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Rural Attractiveness Index and Its Visualization as Tools to Support Local and Regional Decision-Making

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Abstract

Promoting rural regions is crucial for societies all over the world. Prosperous and vital rural regions can contribute to solving many pressing problems that threaten humanity, such as climate change, poverty, hunger, health or clean energy. The attractiveness of rural regions can be improved through targeted measures and support. For the design of such targeted interventions, high-quality assessments of rural attractiveness can provide a solid information basis. However, the attractiveness of rural regions is a complex construct and therefore difficult to assess. Thus, in this paper, we present tools for the assessment of rural attractiveness that address these complexities and support use and interpretation of the results of rural attractiveness assessments by stakeholders: First, we develop a Rural Attractiveness Index (RAI) which provides a general blueprint for assessing rural attractiveness, yet still is flexible and adaptable to each specific context. As integrated measure of rural attractiveness it also facilitates interpretation by stakeholders. Second, to further enhance interpretation and communication, we propose to visualize the RAI in map-based form. We demonstrate the application of these tools through an illustrative showcase in a European context. We discuss strengths, limitations and challenges of the presented tools and highlight directions for future research.

Keywords

Rural regions, rural attractiveness, thematic map, spatial analysis, clustering, spatial data.

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Introduction

Today, 28% of the total European population lives in rural areas (Perpiña Castillo et al. 2018). Maintaining or creating prosperous and vital rural regions can help address many burning issues facing humanity, such as climate change, poverty, hunger, energy transition, agricultural self-sufficiency, and halting or reversing the prevailing trend of urbanization. Yet, rural areas are often less developed and offer less potential than more urbanized territories, i.e., they are often less attractive than urban areas as places to live and do business. Improving the attractiveness or rural territories to retain existing residents and business and attract new ones is therefore essential for rural areas to become or remain vibrant and to fulfil their functions.

The attractiveness of rural regions can be improved through targeted measures and support. For the design of such targeted interventions, high-quality assessments of rural attractiveness can provide a solid information basis. Indeed, interest in assessing the attractiveness of territories, especially of rural territories, has increased recently (Melece et al., 2020).

However, assessing rural attractiveness in quantitative terms is challenging, on the one hand, because of the complexity of the concept of rural attractiveness (Eimermann, 2015; Grieve et al., 2011; Dax et al., 2018). Its exact meaning and composition depend on the time-frame (Argent et al., 2007) and geographical scale (Russo et al., 2012) for which it is assessed as well as on the kinds of individuals to which a region is supposed to be attractive (Argent et al., 2007; Russo et al., 2012; Lysgård et al., 2013; Détang-Dessendre et al., 2008). Thus, the exact meaning of rural attractiveness is always context-bound. Another challenge is that rural attractiveness is composed of a variety of factors. Thus, its assessment generates a large amount of disparate data that is

difficult for individuals to process and interpret.

In this paper, we present tools for the assessment of rural attractiveness that aspire to address these challenges: First, we develop a Rural Attractiveness Index (RAI) which provides a general blueprint for assessing rural attractiveness, yet still is flexible and adaptable to each specific context. Therefore, it can potentially be used to assess rural attractiveness for any set of regions Additionally, it facilitates interpretation and understanding by integrating the large amount of information generated in rural attractiveness assessments into a single at-glance overview of a region's attractiveness status (Foa and Tanner, 2012). It is important to note that the RAI is meant to be a tool to facilitate local or regional decision-making for rural development, adaptable to the different necessities of such decision-making contexts. It is not an "objective" index for global comparison and ranking – and cannot be because the concept of rural attractiveness is always context-dependent.

Second, to further enhance interpretation and communication, we propose to visualize the RAI in map-based form as maps are an ideal graphical tool for such purposes: They are able to communicate complex data in a simple, clear, comparable, understandable and attractive way, making them "perfect interfaces between geoinformation and human users" (Gartner, 2014).

We demonstrate the application of these tools through an illustrative showcase in a European context. Thus, the results presented this article only show one possible example the use of the RAI and its visualizations. These results were meaningful for the specific context in which they were produced but apart from that mainly serve demonstration purposes.

Accordingly, the article is structured as follows: The next section presents our theoretical framework for the RAI and thus for assessing rural attractiveness. In the Materials and Methods section, we shortly introduce our showcase in the context of the EU-funded Horizon 2020 project PoliRural, in which the authors were directly involved. Afterwards, we describe the methods and data needed to create the Rural Attractiveness Index and its visualizations, both in general and in more detail how these steps were implemented in our showcase. In the Results section, we present and explain for the sake of illustration the visualizations of our showcase. Before drawing our final conclusions, we discuss the strengths, limitations, and challenges of our approach as well as opportunities for future development.

Materials and methods

Towards an adaptable framework for assessing rural attractiveness

Rural attractiveness is often associated with various aspects of quality of life and living conditions in rural and peri-urban areas. Issues related to rural attractiveness have been the subject of research in a variety of fields. The research contexts in which the concept is most frequently instrumentalized are counterurbanization / urban-rural migration (Eimermann et al., 2015; Argent et al., 2007; Détang-Dessendre et al., 2008; Pettersson, 2001; Vuin et al., 2016), (rural) tourism (Vuin et al., 2016; Van Huylenbroeck et al., 2006; Puška et al., 2020; Świdyńska and Witkowska-Dąbrowska, 2021), and regional development (Grieve et al., 2011; Argent et al., 2007; Russo et al., 2012; Lysgård et al., 2013; Brereton et al., 2011; Scott et al., 2011; Lange et al., 2013; Živković et al., 2015; Straka and Tuzová, 2017). Rural attractiveness is a relevant and useful concept also in research about economic issues of territorial marketing and investment (Eimermann, 2015; Hamri et al., 2014; Barborič et al., 2018) as well as for social issues such as rural social innovation or rural gender studies (Lindberg, 2017; Vidickienė, 2017).

However, a number of these works do not directly target rural attractiveness but refer to very closely related concepts such as rural idyll (Pettersson, 2001; Eimermann, 2015), quality of life (Brereton et al., 2011; Grieve et al., 2011), territorial attractiveness (Servillo et al., 2012; Hamri et al., 2014; Živković et al., 2015; Barborič et al., 2018), or rural touristic attractiveness (Puška et al., 2020, Świdyńska and Witkowska-Dąbrowska, 2021), to name a few.

Commonly, rural attractiveness is described to be a complex and multi-faceted concept for which there is no single, universally applicable definition (Melece et al., 2020; Argent et al., 2007, Russo et al., 2012; Lysgård et al., 2013; Barborič et al., 2018; Świdyńska and Witkowska-Dąbrowska, 2021). This is due to the fact that the exact meaning of rural attractiveness depends on a variety of contextual factors: What is considered relevant in determining rural attractiveness depends on

1. the time-frame: The characteristics that determine the attractiveness of a place are different for a short-time visit than for a long-term change of residence (Argent et al., 2007).
2. the scale: When rural attractiveness is

considered at the level of a village, some aspects may be different than when rural attractiveness is to be assessed for a larger region (Russo et al. 2012).

3. the stakeholders: Which features are considered relevant for the attractiveness of a rural area depends on the characteristics of the individuals for whom a territory is supposed to be attractive, on their life stage, family constellation, type of occupation, socioeconomic status, health status etc. (Argent et al., 2007; Russo et al., 2012; Lysgård et al., 2013, Détang-Dessendre et al., 2008).

In addition, the attractiveness of rural areas is not an absolute quality, but a relative one, and can only be determined in comparison to other regions. That is, a territory may become more attractive simply because other territories nearby have become less attractive (Russo et al. 2012). Given these characteristics, any assessment of rural attractiveness can only provide results that are specific to the context and relative to the territories assessed. Absolute or objective assessments of rural attractiveness are not possible!

Because of this variability and relativity, previous publications have proposed and applied a wide variety of indicators for rural attractiveness. Some of these studies consider or evaluate rural attractiveness and its related concepts rather comprehensively (Russo et al., 2012; Servillo et al., 2012; Živković et al., 2015; Barborič et al., 2018). Additionally, only few studies tried quantifying rural attractiveness; and those that did considered only very few aspects of this multi-faceted concept or did not create an integrated overall measure (Russo et al., 2012; Vannoppen, 2021).

While there are few similarities among the specific sets of indicators used in previous studies, there is notable overlap in the general categories into which many authors divide their indicators. Not all publications cover the same aspects, and in some publications the categories are ordered differently than in others. Yet, overall, a picture emerges of general categories relevant to rural attractiveness. Our framework for assessing rural attractiveness consists of the following general categories: social, natural, economic, institutional, cultural, anthropic.

This framework is the basis for an assessment approach that is adaptable to different contexts: On the one hand, it determines which categories are generally relevant for assessing rural attractiveness and thus helps to guide the selection of indicators to measure rural attractiveness. On the other hand, it does not prescribe concrete indicators or even the inclusion of all of the proposed categories. Rather, the selection of concrete indicators can be tailored to the specific context in which rural attractiveness is supposed to be assessed, e.g., in the context of a decision-making process for a (set of) specific regions. To adapt the RAI to the requirements of each situation, the relevance and relative importance of all categories must be evaluated – ideally through stakeholder engagement. If a category is found to be relevant, suitable indicators need to be selected to represent this category. Selection criteria for these indicators are their conceptual fit with the RAI category and their relevance to the context of the rural attractiveness assessment (i.e., its time frame, geographical scale, and stakeholders).

Assessing rural attractiveness with the Rural Attractiveness Index

Data mining

In project PoliRural, we needed datasets covering all of Europe and Israel. Therefore, an extensive search for relevant data was conducted in open databases such as those of Eurostat, World Bank or EEA. We mainly aimed to collect data at the NUTS 3 level. NUTS regions are the statistical units used in Europe, based on the administrative regions of the respective countries. NUTS regions are also comparable in terms of their number of inhabitants (e.g., NUTS 3 corresponds to 150 000 to 800 000 inhabitants (Brandmueller, 2017). However, some relevant information was only available at higher levels, up to NUTS 0 (level of an entire country).

Another option would have been to replace administrative boundaries with homogeneous, non-overlapping area units (so-called grids) (Kowalczyk et al., 2019). We opted for using administrative units for three reasons: (1) Input data provided by statistical organizations are primarily available for administrative units. However, it is possible to recalculate these data for individual grid cells (Sládeková Madajová and Hurbánek, 2016). Nevertheless, this calculation is quite demanding and challenging and puts limits to automated calculations required for example for interactive applications. (2) Grid-based attractiveness assessment is computationally very demanding and would require special hardware or software optimization, which is contrary to the capabilities and needs of the target research group.

(3) If a grid is used, there would be a significant bias in attractiveness values where the cells are crossed by boundaries that sharply separate the input data values.

The data for Israel were obtained from national resources of Israel. However, not all required indicators could be covered by suitable data. For this reason, the maps in the results section (Figures 1 through 3) do not cover Israel.

Data selection and harmonization

For the PoliRural project, 37 data sets were selected as input data for the development of the Rural Attractiveness Index and the visualizations (Figure 1). Decisions about the effect (positive or negative) of each data type on the RAI were largely based on common sense. Because of its preliminary nature, our showcase assessment has some limitations: The datasets were selected solely by researchers, without involvement of the stakeholders; and although we used the best data available to us at the time, not all of the selected datasets meet the highest standards of quality and diversity.

Calculation of the Rural Attractiveness Index (RAI)

Before the selected data are transformed into the composite RAI, stakeholder input is again essential: to reflect stakeholder perceptions and preferences, stakeholders need to discuss and decide whether the different dimensions of rural attractiveness are of equal or different importance to them, and if necessary, assign appropriate weights to the different dimensions. Here, stakeholders may also agree to disagree and draft a number of different sets of weights for the dimensions to reflect and explore different viewpoints in the rural attractiveness assessments rather than forcing consensus (Scott et al., 2011; Lysgård et al., 2013). The RAI is then calculated as weighted mean of the data on the different dimensions according to stakeholder preferences (Formula (1)). This means all datasets pertaining to the same rural attractiveness dimension are included with the weight of this dimension.

$$RAI = \frac{\sum_{i=1}^{n} w_i \cdot x_i}{\sum_{i=1}^{n} w_i}, \quad (1)$$

n - number of input dimmensions

w - weight of particular input dimmensions

x - normalized values of input dimmensions

In our preliminary assessment, the weighting of the different factors was determined through a user survey. In this survey, PoliRural stakeholders were asked to indicate on a scale from 1 (low importance) to 3 (high importance) how important the different dimensions of rural attractiveness were for them. The survey was conducted using Mentimeter (mentimeter.com), posted on social media (Facebook, 23 responses), and distributed at a PoliRural consortium meeting (18 responses). The RAI was calculated accordingly as weighted mean using R software.

Visualising the results of the rural attractiveness assessment

The data were divided into nine intervals constructed using the Natural Breaks methods (Jenks and Caspall, 1971) implemented in QGIS. The implementation of these intervals resulted in a high TAI (Tabular Accuracy Index) of 0.86, which means that this map, including the Natural Breaks data classification, is the most accurate map for the users.

Additionally, we chose the choropleth map as the cartographic interpretation technique as it is one of the simplest and most understandable methods for developing thematic maps. For these maps, we used Lambert equal-area projection to visualise undistorted areas, which are crucial for the representation of thematic information like RAI values. All map-based visualizations use areal cartographic symbols (NUTS 3 regions) for which the spatial data in scale 1:10M and ESRI shapefile format were downloaded from the official Eurostat database.

While mapping the values of RAI focuses on highlighting differences between territories, cluster analysis is able to identify groups of regions that are similar in terms of their rural attractiveness. For the cluster analysis, hierarchical and non-hierarchical clusters methods are viable methods (Jain et al. 1999).

In our showcase, we used the Silhouette method (Rousseeuw, 1987) to indicate the optimal number of clusters. In this method, the number of clusters whose silhouette coefficient is closest to 1 should be chosen. In our showcase, it indicated ten clusters as the optimal number of clusters for our input data.

We tested both hierarchical and non-hierarchical clustering methods as well as different input parameters (types of distance, clustering algorithms). The final parameters were selected based on literature (Jain et al. 1999, Abu Abbas, 2008, Ferreira and Hitchcock, 2009, Singh et al. 2013, Sinwar and Kaushik, 2014, Mohibullah

et al. 2015) and tests with samples of the input data. Euclidean distances were used for all distances used in clustering and imputation. They correspond to the classical understanding of space and distances in geography and cartography (Abu Abbas, 2008; Ferreira and Hitchcock, 2009; Singh et al., 2013, Sinwar and Kaushik, 2014; Mohibullah et al., 2015). Both the literature and the results of the initial test runs pointed to two clustering algorithms that were most appropriate: non-hierarchical clustering with k-means method and Lloyd's algorithm (Abu Abbas, 2008; Murtagh and Legendre, 2014), and hierarchical clustering with Euclidean distances and Ward's option clustering criterion (Lloyd, 1982; Ferreira and Hitchcock, 2009). Hierarchical clustering proved to be most suitable.

We used a qualitative color scheme for the creation of map-like representations of the clusters: The different color shades only differentiate the clusters and are not associated with any order or meaning.

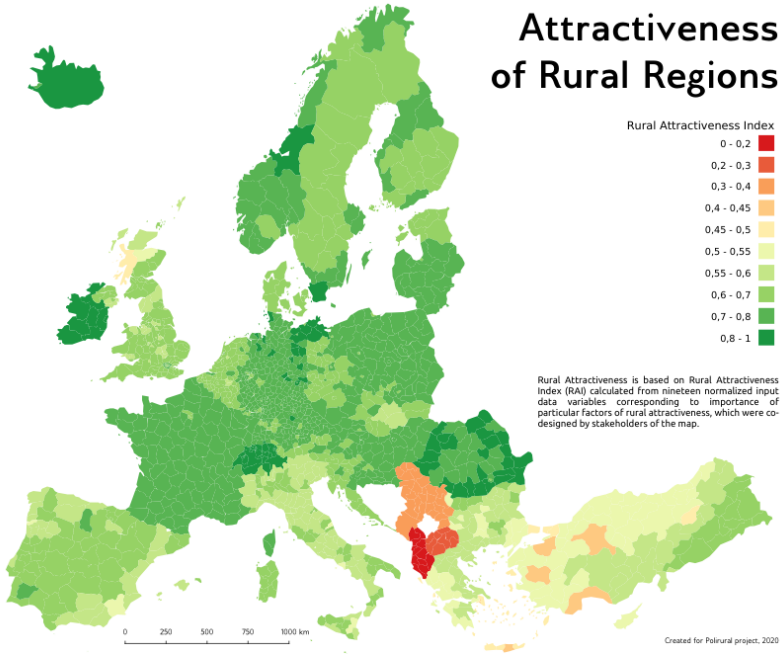
Results and discussion

In this section, we present the outcomes from the showcase application of our approach in the PoliRural project. These results and the illustrations based on them serve illustrative purposes only. Additionally, the presented visualizations only show a few possible ways to visualize rural attractiveness data out of many.

Rural Attractiveness Index values map

The map-based visualizations in Figure 1 through Figure 3 show the RAI values and cluster maps resulting from our showcase rural attractiveness assessment for the PoliRural project based on our framework. Figure 1 shows the RAI scores in NUTS 3 regions in Europe. In our example, the highest attractiveness scores are less associated to regions with increased agricultural activity and more associated with places with a high proportion of pristine nature but also low unemployment rates and good education, such as Sweden or Austria. This spatial pattern is due to the multi-factorial concept of rural attractiveness, which takes into account a variety of aspects. The areas in white could not be properly assessed due to a high share of missing data for these territories.

It is important to note that due to the heterogenous ways of defining rural areas (Jonard et al., 2009; Perlín, 2010; Pászto et al., 2015; Dijkstra et al., 2021), deciding which geographical areas are truly rural and which are not is highly controversial and may even fail to capture existing complex patterns (Hodge and Monk, 2004). Therefore, even maps displaying rural attractiveness may report RAI values for all parts of an investigated territory. For this reason, our maps show the values of RAI for all regions in Europe.

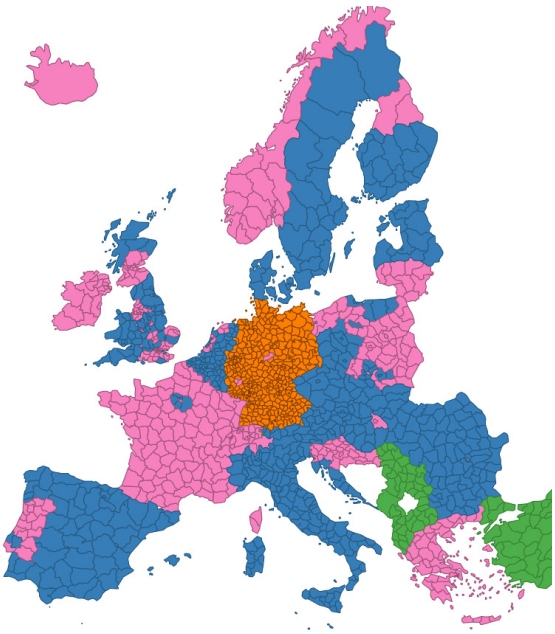


Source: Figure courtesy of the authors of the article

Figure 1: Map of the Rural Attractiveness Index.

Visualizations of clusters of regions with similar rural attractiveness profiles

Figure 2 and Figure 3 show map-like data previews of the cluster analyses with the investigated area divided into ten clusters. The variability in the delineation of the clusters is owed to the use of two different clustering methods – hierarchical and non-hierarchical clustering. Nevertheless, both maps share common features that illustrate the separation of several European regions, e.g., the assignment of the Scandinavian countries, Austria, Italy, Czechia, and parts of Poland to the same cluster.



Note: The colors only indicate to which clusters a region belongs and are not associated to any hierarchy or additional meaning.

Source: Figure courtesy of the authors of the article

Figure 2: Data preview of rural attractiveness clusters (non-hierarchical clustering).

Note: The colors only indicate to which clusters a region belongs and are not associated to any hierarchy or additional meaning.

Source: Figure courtesy of the authors of the article

Figure 3. Data preview of rural attractiveness clusters (non-hierarchical clustering).

Discussion

Our approach to assessing rural attractiveness through a composite index to assess rural attractiveness is not the first of its kind. However, what makes our approach unique is that it comprehensively captures a diversity of aspects of rural attractiveness, is adaptable to different contexts, and still delivers an integrated measure of rural attractiveness.

The adaptability of our approach to assessing rural attractiveness and thus the relativity and context-specificity of the RAI are both its key strength and limitation. The relativity of the RAI is a limitation as this means that the RAI cannot be used for generally valid global assessments like, for example, the Human Development Index. While this is a major limitation of the RAI, this is owed to the fact that absolute and objective assessments of rural attractiveness are not meaningful in any way.

The strength of the RAI lies in the fact that it perfectly mirrors the characteristics of the concept of rural attractiveness, whose exact meaning depends on the time-frame and scale for which it is supposed to be assessed; on the stakeholders that judge the attractiveness of a territory; and on the other territories to which a territory is compared. Accordingly, also the values of the RAI and the distribution of clusters change according to the kinds of included indices/data, to the weighting of to the different dimensions of rural attractiveness, and to the territories that make up a sample. Thus, the RAI can be a very useful tool for assessments realized for a specific purpose (e.g., a decision-making process about rural development) and based on local/regional perceptions to support decision-making on these scales.

This function can be further enhanced through the visualization of the RAI, for instance in the form map-like visualizations. Such visualizations that show which regions present which values of the specific RAI can help to identify patterns as well as best and worst-practice examples according to the applied notion of rural attractiveness. Visualizations that highlight clusters of regions with similar rural attractiveness profiles support the identification of regions that face similar challenges and present similar opportunities. These similar regions can, for example, start exchange and collaboration to address shared problems.

Notwithstanding, our approach to assessing and visualizing the attractiveness of rural territories is intended to be universally applicable to a variety of contexts. Yet, it also presents a number of technical and other challenges that must be addressed in order to produce useful and appropriate results. The issues discussed below do not represent an exhaustive list of challenges, but are a selection of challenges that we have found to be particularly relevant.

One challenge that we encountered in the rural attractiveness assessment in our showcase is the interpretation of the results of the cluster analyses in light of the fact that their outcomes vary widely, depending on the method used. However, some aspects remain the same regardless of the clustering method. For example, in our showcase, Austria and the Scandinavian countries were always in the same cluster in both hierarchical and non-hierarchical cluster analyses. Therefore, it can be assumed that such results that persist in the outputs of different cluster analyses are of distinct robustness and validity. Therefore, conducting cluster analyses using different methods does not necessarily lead to randomness of results. In fact, it can be helpful in identifying the most valid findings.

A critical issue specifically with our showcase application, which should be avoided in future applications of our approach, is that it was based only on a single set of weights determined through a stakeholder survey. This is justifiable in that it was a preliminary assessment that was primarily for demonstration purposes. Nevertheless, the problem here is that rural attractiveness is not only contextual and relative, but also presents another complex element: Even when applied to a particular context/territory, rural attractiveness cannot be reduced to a single shared vision; “rather, it is subject to a diversity of local discursive positions” (Lysgård et al., 2013, p.2879).

If this diversity of views on rural attractiveness is not adequately accounted for and a consensus on a single shared vision is forced, there is a certain risk that the interpretation of rural attractiveness will be dominated by powerful interests that often favor a neoliberal understanding. In such a view, the solution to all rural problems would be to attract new in-migrants by creating jobs and infrastructure, as well as to emphasize visual attractiveness and to develop the tourism sector to attract tourists (Lysgård et al., 2013). While such a strategy has some merit, it may not be in the interest of all stakeholders, especially populations already living in rural areas (Scott et al. 2011). Thus, rural

attractiveness assessments should ideally provide a range of different possible outcomes based on different views in order to make differences visible and to encourage debate (Lysgård et al. 2013).

One way to facilitate the inclusion and exploration of different views of rural attractiveness is the development of an interactive application that would allow not only experts, but all types of stakeholders to create visualizations of rural attractiveness based on their individual preferences. Such an application could include standard functionalities such as zooming or panning as well as the ability to change the weighting of the different categories of rural attractiveness or even to change input datasets. A first version of a web map client of Rural Attractiveness Maps built on HS Layers (Šimek et al., 2013) is available from the PoliRural Digital Innovation Hub (hub.polirural.eu).

Conclusion

Rural attractiveness is a vague and complex concept that is relative and context-dependent and cannot be assessed in absolute and objective ways, rendering its evaluation a real challenge. In this article, we present an adaptable Rural Attractiveness Index (RAI) for the assessment of rural attractiveness. While this approach is supposed to be widely applicable, it still pays heed to the context-dependency and relativity of the concept of rural attractiveness. The RAI is based on a set of categories that are supposed to be generally relevant to rural attractiveness (natural, social, economic, anthropic, cultural, institutional), yet integrates all of these categories into a single integrated measure to facilitate interpretation and communication of the assessment results. To further promote and facilitate the communication of the results of rural attractiveness assessments to stakeholders, we propose to use visualizations in maps based form.

The RAI and the map-based visualizations can provide information about the potential of rural territories, the search for common characteristics of regions, spatial patterns and similarities that can be used for further cooperation and specific and targeted development of rural regions. Hence, they are particularly relevant for policy- and decision-makers, people involved in regional development, strategic planning or investment, people interested in entrepreneurship or citizens living in rural areas. Furthermore, these tools can also be useful for academic regional development studies.

However, key to any of these activities is the inclusion of the relevant stakeholders since any notion of rural attractiveness can only be meaningfully defined by those who ultimately decide whether a territory is attractive to them or not.

Aside from their own value, these tools also present a first step in the development of an interactive online application that allows users of any kind to create maps of rural attractiveness according to their needs and preferences. As this application (which is still under development) helps explore the diversity of views of rural attractiveness, it can help make planning processes based on rural attractiveness assessments more inclusive and increase the acceptability and appropriateness of planning outcomes.

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