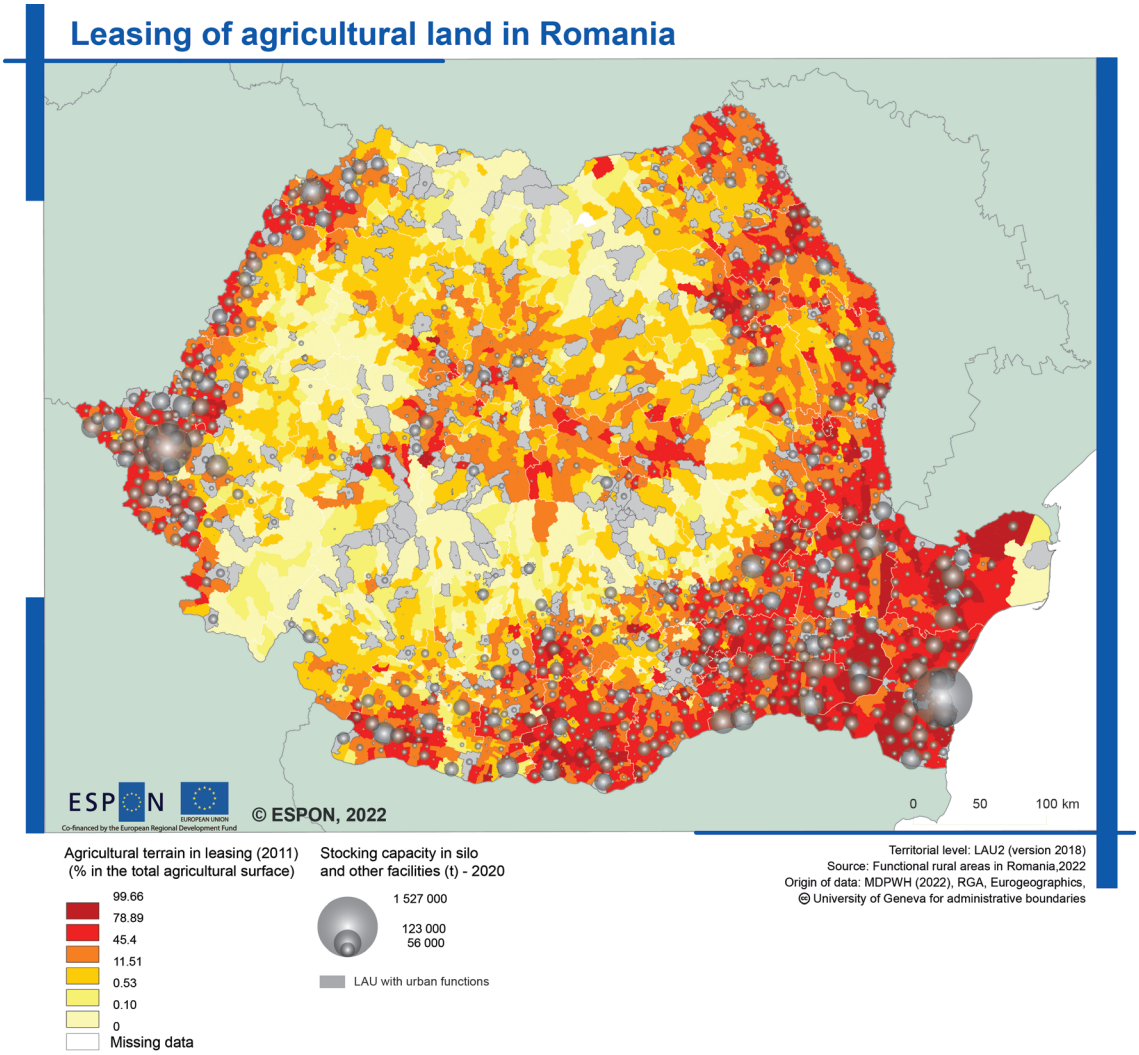
Map 4 The Romanian wheat belt in 2021

For example, the case study applied on wheat cultures in 2021 shows that the agricultural patterns are prudent in terms of local constraints. At the scale of the Romanian rural spaces, as a general rule, the wheat parcels will prefer areas with a local slope inferior to 5%. This can be explained by the necessity to minimize some of the mechanization costs, fitting better on the budget constraints of the exploitation. Few transgressions of this preference are visible on the map, mainly in Central Transylvania, the Getic Pied-

mont, the Covurlui Plateau and the Oltina Plateau, but they are explainable by the very local topography of the wheat cultures. The slope gradient is associated with the terrain fragmentation and in a strong extent with the altitudes, which determines the temperatures and the precipitations, affecting the preference for a culture or another, at local level.

However, given approximately the same natural opportunities, specialization trends appear, when we focus on more than one culture. The specialization reflects other logics of economic organization in the Romanian rural areas, joining the natural capital to the land use financial rents. We suspect that this is the reason why the Romanian wheat belt shows such an intense concentration, marginalizing corn in the local specialization, in some cases. This belt starts in the Western Romanian Plain (a component of the Pannonian Plain), continues in the Romanian Plain and it ends in Dobrogea. The less intense competition between wheat and corn, west of Bucharest, is explained by the concurrence of other productive cultures (colza and sunflower). Advancing to the north, in the North-East NUTS2, the specialization in wheat gradually fades and leaves the place for more complex cultivation patterns, some of them dominated by corn.

The explanation of this intense specialization in the south is not only related to the mobilization of the natural local capital, but also explained by the market proximity (port of Constanța for Dobrogea), the rural agricultural structures (land property fragmentation), traditional agricultural practices and maybe the most important aspect, the phasing out of the transition agriculture and the inevitable installation of the capitalistic one. Data from 2008 (The Online Territorial Atlas of Romania, Atlas of Romania, Rey et all, 2008) already detected these trends. Accessing more indicators and more information, after the publication of the Agricultural Census, will help policy design to better understand how these trends are imbricated.



Map 5 Spatial patterns of agricultural land leasing in Romania

These specialization trends are also dependent on the structure of the land property, which is still a complicated topic to analyse, at the scale of the Romanian rural space. As property of land and economic exploitation are not always coincident, a proxy indicator describing the spatial background of the agricultural orientations can be used – the leasing of the agricultural land. The French expression coining this type of economic land use is *faire valoir indirect*. Unfortunately for our research, this is one of the less accurate indicators, given the year of its recording (2011 – year of the last published General Agricultural Census). Despite the lack of actualization, it is still an interesting dataset because it describes the economic pressure on the agricultural land exploitation. The spatial repartition of the indicators values precisely doubles the "wheat belt", demonstrating that the Romanian market agriculture managed to create a distinct landscape, both from an economic and a land use point of view.

In addition to this concentration pattern of the agricultural land leasing, the local installation and the capacity of the silos and other facilities reflect clearly oriented market logics, with a strong economic extroversion background. The level of spatial association between land leasing and silos location is high, and this intensity can be understood using a multi-scalar analysis approach. The main location factor, in terms of capacity, is given by the agricultural products export facilities – Constanța, Timișoara and the Danubian ports being a clear exemplification for this situation. A second form of spatial implantations of silos can be explained by proximity and transportation cost minimization logics. It is a frequent situation in the Danubian Plain (Buzău, Pogoanele, Lehliu Gară etc.), but also in the Western Plain (Curtici, Sântana, Pâncota, Ardud etc.) The third layer of location logics is visible in regions with a relatively low degree of land leasing – NUTS2 Centre and NUTS2 North-East. In this case, the potential explanation seems to be dictated by the exploration of the local economic opportunities.

The two investigations of the recent transformations in the agricultural landscape of the Romanian rural space show that the market logics and the economic pragmatism become the main drivers of the economic functionality, at local scale. These drivers are not always endogenous, and they involve some risks, mainly attached to the high levels of economic extroversion of some agricultural specializations (wheat mainly). The risk exposure is the result of a mix of production costs (fuel costs, fertilizers, bio protection) and products transfer to the market (transportation disrupters, market saturation, stocks management etc.).

From a policy point of view controlling all these risks is a futile enterprise and, in this specific case, our recommendation is to adopt a sub-optimal strategy based on the reinforcement of the local production systems in agriculture. This reinforcement should primarily assess the local resilience of the Romanian rural space. We consider that this objective is much more feasible, if the policy design and the decisional frame is spatially adjusted by a pragmatic delineation like the functional rural areas. Of course, when the contingencies are impossible to be counter at this scale, punctual interventions at the LAU level will be a correct addition.

3.1.2 Access to services of general interest in the rural areas

Romania is an EU state where the upper and the lower demographic limits for the delineation of the rural vs. non rural LAU are flexible and somehow confusing. For example, the most populated rural LAU is Florești (Cluj County), with approximately 42500 inhabitants, in 2020. At the same time, the lowest urban population for an urban LAU is recorded in the city of Băile Tușnad, a touristic resort in the Harghita County. It barely reaches 1629 inhabitants in 2020. Between these two limits lays an interval of statistical uncertainty, where it is hard to decline an LAU as rural or urban, as a function of its population. In a probabilistic approach and interpretation, this uncertainty can be managed by thinking that an LAU close to 42500 is less likely to be rural, compared to one closed to the lower limit of 1629 inhabitants. This is the logic that guided the elaboration of the graph plotting the cumulative share of the services of public interest, as a function of the demographic mass.

The data used for the analysis is extracted from the Territorial Observatory database, the scale of observation being the LAU geometry (rural and urban mixed). According to the cumulative distributions, the most accessible services in the Romanian territory are the correlated set of schools and libraries. The Ministry of Development database makes no distinction between the libraries, but it is reasonable to suspect that the indicator also includes the libraries located in the school premises. The ubiquity of the schools is no surprising either, as their diffusion in the rural spaces was a top priority national project for a century. In this case, the interpretation of the graph reveals that 70 % of the Romanian schools concentrate in LAU with

less than 10000 inhabitants, in 2019. From this point of view, there is little concern regarding the access to basic educational services. The second set of tertiary activities analysed consists in the distribution of museums and medical offices, also intensely correlated on the graph. This time, there is no logical association between the two services. Again, the widespread distribution of the museums in the rural areas is a matter of cultural spatial planning heritage, locally complicated by recent efforts to attract tourist flows. About 40 % of the museums are to be found in LAU with less than 9000 inhabitants, but we have basically no data regarding their local frequentation. The medicine offices have a more concentrated distribution. The graph reveals that only 10% of the medical offices are located in LAU with less than 2500 inhabitants. The share of the rural LAU below this threshold is about 41 % in the stock of the Romanian administrative units, from the rural areas. The demographic thresholds rise even more for high schools and hospitals, if we systematically compare the value of 10 % cumulative distribution of services.

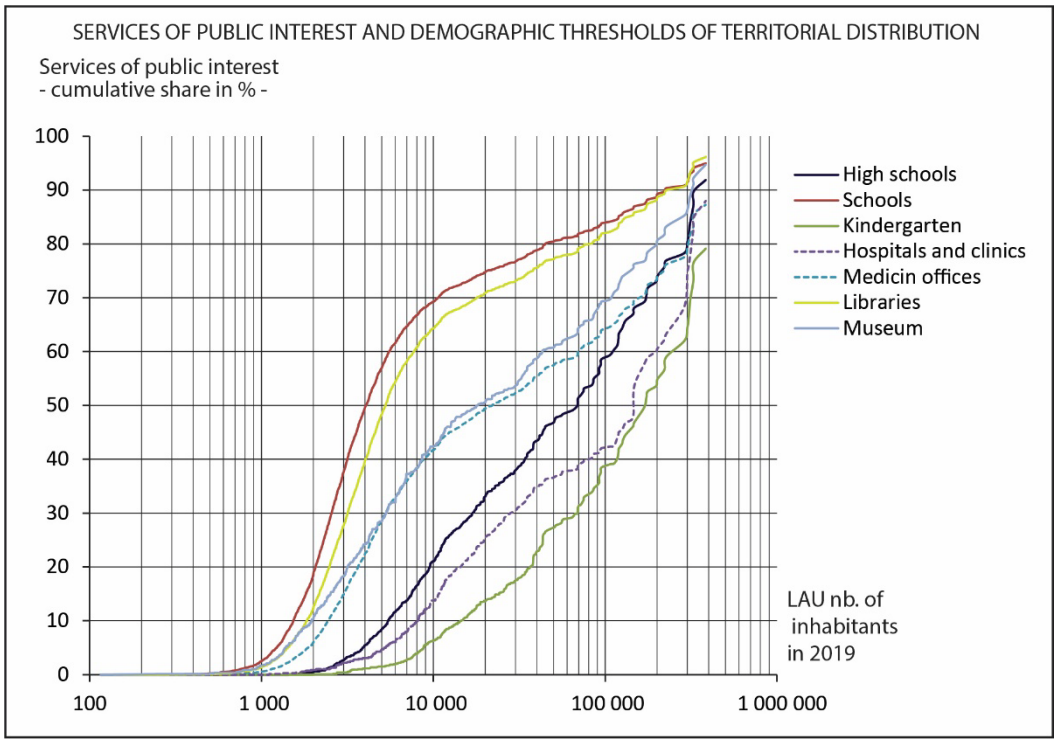
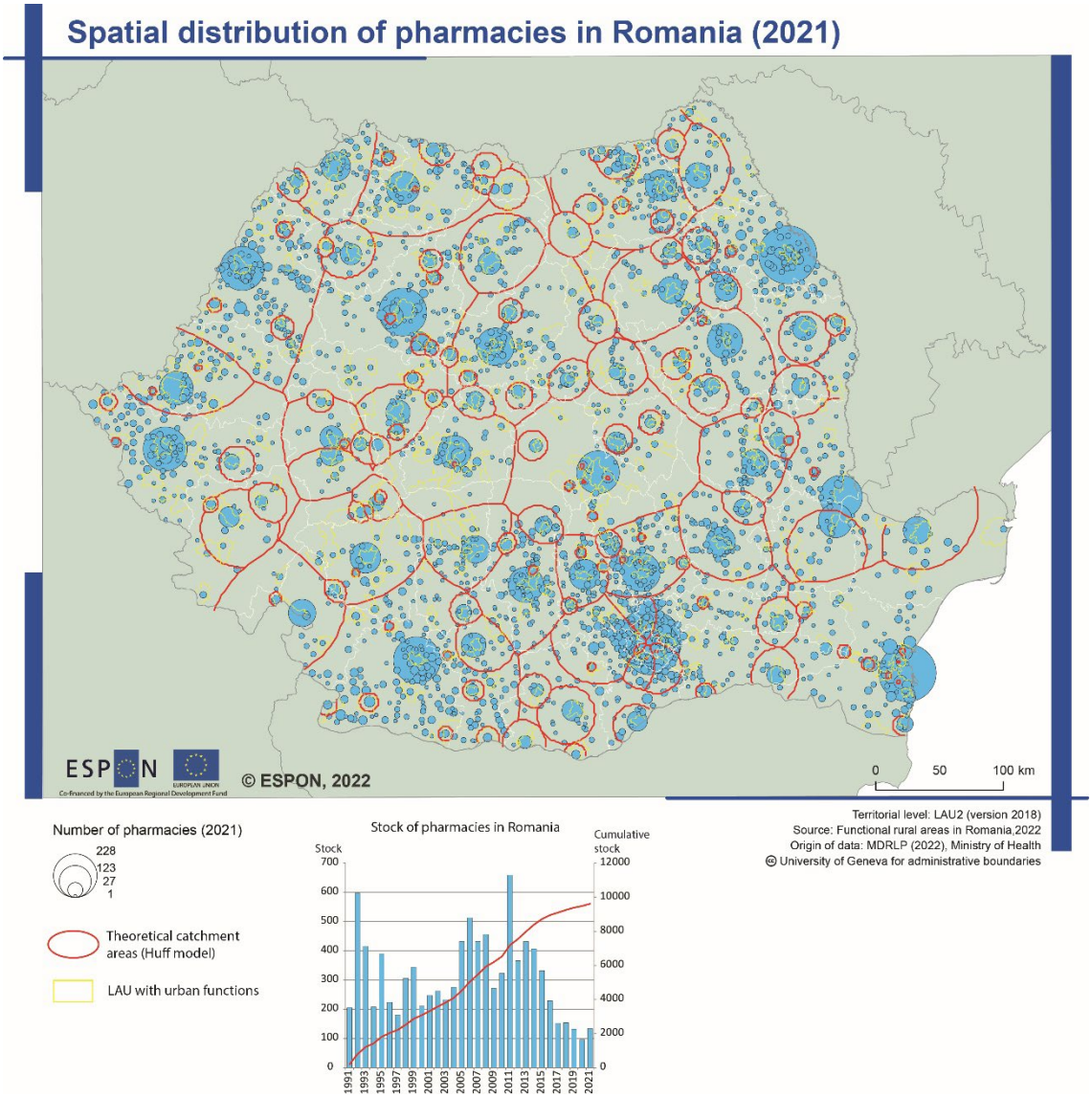


Figure 2 Services of public interest as a cumulative function of the LAU population in 2019

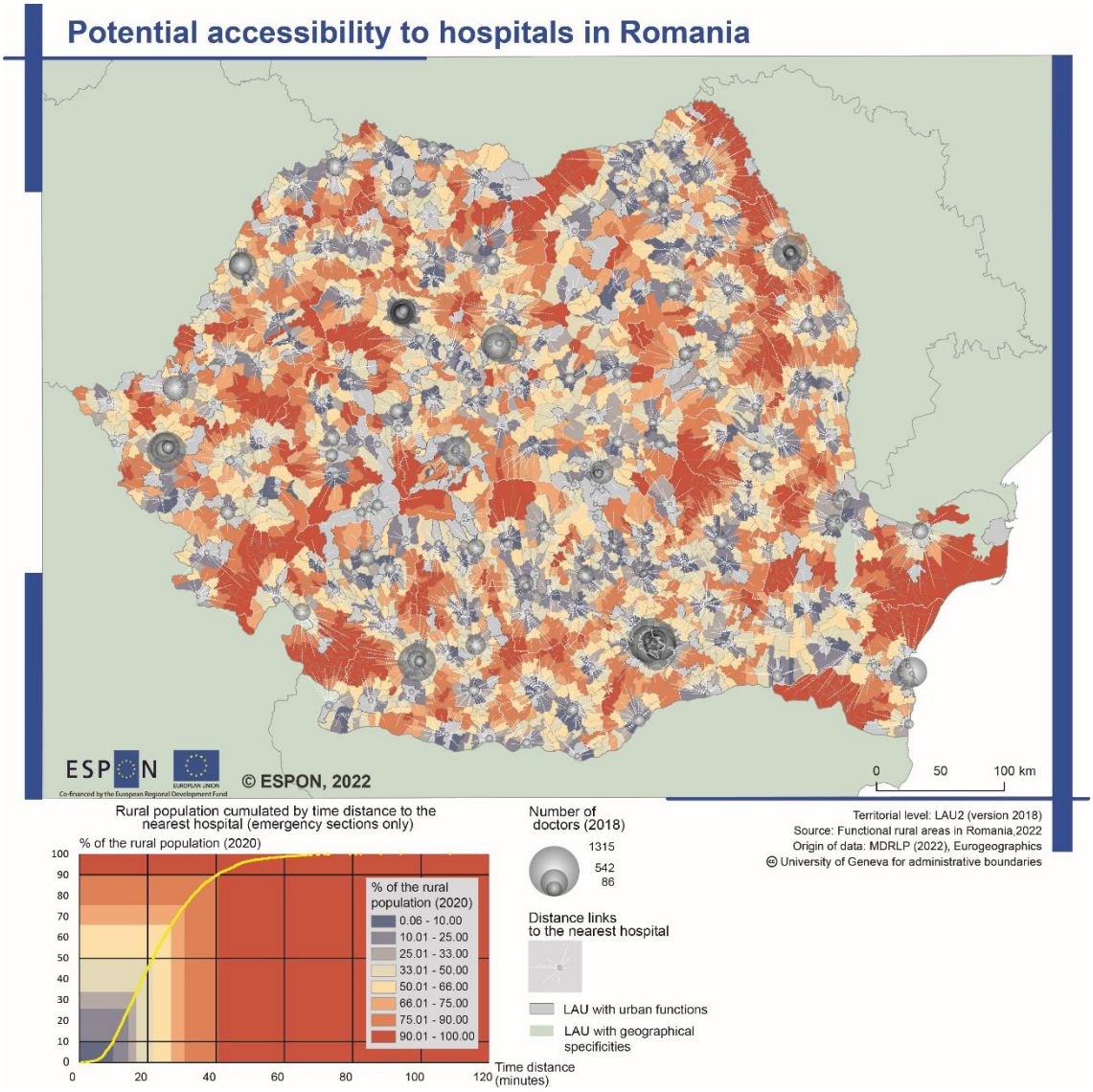
Basically, the hierarchy of tertiary activities is a function of demographic mass, and the rural spaces are subordinated to this geographical, economical and statistical distribution or function. In the case of the kindergartens, we might assist to a potential mathematical artefact, its rarity being created by the definition of the service, rather than by its territorial distribution. The analysis of the distributions on the graph provides us a different image of the deficiencies of services endowment in the rural areas. The data describing access to services with larger polarization areas like the specialized commerce or financial services is missing, for the moment, so the image captures only a part of the tertiary activities stock. Even in these conditions, the hierarchical imbrication of these territorial attraction factors is easy to detect. In our opinion, the lack of access to services or the territorial marginalization of some rural LAU is the results of incomplete policy interventions in this field of action.

The territorial endowment in the case of the education system is relevant, from this point of view. The location of schools, high schools and universities follow a clear central-place theory pattern. The missing elements in the services chain are limited, making that the average distance to reach the educational services to be a secondary problem. For example, reaching a high school in Romania involves an average distance lower than 20 minutes, acceptable and feasible for commuting.



Map 6 The location of pharmacies in Romania and the potential areas of local polarization

The situation is different when the nature of the service becomes more complex. The health facilities are a good illustration for this territorial equation. Being financially more lucrative, compared to the educational ones, the health services will adjust their location taking into account the access to the pools of potential clients, at least for their private component. Such is the case for the pharmacies, for example. The map shows that the correlation between the number of pharmacies and the demographic densities is extremely high and stationary on the map. The implantation logic follows the hierarchy of the population system and creates clusters of services in the urban LAU and its proximity. The penetration in the rural areas is much more reduced and it leaves gaps in the potential polarization at local scale. When this service is not found in the proximity, the potential clients must find solutions to optimize the utility of the city frequentation and acquire this service too. From a territorial point of view, the lack of proper access to pharmacies is visible in a limited number of rural areas – central Dobroudja, Western Carpathians, Tutova Hills or the county of Brasov.



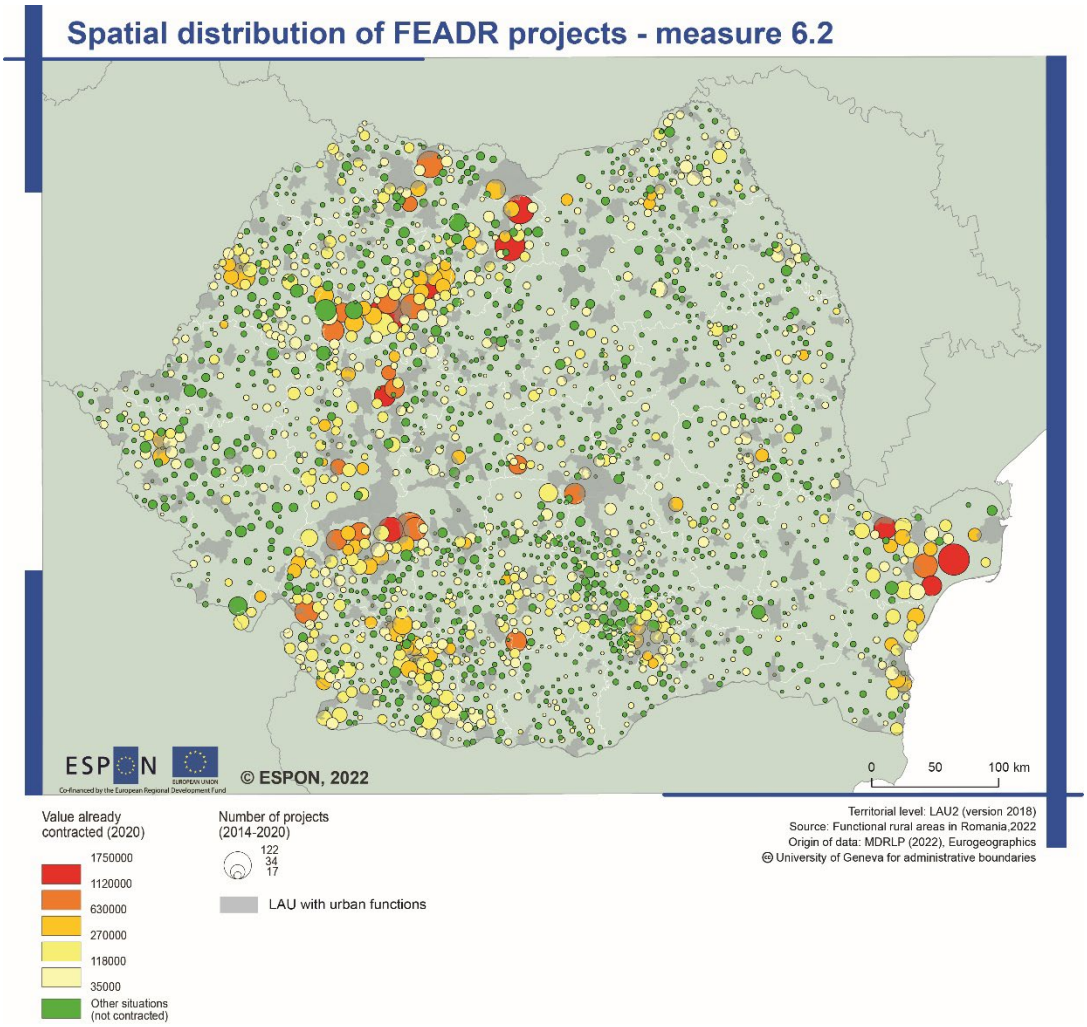
Map 7 Demographic inequalities in accessing emergency health care in Romania (2020)

The access to pharmacies is not the only component of the health services measured in this research. The analysis of the accessibility of services of general interest continued with the evaluation of the reachability of hospitals in the territory, selecting only the emergency sections of these health facilities. Interacting with the hospitals involves other logics of mobility, compared to the educational or commercial services (Dumitrache I., 2020). Given the nature of the hospitals sections selected, the number of opportunities in interaction is generally reduced to 1, the closest emergency section. The national average time distance deduced using road network analyst models is approximately 25 minutes, with a median value of 23 minutes. Consequently, the interest in mapping directly the time distance is rather limited, if one will take into account the central values of the accessibility indicator. A better solution of the data visualisation consists in weighting the indicator by using the cumulative population having access to emergency sections, by time-distance.

The key findings extracted from the map analysis emphasize the need for policy interventions related to the amelioration of the hospitals reachability in the territory. The statistical distribution of the potential accessibility shows that 10 % of the Romanian population lives in an isochrone of more than 40 minutes time distance and all the LAU included in this class are rural, even the former town of Băneasa (Constanta County) is to be found here. Excepting the mountain areas and the Danube Delta, where the natural spatial organization interferes with the road network impedance, the most affected class on the map creates a pattern of distribution that is replicated for other services too.

This pattern aggregates a large amount of rural LAU in the counties of Constanța, Tulcea, Mehedinți, Dolj and the "diagonal of the rural economic depression" in the North-East Region (NUTS2). Secondary spatial clusters join the general model and, as a general rule, these clusters are associated with the NUTS3 administrative limits (Teleorman-Dâmbovita, Gorj-Vâlcea, Vrancea-Brăila). The spatial repartition of this class is the territorial core where other concerning types of rural areas join, for example the group of rural LAU containing 75 % to 90 % of the rural population.

The spatial interaction between the Romanian rural LAU and the services providers is a general frame where the elements of local competitiveness install. It is hard to believe that the rural areas with a limited access to education, health facilities or commercial services will manage to perform economically well and stabilize or attract population. Efforts are made to counter the systemic deficiency in accessibility (road rehabilitation mainly), but these efforts will need to focus more on precise interventions. The Romanian rural spaces are not inert, in some regards they are innovative and pro-active, as the absorption of the EU funding suggests. However, this financial input has little chances to create a catalytic impact on the rural economy, in an unbalanced frame of spatial mobility.



Map 8 The proactive rural spaces in Romania – accessing funding from the FEADR 6.2 measure

The proactive attitude of the rural territory and its ability in attracting funds has its own territorial footprint, different from financial programme to financial programme. The case of the measure 6.2 form the FEADR is relevant for this diversity. This measure concerns the funding of projects able to provide alternatives to the households and to the rural economic actors depending mainly on agriculture. The map shows that there are three major concentrations of projects already contracted, at national scale – the South-West Oltenia Region (NUTS2), the central Transylvania and the county of Tulcea (NUTS3). Without having access to the projects' descriptions, we suspect that the main alternative activity proposed for the economic diversification is related to tourism. The utility of this secondary orientation in tourism related activities is

debatable, but this is of secondary importance. What it is more concerning is the fact that the number of projects in *other situations* is considerably high, their spatial distribution affecting homogeneously the Romanian rural space. Some of these projects are rejected, other are still pending in different forms of evaluation. If the proactive attitudes are spatially concentrated, the lack of experience and the administrative incapacity is ubiquitous.

3.2 Elements of territorial functionality at local scale

This part of the study will focus on elements of territorial functionality provided by the exploratory analysis performed on the economic activities in the rural spaces. The syntheses of the main observations are mapped using multivariate analysis, together with a basic description of the empirical spatial interactions taking place at local scale. Finally, we delineate a concentration index of the rural population, in a multi variate approach – at national and NUTS3 level. The syntheses will focus on the accessibility of the public services and on the agricultural specialization and they are the output of a k-mean clustering technique with no spatial constraint. The classes resulted from the multivariate analysis represent an assessment of the territorial disadvantages, in terms of remoteness to services and urban markets and in terms, or an evaluation of the mobilization of the spatial capital, when implemented on the agricultural crops. They can be used in relation with the final form of the functional rural areas' geometry, in a comparative frame.

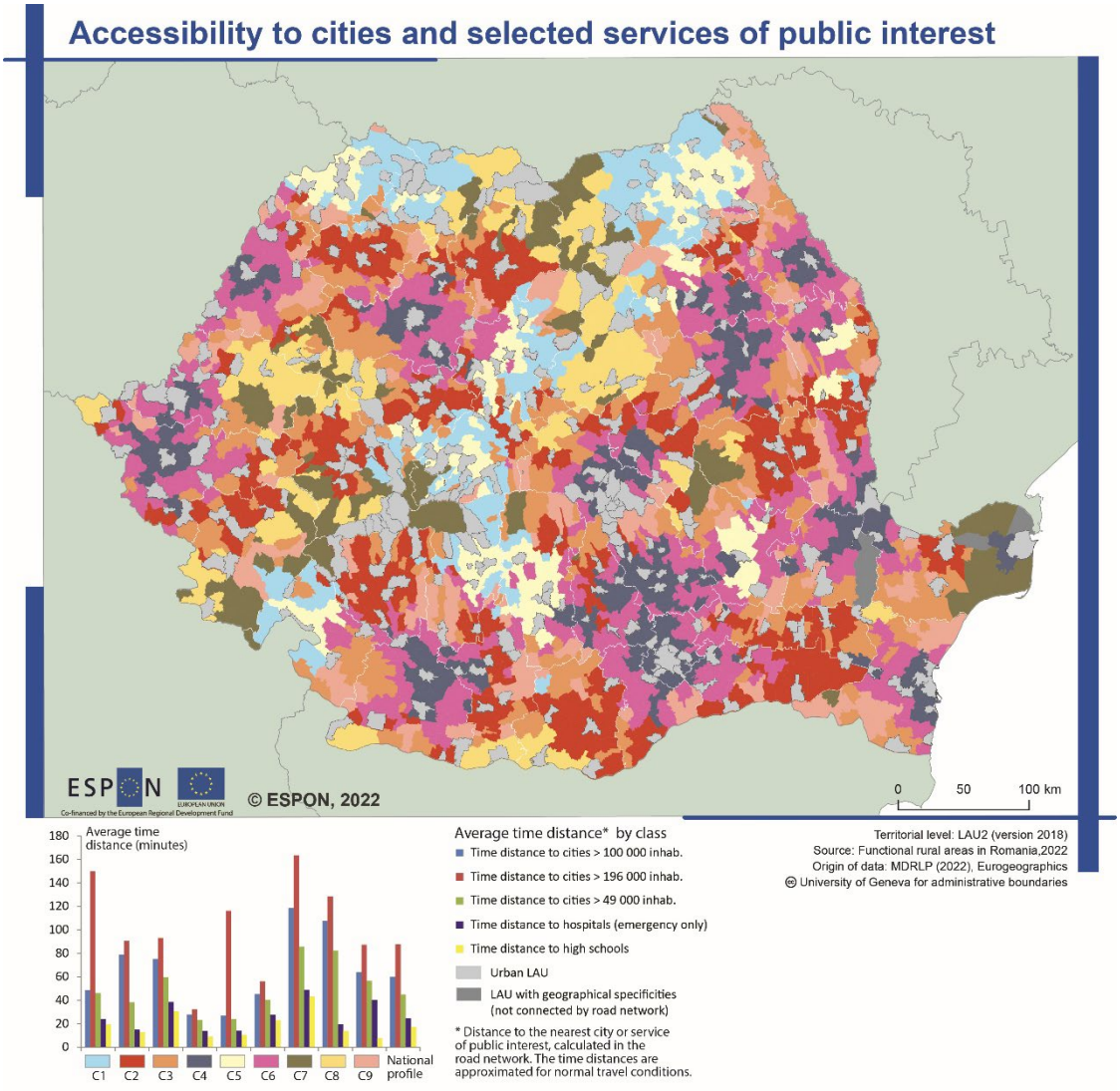
This exercise might be considered useful for the definition of appropriate policies during the transformation of the functional rural areas in a territorial instrument of funding management and cross-thematic challenges countering. The maps describing the relation between economic performance, spatial interaction and the rural areas are created as an auxiliary tool of investigation of the territorial functionality, at local scale. There are two versions of this potential analysis, one focusing on the empirical flows observed in the territory, one serving as a theoretical frame for their deployment – a hypothetical model of spatial interactions, with no constraint on the masses at origin and destination.

Both versions corroborate in suggesting that the delineation of the functional rural areas becomes more feasible, when one will rely more on their homogeneity, than on their inclusion on a spatial interaction network. Apparently looking out of context, the final descriptor of the rural functionality aims to answer a simple question: where does the Romanian population lives? The simplicity of the question invites however to multiple angles and methods to answer to it. Using spatial analysis and the multi-scale approach, one will find that the rural population has many chances to concentrate in successive rings around its weighted national barycentre. When the same question is declined at lower levels (NUTS3), the concentration dissipates in particular forms related to the county geometry. As simple as the question behind, the conclusion of the analysis shows that the stability of the rural population is a datum for the policy design. Despite the demographic changes and the hierarchical readjustments, the concentrations around the rural barycentre are variables to be taken into account for medium- and long-term scenarios and policy interventions.

Using these three synthetic exercises on the territorial functionality – LAU typology of general services accessibility, analysis of the spatial interactions and the classification of the agricultural specialization, we develop a basis for policy recommendations in relation to the emergence of the functional rural areas in Romania.

3.2.1 Building typologies on the access to cities and public services

The first synthetic typology built uses 5 indicators of accessibility to services of general interest (hospitals and high schools) or to cities concentrating tertiary facilities, other or including the first mentioned ones. As a matter of fact, the two categories selected for the typology are not always perfectly overlapping. Given the rank-size distribution of the urban population in Romania, the separation of the three classes of cities taken into account (> 49000, >100000 and more than >196000 inhabitants) approximates a Jenk's classification for the superior part of the hierarchy. Theoretically, the three categories of cities should include more than basic service providers, giving a hierarchical access to more and more tertiary activities – specialized commerce, financial services, high education or diplomatic services.



Map 9 The typology of cities and selected services accessibility in Romania

According to the national profile deduced from the output of the grouping analysis, the rural spaces have a relatively fair access to high schools and the hospitals' emergency sections, with an average time distance around the value of 20 minutes. The three categories of urban LAU included in the study take ranks in the average values of the indicator almost like in a canonical central place theory illustration – 45 minutes for cities with more than 49.000 inhabitants, 60 minutes for the cities larger than 100.000 inhabitants and 90 minutes for the urban entities with basic metropolitan functions (>196.000 inhabitants). The deviations from this national profile create three categories of rural local administrative units, as a function of their magnitude.

The class cumulating the highest number of accessibility advantages is the class no. 4 (C4), with deviation significantly lower compared to the national profile. Its spatial repartition concerns the proximity of the large Romanian cities, overlaying the core of the proposed metropolitan areas delineation. Identified only by the distance to cities larger than 196000 inhabitants, the class no. 5 (C5) is the equivalent of the previous type, for the intermediate medium-high component of the urban hierarchy. It is visible around cities like Târgu Mureș, Sibiu, Satu Mare, Buzău, Pitești and Râmnicu Vâlcea, a category of cities that always kept important functions in the territory, without being able to detain a demographic size larger than 200.000 inhabitants. The C5 type also appears in the North-East NUTS2 region, around Suceava, Botoșani, Vaslui, eventually in a more dispersed pattern around Piatra-Neamț. By statistical contamination, this class can also be identified around Bârlad. At a first analysis, we considered that the input data introduced in the model might present outlier values. However, after a more in-depth analysis we have concluded that the

population estimations concerning the city of Vaslui are partially responsible for this map output, in the case of the C5 repartition.

At the opposite, the types C7 and C8 cumulate the major territorial disadvantages, in terms of spatial accessibility issues to the services of general interest and to cities supporting them. Their spatial repartition is associated to the local geographical specificities, in the case of the Danube Delta or remote mountain areas, the last case being identified all over the Carpathians Mountains. An interesting case of spatial clustering is present in the southern extremities of Dolj, Olt and Teleorman counties (NUTS3), in the LAU contiguous with the border between Romania and Bulgaria.

Their situation reflects how this cumulative package of geographical limitations can interact in order to create rural areas with severe problems, in terms of services polarization. These C8 type local administrative units are not only far from Romanian cities, but also in a remote position from major Bulgarian cities too, even if some potential of cross-border spatial locally exists (Țurcănasu G., Rusu A., 2008). A secondary cluster from this class emphasizes the role played by the architecture of the Romanian urban system, when one will analyse the repartition of medium and large cities. It is the case of the LAU located at the administrative limit between the counties of Tulcea and Constanța, in the proximity of the small city of Hârsova. From a geometrical point of view, this cluster has a central position between three major cities able to provide diversified services to this rural area – Bucharest, Constanța and Braila. Given the distances towards these 3 major cities, the polarization capacity is severely decayed, a decay amplified by the natural discontinuities bordering this LAU sub-group (the Danube). The C3 and C2 types join this subset of territorial disadvantaged LAU induced by the deficit of local accessibility, the deviations of the indicators taken into account being significant, but not extremely distanced from the national profile.

From a policy perspective, the potential interventions for dealing with the local accessibility deficits are a matter of prioritization, rather than total correction. As the urbanization process is dependent on other logics than the ones available in the decision *portfolio* of the policy makers, focusing more on the quality of the transportation networks might have potential positive results. During the last ten years, efforts were made in this direction and some of the effects are measurable. However, the implementation of the roads rehabilitation process was not subordinated to an explicit set of objectives related to the territorial accessibility to services, but to goals of increasing the general accessibility. In a second phase, as the general objective of increasing the overall territorial accessibility has chances to be achieved, focusing on specific accessibility issues might become a relevant topic.

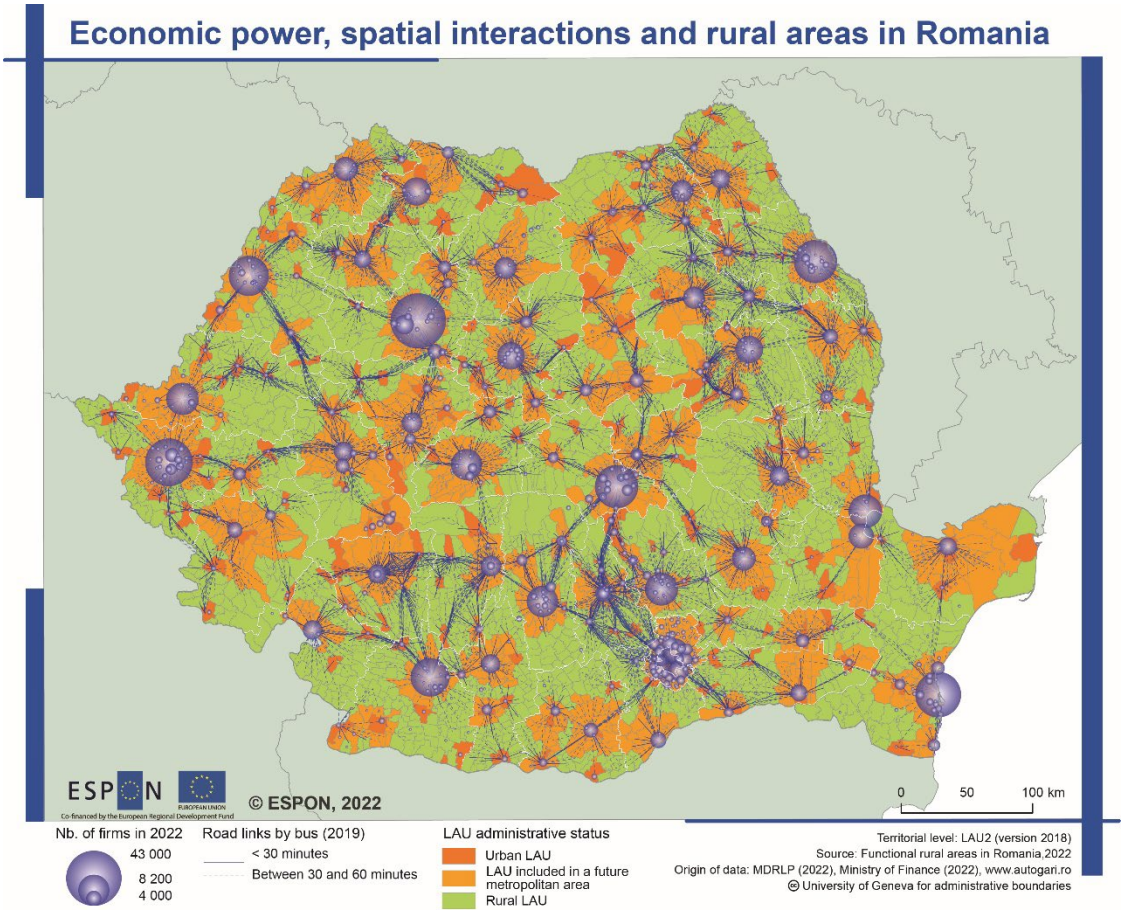
The typology proposed in this study is an assessment of the cumulative problems observed in the rural areas and it serves for a more in-depth analysis of the territorial starting capital of the potential functional areas to be delineated. A distinction should be made between what the accessibility typology reveals and how the local administrative units are interacting with the services providers, mainly the cities. This distinction is hard to evaluate, as the Romanian statistical system of information lacks the needed dataset – flows matrixes between the rural administrative units and the cities.

3.2.2 Spatial interactions and economic specialization

The empirical collection of such data is out of the possibility of the research centres and academic environment in Romania, but proxy indicators can be collected. Other studies faced the same problem (World Bank report on the Romanian cities), including the ESPON attempts in delineating functional urban areas. This specific indicator is a major stake for a better understanding of the territorial functionality. For example, the French INSEE used the matrix of interaction between the LAU and services providers in the elaboration of the “bassins de vie” delineation (INSEE, 2012). From this perspective, it is the frequentation of services and not the distances between the offer and the demand to be considered as a descriptor of the territorial functionality.

Our solution for this research is to include in the analysis a collection of flows based on a large sample dataset describing the number of weekly connections between the Romanian LAU, using the public road transportation. The data was collected manually from the Internet site of a major road trips aggregator (www.autogari.ro), in two versions – one old and stable (2019), one extremely recent (2022) and unreliable. The first version is an asset of the internal datasets collection of the Faculty of Geography and Geology of Iasi. The unreliability of the recent information is the result of the economic context of the post-pandemic period, given that, due to the economic closure of 2020, the transportation sector was hardly hit, and the survivors of the economic turbulence (transportation companies) readjusted some of the links, without truly updating the database input of the aggregator. In this case, extracting and using recent data

is a risk. As the size of the sample is large (more than 11800 links), cut-offs in the data representation and analysis were imposed in 30 minutes and 60 minutes time distance, between the Romanian populated places.



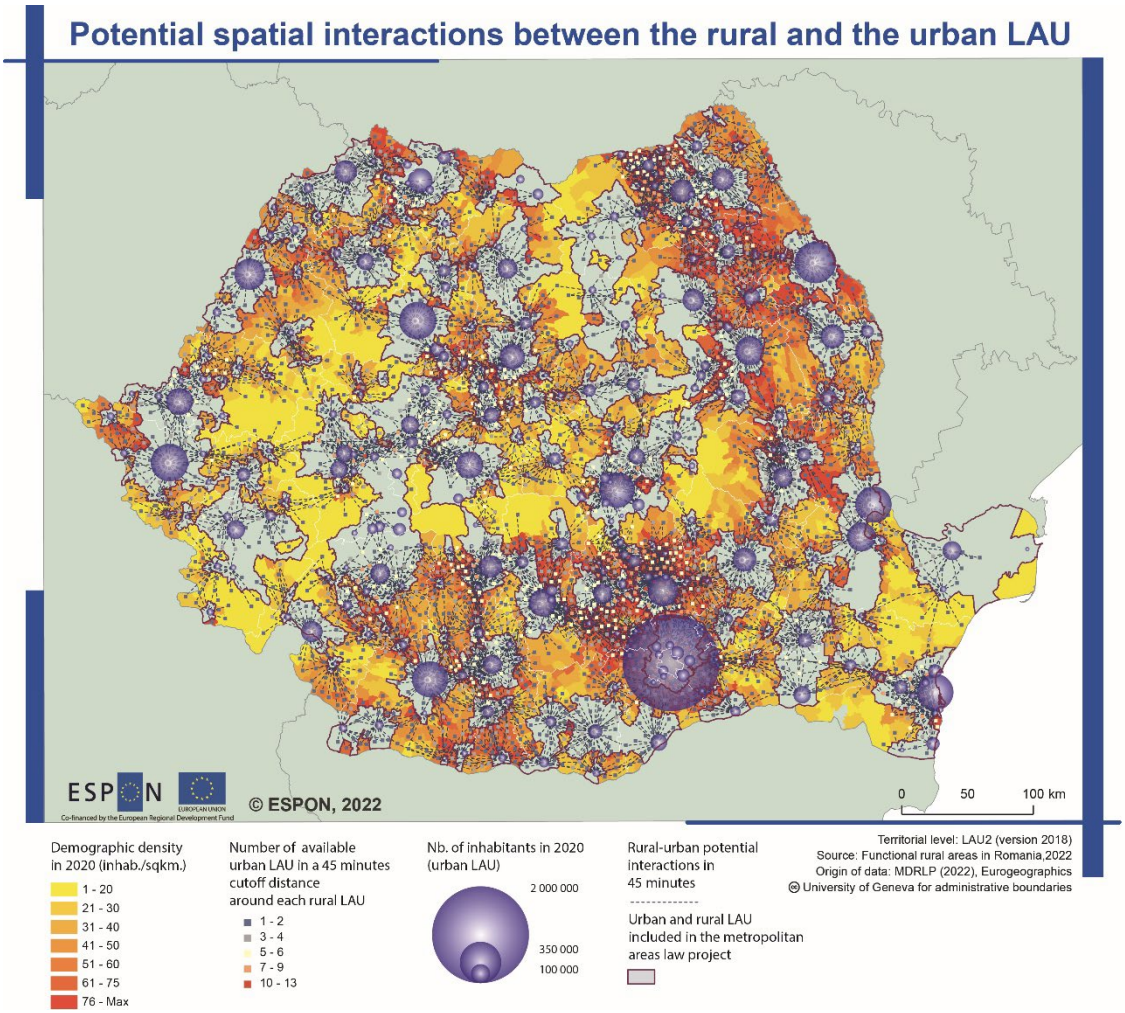
Map 10 Patterns of spatial interaction between the Romanian populated places in 2019

As expected, and predicted by other researches, the statistical distribution emphasizes the role played by the low range of spatial interactions. For example, 33 % of the links are deployed in distances contained between 10 and 38 minutes, with dominant flows systematically oriented to the nearest cities. About 22 % of the remaining interactions have a time threshold of approximately 60 minutes. An exploratory analysis applied on the data revealed that each 5 additional minutes added to the distance between the populated places, will reduce the number of spatial interactions with 4 links. The restrictive role played by the distance should be interpreted in a prudent way, as we deal only with the road public transportation, ignoring personal trips and train transportation. It is however suggestive for the way in which the cities organized the rural spaces, at different scales. For example, combining the information obtained from the typology of the accessibility to services with the distribution of the spatial interactions, at local level, one will observe how dependent the C8 type rural clusters are to the small cities found in the proximity, for obtaining at least a basic access to general services. In the case of the Danubian example from the south of Olt and Teleorman counties, cities like Turnu Măgurele and Corabia managed to develop an active network of transportation links in their rural hinterland. This development is similar to a position of spatial local monopole.

The indicators extracted in the spatial interaction database also include the intensity of the flows (the number of weekly trips between the populated places). An usual tool for investigating the flows matrix is using gravity models in their exploration (Cattan N., Grasland C., 1995), where the distance and the population at origin and destination act as predictors (X1, X2, …Xn). Applied on the spatial interaction matrix used for our research, the gravity model provides unreliable parameters – a low quality of the adjustment (R2 = 0.13) and a close to -1 distance decay value (slope of the non-linear power function). Explaining these

parameters demands a hypothesis that was not tested in our study: the gravity model might perform better on disaggregated data (city by city and functional rural area by functional rural areas), because the costs of transportation are not uniformly distributed in the territory. If this hypothesis will be proven right, the results might be corroborated with the gradients of entrepreneurial diffusion, at local scale.

One important key-finding can be extracted from the analysis of the Map no.9 and this key-finding can be articulated with the set of policy recommendations concerning the functional rural areas. Independently to the regional belonging of the flows sub-systems, the lack of territorial polarization is a severe and homogeneous problem in the proximity of the NUTS3 limits. In some cases, these deficiencies are easy to observe (limit between Constanța and Tulcea, limit between Brăila and Buzău or Argeș-Teleorman). When the NUTS3 administrative boundaries overlay mountain areas, the lack of interactions is acceptable; the distance decay strongly increases, even in conditions of fair territorial endowment. However, in regions where the natural constraints are absent, the low intensity or the absence of flows is explained by elements of territorial endowment – road quality, road density, networks local orientation or economic barriers in the spatial interactions (cost of transportation e.g.).



Map 11 Theoretical patterns of spatial interaction at local scale in 2020

One possible explanation is provided by the recent administrative history of Romania (Groza O., 2010), an explanation that puts on the first place the role played by the counties in modelling the social and economic individual behaviour, including the territorial mobility. As the territorial structures have a strong resilience, disrupting these patterns of mobility in the rural areas and encouraging new ones is a subtle problem for the policy design.

The contrast between the observed patterns of local mobility based on the road trips sample and the theoretical model of potential interaction is considerable. As the gravity model tested had little use in giving a frame of comparison for the 2019 flows, our theoretical depiction of the local potential interaction took into

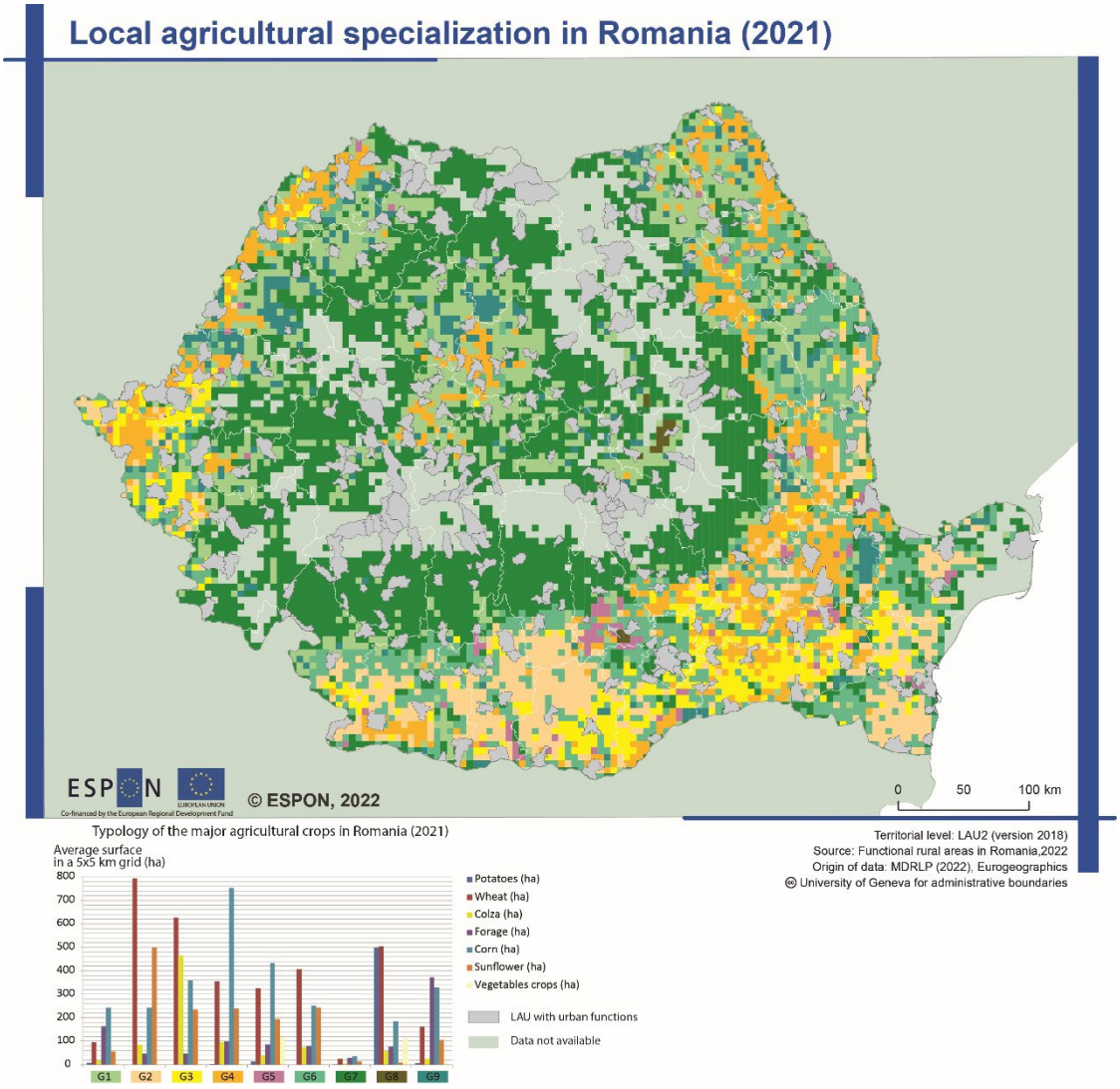
account a set of limited variables and an unweighted potential accessibility model to the cities. The rural LAU were put into relation with the nearest cities in an isochrone of 45 minutes, using the road network. For each rural LAU, the number of available cities in the cut-off distance was calculated and mapped, together with the potential links. If the time-distance is reliable, there are 162 rural LAU unable to reach a city in 45 minutes, mostly in areas with geographical specificities (mountains and Danube Delta). Some 502 rural local administrative units have only one city available in the limit of 45 minutes and 737 only two cities. However, for 1463 LAU in the rural areas, the potential accessibility to providers of services of general interest is not a problem, having an option for at least 3 cities.

Even if it is attempting to associate the lack of accessibility to cities and the low potential spatial interaction with the demographic gradients of rural density, this correlation is not necessarily functional, as the map illustrates. One relevant key finding derived from the analysis consists in the way in which having access to a set of cities will limit the demographic decline in rural areas. In average, the rural LAU finding no city in 45 minutes lost 7.5 % of the population, between 2011 and 2020. The local administrative units located in areas with a medium level of urbanization (4-5 cities) registered a much more limited demographic decline, only 2 – 2.5 %. The rural local administrative units placed in areas with a high density of urban LAU (more than 8 cities in 45 minutes time-distance) reveal positive demographic evolution, for the period analysed.

The main conclusion of the analysis of the spatial interactions (observed and theoretically estimated) in the Romanian rural areas is related to the way in which the cities functions as a catalyst for multiple demographic and economic process, otherwise more difficult to explore and explain. If the demographic decline is associated with the level of local urbanization and the economic performance with the access to services providers, the policy interventions might be articulated on a more in-depth analysis and exploration of this nexus of links and distance gradients. At the same time, attention should be payed to the main foundation of the rural economy, in the case of Romanian agricultural specialization. Together with the elements already mentioned these specializations shape the territorial functionality of the rural spaces and provide key-findings to reflect on during the delineation of the functional rural areas in Romania. The general picture of the cultures concentration at grid scale (5x5 km) suggest that strong associations can be found between the natural local capital (the physical foundation of land-use) and the emergence of the crop specializations. However, the mobilization of the natural capital is also filtered by other logics, such as the market integration of rural spaces, the agricultural structures embedded in the local territory and the assimilation of new land use management techniques.

Using the same approach based on multivariate analysis, a typology of the agricultural specialization was implemented in the study. The variables are represented by the main cultures allocated to the grid pattern – cereals (wheat and corn), technical plants (sunflower, colza), forage and market cultures (vegetables). The 9 types resulted have a common trait: with the exception of the group no. 4 (G4), all the other classes indirectly describe the persistence of the polyculture pattern, at local level. The Romanian literature in rural geography systematically associated the prevalence of corn, the specificity of the G4 class, with the “subsistence agriculture” (Tudora D., Muntele I., 2012). As Muntele I. and Tudora D. (2012) suggested, the label of subsistence is not truly appropriate for this form of agriculture. In the decapitalized rural households, the corn is a winning bet. The specialization of the small farming in this crop helps investing the small amounts of capital in other forms of consumption, the stocks of corn being enough to sustain some important aspects of the household necessities – animal foraging, internal consumption or small exchange on the local markets. At the same time, a closer analysis of the G4 spatial distribution indicates that some of the local concentrations of this type are associated with the large farming systems, occupying productivity niches ignored by other cultures. This is the case at the limit between the counties of Iasi and Botoșani or on the western border of Romania.

According to the grouping analysis and the class profiles, G1 is much more appropriate to be labelled as economically introverted small farming, rather than G4. It presents ubiquity at national scale, and it can be correlated with the lagging rural areas – Tutova’s Hills, the Transylvanian Plain, the Moldavian Plain. It is also a type located at the contact between two major agricultural orientations – the arable land (plateaus and plains) and the permanent cultures area (higher altitudes, specific to the Sub-Carpathians or the Western Hills, G7 in the typology). The values from the class profile are much more reduced, for the crops selected in the multivariate approach, and the prevalence of corn is an indication that the local agricultural structures are oriented to self-consumption rather than the market.



Map 12 The typology of the local agriculture specialization in 2021

The Romanian wheat belt is represented by the groups G2 and G3, with a spatial distribution clearly concentrated in the South and in the two counties of Arad and Timiș. While the wheat is the most intensely cultivated crop in the G2 and G3 grid cells, the general trend to polyculture explains why it is spatially correlated with concurrent cultures like sunflower (G2) and colza (G3). The two classes occupy what it might be considered the agricultural optimum, at the national scale. It is not only the natural capital mobilized in the specialization (soil and climate, mainly) responsible for this territorial optimum, but also the proximity to the Romanian export gates – port of Constanta, the Danubian ports or the small distance to the border, in Arad and Timiș.

Another class that presents interest in the explanation of the agricultural specialization is G5. Its presence on the map is limited, but it describes the paradox of the market orientation, in the case of some extremely work intensive cultures, like the vegetables. The G5 cluster located north-west of Bucharest is not surprising; after all, the market specialization in perishable products is natural in the proximity of a large metropolitan market. In this logic, with a lesser extent, one would expect to observe the emergence of the G5 rings around other major cities too, reproducing land use patterns similar to the canonical Von Thunen's model. In reality, this is not the case. The grid cells allocated to the G5 class are located in the proximity of some small and medium cities – Făurei (Brăila county), Babadag (Tulcea county), Tecuci (Galați county) or Țăndărei (Ialomita county), creating an interesting pattern of local specialization. This proximity might be explained by the former status of these cities (agro-industrial), in their recent urban and economic history. The elements forming the G5 groups are sensitive to a large set of external interventions, ranging from market prices and external competition to consumption patterns. The stability of this specialization is a

function of their integration on the markets, not only for the raw products, but possibly for the derived and intermediate outputs of agro-industrial business.

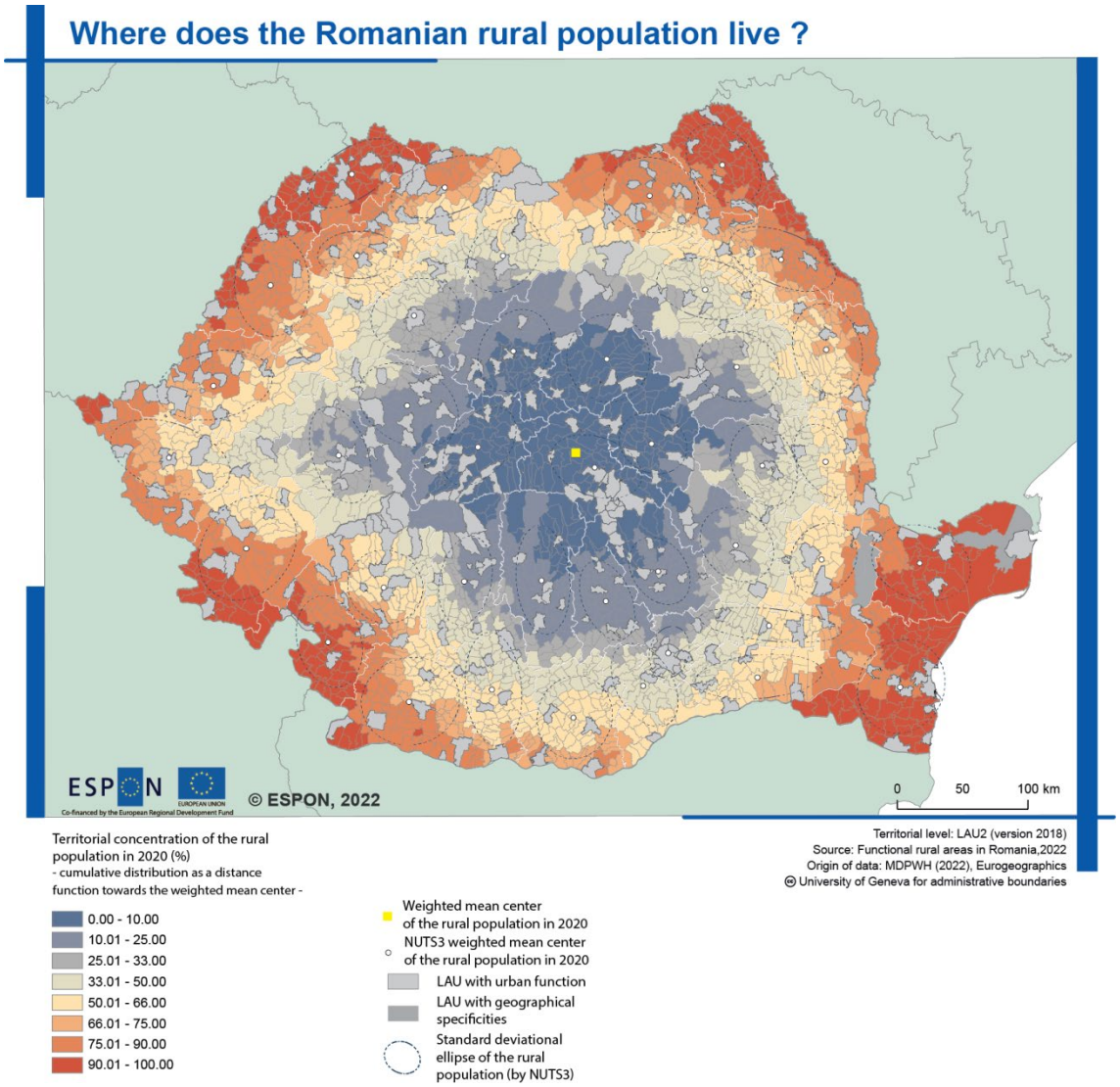
Two other classes, G6 and G9, reflect the diversity of mutations faced by the main economic base of the rural activities, the agriculture. These two groups are in an intermediary position, with unclear trends of specialization and, according to the class profiles, with smaller surfaces dedicated to the crops taken into account during the multivariate grouping process. The mutations and the challenges they face can be correlated with an increased need for farming association, where possible. In other situations, their territorial presence is related to the efforts made by the large farms to recompose the land use patterns of cultivation (parcels aggregation). Marginal as number of grid cells occupied and extremely clustered the group no. 8 is mainly visible in the counties of Covasna and Harghita. It is discriminated by the average surfaces of two crops – potatoes and wheat, almost at parity in the class profile. From an agronomic perspective, the presence of G8 in this area is not a surprise, matching the optimum conditions for the potatoes and sub-optimal fair conditions for wheat. What is truly puzzling in its spatial distribution is the absence from other NUTS3 regions, especially in those with a similar natural capital.

The general image provided by the typology and by the class profiles is converging to some key findings that can be used as a base for further policy interventions and design. The specializations observed are derived from the exploitation of the natural opportunities, in a perfectible market context. The underlying natural conditions are stable for a long time, being rhythmed by predictable geophysical processes. In this case, the most concerning problem is how the rural communities will adapt to these processes, for example the climate changes. Projecting these changes in relation with the agriculture specialization at the local level of the rural LAU is a separate topic of our investigation. Projecting the market trends and their impact on the cultures specialization is impossible, under the present circumstances – lack of data output from the General Agriculture Census of Romania (2021-2022), pre-census period for the socio-economic indicators and the general political context in the proximity of Romania. What is clear is the fact that the food security of a macro-region with more than 500 million people (the EU) is becoming a major dimension of the resilience policies and the Romanian agriculture, with its rural specialization, is not a topic to ignore. From the national perspective, the typology is a picture of the transition of the Romanian rural spaces from a disorganised and vulnerable state, specific for the late years of the transition, to more solid and economically performant patterns of territorial functionality. The main question still remains: is this gain in specialization, productivity and performance profitable for all the rural actors involved, including the rural communities?

3.2.3 Rural population distribution and demographic trends

This question is not just a simple scientific style intervention in the text. Whatever the dynamics of the economic specialization in agriculture or the future shapes of spatial interactions in rural areas will be, the macro-demographic stability of the rural space is extremely robust and the observed specializations will have an impact on them. An analysis of the population's mean weighted centres between 1992 and 2020 indicates that the yearly barycentre migrates in a reduced bounding box (approximately a 7x3 km rectangle). It will take generations to alter this stability, despite the negative trends concerning the population's natural balance or the rural emigration. From this point of view, the macro-demographic stability is a datum, the transformations occurring in the economic and the social coordinates of the rural LAU being the dynamic of the rural system. Having a general image on this stability was the final task associated to the investigation of the territorial functionality, at local level.

Taking into account the location of the last barycentre (2020), a time distance indicator was created between the centroids of the rural LAU and the mean weighted centre. This distance allowed us to elaborate of a cumulative demographic indicator that was mapped. The spatial repartition of the concentration classes can be interpreted by comparing it with the outputs of the accessibility and specialization typologies. For example, the classes forming the Romanian wheat belt are overlaying the external rings of the rural population cumulative distribution, but the overlapping is not perfect. It means that, at the scale of the rural space and in time, a relative low amount of rural population is in charge with the economic reproduction of this agricultural specialization. The spatial rhythms of passage from one class of concentration to another reveal the logics of the spatial distribution of the rural population. These rhythms can be used as a tool for the measurement of the territorial impact assessment of the policy interventions related to the rural spaces, in Romania, at least at the level of their demographic addressability.

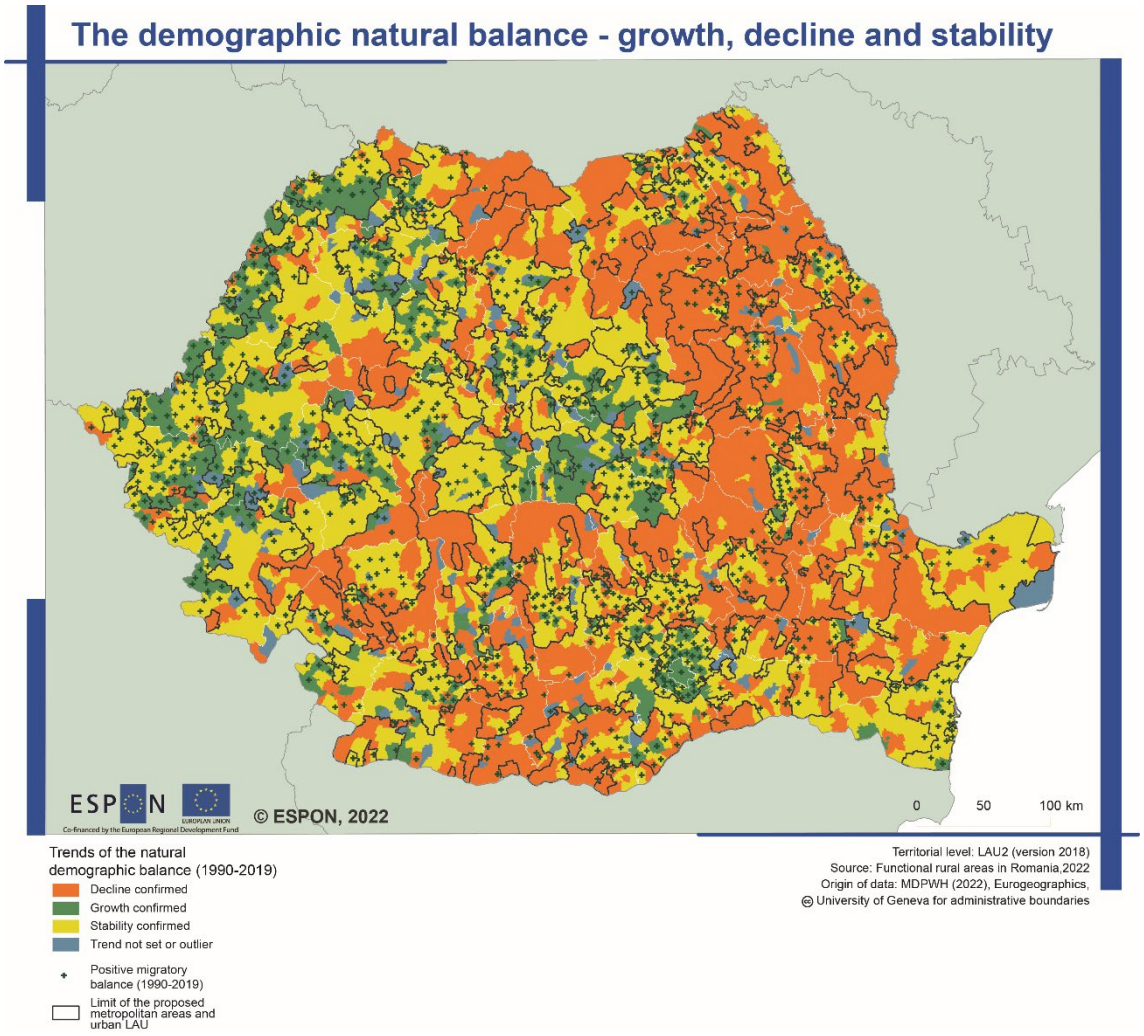


Map 13 Modelling the cumulative concentration of the rural population in Romania (2020)

Using the multi-scalar approach, the same identification of the rural population mean centres was applied at NUTS3 scale. However, detailing the cumulative NUTS3 distributions, in association with the national territorial concentration, is technically impossible, even in a qualitative solution of the mapping problem. In this case, an alternative approach was implemented – the use of the standard deviational ellipse of the rural stock of population, in 2020, for each Romanian county. These ellipses should have a small and large radius provided by the weighted standard distance towards the mean centre and they are supposed to collect 68 % of the rural population, in theory. Some studies (CN) suggest that the ratio can be lower, depending on the statistical distribution taken into account (Rayleigh instead of normal distribution, e.g.). This second tool has the capacity to reveal the situations of double spatial and demographic rural marginalization, especially in the peripheral NUTS3. For example, a rural LAU as Limanu (Constanța county) is not only spatially and demographically remote, at national scale. Given its position outside the standard deviational ellipse, it is also marginal in its own county. Probably, the most appropriate label to illustrate its territorial situation is a low-low scale dependent attribute.

The stability described by the cumulative distributions of the rural population is the results of two classical demographic balances at work in the Romanian rural space – the natural and the migratory balance. Analysed in a large chronological extent (1990-2019), the natural balance depicts three possible trends – growth, decline or stability. In the general demographic context of Romania, it is rather reasonable to imagine that the stability concerns a near to 0 difference between the number of birth and the mortality. This class of the typology also contains the LAU with fluctuating dynamics, some of the spatial units becoming recently pro-natalist, after long periods of negative balance. The values associated with the decline are

overlapping almost 66 % of the Romanian territory. Compared with the class depicting the positive evolution of the indicator, a spatial gradient is detectable, at the scale of the Romanian rural space. This gradient is oriented west-east, and it loses magnitude when it crosses the Carpathians. The addition of the positive migratory balance calculated for the same period of time (1990-2019) confirms the existence of a sophisticated territorial imbrication of different rural demographic trajectories. The long terms analysis reshapes the classical frame of analysis, in the case of the rural areas. The output of the typology describing the trends of the natural balance and the positive migratory stock suggest that the demographic situations of the non-urban LAU are not systematically close to disaster. In fact, a smart and comprehensive policy design might be able to stabilize the decline and diffuse demographic growth in the territory. The use of the functional rural areas as an intervention frame will be more than appropriate, as the three situations described (growth, decline and stability) show an intense spatial autocorrelation.



Map 14 - Demographic trends in the rural spaces – the natural balance between 1990 and 2019.

The functionality of rural areas is the result of multiple territorial situations. Some of these local particularities are subject to the spatial distribution of indicators describing the accessibility to service providers. In other cases, the agricultural specialization at local scale becomes relevant for the geo-statistical detection of the rural functionality. The potential spatial interaction between the rural LAU and the cities is the third frame of evaluation. All these three aspects are the floating trajectories of the potential functional rural areas in Romania, trajectories grounded in a demographic datum marked by the long-term stability, despite some contextualized fluctuations. We consider that many of the negative trends observed during the analysis are reversible or they can be stabilized, if targeted policy interventions will be prepared.

3.3 Arable land parameters influencing the sustainability of functional rural areas in Romania

In the context of continuous climatic changes, emphasized by current geo-political and social crises, the requirement to ensure food security for the member states is an ever-growing priority. In order to successfully address this issue, rural areas must be included in sustainable management plans and policies, mainly from an agricultural perspective. Thus, the significance of rural areas has continuously increased over the last decades, justifying their relevant position in the European policies. Considering the more severe impact of climate change and an ever-increasing pressure on agricultural land, in order to reach higher crop yields, newer policies have to address this transition and adapt to the new changing climate paradigm. Therefore, the future development of European rural areas must account for the agricultural activities, while simultaneously taking into consideration two crucial aspects, namely: 1) the conservation of natural land resources based on sustainable use; and 2) the permanent adaptation of crops and agricultural practices to the challenges of climate change.

Among the indicators in the first category, the impact of land degradation through water erosion and soil compaction was addressed and mapped. In regard to the second category, the identification of crop thermal restrictiveness related to future climate change, has also been spatially quantified. For the purpose of this study, the research focuses on the most important crops in Romania, namely wheat and corn. Their relevance is even greater in the context of the current challenges regarding food security issues aggravated by the conflict in Ukraine. Water erosion is relevant both from an annual yield perspective, and a sustainable use of land resources. The spatial layer was sourced from JRC (Panagos et al., 2012). Soil compaction is a cumulative consequence of particular soil characteristics, in relation to human impact, through agricultural practices. The Soil Compaction layer was also sourced from JRC (ESDAC, 2008).

The methodology for identifying wheat and corn thermal restrictiveness is based on the workflow for assessing land suitability for different crops, described in detail in the Soil Studies Development Methodology – SSDM (INCDPAPM – ICPA, 1987). This workflow takes into consideration 18 environmental parameters, which pose restrictions for crop development. Out of all of these, 12 are related to pedological conditions and processes, such as: carbonatation (the total CaCO3 content in 0-50 cm range), gleization, surface-water gleization, salinization or alkalization. Several physical soil properties are also taken into account: texture in the Ap horizon (or in 0-20 cm range), total porosity, physiologically useful volume, groundwater depth. The soil reaction within Ap horizon (or in 0-20 cm range), the humus storage (in 0-50 cm range), the degree of base saturation and the human influence on the pollution are some of the chemical properties. There are also other factors, such as: the landforms depicted by slope and landslides, the climate (by annual mean temperature and annual mean precipitation values), and excess surface moisture. This methodological approach has been successfully addressed in previous studies, in relation to the most relevant crops (Niacșu, 2012), detailing crop restrictiveness in a representative basin, for the agricultural hilly region of Romania.

The applied methodology involves attributing scores for each parameter from 0 (no production due to maximum restrictiveness), to 1(maximum production due to optimum growth condition), based on favourability or restrictiveness values. Therefore, scores between 0.8 and 1 (low restrictiveness) corresponds to a decrease in productivity by 0-20%, while scores lower than 0.8 (medium or major restrictiveness) introduce significant crop losses. For example, in the case of the annual mean temperature, restrictiveness classes were assigned for each representative crop type (Table 1).

	Wheat		Corn	
Restrictiveness class	Lower t (°C)	Upper t (°C)	Lower t (°C)	Upper t (°C)
No restrictiveness	>8	≤12	>10	
Low restrictiveness	>6	≤8	>7	≤10
Low restrictiveness	≥12			
Major restrictiveness		≤6	≤7	

Table 3 Thermic restriction for two crops – wheat and corn

Based on historical and modern climate data, powerful mathematical algorithms have been developed in order to try to predict with a high degree of precision the potential future outcome, based on several, universally accepted scenarios. The most common scenarios that are used in scientific modelling for future climate predictions are based on WorldClim data (Fick et al., 2017), which was also used in the current study. There are a total of 4 SSPs (Shared Socio-economic Pathways) addressed by WorldClim scenarios: 126, 245, 370 and 585. All of these have been modelled through a total of 23 global climate models (GCMs), which try to mitigate any potential errors, and provide spatially quantified outcomes, as close as possible to the associated predictions. The 4 SSPs reveal different trends, based on the estimated quantity of greenhouse gas emissions. There are several, individual parameters, from which the bioclimatic variables are the most relevant for vegetation-related analysis, and for the purpose of this analysis, a simple, relevant variable was used, in the form of Annual Mean Temperature. This is an easily comparable parameter that could be included in numerous types of analysis.

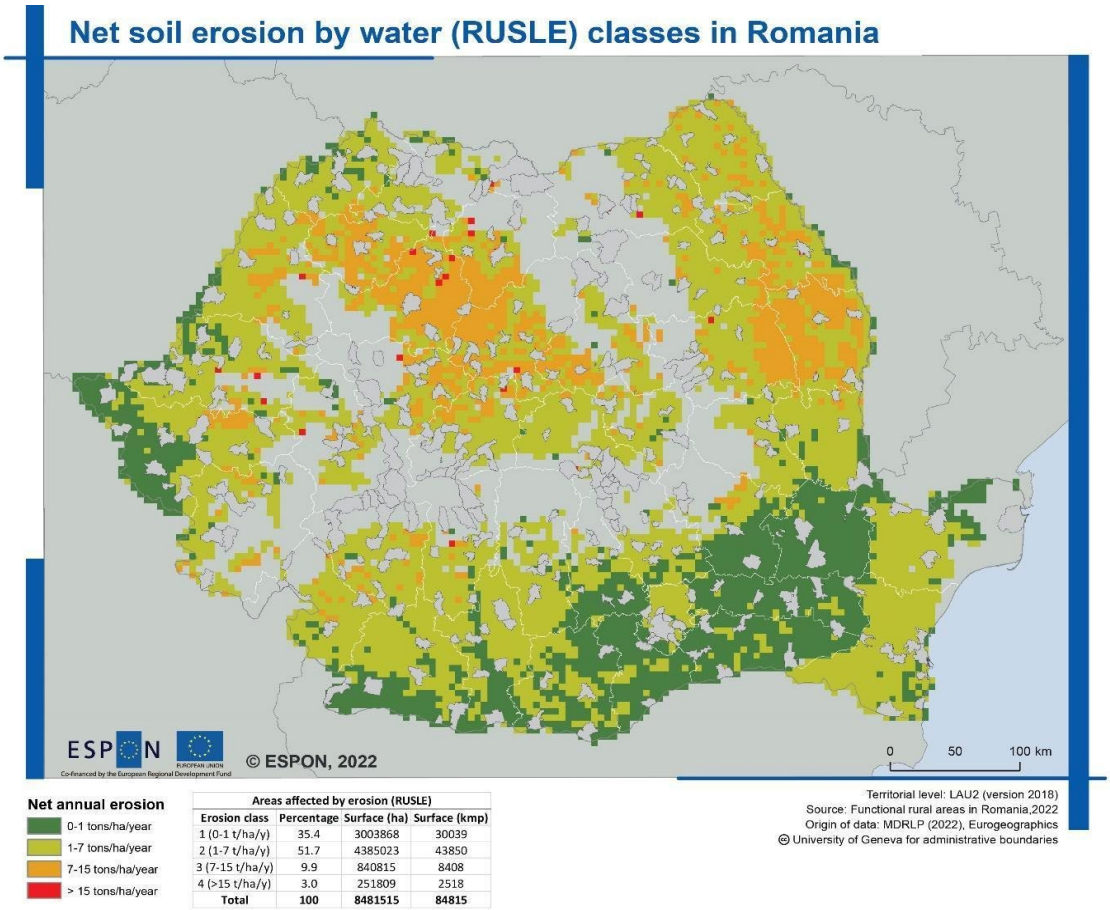
Out of the 4 given SSPs, only two were used, for increased relevance, and to emphasize a more probable future prediction regarding potential crop restrictiveness in the given thermal conditions. Therefore, the main SSP used was 2-4.5, which is considered to be a more realistic representation of a future outcome by numerous researchers, in a large number of climate change-related topics. The other SSP taken into account was 5-8.5, which is oriented towards emphasizing a “worst case scenario” with significantly larger predicted temperature ranges. The latter was only applied for reference purposes, and not to depict cartographic material in this given report, due to its tendency to exaggerate the possible outcome and not describe a more “close to real life” case. Previous peer-reviewed studies have included these two specific SSPs in their analysis, such as climatic statistical modelling for European countries, i.e., Germany (Kreienkamp et al., 2020), evaluation of climate change risk in South American countries, i.e. Surinam (Antich-Homar et al., 2022), hydrological studies in the context of climate change, i.e. in Brazil (Vinicius Maciel da Silva et al., 2022), or changes in temperature and precipitation (Supharatid et al., 2022).

The most relevant estimations are the short-to-medium term models that would require immediate action and policies, rather than the ones of a more distant future, which have a higher degree of uncertainty, as well as lower relevance for the present time. Therefore, 3 temporal reference points were used: present time, and two future scenarios (2021-2040, and 2041-2060). They are all in the form of raster layers, containing temperature data. The GIS analysis involved classifying spatial layers and generating statistical data, based on the results, in order to quantify the areas that are prone to high restrictiveness from the perspective of the used layers. The general aim was to use as many geo-spatial layers available for the entire European Union, as possible, in order to ensure methodological replicability for other member states, if feasible. For this reason, the main data source was the Joint Research Centre (JRC), from the European Commission, which provides extensive datasets for numerous spatial parameters for the member states.

With an area of 23.8 million ha and a population of 19.1 million inhabitants, Romania is the 8th and 6th country in the EU, respectively (MDPWA, 2021). Despite these rankings, Romania is only the 27th in the EU, in terms of Gross Domestic Product (GDP). Furthermore, based on a significantly high potential (14.8 mil. ha of agricultural land), the agricultural sector contributes with less than 5 % to the country's GDP. According to EUROSTAT (2021), the agricultural production in Romania mainly consists of several cereals (winter wheat, corn, barley, and oat) which produced over 18.9 million tons in 2020 (on 5.4 million ha). They are followed by oilseeds plants (sunflower, soybeans, and rapeseed) with 3.1 million tons on 1.7 million ha, vegetables (3.5 million tons), potatoes and leguminous plants for grains (peas, beans). The vineyards and orchards have a production of about 1 million tons each.

The diversity of natural conditions under specific anthropic influence generates significant fluctuation of agricultural production, even from one year to the next. For example, without having a significant variation of cultivated areas, the winter wheat and corn production varied greatly in the last two decades between 3.0-7.6 million tons/year and 3.8-12.0 million tons/year, respectively (MARD, 2000-2021). In fact, this is the effect of an unfortunate combination between natural limiting factors such as: drought, soil erosion by water and wind, humus reserve in the soil, deficiencies of macro and microelements etc., coupled with faulty land management over large areas. According to the National Institute of Statistics (NIS, 2020), the 14.8 million ha of agricultural land of Romania are divided in 4.48 million individual exploitations. Furthermore, there are 3.42 million individual smallholdings, for the entire agricultural land (Anghelache, 2018). In conclusion, the existence of a very large number of small exploitations in parallel with the very large ones reveals the structural imbalance that influences Romanian agriculture.

Under these circumstances, the widespread degradation of agricultural lands represents one of the most important issues the Romanian environment is dealing with, in the context of the need to ensure food security and sustainable development in a changing world. A suggestive example is represented by the map of net soil erosion by water based on Revised Universal Soil Loss Equation – USLE methodology (Renard et al., 1997) that highlights the lands prone to be affected by such a destructive process. Nowadays, over 1.1 million ha (13% of total agricultural land) are affected by intense erosion processes by water (over 7 t/ha/yr, Niacsu et al., 2022) which no longer allows the soil to recover on its own.



Map 15 Soil erosion by water – a threat to the rural natural capital

When referring to areas cultivated exclusively with wheat, almost 0.2 million ha are severely affected. Considering it offers little protection against water erosion, corn is irremediably affected on over 0.3 million ha, to which another 1.35 million ha are added, located at the limit of natural pattern sustainability.

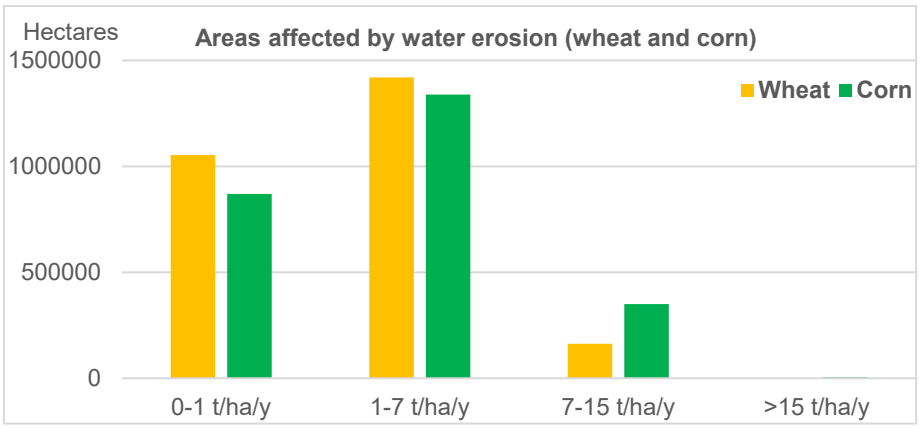
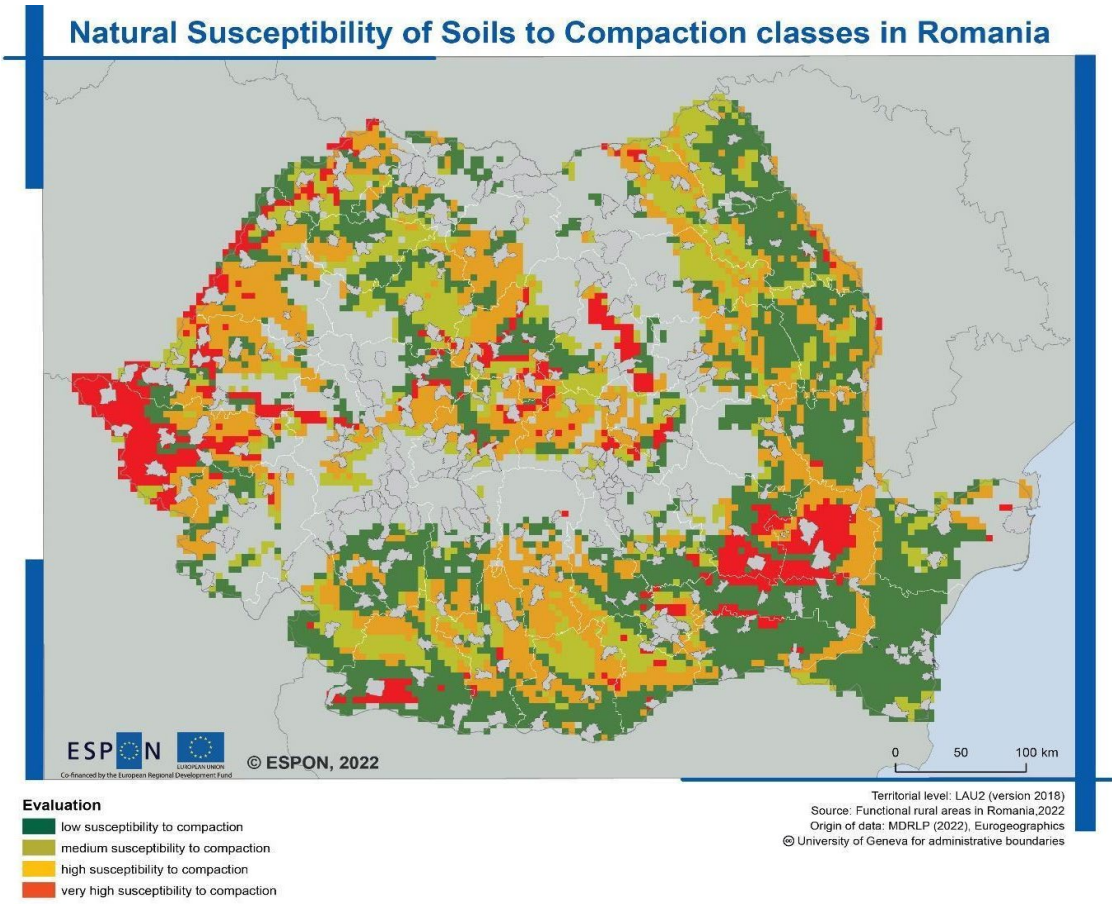


Figure 3 Areas affected by water erosions – a comparative analysis

In a similar way, the map of the natural soil susceptibility to compaction reveals worrying conclusions regarding the actual state of the soils currently cultivated with the two analysed crops. Over 1.35 million ha of corn and 1.23 million ha of wheat are located in high and very high susceptibility to soil compaction classes. Effectively, the most important cereal growing areas of Romania, namely Southern and Western Romanian Plains are mostly affected by this process (Figure 3, 4).



Map 16 Risks threatening the soil reserves - compaction

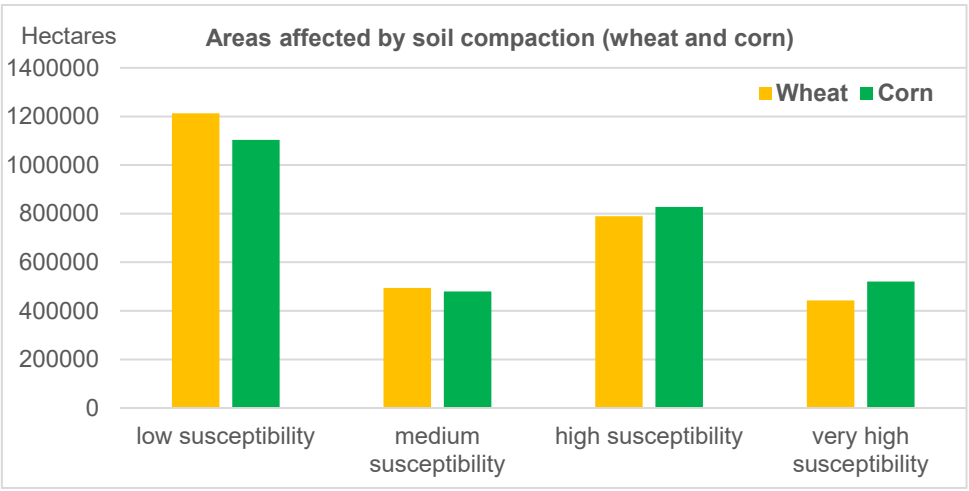
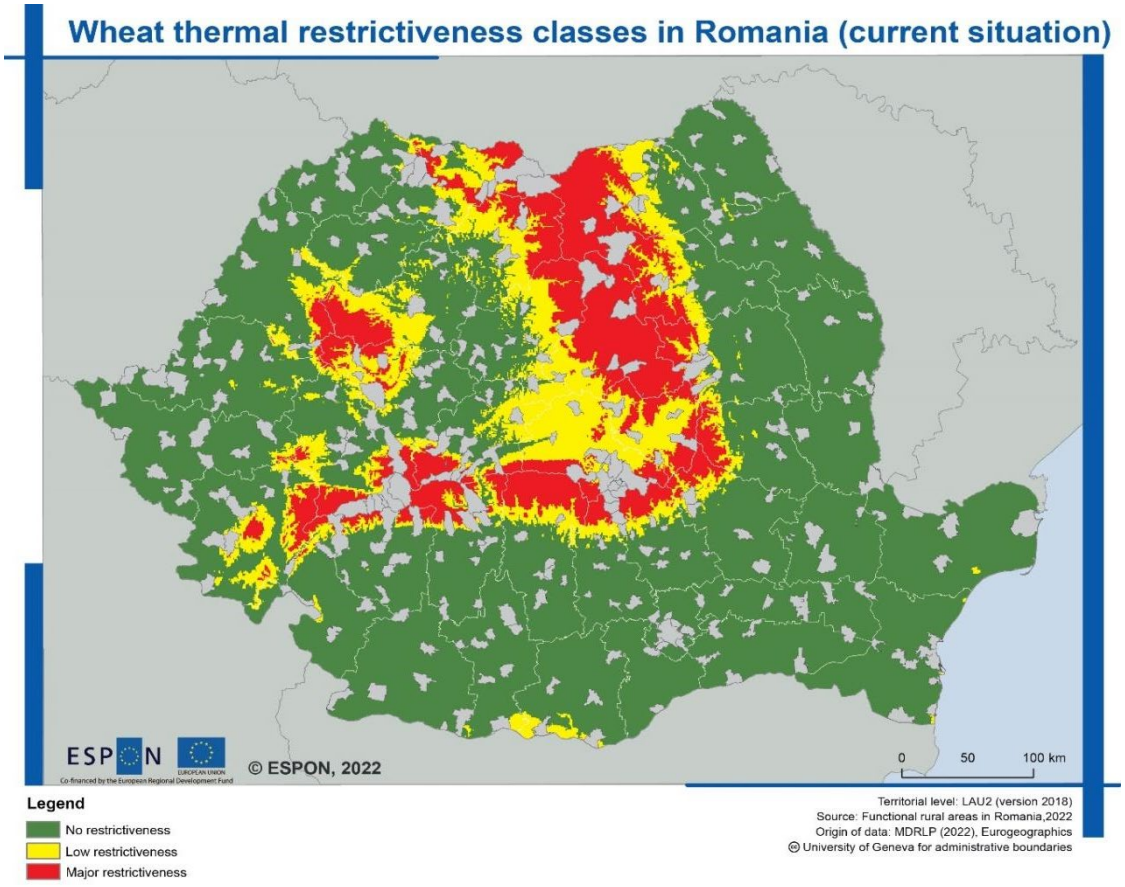


Figure 4 Areas affected by soil compaction – a comparative analysis

Alongside the indicators representing the actual degradation (conservation) state of the natural land resources presented above, the adaptation scenario of crops and agricultural practices to the challenges of climate change, revealed through the quantification of crop thermal restrictiveness are of special interest. In order to best represent the most probable evolution of the following two decades, regarding wheat crop spatial distribution, only the most probable and reasonable climatic scenario was addressed, in the form of Shared Socioeconomic Pathway 2-4.5 (SSP2-4.5). The more extreme SSP5-8.5 scenario was disregarded for this thermal restrictiveness analysis, due to the high extent of the regions which would require action, to the point at which only very small mountainous areas in the entire country would remain reasonably not affected. Therefore, the analysis addresses the SSP2-4.5 scenario, so that more region-oriented measures and policies can be taken, which would provide more quantifiable results.

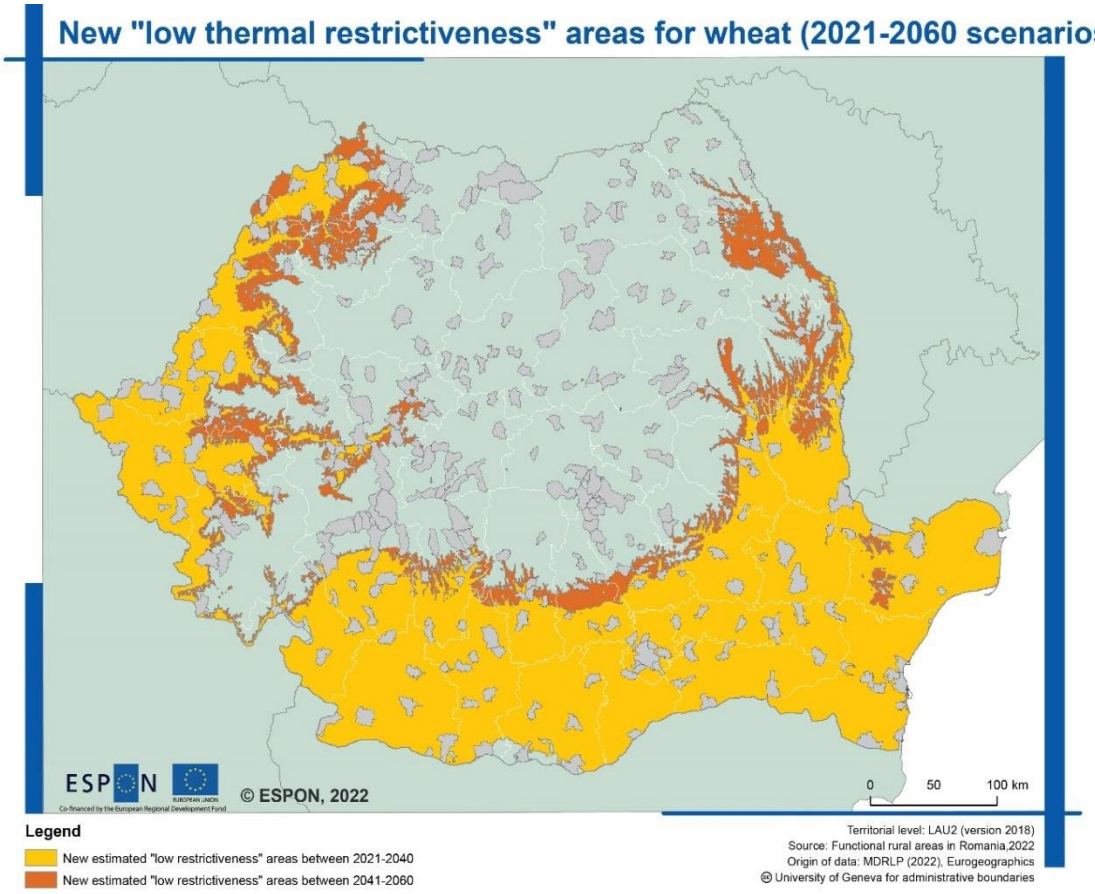


Map 17 Climatic limits in the repartition of wheat – an operational typology

In accordance with the current climatic pattern, the vast majority (98.1%) of wheat crops in Romania has no thermal restrictiveness, while low restrictiveness occurs on only 1.9% of areas, in some isolated mountain areas .After generating raster spatial layers for wheat crops, depicting the thermal restrictiveness classes for the 3 temporal scenarios (current situation, 2021-2040 scenario, and the 2041-2060 scenario), the spatial differences were also generated and grouped into a single map of “New low thermal restrictiveness” areas for wheat, 2021-2060 scenarios (see Annex).

In comparison to the current thermal context, in the future predicted scenarios, their location will correspond to a restrictive thermal class. The predictions estimate that 79.2% (over 1.7 mil hectares from a total of 2.146 million ha in 2020) of the current wheat crops will transition into a restrictive thermal class, for the 2021–2040-time interval. When referring to the 2041-2060 period, the total surfaces that will face thermal restrictiveness add another 4.7% (over 0.1 million hectares) of the areas currently cultivated with wheat. In conclusion, this scientific approach was performed in order to identify the areas where relevant changes in restrictiveness would occur for the two most important crops in Romania, according to the two, future scenarios. Out of all the information derived from this difference, the only relevant one correlates to the change from “No restrictiveness”, into the “Low restrictiveness” class, which would imply the need to take

action, in order to mitigate the effects of this change. This would have negative potential consequences, such as decreased yearly yield, decreased soil fertility, increased potential for erosion, or even the impossibility to grow wheat crops on certain arable plots, in the worst case. Therefore, appropriate policies would generate benefits in areas that are currently under no thermal restrictions but would drop in productivity values in the following two decades, as they would encounter low restrictions and overall higher mean annual temperatures.



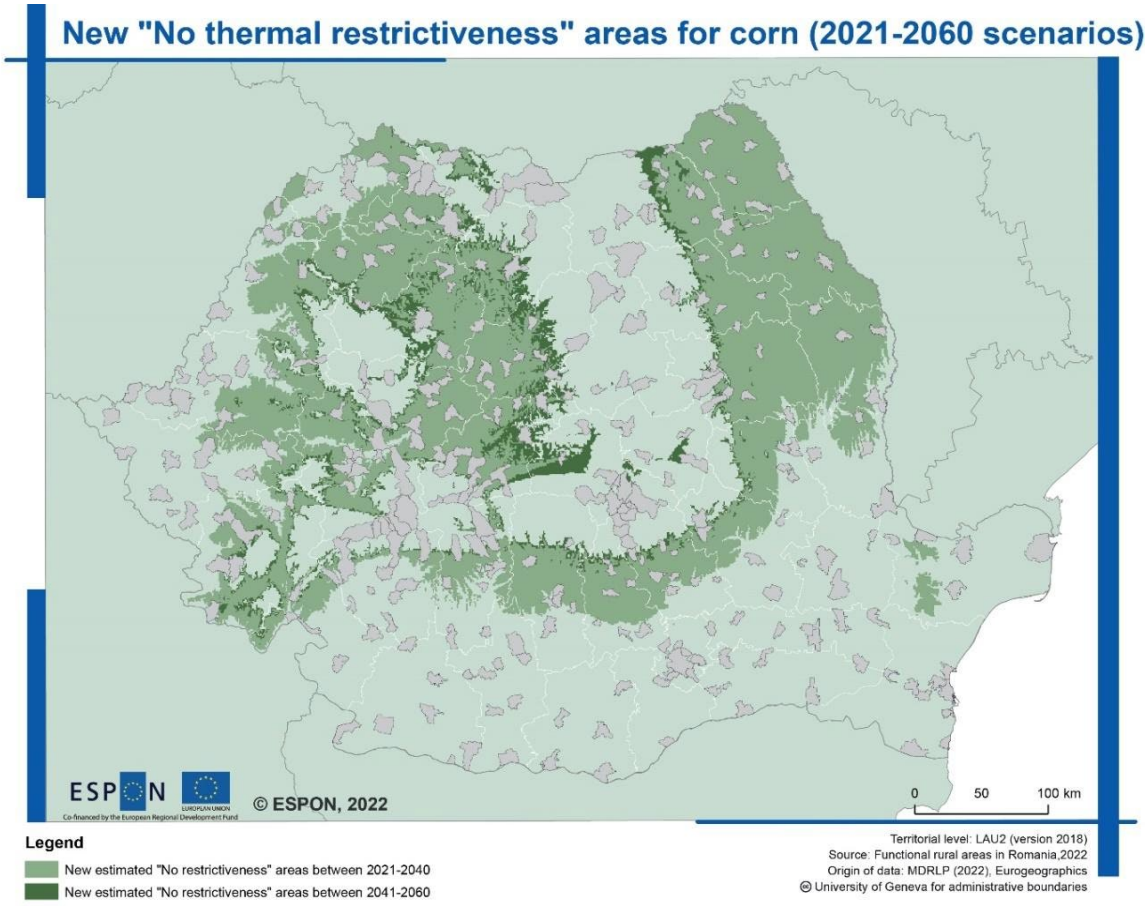
Map 18 Assessing the climate scenarios – new restriction for wheat (2021-2040 and 2041-2060)

Other classes depict stability (no change) or major restrictiveness which would not yield significant in-field results from centralized policies, as well as more targeted ones in specific areas, therefore not recommending any supplementary policies or actions. By contrast to wheat, modelling for corn crops reveals a reversing trend. Only based on thermal forecasted evolution, the potential arable land for corn will extend in area from about 9.7 million ha at present, to over 10.5 million ha during 201-2040, and another gaining 1,1 million ha during 2041-2060 (Figure 7). Following the model, it will be interesting to observe how much of this thermally gained land will be agriculturally capitalized through corn cultivation. Unfortunately, although thermal conditions actually improve for corn crops, extending its potential spread, the other bio-pedo-climatic parameters will create major restrictiveness for corn crops. Of these, particularly in this region of Europe, the most important will probably be the drought expansion (more frequent and intense droughts), that will restrict the cultivation of corn much more, than it will be favoured by the new “No thermal restrictiveness” areas.

Despite the fact that the intensity of the restrictiveness is not overwhelmingly major according to the cartographic material, the affected surfaces are of significant extent. This is due to the fact that there is not just a single restrictive parameter at work (temperature), but also other physical geographical parameters, which are also restrictive, such as precipitation distribution, the tendency towards aridity, the reduction of soil organic carbon stock, increased water erosion etc. All these analyses can only emphasize the constantly increasing need for the policy makers to take into account the requirement of acknowledging the

importance of these natural parameters in writing future policies, regarding the sustainable development of rural areas and their associated, arable land.

The analysis proposed in this section underlines the necessity to project the delineation of the Romanian functional rural areas into the near future, taking into account basic scenarios of evolution of the local natural capital. The emerging wheat belt from the Danubian Plain will definitely face challenges, at the horizon of 2040, and these challenges must be countered by an effective set of policies. However, from our perspective, the policy interventions should be cross thematic, and they should be defined by more than one decisional body. Our research has its inherent limitations, as only one climate parameter was taken into account (temperature). However, it can serve as an example for the potential methodological approach and for the research piloting strategies on this topic.



Map 19 Assessing the climate scenarios – new restriction for corn (2021-2040 and 2041-2060)

Box 1 Improving relations between rural areas: relevant findings for policy design

1. The economic transformation of the rural landscape is impacted by the distance to cities and spatial position in relation to the major corridors of transportation. The transformation can be measured by the accumulation of economic actors (companies), a key feature of functionality of the rural spaces. This accumulation is much more intense in the proximity of cities. Beyond a certain distance from the main cities, distance that varies from county to county, the rhythm of accumulation becomes independent from the urban proximity and presents other territorial logics (local economic context, potential for tourism or agricultural specialization). This limit generally corresponds to the space of the functional rural areas delineated in our research. From a policy perspective, encouraging the establishment of new economic actors in the functional rural areas is a matter of emancipating from the “tyranny of the distance” - in this case the remoteness from major urban network. Specific measures can be planned and implemented, such as incentives for companies’ creation or transfer, at the scale of the functional rural areas.

2. Encouraging functional rural areas to solve the main local problems related to the road quality may improve accessibility to services in the rural territory. Previous interventions in modernising county or national road segments provided encouraging results, ameliorating the general accessibility. Yet, a new phase of interventions needs to be planned, with the objective to correct the deficiencies of accessibility in punctual situations – like distance to commercial or administrative services, for example. More specifically, these punctual interventions should be based on the local needs assessment, an element that can be more easily identified at the scale of the functional rural areas. The experience of the pandemic period showed that the accessibility to services is no longer a pure function of spatial proximity, but also a function of technological connectedness (e-commerce, e-services, e-learning etc.). **A policy mix that aims to reduce both the spatial remoteness and the technological fracture can be envisaged, at the scale of the functional rural areas.**

3. Just as stable as the macro-demographic system, the economic specialization of the functional rural areas is still largely relying on the agriculture. The quantity of data at our disposal indicates that the rural territory becomes more and more performant in balancing two competing factors - the agricultural market and the natural local or regional endowment. The equilibrium between the two factors is dynamic and demands further scientific investigation, in order to provide a sound set of policy recommendations. Nevertheless, one direction of action is relatively clear: the dissociation between the large farming systems and the small to medium sized exploitations is responsible for the largest part of the specializations patterns observed on the maps. In many cases, this dissociation can be perceived as a factor of rural modernization – increase in productivity, technological transfer, new agronomic practices that diffuse etc. At the same time, some questions that are related to the welfare transfer to local rural communities arise. It is questionable, weather if the answer to these questions turns more to enhancing regulation or to the elaboration of new frames of interventions, focusing on intensifying the catalytic effect and diffused throughout the functional rural areas.

4. The agricultural, local, **specializations are depending on market trends and on the natural capital.** The first factor is difficult to control/predict, and it is a constant subject to different economic and geopolitical contingencies. The evolution of the natural systems is easier to decode, and different climate evolution scenarios were mobilized for this objective. The main conclusion extracted from the data modelling suggests that the risks induced by the climate change on the agricultural systems are moderate and it will remain moderate, if:

- a cross-thematic set of policies will be designed, developed and implemented. The elaboration of these policies involves a strengthen collaboration between actors from different ministries and the academic environment. These policies should focus on the elaboration of adaptation strategies for the economic actors active in agriculture, together with a set of measures related to a better conservation of the agricultural production factors (for example, conservation of the soil resource).
- policies targeting the local resilience facing the climate change will become common. This kind of policies will find a sound anchorage in the territorial frame of the functional rural areas, as these communities will be in the first line of the climate modifications.

5. The contrasting signs of economic functionality in the Romanian rural space are the result of the intersection between market practices diffusion and the local capacity to generate patterns of economic growth. The diversification of the activities in the Romanian rural areas will need to find a way to balance the two trends, but it should also avoid the competition on land use. For example, encouraging the emergence of green energy projects in rural areas should be subordinated to smart models of circular economy, rather than becoming just another form of consumption of the agricultural land (zero net land take approach for solar energy, for example). The potential functional rural areas should be encouraged to develop strategies of local economic diversification based on the principles of sustainability and smart local development. Some of the leverages that can accelerate the implementation of policies centred on this objective need to gain priority on the agenda of policymakers, at all the action scales:

- digitalization of the rural spaces. This process should not be seen just as a reduction of the technological gap, compared to cities, but as an emergent comparative advantage of the functional rural areas. Leverage effect on the economic diversification: small companies and skilled self-employed installing in the functional rural areas.
- re-industrialization of the rural areas, using the local opportunities for production, mainly in the field of agro-industrial local chains. This intervention will have an impact on the agricultural specializations in place. Leverage effect on the economic diversification: a new design of the interactions between agricultural production, processing, transportation and commercialization.
- a continuous focus on the green energy production in the rural areas in a smart way. This economic activity is highly demanding in skills and technology, and both give opportunities to spillovers and bring economic diversity in the rural space. Leverage effect on the economic

diversification: technological and competences transfer, potentially doubled by land use recycling of the unproductive land.

4 The delineation of functional rural areas in Romania – methodological challenges

4.1 The potential functional rural areas: homogenous regions versus locally polarized regions

In many regards, detecting the functional rural areas in Romania is a problem of supervised regionalization, in a context of multiple spatial and territorial constraints induced by access to indicators and the quality of data. The results of our approach (two separate versions of the Romanian FRA – functional rural areas) are produced by implementing a spatial analysis method that is guided by a main objective: keeping a high level of internal homogeneity when designing functional rural areas. In delineating a FUA, the use of spatial interactions represents an explicit option that takes into account that the resulting geographical objects will detain a high level of heterogeneity. In the precise case of delineating Romanian functional rural areas, the data describing the spatial interactions is extremely limited and unsuitable for use at local scale.

Even in the hypothetical case that data on local flows were available, we considered that the network of local interactions is rather insignificant in defining rural functionality, as expression of some particular situations (like, commuting for attaining educational services or the local markets or, of inconstant economic exchanges between the LAU). In this case, we made an option to delineate the functional rural areas independently to the matrix of potential spatial interactions, using the set of available indicators collected during the projects lifetime.

Our goal was to obtain different delineations of functional rural areas and to assess their degree of internal homogeneity, into a multivariate geo-statistical work frame. The technical solutions available for obtaining an aggregation of LAU in functional rural areas are not a recent topic of interest in geography[2] and there is a constant effort to implement them in different software – GeoDa[3], Philcarto (it lacks the spatial constraints option), ArcMap (only k-mean clustering), QGIS[4] (dedicated plugins and tools). Each of the mentioned computing tools is a candidate for delineating and mapping FRA , which also come with major limitations (for example, excepting the situation when a dedicated spatial weight matrix is already created, ArcMap will not allow the user to set a double constraint for the model – spatial contiguity and NUTS3 belonging, for example. Of course, one could use iterations for each set of LAU, separated by NUTS3, complicating the workflow.)

Even if a spatial constraint will be available in Philcarto, demanding and obtaining a large number of aggregated LAU in functional areas is a challenge, when dealing with hierarchical clustering approaches. For example, obtaining a specific number of functional regions and having a fair ratio of inter-class and intra-class variance is not always an option. All these potential solutions and the inherent problems guided us to apply a different method and algorithm for LAU clustering in functional rural areas. In a first instance, the algorithm will need to overcome some basic spatial and territorial constraints, implicit in the delineation of the FRA. One major challenge consisted in the interference between three competing geometries, during

[2] For more details regarding the new approaches on the classification topics, see Cova, Thomas J., and Richard L. Church. 2000. “Contiguity Constraints for Single-Region Site Search Problems.” Geographical Analysis 32: 306–29./ Duque, Juan, Luc Anselin, and Sergio J. Rey. 2012. “The Max-P-Regions Problem.” Journal of Regional Science 52 (3): 397–419. / Duque, Juan Carlos, Raúl Ramos, and Jordi Suriñach. 2007. “Supervised Regionalization Methods: A Survey.” International Regional Science Review 30: 195–220. / Duque, Juan C., Richard L. Church, and Richard S. Middleton. 2011. “The P-Regions Problem.” Geographical Analysis 43: 104–26.

[3] A sound description of the R tools for solving hierarchical clustering with spatial constraints is available in Chavent, Marie, Vanessa Kuentz-Simonet, Amaury Labenne, and Jérôme Saracco. 2018. “ClustGeo: An R Package for Hierarchical Clustering with Spatial Constraints.” Computational Statistics 33: 1799–1822.

[4] It lacks the possibility to cluster the spatial units using a statistical distance and a matrix of similarity. However, some of these tools have the potential to work with large datasets – the nearest neighbour clustering technique in Visualist and the DBSCAN tool.

the delineation process – the NUTS3, the future metropolitan areas and the spatial distribution of the rural LAU.

The methodology used in this delineation exercise is a hybrid between the multivariate statistical analysis and the clustering techniques. Previous similar approaches in ESPON projects attempted to create functional regions similar in size with the German NUTS3 geometry, which were considered optimal for avoiding the mass effect produced by the different administrative divisions in the ESPON space (ESPON DB Phase II, Local Data in M4D). These first attempts managed to aggregate LAU in different Eastern European states, using a single criterion (density of population) and ignoring their functions (rural or urban). The approach was experimental, but managed to match the expectations, even if it was applied on a limited set of countries (Poland and Romania).

4.2 Spatial and territorial constraints in the elaboration of the delineation algorithm

Seeking to create a spatial frame that aggregates the Romanian LAU in functional rural areas involves dealing with the definition of the main two geographical constraints interfering with the technical process: the nature of the spatial relations between the LAU and the regional (administrative) subordination of the functional entities. In both cases, it seemed logical to prioritize the emergence of FRA based on LAU contiguity and belonging to the same NUTS3. If the second constraint is not a problem, given the general stability of the nomenclature, the first one is rather a particular case. If the algorithm needs to be extrapolated to larger scales, a closer look at the nature of the spatial (topological) relations between the LAU is a topic of major importance. For example, the particular case of contiguity might be of little value in Greece or Croatia, given the geographical specificities of a large part of their territories. In this case, the spatial weight matrix defining the relations between the LAU should be a combination between a contiguity matrix and a Delaunay triangulation or k-nearest neighbour matrix. Making a distinction between the rural LAU and the urban LAU in Romania, we created a neighbourhood matrix between any two rural LAU i and j. With the exception of the LAU of Cristian (Brașov county), all the other spatial units were able to populate the table, creating 14762 links of contiguity. This matrix was filtered by the LAU belonging to the same NUTS3 and we reduced the number of links to 12498. The degree of connectivity is given by the average number of neighbours for one LAU. Without filtering the contiguity matrix by a NUTS3 belonging, the value is 5.81. When the filter, is applied it drops to 4.37. The geometry used for the analysis and the creation of the contiguity table between the LAU is the same with the spatial dataset used by the Romanian Ministry of Development, in the mapping products hosted in the Territorial Observatory of Romania. The geodatabase containing the files is available at (https://ot.mdrap.ro/website/maps/).

This geometry has some advantages compared to other similar products: it preserves well the contiguity relations between the LAU, having an optimal size for a GIS product. Working with other LAU datasets (GISCO, GADM or the Romanian Agency for Cadastral Survey and Real Estate) might produce different results, including a smaller number of links and not necessary the same spatial connectivity. The spatial database created for the implementation of this project retained this version of the contiguity matrix between the rural LAU under the label V1_SWM_RURAL. At the same time, the potential future transformations of the Romanian LAU status were also taken into account. The law project concerning the metropolitan areas of Romania is approved and it will finally provide a frame of coherent definitions of these geographical objects. From a spatial perspective, the rural LAU potentially participating in the future metropolitan areas are not a candidate for their introduction into a functional rural area. Even if the delineation proposed in the law project might be subject to modifications, the general principles would stay valid (for example, rural LAU in the immediate vicinity of county capitals, which are more or less suburban in characteristics, will likely benefit from this association).

Both the geometry of the proposed metropolitan areas and the motivation of the law are available on the dedicated page at https://www.mdlpa.ro/pages/proiectlegezonemetropolitane. This aspect is only apparently complicating the delineation of the functional rural areas, being in fact an excellent opportunity to investigate the aggregation process in different territorial and spatial contexts or scenarios. From a methodological point of view, the intervention in the initial matrix of LAU contiguity was simple and reduced to the exclusion of the links describing the neighbourhoods' situations of the rural LAU qualified for the inclusion in a metropolitan area. A second version of the contiguity matrix was created and stocked in the spatial database of the project – V2_SWM_RURAL. Once the two matrixes were created, the next step in our approach was dedicated to the operationalization of the products for the functional rural areas' delineation.

4.3 The algorithm implementation and detected limitations

The general structure of a spatial weight matrix is presented in a 3 columns format, with the possibility to add row standardization as a function of the nature of the spatial relations included. The first column is dedicated to the LAU i, the second one to the neighbours (LAU j), while the third one contains the values of the weight. In our case, working with a contiguity matrix, the value for the weight is 1 (two LAU I and j are contiguous, when they share a common border). For simplification, the first two columns contain only the codes of the LAU (SIRUTA or the national code).

No matter the working version of the matrix (V1_SWM_RURAL or V2_SWM_RURAL), a double process of attributes join was implemented. The first data join process concerned the first column, the second process was dedicated to the second column. The attributes appended to the spatial weight matrix describes the situation of each rural LAU, from the perspective of the demographic stability, the accessibility to the administrative centres or from the ability to perform in funding absorption, among others. One major concern in the selection of the indicators used for the delineation consisted in the constant exclusion of the potential collinearity between them. At the same time, we aimed to have a good coverage of the major descriptors of the rural space, including indicators regarding the natural constraints that might interfere with the agricultural activities. Each indicator is shortly described, and we explain why it was included in the dataset:

* **Mean altitude** – using the Romanian version of the SRTM, a mean altitude was calculated for each LAU.

The indicator is usually used to predict temperatures and precipitations, two key factors for the spatial distribution of the agricultural activities. For further description, we labelled the indicator as N1.

* **Rural population density in 2020** – it assesses the spatial distribution of the rural population. The gradients of density are responsible for the presence of public services of general interest, being also an important factor in the emergence of the local markets. For further description, we labelled the indicator as D1.

* **Relative demographic evolution between 2011 and 2020** – the values describe several demographic shocks registered by the rural LAU (natality breakdown, internal and external migration, population ageing or changes in the local demographic structures). We retained 2011 and 2020 for having a good coverage of the population mutations, 2011 being a census year and 2020 the most recent estimation in the spatial database. For further description, we labelled the indicator as D2.

* **Distance to the border** – the indicator describes the proximity of each LAU in relation with the national borders. Despite their potential, the border areas are still lagging and their transformation in locally relevant economic poles and corridors needs more intervention. Being an interesting indicator for the analysis, it has some statistical issues, when it is joined to the V2_SWM_RURAL (local and regional correlation with the distance to the administrative centres). For further description, we labelled the indicator as A1.

* **Distance to the administrative centre** – the Euclidean distance was calculated between the centroids of each LAU and the centroid of the administrative centre. Even if a time distance matrix is available, the indicator is supposed to underline more the spatial position, rather the territorial endowment deficiencies, reducing the number of potential outlier values. For further description, we labelled the indicator as A2.

* **Capacity to absorb funding from national programmes** – the indicator describes the total amount of financial amounts invested at local rural scale, via different national schemas – National Plan of Local Development, environment funding etc. The data is provided as a stock, and it describes the cumulative situation of 2020. For further description, we labelled the indicator as F1.

* **Capacity to absorb funding from national programmes/inhabitant** – the values of the indicator associate the rural demographic concentrations with the financial irrigation of the Romanian rural territory, smoothing the large asperities of the spatial distribution observed during the mapping of the previous indicator. For further description, we labelled the indicator as F2.

The seven indicators retained in the first version of the functional areas delineation or the six maintained for the second one were transformed in an index ranging from 0 to 1. The transformation method is based on the ratio between the difference to the minimum and the amplitude, being necessary for the standardization of the multiple units of measure attached to the raw indicators.

$$Ni = \frac{Vi - minN}{MaxN - minN}, where\ Vi = the\ value\ of\ the\ indicator\ N\ for\ each\ LAU\ i$$

Variables	N1	D1	A2	D2	F1	F2
N1	**1**	0.025	0.057	-0.179	-0.053	0.021
D1	0.025	**1**	-0.089	0.336	0.063	-0.128
A2	0.057	-0.089	**1**	-0.177	-0.061	0.068
D2	-0.179	0.336	-0.177	**1**	0.042	-0.304
F1	-0.053	0.063	-0.061	0.042	**1**	0.608
F2	0.021	-0.128	0.068	-0.304	0.608	**1**

Table 4 Intensity of Pearson correlation between the indicators participating in the elaboration of the similarity index

The correlation table between the indicators suggest that the elimination of the collinearity was largely achieved, except for the indicator F2 (capacity of funding absorption from national programmes/inhabitant). The last indicator is positively correlated with the gross local financing (F1), but the value of the Pearson's r is artificially inflated by the presence of some outlier values. Also, the negative statistical association with the population density (D2) is also a mathematical artefact, given the shape of the point cloud on the graph.

Once this transformation was applied, a similarity index Sij was calculated for each pair of rural LAU I and j, spatially weighted by the contiguity matrix. There is a consistent set of methodological approaches, when one will calculate the similarities between two or more spatial units. The statistical distance included in our algorithm is based on a multivariate construction of the Manhattan distance (absolute differences between the indicators). This option was considered an optimal solution, taking into account the scale of the data transformation (range between 0 and 1) and the technical need to obtain a set of similarities Sij with a higher variance than the one produced by Euclidean statistical distances. If a hierarchy of the indicators is available or implicit in the study, the formalization also allows for the introduction of weights for the calculus of the individual absolute differences, but this solution was not tested.

$$Sij = |Ni - Nj| + |D1i - D1j| + |D2i - D2j| + |A1i - A1j| + |A2i - A2J| + |F1i - F1j| + |F2I - F2J|$$

The elaboration of the Sij indicator allowed us to go to the next steps of our approach, mainly, the elaboration of a spatial pattern that synthetizes both the spatial relations between the Romanian rural LAU (based on the contiguity context- V1_SWM_RURAL. and V2_SWM_RURAL.) and the statistical differences between them (Sij). Two new products were added to the projects spatial database – V1_SL_RURAL and V2_SL_RURAL, where SL designs spatial pattern. Using ArcMap Network Analyst options, we have transformed the two spatial patterns in two distinct network datasets, where the impedance is given by the values of the Sij. By analogy with a normal road network, large values of the Sij are associated with remoteness between any pair of rural LAU i and j, the small values being correlated with the statistical proximity. The two network datasets based on the spatial patterns and the Sij impedances were tested, before being used for the delineation of the functional rural areas.

The method chosen for the construction of the functional rural areas map is derived from the algorithm of location-allocation problems, already implemented in the GIS environment mobilized for the project. Basically, the problems of location-allocation (or p-median solutions) involve the selection of p facilities able to minimize distances between the spatial offer and the spatial demand for services, in a precise territorial context. For example, how to allocate 10 supermarkets in a city, so that the distances between the clients

and the commercial offer are minimized? Moreover, the location of the supermarkets should also respond to a supplementary constraint that allows the offer to maximize its market share. The first versions of the problem can be traced in the classical problem of Hotelling's location (1929, Stability in competition), with solutions are dealing with a mono-dimensional space. When transferred to bi-dimensional spaces and when the distances approximate well the proximity between the demand and the offer, the problem becomes extremely complex and demanding in calculation power (Models in spatial analysis, Lena Sanders, 2007)

Despite these technical challenges, for the objective of our research, the location-allocation model provides the solutions needed for the delineation of the functional rural areas. The option to minimize the sum of statistical distances provided us a sub-optimal solution for the territorial homogeneity constraint, while finding the candidate facilities is assimilated to the detection of the rural LAU used as "seeds" for the local aggregation of the spatial units in functional regions. When implemented, the location-allocation model used for the delineation demands that some conditions are respected:

- each rural LAU presents an equal probability to be a candidate centre, so that all the links in the spatial pattern and all the Sij values are used for the solution.
- each rural LAU is considered a "demand" point in the model
- a Sij cut-off value should be implemented. In our case, this value is given by the maximum of the Sij index.

Respecting these conditions reinforce the possibility to obtain homogeneous functional rural areas, from the perspective of the indicators introduced in the model. Specifying the number of candidate centres for the LAU aggregation is a topic of debate and more investigation, as there is no optimum number of regions to be created. Measuring the efficiency of the solution s1 is possible after the implementation of the algorithm and only when a frame of comparison was established (the solution set s, varying from 1 to n). A solution can be considered better than another one, when it will minimize a basic territorial auto-correlation index (Decroly, Grasland, 1993), formalized as:

$TACs1 = 1 - (\sum Sij_{s1} / (\sum Sij - \sum Sij_{s1}))$, where

TACs1 = territorial auto-correlation index for solution 1

Sijs1 = values of the similarity index for each pair of rural LAU included in a functional rural area

Sij = values of the similarity index for each pair of rural LAU included in the spatial pattern

The positive values of the indicator might be read as positive territorial autocorrelation and the largest positive values mark the optimal solutions. Elaborating this index as a GIS tool was out of the scope of this project, but it is a feasible approach, if one will have to benchmark multiple solutions.

According to the steps presented in this section, we have created several maps for each version of the spatial pattern mobilized for the functional rural areas delineation. In a first stage, we created 5 maps (M1 to M5) using the V1_SL_RURAL, a spatial pattern that excludes from the analysis only the urban LAU. The second implementation focused only on 3 maps (M1 to M3), using the spatial pattern that excludes the rural LAU participating in the projected metropolitan areas - V2_SL_RURAL.

SIRUTAij	2130	2381	2577	3459	3841	4008
2130						
2381			0.676			
2577		0.676				
3459						0.356
3841						
4008				0.356		

Table 5 Illustration of the contiguity matrix populated with the similarity index Sij.

For illustration purpose, the table extracts from the similarity pattern V2_SL_RURAL. The comparison of the values of the similarity index suggests that the spatial units 3459 and 4008, both of them being rural LAU labelled by the national code, are more similar than 2577 vs. 2381. The spatial expression of the similarity matrix is visible in figure (XXX), a zoom-in on 4 counties (NUTS3) placed at the limit between the

North-East NUTS2 Region and the South-East NUTS2 Region – Bacău, Vaslui, Vrancea and Galați. At the scale of the rural LAU, the snapshot makes more visible the spatial units that are able to participate in the functional rural areas and aggregation links obtained after the implementation of the location-allocation algroithm. The delineation is a proposal for the second version of the research ouput.

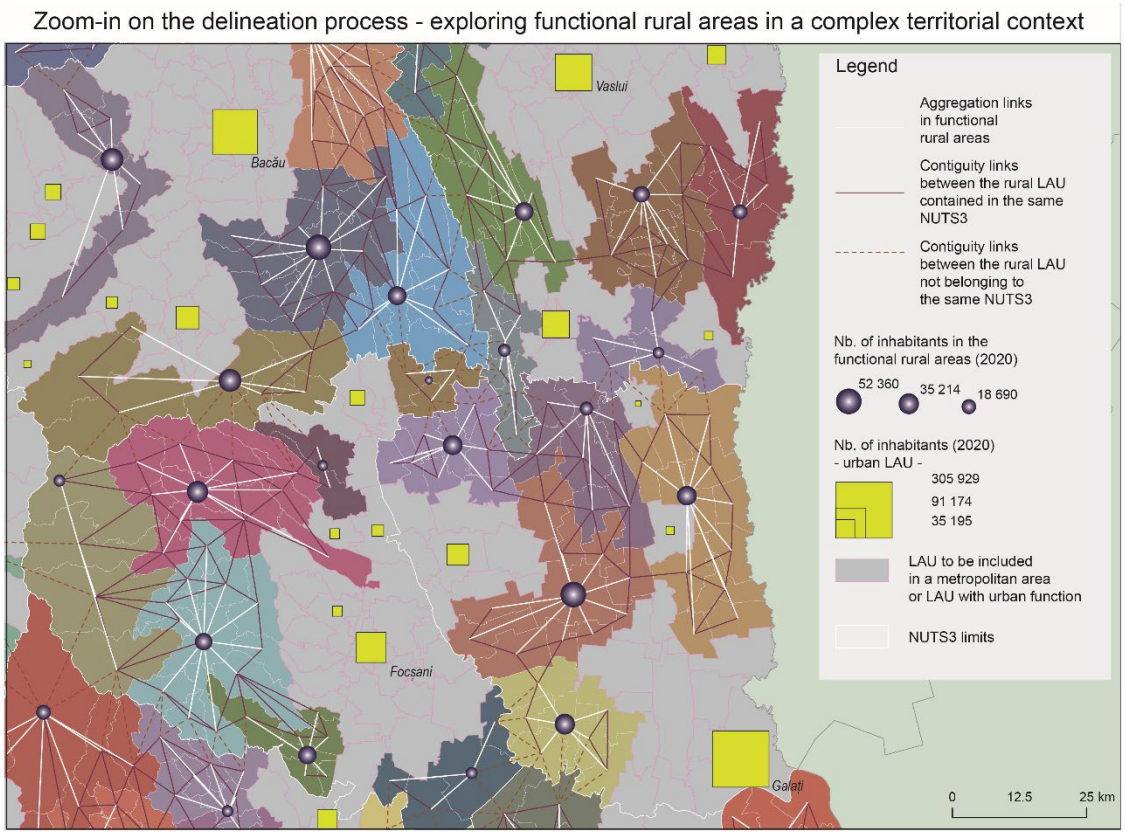


Figure 5 From contiguity matrix to spatial pattern – an illustration of the delineation algorithm of the functional rural areas.

A step-by-step description of the methodology and the algorithm implementation is available in the next table. The logic of the table uses a GIS approach and it will emphasize the main challenges and limitations of the approach. For the moment, it is impossible to propose a complete GIS tool encompassing the algorithm, but tests are done for segmentation in model builders and scripts. A graphical illustration of the process is not feasible, due to the number of steps and interventions during the delineation process.

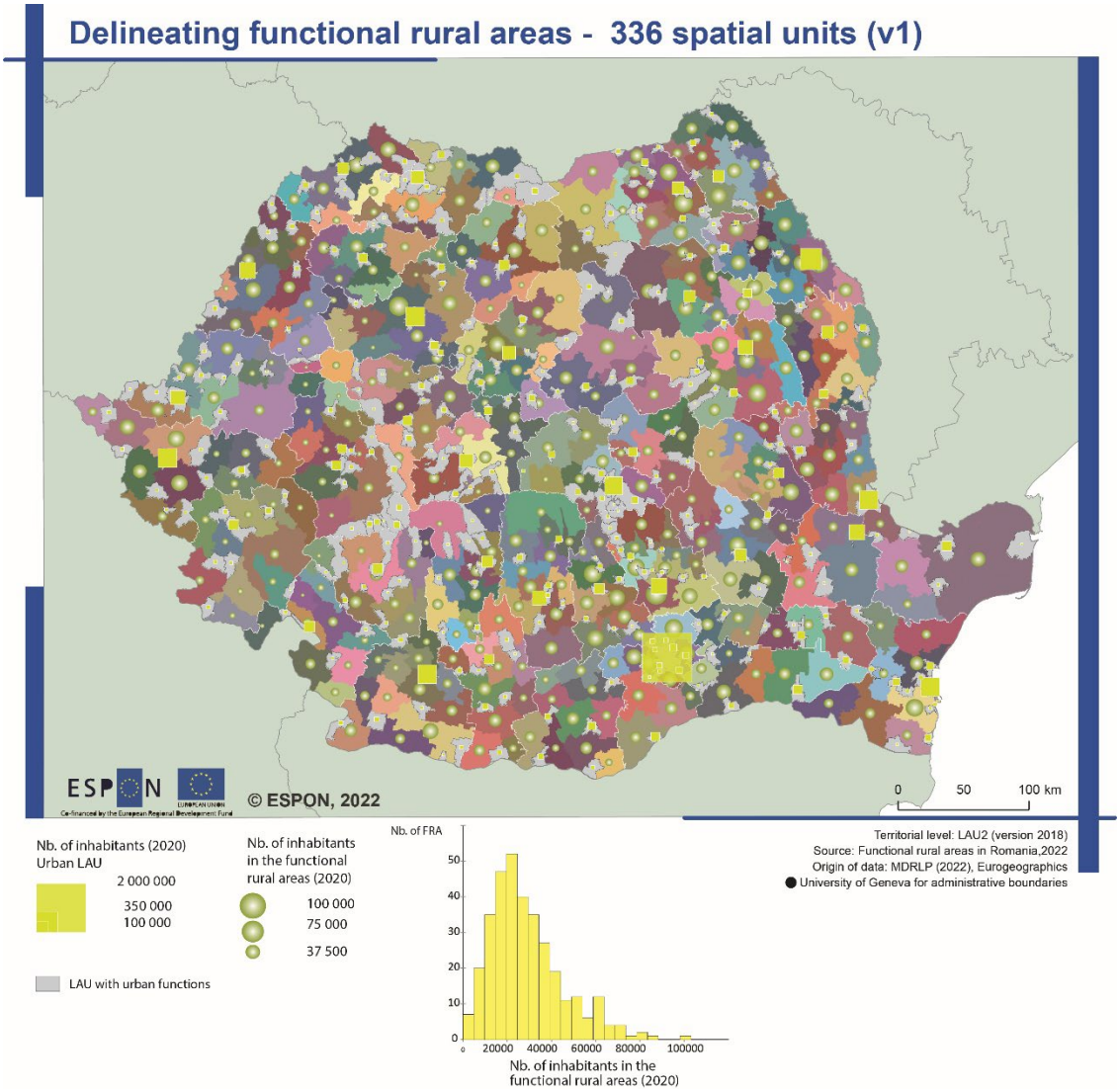
Steps	Description	Challenges
Step1	The user should opt for a polygon layer that needs to be segmented in functional regions.	No significant problems are detected for this step. One precaution is needed – the user should ensure the presence of a nomenclature attribute (NUTS3, for example).
Step2	Integrate the set of indicators that will be used during the delineation process. This operation can be an attribute join, if the data is not already present in the polygon layer.	The set of indicators used for the similarity detection between the spatial units is supposed to follow some restrictions: avoid the use of indicators with a large quantity of missing data and eliminate multi-collinearity, as much as possible.
Step3	The set of indicators used for the regionalization solution must be mathematically transformed and normalized in an index.	Not all the solutions of data transformation are suitable for this operation. The operations based on a reduction to the mean or Z score transformation should be avoided.

Steps	Description	Challenges
Step 4	Transform the polygon layer charged with normalized indicators into a point layer. Add XY coordinates to this layer.	The point layer will serve for the construction of the spatial pattern in a later phase of the algorithm. The user should be sure that the spatial units composed by more than one polygon are only assigned to one centroid.
Step 5	Create a spatial weight matrix based on contiguity constraints, using the polygon layers. The matrix needs to have at least 2 columns – LAU identifier code and neighbours LAU identifier code.	The construction of the matrix is dependent on the topology of the polygons. Problems of topology will affect the accuracy of the matrix of contiguity.
Step 6	Double join the point layer created at step 4 to the contiguity matrix. Be sure to add the data using the unique identifier of each LAU and its neighbours.	The double join will create a new matrix, populated both with the spatial weight (neighbourhood situation) and the normalized indicators. It is essential to stock this matrix for further use, as in many GIS environments the join process is temporary.
Step 7	Use the XY coordinates to transform the matrix in a spatial pattern. The result will have the aspect of the contiguity links described in Figure 5.	No specific precautions are needed in this step.
Step 8	Join the normalized indicators from the matrix to the spatial pattern. Add a new field and calculate the similarity index, according to a statistical distance appropriated for the underline of the differences between an LAU and its neighbours. Eliminate the links that describe contiguity between LAU not belonging to the same NUTS3.	When the data is transformed in an index from 0 to 1, the Manhattan distance will mathematically inflate the dissimilarities between two contiguous LAU.
Step 9	Transform the spatial pattern in a network dataset, using the similarity index as impedance.	The process demands no particular precautions.
Step 10	Load the point dataset as facilities and demand in the network dataset and implement the location allocation process to regionalize the layer. The output has the form of a line dataset labelled *Aggregation links in functional rural areas* in Figure 5.	The main precaution is related to the use of the same number of points in both situations. The location-allocation model needs an important input parameter: the number of functional regions to be created. This parameter can be optimized by the iteration of the process.
Step11	Join the output to the polygon layer and proceed to the mapping process, using a qualitative method.	Conserve the results as a separate version and reiterate step 10 for other comparative delineations.

Table 6 A schematic approach of the delineation method in a GIS environment

4.4 Output of the delineation method: two competing or complementary versions of the functional rural areas map?

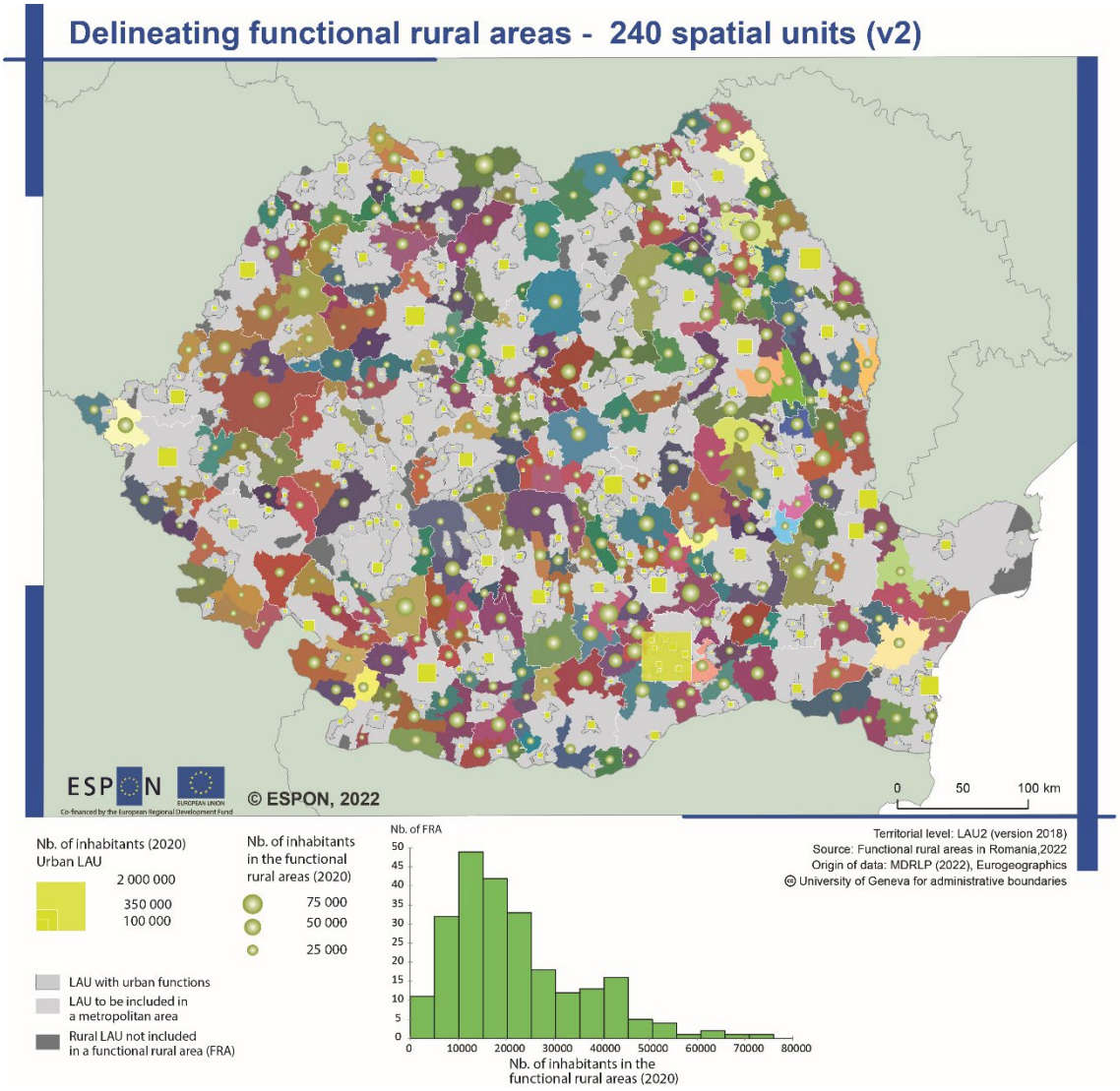
The first model proposed for the delineation of the functional rural areas served for testing purposes. Given the size of the NUTS3 and the number of LAU included in each Romanian county, the objective was to create an equal number of functional regional by NUTS3. As the model excludes the urban LAU, we targeted for a variable number of candidate LAU for the aggregation (210, 252, 328, 336 and 420), obtaining 5 different maps. The multiple mapping versions are not just alternative solutions of the model; they can be mobilized to correct some of the functional rural areas that are exaggerated as size, in the local context.



Map 20 Output of the functional rural areas' delineation method – version 1

Even if this version (V1) was not retained for further analysis, it presents some interest, both from technical and geographical perspectives. The degree of territorial fragmentation in functional rural areas depends, as expected, on the number of LAU by NUTS3. In the case of Brăila and Tulcea, this limitation is easy to detect, and it is associated with the high degree of homogeneity of the rural spaces, in these two counties. The delineation of the functional regions is also particularly interesting in the proximity of the large Romanian cities – the capital, Iași, Cluj-Napoca or Constanța, where the different economic and demographic dynamics of the metropolitan areas are captured by the resulted spatial units. In the case of Constanta, for example, the rural LAU functionally gravitating around the metropolitan core are divided in two potential FRA, one to the north and one to the south, indicating different patterns of the rural space organization. The same situation is visible at the scale of Iasi metropolitan area, where the opposition is dictated by the differences between the western rural areas and the eastern ones.

Eliminating the rural LAU to be included in a future metropolitan area was an opportunity to test the model on the Romanian rural space, a territory less intensely polarized by medium and large cities. In this case, the implementation of the delineation algorithm was applied on the second version of the spatial pattern, a version that is functional only for the rural space post the metropolitan reform.

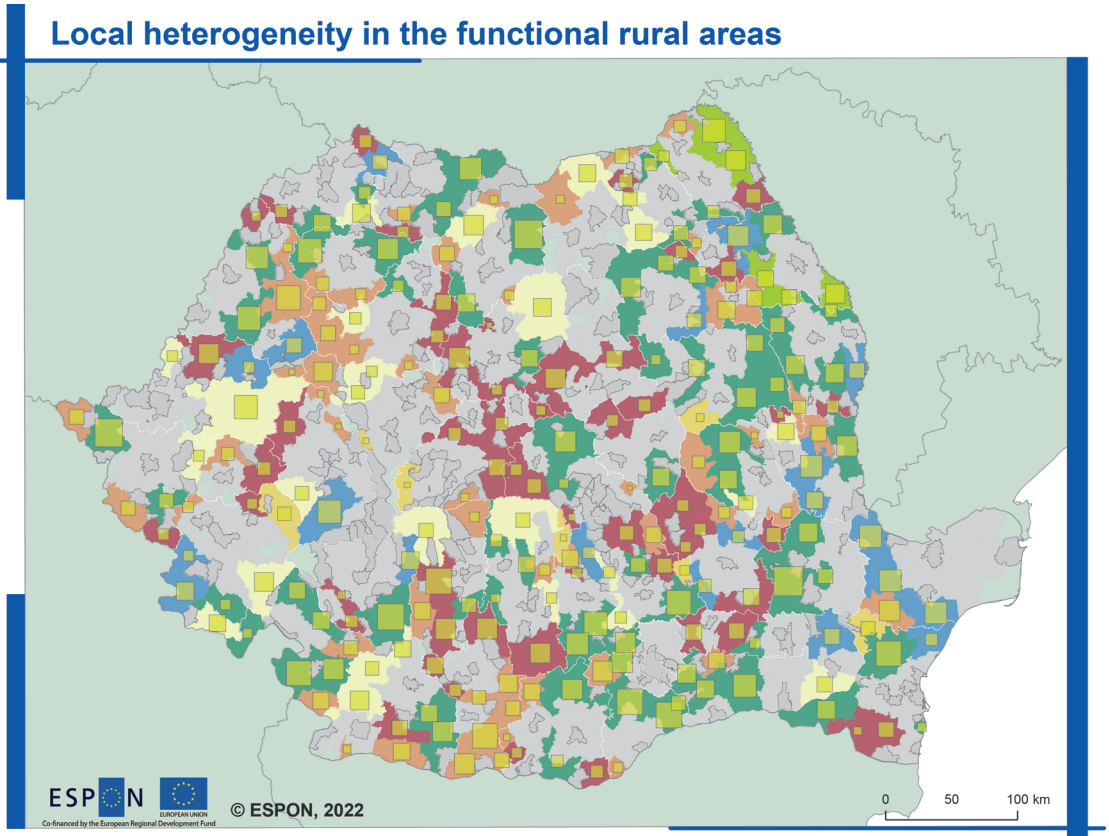


Map 21 Output of the functional rural areas' delineation method – version 2

The exclusion of a large set of rural LAU created a spatial pattern with a reduced average connectivity. Moreover, the geometry of the proposed metropolitan areas creates spatial and territorial discontinuities in the rural areas, impossible to overcome. Such is the case for the LAU C.A. Rosetti and Sfântu Gheorghe, in the county of Tulcea or Poiana Stampei, Panaci and Ostra, in the county of Suceava. These rural LAU are located in a particular spatial context that denies their linkage to other rural LAU. Finally, we have detected 34 such situations, representing about 1.8% of the total rural population available in the study area. This amount is a constant and it does not depend on the number of functional rural areas delineated (200, 240 or 320, for the three working maps created).

Despite the technical inconvenient described, the delineations obtained represent the solutions for the regionalization problem imposed by the nature of the project, respecting the set of constraints built for the task – spatial contiguity, territorial belonging, a limited and sound set of indicators. In these conditions, one map deserves more attention – the version that creates 240 functional rural areas. From a demographic perspective, the functional regions created are relatively similar, almost 70% of them ranging between 10.000 and 40.000 inhabitants, in 2020. The functional rural areas with more than 50.000 inhabitants represent rather a marginal case, being located in areas with high densities of rural population. If we take into account other indicators, like the financial absorption from the state-budget funded programs, 49.6 % of the functional rural areas have a limited experience (maximum 120 000 000 RON by FRA), while the other half will present values that reach a maximum of 480 000 000 RON. However, only one indicator describing the financial capacity was included. In reality, given the multiple frames of programming, this experience is considerably larger.

The final version retained as the most appropriate proposal for the delineation of Romanian functional rural areas was tested for local heterogeneity, Given the spatial distribution of the indicators values and the scale effects induced by the administrative frame (NUTS3), it is normal that a certain degree of local heterogeneity exists. In a multi-variate context, measuring this parameter is relatively simple, when the data allows the implementation of a decomposition of the statistical variance. Our approach followed his principle, but our intention focused more on the visualisation of the role played by the chosen indicators in the creation of the local heterogeneity. For example, we wanted to establish what contribution has the demographic density in the apparition of local differences, at the scale of each functional rural area.



Indicators \ Classes	1	2	3	4	5	6	7
Altitude	LOW	LOW	LOW	MEDIUM	LOW	MEDIUM	LOW
Density (2020)	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH
Distance to the nearest NUTS3 administrative centre	LOW	MEDIUM	MEDIUM	LOW	LOW	LOW	LOW
Relative demographic growth (2011-2020)	LOW	MEDIUM	LOW	LOW	LOW	LOW	LOW
Funds absorption (2019)	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH	HIGH
Funds absorption/inhab. (2019)	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH	HIGH

Map 22 Assessing the local territorial heterogeneity at the scale of the potential functional areas

Detaining an image of the local heterogeneity involved the use of a grouping analysis (k-mean multivariate classification) based on the coefficients of variance of each indicator, calculated for all the functional rural areas. The output of the classification clearly indicates that the most important factor that creates local differences is the **funding absorption**, either in gross or relative (per inhabitant) values. Three classes of the typology (5, 6 and 7) underline the importance of this indicator for the future functionality of this intermediate geometry.

The main policy suggestion is to focus more on the factors that lead to an unequal attraction of the financial instruments, taking into account the intense local similarity of territorial challenges and opportunities, in many of the functional rural areas. The heterogeneity introduced by the funding absorption is even more inquiring, when the level of involvement in inter-communal cooperation forms is taken into consideration. With very few exceptions - 5 potential functional rural areas from 33 composing the classes 5, 6 and 7, all the LAU participating into the delineation V2 have a sound experience as members into a LAG (Local Action Group). The local heterogeneity related to the financial indicators is expressed by contrasting val-

ues of the funds absorption. For example, in one functional rural area located in the north-west of the Constanta county, the ratio between the highest level of absorption and the smallest one is 56 to 1.

The second indicator creating local heterogeneity is the **demographic density in 2020**. The large values affect again the classes 6 and 7, associated with territories with geographical specificities (mountain areas, for example). This could explain why the distributions of densities are heterogeneous, as the local habitat system forms patterns resulted from adaptations to local conditions. The uneven ratios of densities within a functional rural area are a potential challenge for the proper prioritization of the potential projects, at local scale. In order to be functional or sustainable, many infrastructures and assets of territorial endowment rely on the demographic masses available in an area. More investigation is needed in order to understand if the contrasting densities are the result of an unbalanced population distribution, or it is just the output of the local presence of some demographic outliers.

The contribution of the **demographic evolution** to the local heterogeneity is interesting because it is responsible on the creation of a functional rural areas group – class 2. This group has a concentrated spatial presence in only two NUTS3 regions, Botoșani and Iași, both from the North-East NUTS2 Region. Many elements composing this group are in a particular geographical situation, sharing border with the Republic of Moldova or Ukraine. As the indicators taken into account for the elaboration of the relative demographic evolution are measured using the population by address and not by usual residence, the local heterogeneity can be explained. Our recommendation is to maintain this type of indicator in further studies, despite its inherent limitations created by fluctuations in the LAU migratory balance (positive or negative). The apparition of the demographic local heterogeneity suggests the installation of demographic trends and these trends can be integrated in relevant policies.

Defining the typologies for functional rural areas (V2) helped us to better understand what role each indicator is playing in the evaluation of the local homogeneity, for each spatial unit included in the delineation. At the same time, one can detect which are the rural areas that can be considered homogeneous, using the delineation proposed by our research. From this perspective, the local homogeneity is much more present in the cases of classes 1, 5 and 7, classes that register the highest number of low heterogeneity labels. These three types of functional rural areas cumulate 137 spatial units. At the opposite, the class where the indicators retained for the delineation are more contrasting, at local scale, is the class number 2 (only 6 spatial units in 240 created). The rest of the territorial types created by the mapping output are in an intermediate position, with different patterns of low, medium or high local heterogeneity.

Assessing the degree of internal homogeneity was a necessary step in validating the delineation proposed for the functional rural areas, the working version based on 240 spatial units. It also presents interest for policy design because it facilitates the grouping of functional rural areas using a common frame of problems identification – rural density, funding absorption, demographic evolution etc. This cartographic evaluation of the methodological outputs is also an indirect measure for the performance of the chosen algorithm.

Further application of the methodology: a first trial in a bigger territorial context

According to the recent developments in the exploration of the concept of functional rural areas, two possible ways of investigations are opened – the first one partially based on the instrumentalisation of the methodology applied for creating FUA (Dijkstra, 2022), the second one encompassing a different set of definitions, more in the spirit of the Polish experience (The National Spatial Development Concept 2030 in Poland). Given the methodology implemented and the results obtained from the analysis, the delineation proposed by this research is more similar to the second approach, with some inherent limitations.

	Recent developments proposed by Dijkstra et all (2020)	**Technical implementation proposed by the delineation of the functional rural areas in Romania**
Main logic of the delineation	Potential spatial Interactions calculated as distances to the nearest services providers. Supplementary targets are added to the algorithm: target population, maximum time for catchment areas etc.	A multi-variate analysis with spatial constraints. The main objective is to exploit a similarity index in order to create homogeneous groups of LAU. The number of potentials functional regions are dictated by the user. Given the statistical distribution of the similarity index, a cut-off value can be

		implemented, in order to control the local homogeneity of the output.
Main limitations	The quality of the network and the quality of the services providers spatial datasets are problems of major importance. For example, missing elements from the services dataset can lead to unstable results. The road classification can also interfere with the final output, especially in contexts of high uncertainty. No limitation concerning the spatial and territorial constraints. The catchment areas can be build using NUTS3 barriers, even if these barriers will affect the population targets.	Building the similarity index demands some compulsory steps: choosing uncorrelated indicators, dealing with the missing values, options regarding the formalization of the statistical distance etc. Also, fixing a specific number of spatial units, instead of a target deduced during the algorithm implementation, demands an expert opinion regarding the result. There is a possibility to overcome this limitation, but the process is much more time demanding as it includes an optimization phase.
Interest for policy design	The method puts a clear emphasis on the territorial issues related to services accessibility and local centrality, at the scale of the rural spaces. The policies will be eventually related to the emergence of a functional layer of rural poles of local attraction.	The algorithm targets for the delineation of a set of spatial units characterized by local homogeneity, measured from different perspectives. At the local scale of the rural space, it does not ignore the accessibility to services issues, it just considers them another variable in the construction of the similarity index. The policy design and the relevant scientific findings might need to be judged having in mind that the delineation reflects the input indicators. The results of the delineation process are useful as a frame of reference for an operational geometry in planning and as a support for finance programming.

Table 7 The functional rural areas - two possible ways of investigation

Both methods and delineation directions of study can be extrapolated to larger areas, if the access to data is not a barrier. A preliminary attempt to check for the potential of extrapolation to other states was implemented, but the results are for pure illustration purpose.

The case study area is limited to Poland, Czech Republic, Slovakia, Hungary and Romania. The number of indicators was reduced to 4: (1) density of population in 2018 (LAU scale), (2+3) distance to the transportation corridors (highways and national roads) and (4) distance to the nearest city with more than 50.000 inhabitants.

The workflow was identical, involving the calculus of the similarity index, the construction of the similarity graph and the detection of a large number of functional areas (2000 functional regions were supposed to aggregate 17999 LAU, from the 5 mentioned EU states). Using the same constraints of contiguity and NUTS3 belonging, one will observe that the size and the shape of the resulted functional regions need to be optimized. The differences in size are explained by the fact that, at LAU scale, the analysis will face a large variety of situations, from one state to another. For example, the delineation algorithm works correctly on Romania and Hungary (similar LAU geometry), but provides some unreliable results in Slovakia, for example. These technical problems can be overcome, and the model has many chances to be refined, but the optimization demands more time for the detection of all the potential problems interfering with the algorithm (topology check for contiguity, scale harmonization between the LAU frame and the NUTS3 frame and missing data problems). In this example, the LAU with urban functions were included in the modelling process and this aspect has an impact on the shape of the functional regions created as map output.

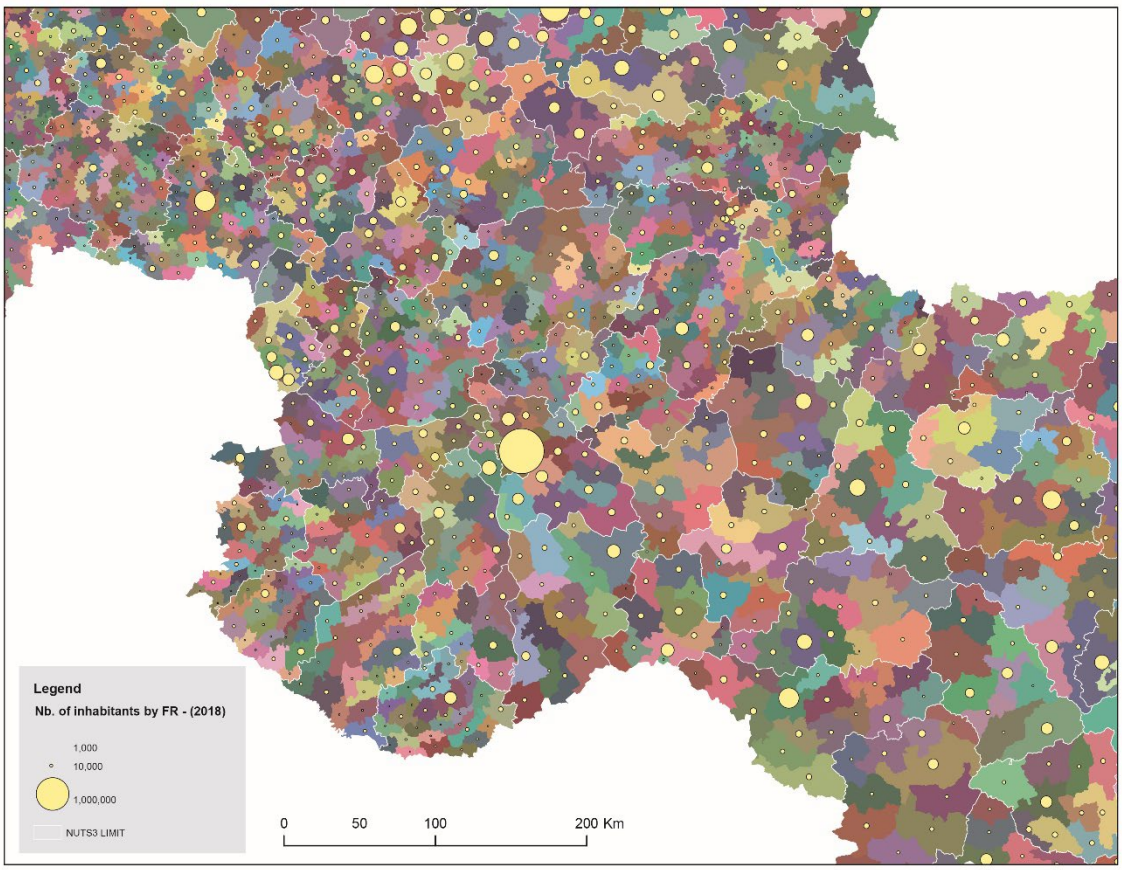


Figure 6 A draft illustration of the delineation method applied to selected states from Eastern Europe

5 Conclusions and policy recommendations

The study dedicated to the delineation and observation of the functional rural areas in Romania has inherent imperfections due to data access, methodological options and the implicit intention to avoid doubling other research already implemented. The set of conclusions and recommendations proposed in this final part is also limited by the impossibility to predict the general context in which the European rural areas will evolve in the near future. The challenges in the Eastern EU border, combined with the economic turbulences and with the recent natural resources crisis are elements of concern for the policy design. What place is to be left for the rural areas in this design? Our opinion is that it shall occupy a central position, at least as central as the cities did. In the particular case of Romania, this importance for the policy makers can be obtained using a set of instruments dedicated to a better balancing between capitalising rural opportunities and countering the effects of the territorial disadvantages/disparities. The analysis of the economic dimension of the rural LAU shows that the diffusion of the innovations (companies, for example) is systematically altered by different territorial barriers, even in areas where many forms of local economic potential can be mobilized.

The same part of the study showed that the emergence of some spectacular agricultural specializations, like the wheat belt in the Romanian Plain, passed almost unobserved for years. This specialization functions in parallel with traditional forms of agricultural exploitation, less productive and with an erratic market integration. Some of the rural communities are facing severe problems in terms of access to the cities, partially explaining their demographic decay, but others manage to become proactive communities that implement a large variety of projects and attract funds. The maps, the graphs and the analysis proposed underline this double status of the Romanian rural areas. In this case, the most ambitious plan for a sound set of policies and interventions is to systematically reduce the accumulation of territorial disparities, at local scale, promoting at the same time measures to encourage the mobilization of the local capital (natural, social or demographic). This general objective has many more chances to be achieved, if two settings for the policy interventions are prepared and planned: the chronology of the interventions and its spatial corollary, with a timeline detailing their sequence and location within the functional rural areas.

Both the literature and the methodological investigation show that the Romanian rural areas display a double functionality, one endogenous - based on the local homogeneity of multiple demographic and economic indicators, and second, exogenous - derived from the asymmetric spatial interactions between the rural LAU and the urban system. The elements of endogenous functionality are not always able to mobilize resources and capital for priority interventions, such as new forms of local cooperation between the economic actors, improve accessibility to services or create new pools of services providers, long term policies for agricultural land management and protection. The exogenous functionality presents a set of risks that are systematically associated with the economic extroversion of the rural areas – economic drainage of the local financial resources, inflexible market dependency or unsustainable pressure on the ecologic and natural capital.

Counterbalancing these risks is an intrinsic objective of the functional rural areas viewed as a planning instrument. However, their performance will be strengthened if the administrative units included in the functional rural areas will have the capacity to share their different resources – experts, experience in project management, the ability to attract funding and the local know-how in the economic specializations. This horizontal form of local cooperation needs a clear support at higher levels of decision and policy design, especially in matters concerning the budgets allocated to the functional rural areas. For reasons of legislative coherence, the financial aspects regarding the economic sustainability of the functional rural areas are easier to manage, if they are placed on the coordinates proposed by the law defining the Romanian metropolitan areas, with adjustments regarding the financial quotas and circuits. From a technical point of view, the functional rural areas need to respond to a set of clear requirements:

- ensure the emergence of new forms of local cooperation between different actors, at local scale. These forms of cooperation can touch multiple fields of action – economic association between economic actors, administrative sharing of expertise and common participation to relevant projects etc.

- define clear objectives for funding, responding to local priorities. For example, in the rural areas with low to sever access to services, there is a need to eliminate this territorial disadvantage by well targeted projects, with clear and measurable objectives. Recording the share of the rural population with an improved access to services of general interest is a potential way to quantify the territorial impact of the implemented projects, in the future.
- ensuring the predictability of the funding and a transparent budget allocated to the functional rural areas are topics of major importance, but the management of these two points is already framed by legislation. However, increasing the transparency on the budget is possible using dedicated tools - media and social-media dissemination, participatory governance or systematic surveys.

The analysis of the functional rural areas in Romania allowed us to elaborate 5 general policy recommendations.

(I) The first one focuses on the pragmatic preparation of the FRA following a geographical scale of intervention. Different studies and the results of our research highlight that the functional rural areas should be integrated in the policy design as a comprehensible representation of the usual pool of activities for the rural communities, a space of local interactions and shared similarity. In this case, the next interventions should focus more on the functional rural area as a *geographical entity* and take some distance from the former policies regarding the rural spaces. These former policies used to prioritize infrastructures development, services installation or reinforcing the local economic actors, in the rural territory. The sectorial approach makes sense in a coordinated frame of actions, but we see that this coordination will be more and more difficult, as the challenges that the EU territory faces become more and more complex. Using the available financial instruments, the functional rural areas have the capacity to mobilize the experience in local projects' management and to apply for relevant local objectives, using a set of common priorities for the definition of these objectives. Expressed in a simpler way, the emergence of the functional rural areas is an excellent opportunity to enable cooperation between local decision makers.

(II) The second recommendation explores the possibility that the functional rural areas become an experimental ground for new local governance models. The collaboration networks surfacing in the functional rural areas will need to link the local expectations of the citizens with the upper levels of decision (NUTS3, NUTS2). In this scenario, betting on their mass (demographic, economic and voting pool), this transfer will be smoothed, and the elaboration of relevant local policies will turn into a common exercise. Exercising new forms of local governance is already an asset of the potential functional rural areas, as many LAU already are part of a Local Action Group (LAG). However, the size and the shape of these forms of territorial cooperation might not be appropriate for framing new policy interventions, as their territorial homogeneity is questionable. Participating in a LAG and in a future functional rural area is a good opportunity to reinforce the networks of horizontal territorial cooperation, at the scale of the rural LAU. Derived from these considerations, we want to emphasize that the *de facto* conditions for a performing local governance are related more to creating sustainable collaboration links and interactions and to a lesser extent on the *survival* of the actors that are only nodes in this network. The experience of the French *pays* is a good example on how the inter-communality networks of collaboration stay resilient and active, despite the multiplication of reforms in the field of planning. The functional rural areas are an excellent opportunity to test this hypothesis.

(III) The third recommendation addresses the need to elaborate adaptive policies that mitigate territorial disadvantages, in rural areas. The analysis of the economic situation and territorial functionality in the rural LAU invites to a reflection close to the theoretical frames of the critical social sciences, more precisely in terms of spatial intersectionality. When the territorial disadvantages associated to accessibility issues, demographic decline and slow diffusion of social and technical innovation overlay, objectives like promoting the equal opportunities and chances, at local territorial scale, become systematically more and more difficult to achieve. This punctual accumulation of territorial disadvantages creates a territorial frame where the disparities between rural and urban LAU and communities increase, making almost impossible the implementation of a sound policy of territorial cohesion. Consequently, testing measures and tailored policies to counter the cumulative manifestation of the territorial dis-

advantages has supplementary chances to succeed in the potential geometry of the functional rural areas. Accessibility and mobility remain at the core of the rural territorial marginalization. As these issues display spatial autocorrelation and clustering at local scale, it is natural to consider that the potential solutions should also be imagined at intermediate scales of action, lower than the NUTS 3.

(IV) The fourth recommendation is related to developing a monitoring system of rural economic performance, following the model of the Territorial Observatory deployed by the Ministry of Development. The quantity of information that can be mobilized in this purpose is considerable: like the future results of the Romanian Population Census, the Agricultural Census, the yearly databases of various ministries and agencies, etc. A part of this information is already linked to a spatial and administrative reference, providing key findings and relevant information. In the hypothesis that the functional rural areas will be conserved in the geometry expressed in the V2 version (240 spatial units), aggregating the available and future indicators in this territorial frame will give access to the trends and the dynamics of the rural spaces, in a simplified but sound format. In this research, only a limited approach of this data aggregation was tested (population size of the functional rural areas in different versions and local financing by planning programmes). This monitoring tool can also function as a counterweight to the analysis of the future metropolitan areas, a topic for which adapted methodologies and research already exist.

(V) The final recommendation addresses the basic foundation of the rural economy, the agriculture. Comparable to the case of the macro-demographic structures, the agricultural specializations remain stable overtime, in their major coordinates (land pattern use, economic orientation of the exploitations, land pressure and land transactions). The changes in the leading structures of the agricultural organization derives from market constraints and adaptations, including the way in which the natural opportunities (natural local capital) are capitalised. The conclusions of this analysis that tried to project the sustainability of the rural areas in the future, at least from the perspective of the challenges induced by the climate change, are not so pessimistic. It is clear that these changes will have an impact on the local patterns of agriculture, but with policy interventions and a sound framework of collaboration between different decisional actors, the negative consequences can be mastered or eliminated. Again, the scale of the intervention will vary. Some of the negative effects will be macro-regional, demanding national responses. In other cases, the NUTS2 scale will be more appropriate – countering some aggressive forms of soil erosion, for example. We consider that one interesting attribute of the functional rural areas in Romania stays in its capacity to promote multiscale territorial collaboration, linking the national policies to the regional ones, especially in this context. The diversification of the economic activities in the functional rural areas is the second component of this final recommendation. This diversification should first take into account a sound support to the economic activities linked to the local agriculture specialization – storage spaces, basic industrial transformation of the raw products, repair and maintenance etc. All these auxiliary activities have an impact on the functionality of the agricultural specialization and their interruption or absence put at risk the local economic performance. Some other forms of economic diversification are also possible, but they demand a good correlation with the distribution of more concentrated resources – touristic attractions and green energy potential, mainly.

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