Spatial Localization of the Sustainable Development Goals

József Benedek
University of Miskolc, Babes-Bolyai University, Hungarian Academy of Sciences
regbenjo@uni-miskolc.hu

Summary

This study examines sustainable development from the perspective of financial risks, focusing on measurement issues, like the spatial localization of the Sustainable Development Goals (SDGs). More exactly, the goal of the study is to present the European reception and implementation of the 17 Sustainable Development Goals established by the United Nations, and to determine the spatial localization of the SDGs at local level. Furthermore, it addresses the measurement of the sustainable development goals, because a measurement-based risk assessment plays a key role in the successful implementation of sustainable development based economic policy. As a case study for the measurement and localization of the SDGs, we will use the case of Romania, deploying a set of 90 indicators with a data source and method-mix, where Earth Observations and Geographical Information Systems play an important role. The results show that the methodology used in our studies can be applied with good results in the spatial localisation and the measurement of the sustainability indices. The latter register the highest scores, and therefore the lowest associated banking risks – with the exception of a few peri-urban communities – in large and medium sized cities.

Keywords: sustainable development, financial risks, sustainable development index, Romania.

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Sustainable development is now an unavoidable topic of the scientific, economic and public discourse, and is an integral part of the secondary and tertiary curricula in many countries. It is little known that the concept of sustainable development has come a long way in the past half century: the first report of the Club of Rome published in 1972 (Meadows et al., 1972) does not name this concept in its current form, but the modelling of the use of non-renewable resources and the forecasts on their exhaustion can be considered at least as important as the Brundtland report (WCED, 1987), which was published later. So, this steep curve of conceptual development is the result of a process that started, as mentioned above, half a century ago from an innocent and seemingly naive metaphor, and can now be described as the defining territorial development and development policy paradigm of our time on the European continent (Benedek, 2021). Although several important authors believe that an economic development policy that is based on sustainability and a centralized and increased involvement of the state may even contribute to a more comprehensive transformation, perhaps affecting capitalism as a whole (Jacobs & Mazzucato 2018; Szavics & Benedek 2020; Benedek, 2021; Martin, 2021; Mazzucato 2021), the conflict that broke out in our region and the ensuing revision of our energy policy requiring us to partly return to fossil energy resources warn us of the need to apply a more cautious and flexible approach beyond ideologies.

This article is a type of synthesis that proceeds from the international, global level to the European level, and then to the national and local level. It is a summary and certain parts of it have been published in a different form in our previous studies (Benedek et al., 2021; Benedek, 2021). This paper deals with the topic of sustainable development, especially from the perspective of development policy, while focusing on measurement and methodological issues, such as the spatial localization of the Sustainable Development Goals (SDGs). More precisely, the article aims to present how the 17 Sustainable Development Goals established by the United Nations have been received and applied in Europe, and to determine the spatial localization of each SDG. The local level of the measurements and the spatial localization of SDGs is presented through a case study of Romania, using a complex set of 90 indicators and a specific combination of data sources and methods, where the use of Earth Observation Methods and Geographic Information Systems (GIS) plays an important role.

The sustainable development paradigm entered the phase of mature politics with the UN Millennium Summit in New York (2000), and the principles, goals and instruments of sustainability are now unavoidable when developing general or policy objectives or programmes (Benedek, 2021). At the Summit in 2000, the UN adopted the Millennium Declaration and the Millennium Development Goals for the period 2000–2015 (United Nations 2000):

1. eradicate extreme poverty and hunger,
2. achieve universal primary education,
3. promote gender equality,
4. reduce child mortality,
5. mprove maternal health care,
6. combat HIV, malaria and other diseases,
7. ensure environmental sustainability,
8. support global partnership for development.

After the conclusion of the Millennium Development Goals programme, which may be deemed effective (Sachs, 2018), and as a continuation of it, the UN General Assembly, held in New York from 25 to 27 September 2015, unanimously adopted the 17 Sustainable Development Goals (SDGs), as known today,

and set a date for their implementation: until 2030 (Agenda 2030). The 17 adopted objectives are the followings (United Nations, 2015, United Nations, 2022):

1. no poverty,
2. zero hunger,
3. good health and well-being,
4. quality education,
5. gender equality,
6. clean water and sanitation,
7. affordable and clean energy,
8. decent work and economic growth,
9. industry, innovation and infrastructure,
10. reduced inequalities,
11. sustainable cities and communities,
12. responsible consumption and production,
13. climate action,
14. life below water (protection of oceans and seas),
15. life on land (protection of ecosystems on land),
16. peace, justice and strong institutions
17. partnerships for the goals of sustainable development.

In order for us to apply the principles and goals of sustainable development in development policies, we must determine fair and just economic and territorial development directions, including conflicting economic, social and environmental conservation interests and priorities. It can be definitely stated that the economic and economic development dimensions of sustainable development (competitiveness, innovation, smart specialization) have remained key priorities in regional development practices in Europe, while the social and environmental dimensions have been given secondary importance, especially in the Eastern European countries, which are poorer in resources but treat economic and regional consolidation a priority (Benedek & Lembcke, 2017; Nagy & Benedek, 2021). The European Green Deal (EGD) adopted by the European Commission (EC) as a new growth strategy in 2019, with the political commitment of the EB to attain the SDGs, was definitely an important milestone (Lafortune et al., 2021). The two most ambitious goals of the document are (i) climate neutrality (i.e. a radical reduction of greenhouse gas emissions to net zero by 2050 and, as an interim goal, by 2030 Member States are to reduce emissions by at least 55% compared to levels in 1990) and (ii) the requirement that economic growth must be made independent of the use of resources (European Commission, 2019). Funds will be made available to achieve these goals, in an amount no less than six hundred billion euros. At the same time, the EGD clearly shows a shift in the sustainable development paradigm towards climate policy commitments, as a response to the dangers and challenges of climate change, which are now supported by undeniable empirical evidence. The EGD is declared to be an integral part of the UN Agenda 2030 and the SDGs formulated therein. Thereby, the EU institutions seemed to become committed to an agenda that is based on a sustainable development paradigm, and this can definitely be interpreted as a shift in the regional development paradigm (Csath, 2020). This change of direction, manifested primarily in political responsibility, was overridden by the energy security risks caused by the war in Ukraine from 24 February 2022. It seems that, in order to put the principle of sustainable development into practice, it is not only the necessary political will and the appropriate institutional framework that is missing, but also the geopolitical environment appears to be unsuitable for this move: a factor that many sustainability analysts have failed to take into account so far.

SPATIAL LOCALIZATION OF THE INDICATORS ASSIGNED TO THE SUSTAINABLE DEVELOPMENT GOALS

The Eurostat monitoring reports on the Sustainable Development Goals take into account the national level, which is the easiest to quantify. We find it important to supplement these reports with data from the local and regional levels (NUTS 2, NUTS 3 and LAU 1). There are three reasons for this:

❶ SDGs are impossible to attain by using only a globalist or a national approach, without the involvement and mobilization of local and regional actors.

❷ without the acquisition and processing of data, it is impossible to measure progress in the attainment of the SDGs, to establish milestones, and to determine further goals and instruments at the lowest possible territorial level.

❸ natural and environmental risks play an increasingly important role in the risk analyses of the financial and banking sector (Tóth et al., 2021). Data for measurements of the environmental dimension of the SDGs and the related four objectives (6. clean water and sanitation, 13. climate action, 14. life below water, 15. life on land) may provide important input for the evaluation of the environmental risks related to insurance and loan products.

The set sustainable development goals and sub-goals (Agenda 2030 assigned 169 additional sub-goals to the 17 SDGs) must be measurable in a transparent and replicable manner, and all this requires the establishment and operation of a continuous monitoring system. This is a task that has been naturally assumed at the national level by statistical offices, due to their core mission, but the task of monitoring at regional and local levels has remained mostly unsolved. Initially, 230 indicators were designated for measuring goals and sub-goals, a list that has continuously been expanded. However, many of the globally designated indicators are not available at the regional and local levels, so it has become clear that the collection catalogue of nationally used data and sources must be reconsidered and diversified at these levels for the purpose of defining additional indicators. The latter task has been undertaken by the Sustainable Development Research Centre (SDRC) at the Faculty of Geography of the Babes-Bolyai University in Cluj-Napoca, as the only Member from the Carpathian Basin of the international Sustainable Development Solutions Network (SDSN) operating within the framework of the United Nations. The SDRC has developed a local and regional indicator system that enables every village, town, county and region to use two internationally recognized and standardized measurement instruments for determining: 1. the overall index of sustainability and the sub-indices assigned to the goals, and 2. the statistically measured distance from the fulfilment of the 17 Sustainable Development Goals, using an automated measurement instrument ("Dashboard").

Even European countries with advanced statistical systems are faced with serious problems in compiling the indicator system and producing the appropriate data, primarily in the non-OECD countries such as Romania (Benedek et al., 2021), where survey-type data measuring public attitudes are not available. The first global sustainable development report identified four data issues (Sachs et al., 2016):

❶ no robust indicators can be assigned to some of the Sustainable Development Goals,

❷ some indicators would require more frequent data collection,

❸ several data produced by scientific institutions and "big data" are not used officially in the system monitoring the Sustainable Development Goals,

❹ there is a spill over effect.

In Romania, the National Statistical Office, in cooperation with the National Sustainable Development Council completed an exercise in 2022 to redefine the indicator system for measuring the Sustainable Development Goals in line with the goals of the National Sustainable Development Strategy adopted in 2021 (Guvernul Romaniei, 2022). There were some difficulties, which mainly came from a lower number of indicators in comparison with the OECD, a lack of high-quality data, and a lack of data from alternative sources (Geographical Information Systems, remote sensing, databases of ministries) (Benedek et al., 2018, Benedek, 2021). The developed system contains a total of 99 nationwide indicators, some of which are also available at the regional level, which is an improvement compared to the previous situation, but the local level still lacks a significant amount of data and indicators.

Partly using and also supplementing *Benedek's* (2021) study, we undertake to summarize below, in a few thoughts, the essence of an integrated methodology that has been developed by us in Cluj-Napoca to measure the SDGs, as published in the journal "Sustainable Development" (see the full study: Benedek et al. 2021).

The research, which spanned approximately two years, had four characteristic stages (Benedek et al., 2021):

1. Data collection
2. Creating a database and processing data
3. Statistical testing
4. Calculation of the overall sustainable development index, the sub-indices of the 17 Sustainable Development Goals, and the "Dashboard".

Below, we present the main data science relationships and results of these activities. In the course of data collection, we selected 90 indicators by combining classic official data sources with official but non-classic sources as well as our own sources derived from Earth Observations. In this triple data source mix, annual statistical data and census data (2011 census) provided by the National Statistical Office formed the first source, while publicly available and downloadable data platforms of some ministries represented official but non-classic sources. We used the website of the Ministry of Regional Development and Public Administration for downloading data for budgets of local administrative units – villages and towns –, including local income data used as indicators, and data of the General Directorate for Traffic of the Romanian Police (database of road accidents, crime). Checking the latter databases and cleaning them of errors was rather time-consuming. Finally, our satellite Earth Observation sources included the following data sources (Benedek et al., 2021):

- Copernicus Land Monitoring database, from which we calculated and localized the following indicators for each village, town and county: proportion of areas covered by forests, changes in areas covered by forests, changes in built-up areas.
- Sentinel 5-P space images, from which we calculated and localized one indicator: the annual average nitrogen dioxide concentration.
- ROCADA database, from which climatic indices were calculated and localized: a cooling index – the number of days with registered temperatures below -15 °C – and a temperature-humidity index.

So, in fact, we did not use any completely unknown data sources, but it was an original process through which we managed to use a special mix of sources for the localization and measurement of Sustainable Development Goals at the local and regional levels in such a way that these sources could complement and rely on each other, enabling us to quantify and localize goals showing data deficiencies,

as was the case, for example, for Sustainable Development Goal 13 ("climate action").

In order to handle such large amounts of data more efficiently, we created a PostgreSQL database in the PostGIS extension before processing data and calculating the sustainability indices. Using the data build tool (dbt) and the SQL programming language, a model was created to calculate each indicator and work process, which consisted of five steps (Benedek et al., 2021):

1. adding up values by category;
2. localization of data, i.e. spatial association of data with the boundaries of administrative units;
3. calculation of indices;
4. normalisation of the values on a scale from one to ten, using the min-max and max-min normalization methods (Hull score);
5. aggregation of data in the form of a final table with 90 indicators for all local administrative units, i.e. villages, towns and counties.

The database created in this way enables the construction of an efficient monitoring system, as any information can be quickly updated by using new inputs and so can any sustainability indices, and thereby, we can eliminate errors that may arise from manual data processing.

Following the relevant international standards, we calculated the SDG Index from the sub-indices of the individual SDGs, applying equal weighting and aggregation. Data were aggregated and visualized in three steps:

1. combination of scaled variables into an SDG sub-index. The values of the indicators were aggregated into the sub-index by calculating arithmetic averages, following the internationally accepted procedure;
2. the values of the sub-indices were aggregated into the final SDG index from the arithmetic average of the sub-indices without weighting;
3. generating a "dashboard" of Sustainable Development Goals, using the internationally standardized colours of traffic lights *(Figure 1)*. Green indicates a status close to achieving the goals (first quartile), red indicates the biggest gap towards achieving them (fourth quartile), while yellow and orange represent the second and third quartiles.

The territorial distribution of the SGD Index in the villages and towns of Romania can be followed in *Figure 2*. The first comment on the figure is related to the values of the SDG Index: the values of the SDG Index are low in European comparison even for the best performing villages and towns. The highest values of the sustainability index are around five on a scale from zero to ten, where zero is the lowest and ten is the highest value. The second comment is related to the regions that perform well under Romanian standards, which, at the same time, are the most economically developed regions (Banat, South Transylvania) and the urban agglomerations (Bucharest, Brasov, Cluj Napoca, Oradea, Sibiu). Interestingly, some mountain villages (in Harghita County, Hunedoara County and Maramureș region) and the Black Sea coastal area (Constanța County) also perform well in a Romanian comparison. As the other extreme, the lowest values are characteristic of the rural peripheries located in the eastern (Moldavia) and southern (Oltenia, Muntenia) regions of the country. In Transylvania, low performance is demonstrated by the Sălaj region, the Transylvanian Plain and the Apuseni Mountains. The above territorial pattern of sustainability is not surprising, especially if we take into account the fact that most of the goals and indicators that make up the Sustainability Index belong to the economic dimension of sustainability. However, it is known from previous research that there is a territorial distribution in terms of economic performance, competitiveness and innovation along a typically west-to-

1. Figure

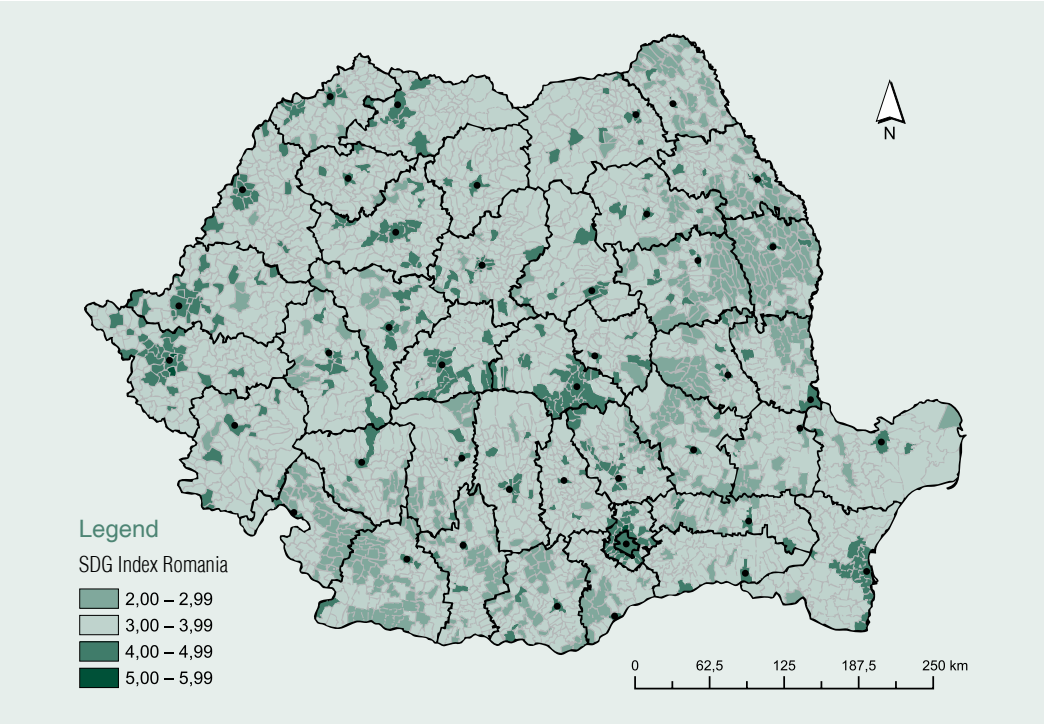
RANKING OF SETTLEMENTS BASED ON GLOBAL INDICES AND SUB-INDICES OF THE SUSTAINABLE DEVELOPMENT GOALS

Ranking	Villages, Towns	Counties	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1	Dumbrăviţa	Timiş	5,4	5,4	5,3	7,2	7,9	7,2	9,5	2,7	1,5	10,0	7,3	9,8	5,8	0,2	0,4	4,0	0,1	5,3
2	Otopeni	Ilfov	7,8	3,7	5,4	6,3	7,4	6,5	9,5	3,6	1,6	7,9	6,6	9,6	4,7	0,0	0,4	3,7	0,1	5,0
3	Giroc	Timiş	5,1	7,5	5,2	5,7	7,5	6,4	9,2	2,7	1,0	7,2	6,8	9,5	6,1	0,2	0,7	3,6	0,1	5,0
4	Cluj-Napoca	Cluj	4,9	5,0	5,2	6,5	7,7	6,9	9,7	3,2	2,1	7,3	5,8	9,9	5,5	0,0	0,7	3,3	0,2	4,9
5	Sibiu	Sibiu	5,4	5,2	4,9	5,9	7,6	6,9	9,4	3,0	1,8	7,1	5,8	9,9	5,6	0,0	0,6	3,8	0,0	4,9
6	Timişoara	Timiş	5,2	5,3	5,3	6,1	7,5	7,2	9,7	2,9	2,7	6,8	5,8	9,9	4,9	0,1	0,6	2,8	0,0	4,9
7	Floreşti	Cluj	4,4	5,6	5,3	6,8	7,9	6,5	9,5	2,4	0,7	7,1	6,7	9,7	5,1	0,3	0,4	4,0	0,0	4,9
8	Galaţi	Galaţi	4,5	6,1	4,4	5,1	7,2	6,7	9,6	2,6	1,6	5,9	5,7	9,8	5,0	2,1	2,3	3,1	0,0	4,8
9	Tîrgu Mureş	Mureş	5,0	3,0	5,5	5,6	7,5	7,5	9,4	2,9	1,9	6,7	5,6	9,8	6,4	0,1	1,4	2,8	0,0	4,8
10	Bucureşti	Bucureşti	5,1	1,4	4,9	7,1	7,6	8,3	9,7	3,0	2,9	7,0	5,4	9,9	3,9	0,6	0,4	4,1	0,0	4,8
11	Drobeta-Turnu Severin	Mehedinţi	4,2	2,4	4,6	5,2	7,2	6,6	9,2	2,5	1,9	5,7	5,6	9,7	6,7	3,3	2,6	3,7	0,0	4,8
12	Arad	Arad	5,0	7,5	4,6	5,4	7,3	6,6	9,2	2,9	2,3	6,1	5,9	9,8	5,0	0,2	0,7	2,6	0,0	4,8
13	Deva	Hunedoara	4,7	6,0	4,6	5,7	7,3	6,7	9,6	2,9	1,4	6,2	5,8	9,8	5,2	0,1	1,3	3,6	0,0	4,8
14	Bistriţa	Bistrita-Năsăud	4,8	6,1	4,9	5,5	7,3	6,7	9,4	2,8	1,7	6,7	5,8	9,7	6,0	0,0	0,4	3,2	0,1	4,8
15	Alba Iulia	Alba	5,0	4,5	4,8	5,9	7,5	6,7	9,6	2,8	1,5	7,0	5,9	9,8	5,8	0,3	0,6	3,4	0,0	4,8
16	Corbeanca	Ilfov	4,9	6,6	5,0	6,6	7,5	5,8	8,4	2,4	0,5	9,1	6,3	8,5	4,8	0,4	0,4	3,7	0,1	4,8
17	Iaşi	Iaşi	5,1	3,8	5,3	6,3	7,7	7,1	9,8	2,8	2,2	6,7	5,5	9,8	5,5	0,2	0,4	2,5	0,1	4,8
18	Mogoşoaia	Ilfov	5,5	6,5	4,5	5,4	7,3	5,8	8,4	2,8	1,0	7,4	5,5	9,0	5,8	0,7	0,4	4,7	0,1	4,8
19	Oradea	Bihor	5,2	5,1	4,9	5,7	7,5	7,2	9,5	2,8	2,4	6,1	5,8	9,9	5,1	0,4	0,4	2,4	0,5	4,7
20	Craiova	Dolj	4,9	3,3	5,0	5,9	7,5	7,2	9,5	2,7	2,6	6,7	5,4	9,7	5,7	0,3	0,4	3,8	0,0	4,7

Source: own editing

2. Figure

TERRITORIAL DISTRIBUTION OF THE SUSTAINABLE DEVELOPMENT GOAL INDEX IN ROMANIA AT THE LEVEL OF VILLAGES AND TOWNS (2020)



Source: own editing

east development slope, and in a capital city versus provinces relation (Benedek, 2006; Benedek, 2015; Benedek et al., 2016; Benedek & Lelmcke, 2017, Cebotari & Benedek, 2017; Benedek et al., 2018; Benedek et al., 2020; Benedek, 2021).

From a financial point of view, the above calculation results delineate the areas where lending risks are the highest (in villages and towns whose sustainability indices are low or close to zero) or the lowest (close to ten; in our case, usually large cities or peri-urban villages having a value between 4 and 6). This typical division clearly shows the territorial distribution of banking risks, a fact that is believed to further strengthen the existing regional disparities.

CONCLUSIONS

The current international situation caused by the war in Ukraine has made it clear that geopolitical factors had been underestimated in defining the Sustainable Development Goals and sub-goals. Although SDGs 16 and 17 (peace, justice and strong institutions; as well as partnerships for the goals of sustainable development) are in principle also related to geopolitics, in practice these goals have no integrated geopolitical factors at the level of sub-goals or indicators. In this new environment, the most fundamental issues of sustainable development – energy supply and climate protection (Goals 7 and 13) – are becoming even more acute, and it is necessary

to reconsider the existing, perhaps oversized undertakings and adjust them to the realities.

This study focused on the shortcomings of the monitoring system of the Sustainable Development Goals, in particular, on the development and availability of relevant data and indicators. It will certainly take years to set up such a system, which could play a significant role in development policy and, not least, in decision-making on taking risks in the financial and banking sector, given its ability to produce harmonized, comparable, real time data at national, regional and local levels. However, our study also showed that the highest values of the Sustainable Development Index, i.e. the lowest banking risks appear in large and medium-sized cities, with the exception of some peri-urban villages. In the absence of policy measures, this situation forecasts a further increase in regional disparities.

From a methodological point of view, our most important result comes from the fact that we have successfully supplemented traditional data sources with progressive sources derived from Earth Observations. The indicators obtained through Earth Observation methods and those produced from the databases of some ministries fitted well with the indicators of the Romanian Statistical Office.

This conclusion comes from a comparison of our own results and some other studies produced by using classic data sources relying on indicator systems; in particular, the values of the SDG Index for the case study of Romania are located in very close variance intervals in the different studies (Benedek et al., 2021). Based on the above, we strongly recommend the use of our integrated methodology also in other countries, including Hungary. ■

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