Scientific report related to the activity during 2021 for the project
PN-III-P4-ID-PCE-2020-0920 entitled *Earth Observations-based Analysis and Modeling of Urban Growth in Large Urban Areas*

During 2021, the activities mentioned in the Project Implementation Plan, phase 1- Urban growth analysis based on satellite data were accomplished.

1. The objectives:

O1 Urban growth analysis based on satellite data.

O4 Determining Economic Specialization and Economic Complexity

O7 Dissemination of research results

O8 Involvement of PhD students in the research process.

2. The research activities conducted

$A_{1.1}$ Selection and preprocessing of satellite images.

$A_{1.2}$ Extraction of built-up areas using change detection.

$A_{1.3}$ Analysis of the spatial and temporal extension of the built-up areas in eight metropolitan areas from Romania.

$A_{1.4}$ Preparation and selection of urban growth factors.

$A_{1.5}$ Calibration of protection using CA.

$A_{1.6}$ Validation of simulated built areas.

$A_{1.7}$ Apply the reflection method to measure economic complexity.

$A_{1.8}$ Calculation of the localization coefficient in order to establish the economic structure of the growth poles.

$A_{1.9}$ Indicator computation

$A_{1.10}$ Creating population grid maps.

3. The main results

For achieving the first objective, activities **$A_{1.1}$** - **$A_{1.6}$**were conducted and two results were obtained (**R_1** and **R_2)**, described as it follows. The first one includes the construction of a time series database with the built-up areas related to eight metropolitan areas from Romania for the period 2015-2020. Between 2006 and 2018, the data were extracted from the European Copernicus Land Monitoring Service database (https://land.copernicus.eu/) and were processed at the level of each territorial administrative unit (TAU) of the metropolitan areas . The temporal changes were then obtained both at the level of the metropolitan area and at the level of each TAU.

R_2 The second result refers to the selection, download and preprocessing of satellite images. During this process, we encountered an obstacle: for 2020, the built-up areas were not available in the European Copernicus Land Monitoring Service database. Radar (Sentinel 1) and optical (Sentinel 2) satellite images were downloaded to obtain the recently built surfaces. They were then preprocessed so that they could be integrated into MASADA tool that was used by the European Commission to identify built-up areas (https://publications.jrc.ec.europa.eu/repository/handle/JRC116510). Some issues have been identified with the use of either passive image detection or active remote sensing only images. Taken individually, they had large errors in the detection of built-up areas. Several methods of integrating multi-sensor images have been tried to improve detection. The most promising method is the one that involves the integration of MASADA results on Sentinel 1 images from complementary orbits (ascending and descending) with those in the optical system (Sentinel 2).

Table 1 The Sentinel scenes used

		Sentinel 1A		Sentinel 1B		Sentinel 2A	
No.	Metropolitan area name	Date	Number of satellite scenes	Date	Number of satellite scenes	Date	Number of satellite scenes
1.	Cluj-Napoca	24.08.2020	1	10.08.2020	2	31.08.2020	4
2.	Bucureşti	30.08.2020	1	-	-	28.08.2020	1
3.	Braşov	31.08.2020	1	17.08.2020	2	28.08.2020	2
4.	Constanţa	14.08.2020	1	19.08.2020	1	25.08.2020	2
5.	Craiova	12.08.2020	2	22.08.2020	1	31.08.2020	3
6.	Iaşi	-	-	-	-	7.09.2020	1
7.	Ploieşti	30.08.2020	1	-	-	28.08.2020	1
8.	Timişoara	21.08.2020	1	15.08.2020	1	13.09.2020	2

R_3 For the purpose of achieving the second objective **(O_2)** through activities **$A_{1.7}$** - **$A_{1.10}$**, the results **R_3** – **R_6** were obtained and furtherly described. The third result is represented by the collection of data and the creation of databases. Thus, in the research carried out in the period 2020-2021, we aimed to measure

the economic complexity of the functional urban areas formed around the seven growth poles in Romania, for the period 2008-2018.

In order to calculate the economic complexity, databases regarding the activity of the companies obtained from the National Office of the Trade Register for the period 2008-2018 were used. This database contains information on the number of companies, the number of employees and the turnover for all CANE (Classification of activities in the national economy) classes - rev.2 (CAEN in Romanian) consisting of 4 digits. In order to focus mainly on innovative economies, we grouped the 615 existing CANE codes according to the methodology developed by the authors of the European Cluster Panorama and Industrial Change 2020. The document proposes the delimitation of 51 categories of traded clusters (exporting industries), which compete globally and have a high level of innovation and productive knowledge. Cluster categories were defined by specialization (by calculating the employment coefficient), cluster size (taking into account the number of employees) and employee productivity (considering the average salary), SME performance (by analyzing companies) and innovation leaders (focusing mainly on global enterprises). The remaining economic activities (17 cluster categories in total) have mainly local importance and are usually present in most regions. These activities have a high potential for development, thus being able to generate economic growth that radiates beyond the area of influence of those territories. In total, the 51 global and 17 local cluster categories mentioned comprise 615 different economic activities (sectors) and over 700,000 companies. We consider that these data are very adequate for the description of the economic structure of the studied localities.

R_4 The fourth result is the application of the reflection method to measure economic complexity. The Economic Complexity Index (ECI) represents the degree of sophistication of large economies. The basis for calculating economic complexity is economic diversity and economic ubiquity. Economic diversity refers to the number of products that a particular country produces. On the other hand, economic ubiquity shows whether or not those goods and services are also produced by other countries. ECI is a predictive tool rather than a descriptive tool. It is often used to predict a country's economic growth in terms of GDP per capita. In addition, it explains the international variations in income inequality.

Thus, in the second stage, the technique of the Reflection Method was used, which helps us to calculate the economic diversity of the counties and the ubiquity of the respective products. In this way, the complexity of a county economy is given by the variety of exported products with comparative advantage (high diversity), while for a product to be considered complex, it is essential that it should not be exported widely by many counties (low ubiquity).

R_4 Computation of the localization coefficient in order to establish the economic structure of the growth poles

In order to calculate the Economic Complexity Index, we applied a three-step method, the final index being used to determine the economic complexity of the counties in Romania.

In a first phase, the Revealed Comparative Advantage Index was calculated to determine the specialization model of each county. For this, we used the mathematical method known as the location coefficient or the Balassa index (Balassa, 1965). The location coefficient analyzes the concentration of labor on industries in a given region.

R_5 Indicator computation. Because ECI is a relative metric, in the last step we applied a normalization process using the Z score transformation. Thus, the more diverse the scale of exported products and the

less ubiquitous the goods, the more complex the economic structure of a county. Therefore, measuring ECI using diversity and ubiquity can explain in depth the distribution of productive knowledge among the analyzed localities. Research has led to the conclusion that growth poles with a higher ECI which are ranked lower in terms of GDP have a higher growth rate compared to those in which both components have above average values.

R_6 This result relates to objective **O_7**, the dissemination of research findings. Thus, the following publications and conference entries were made:

Török I., Benedek J., Gómez-Zaldivar, M. (2021). Quantifying subnational economic complexity. Evidence from Romania (manuscript sent for review at Regional Studies)

Lőcsei H., Farkas Gy., Kovály K., Török I. (2021) Területi növekedési pályák a Kárpát-medencében a 2010-es években. Kisebbségi Szemle 3, pp. 7-28.

Török I., Croitoru, A.E., Man, T.C. (2021) Assessing the impact of extreme temperature conditions on social vulnerability. Sustainability 13, 8510. https://doi.org/10.3390/su13158510

BENEDEK J. (2021) Regionális egyenlőtlenség és gazdasági felzárkózás. Magyar és romániai régiók összehasonlító vizsgálata. *Észak-magyarországi Stratégiai Füzetek*, 18:1, 1-14.

Nagy J., Benedek J. (2021) Can the EU Cohesion Policy Fight Peripherialization*?* In: Rauhut D., Sielker, F., Humer, A. (eds.) *EU Cohesion Policy and Spatial Governance. Territorial, Social and Economic Challenges*, 142-156. Elgar Studies in Planning Theory, Policy and Practice, Edward Elgar. **ISBN:** 978 1 83910 357 5

Ursu C.-D. & Benedek, J. (2021). The Evolution of Impervious Surfaces Based on Copernicus High Resolution Layers. Case Study: Major Cities Metropolitan Areas, Romania. Regional Statistics (in evaluation).

Conferences:

Ibolya Török (p), József Benedek, Manuel Gómez-Zaldívar: Quantifying subnational economic complexity. An evidence from Romania, 60 European Regional Studies Association Congress, Bolzano, Italy (online).

Ibolya Török (p), József Benedek: Measuring the spatial dimension of income inequality: evidence from Romania. International Geographic Union's - Commission on Marginalization, Globalization, and Regional and Local Responses, Cluj-Napoca, Romania (online). 2021. aug. 09-10.

Benedek J. III. Területfejlesztők Napja. Fejlesztés és fejlődés 2020 előtt és után. "Regionális egyenlőtlenség és gazdasági felzárkózás. Magyar és romániai régiók összehasonlító vizsgálata. 2021.04.28-29.

Ursu Cosmina-Daniela. The Evolution of Impervious Surfaces Based on Copernicus High Resolution Layers. Case Study: Growth Poles and their Metropolitan Areas, Romania. International Geographic Union's - Commission on Marginalization, Globalization, and Regional and Local Responses, Cluj-Napoca, Romania (online). 2021. aug. 09-10.

R_7 This result is related to the objective **O_8**- the involvement of PhD students in the research process. Thus, a doctoral student, Cosmina Daniela Ursu, was involved in the project.

Cluj-Napoca, 25.11.2021

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