Index of Multiple Deprivation

Conceptual framework for identifying lagging municipalities and towns in Croatia

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1. Background

As an EU member state, Croatia is a part of the Europe 2020 strategy and, accordingly, aims to reduce the number of persons living at risk of poverty or social exclusion. Achieving that goal depends on developing right the policies and programs and an effective targeting mechanism, which requires detailed knowledge on the disparities in living standards across space. Croatia is interested in designing policies and programs to reduce regional disparities within its national borders. As one example, the Strategy on Combating Poverty and Social Exclusion in Croatia (2014-2020) specifically cites taking a regional approach as part of its strategy to reduce poverty and social exclusion.

The Strategy for Combating Poverty and Social Exclusion in the Republic of Croatia 2014-2020 examines segments of the population that remain vulnerable to poverty, social exclusion and different forms of material deprivation that lead to discrimination. These groups include the elderly, single adult households, one-parent families, families with more than 2 children, children without adequate parental care, individuals with lower educational attainment, individuals with disabilities, Croatian war veterans and victims of war and members of their families, returnees, displaced persons and ethnic minorities (mainly Roma and Serbs).

In Croatia, poverty has a strong territorial dimension. Incorporating the territorial dimension into policy can lead to improved outcomes. The highest geographical concentration of factors influencing the share of people at risk of poverty can be found in small towns and settlements in the east and southeast of the country mainly along the border with Bosnia & Herzegovina and Serbia. These areas are also those affected most by the Homeland war in the 1990s.

The Ministry of Regional Development and European Union Funds (MRDEUF), Ministry of Demography, Family, Youth and Social Policy (MDFYSP), Central Bureau of Statistics (CBS) and other government bodies aim to gain more detailed and complete evidence on the geographical distribution of poverty and social exclusion, and the resources available to combat these issues. This evidence base will then be used by the Government of Croatia to inform the design of policies and the allocation of budgetary as well as EU funded resources to promote inclusion and regional development particularly in deprived areas.

To help achieve this objective, one of the activities under the MRDEUF project with the World Bank under the Reimbursable Advisory Services on *Spatial Analysis of Poverty and Social Exclusion* is the development of a detailed geo-referenced database that provides information regarding the geographic

distribution of social exclusion using a range of actionable indicators of well-being, deprivation and the distribution of social services and infrastructure.

2. Objective

In December 2014, The European Commission adopted the Operational Programme (OP) for Competitiveness and Cohesion 2014-2020 for Croatia.[1] This OP has nine thematic objectives with investment priorities, specific objectives and their financial allocations. The expected result Under Specific objective 9.b1 – Sustainable physical, social and economic regeneration of 5 deprived pilot areas - is the improvement of the socio-economic and living conditions for inhabitants living in pilot areas with over 10.000 to 35.000 of inhabitants, that will halt or reverse population loss.[2] In the selected pilot areas, particular attention will be given to the needs of marginalized and vulnerable communities living therein. This integrated regeneration will be embedded as Croatia's future approach to sustainable development linked to poverty reduction and social inclusion.

The development of an integrated area-based approach to regeneration is planned through three mechanisms: (i) Five pilots independently implemented and formally evaluated; (ii) The generation of enhanced small-area data and associated poverty mapping and the establishment of appropriate management and control systems and; (iii) Institutional capacity-raising of key stakeholders and staff. Interventions undertaken in the pilot areas are planned to be rolled out to other areas.

The European Regional Development Fund (ERDF), source of financing for OP Competitiveness and Cohesion 2014-20, has allocated approximately EUR100 million for providing support to physical, economic and social regeneration of deprived communities in urban and rural areas. The OP also aims to promote equal opportunities, active participation, and improved employability. Under the ERDF, these would encompass construction or rehabilitation of infrastructure and housing units along with providing support to enterprises.

Additionally, under the European Social (ESF), source of financing for OP Efficient Human Resources 2014-20, the supported output indicators aim to increase the participation of long-term

[1] Operational Programme Competitiveness and Cohesion 2014 - 2020, www.strukturnifondovi.hr

[2] According to the Law on local and regional self-government, small towns are considered those below 35,000 inhabitants by Croatian legislation. According to Census 2011 data, in Croatia there are 50 small towns with 10,000 to 35,000 inhabitants and 8 medium sized towns with more than 35,000 to 50,000 inhabitants. Only 9 towns can be considered as large towns including 4 cities with more than 100,000 inhabitants. Also there are 60 very small towns with population below 10,000.

unemployed individuals, as well as Roma and other minority participants in the active labor market programs. Complementary activities are envisaged under specific objective 9i2 of the OP Efficient Human Resources "Enhancing active inclusion through the implementation of integrated pathways to the regeneration of 5 deprived pilot areas" with approximate allocation of EUR 20 million. The activities will be used to co-finance provision of social, educational, economic and employment-related services such as integrated pathways, which may combine various forms of employability measures, such as individualized support, counselling, guidance, access to general and vocational education and training, self-employment, social entrepreneurship, as well as access to social and health services.

The program-specific result indicator (ERDF specific objective 9b1)[3] is a decrease in the loss of population of the five Pilot areas affected by social, economic and territorial regeneration program (as measured by the vital index).

There is limited availability of small-area data to support the identification of targeted territories, as well as integrated policy and program development for deprived urban and rural communities. MRDEUF has proposed the development of an index on multiple deprivation (IMD). While the MRDEUF has already constructed an IMD[4], it requested World Bank support for the further development of the index.

3. Current Deprivation Indices in Croatia

The IMD is based on the notion of using several different dimensions of deprivation which can be measured separately. Multiple deprivation is often defined as a situation that reflects low levels of living standards and can be derived from a set of non-monetary indicators. Academics and practitioners have long accepted that poverty is multidimensional in nature. Being poor does not simply mean having low monetary resources. Individuals with the same income may suffer different deprivations; for example, poorer living standards due to the effects of accumulated resources, employment status, educational level, health conditions, housing tenure, non-cash income and social benefits.

CBS. The Croatian Bureau of Statistics publishes *material deprivation* indicators on a yearly basis along with a material deprivation rate that presents the percentage of persons who live in households that

[3] Indicator is measured by the vital index of population to indicate the growth potential of a population as the number of live births per 100 of deaths. the target value for 5 pilot areas is set on 67.00.
[4] The existing IMD of the MRDEUF is discussed in detail later in the paper

cannot afford (explicitly due to lack of financial resources) at least three of seven deprivation items.[5] The EU-SILC survey which is representative at national level is used as the source of data for obtaining material deprivation. The national material deprivation rate in 2016 was 30.1 percent. The indicator is the same to the one published by EUROSTAT[6] for the entire EU.

MRDEUF.[7] The *development index*, developed by MRDEUF, is used to define lagging regional and local self-government units (counties, towns and municipalities) in Croatia subject to tax exemptions enshrined in personal income and corporate income tax laws. Additionally, the index is also used to assess development of local and regional autonomous areas. The index is constructed as a function of five indicators and uses the following weights:

a. unemployment rate – 30 percent;
b. income (taxable income of physical taxpayers) per capita – 25 percent;
c. budget revenues of local government per capita – 15 percent;
d. population change – 15 percent;
e. share of secondary and above educated citizens in working age population – 15 percent.

In accordance with the Decree on the development index, these indicators have been calculated as 3-year averages to avoid fluctuations. Data are standardized across the distribution. The process of standardization of the above indicators is carried out on the basis of the following formula:

$$X_{i\ \text{stand.}} = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}}$$

where x is the value of indicators for each unit of local government, while x_{min} and x_{max} are the minimum and maximum value of the indicator at the level of local government, respectively. The index is calculated as the weighted average of the deviations of the standardized values of each indicator from the national average.

The existing *multiple deprivation index* (MDI)[8] for all local government units, as conceptualized by the MRDEUF, is a weighted aggregation of specific indicators of poverty and social exclusion, categorized under a series of Domains (like Demographic, Social, Education, Economy, War-affected area). Domains (and Indicators) can be mapped separately or together as a map of Multiple Deprivation.

[5] www.dzs.hr
[6] The EUROSTAT multiple deprivation indicator is described later in the report
[7] Only two measures for lagging regions are presented, others exist
[8] This exercise is not official, and should not be confused with the index proposed in this note.

The temporarily used MDI is based on the existing aggregated data collected through the census and public administrative registries. The methodology includes indicators for calculating the value of the index of multiple deprivation, the share of the individual indicator in the index's calculation, data sources and method of calculating the index of multiple deprivation. The value of the index is calculated as the weighted average deviation of standardized value of the indicator from the Croatian average. The index of multiple deprivation was used as one of the criteria for selection of five pilot areas for the implementation of the integrated physical, economic and social regeneration of small towns in the war-affected areas.

Table 1. The Multiple Deprivation Index and Share of Indicators in the Calculation of the Index

Domain / Indicator	**Weight**
Demographic situation	**20%**
a) Population change	15%
b) Population ageing index	5%
Social status	**35%**
a) Unemployment rate	15%
b) Population activity rates	10%
c) Share of social welfare beneficiaries	10%
Educational status	**10%**
a) Share of tertiary educated in the working age population	10%
Economic strength and potential of the local self-government	**20%**
a) Income per capita	10%
b) Budget revenues of local governments per capita	10%
Population density	**5%**
Coefficient for the war-affected areas	**10%**

Source: MRDEUF.

Through Technical Assistance, the MRDEUF aims to strengthen the MDI for a further roll-out through:

a. The identification of appropriate and extended set of indicators for which small-area data is available;
b. Agreement about a set of relevant Domains;
c. The methodological robustness of a Multiple Deprivation Index – including the weighting of different Indicators and Domains;
d. The GIS mapping of this data at the level of municipality to produce interactive maps of Croatia;
e. Training of Ministry officials on updating and enhancing the maps on the GIS system.

4. Europe-Wide Experience with Multidimensional Deprivation Measures

Several European countries (most notably Germany and the UK) have developed indices of multiple deprivation (IMDs). Moreover, Eurostat has engaged in describing the body of EU-wide experiences in designing the IMD, as well as constructing such indicators for EU member states.

In a more global context, the UNDP and Oxford Poverty & Human Development Initiative (OPHI) have developed the Multidimensional Poverty Index (MPI) covering over 100 developing countries. The MPI looks at individual-level poverty, and is based on household survey data. If someone is deprived in three or more indicators out of ten (weighting procedure is applied), the index considers them as poor and the intensity of their poverty is measured by the number of deprivations they are experiencing. There are three dimensions (health, education and living standards) and ten indicators (child mortality, nutrition, years of schooling, school attendance, cooking fuel, toilet, water, electricity, floor and assets) used in the calculation of the index.

Eurostat. Eurostat is engaged in the production of indicators of material deprivation for the EU member states. Material deprivation is understood as a state of economic strain and lack of durable items in the household. It refers to 'the inability to afford some items considered by most people to be desirable or even necessary to lead an adequate life'. The indicators of material deprivation measure the proportion of the population that cannot afford between three and four of the following items: (i) to pay their rent, mortgage or utility bills; (ii) to keep their home adequately warm; (iii) to face unexpected expenses; (iv) to eat meat or proteins regularly; (v) to go on holiday; (vi) a television set; (vii) a washing machine; (viii) a car; (ix) a telephone. Individuals living in households that cannot afford at least three of these nine items are considered to be materially deprived, whereas those living in households that cannot afford at least four are considered to face severe material deprivation.

The material deprivation and severe material deprivation rates are calculated as the proportion of the population unable to pay for at least three and four out of nine items, respectively. The indicators are derived from the EU-SILC datasets and are also available at the NUTS1 or NUTS2 level depending on the country. It is worth noting that these indicators are focused on aspects of material living conditions and do not cover other dimensions of deprivation such as health, employment, education or social participation, nor are they directly linked with policies.

Within a broader scope of material deprivation indicators, Eurostat additionally calculates an indicator of housing deprivation and an indicator on environment of the dwelling. The indicator of housing

deprivation is defined as the percentage of the population living in a dwelling that suffers from (i) a leaking roof, damp walls/floors/foundation, or rot in window frames or floor; (ii) a lack of bath or shower in the dwelling; (iii) a lack of indoor flushing toilet for sole use of the household; and (iv) additional problems with the dwelling (e.g. too dark, not enough light). Proportions are calculated for deprivation in zero, one, two, three or all four dimensions. A separate indicator on the environment of the dwelling refers to the proportion of population living in households that report suffering from noise. These additional indicators are not combined with the original list of nine items of material deprivation.[9]

United Kingdom. The United Kingdom has advanced the most in the development of multiple deprivation indices for small areas. Separate indices are developed and produced for each of four countries in the United Kingdom (England, Wales, Northern Ireland, and Scotland). These country indices share the same concept and general methodology. However, there are differences in the domains, indicators, geographies and time points used in their production. Indices are 'owned' by country governments. Accordingly, the methodology of their construction, results and explanations are made public on government web sites.[10] These indices are aimed at the identification of the most deprived areas. But, as pointed out by the Department for Communities and Local Government, local policy makers and communities can also use them for the effective targeting of resources.

An overview of English Indices of Deprivation for 2015 illustrates well-developed experience in operationalization of multiple deprivation measurement in the EU. [11] The English Indices of Deprivation for 2015 is the fifth release of these measures. Deprivation is depicted by a set of relative measures at the small spatial scale. Small areas or neighborhoods are designed to be of a similar population size, with an average of approximately 1,500 residents or 650 households. These areas are produced by the Office for National Statistics for the purpose of reporting of small area statistics. There were 32,844 such areas in England in 2015. Indices are based on seven Domains of deprivation:

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[9] For the discussion on material deprivation indicators in a EU-level context, see, for example, Fusco, Guio and Marlier (2013) and Guio (2009). Fusco, Guio and Marlier (2013; p 46) comment that "intuitive appeal of these measures can explain their popularity but offers little guidance on their practical implementation, whether for statistical analysis or policy design".

[10] Information on English Indices of Deprivation 2015, https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015; Scottish Index of Multiple Deprivation 2012, http://www.gov.scot/Topics/Statistics/SIMD; Welsh Index of Multiple Deprivation 2014, http://gov.wales/statistics-and-research/welsh-index-multiple-deprivation/?lang=en; Northern Ireland Multiple Deprivation Measure 2010 http://www.nisra.gov.uk/deprivation/nimdm_2010.htm.

[11] The Indices of Deprivation for 2015 is a collective reference for the Index of Multiple Deprivation 2015, domain indices, the supplementary indices, and the higher area geographical summaries.

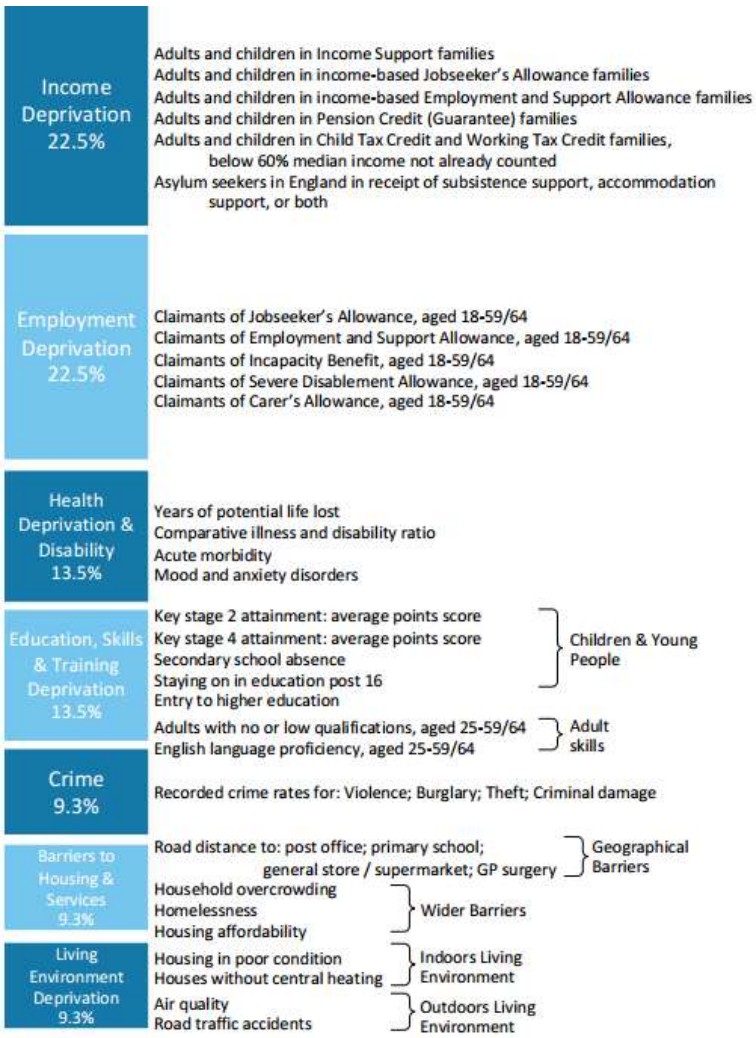
- Income Deprivation;
- Employment Deprivation;
- Education, Skills and Training Deprivation;
- Health Deprivation and Disability;
- Crime;
- Barriers to Housing and Services;
- Living Environment Deprivation.

Each Domain is further elaborated through a set of indicators. The list of indicators is shown in Table 2. Indicators refer to the data from the most recent time point. In the case of the 2015 release, most indicators cover data for the tax year 2012/13. For some indicators, two or three years of data are used to reduce the problem of small numbers or fluctuations between years. Shrinkage procedure was applied at some instances. Shrinkage is the mechanism for estimation of the indicator by using the weighted combination of data from a specific small area, and data from the higher-level area score.

Indicators within each Domain were standardized by ranking and transformed to a normal distribution before combining into Domain score by using weights determined by factor analysis. A slight variation of the above aggregation procedure is applied for some of Domains or Sub-domains.

A summary measure of deprivation, the Index of Multiple Deprivation, combines seven Domain scores by applying fixed weights (Table 2). Within three Domains, there are six Subdomains and scores are produced for them as well. Each index is published in the form of a rank (where 1 is a designation of the most deprived area) and decile indicator (where 1 stands for being among 10% of the most deprived units). In addition to the Index of Multiple Deprivation, there are two supplementary indices: The Income Deprivation Affecting Children Index and the Income Deprivation Affecting Older People Index.

Table 2. Domains, Weights and Indicators for the English Indices of Deprivation in 2015



Source: *Department for Communities and Local Government (2015); p 18.*

Development and production of these indices is based on a firm methodological background and follows extensive research of data sources and quality assurance of these data sources and indicators. For example, particular attention was given to selecting indicators that measure major features of deprivation, are updatable on a regular basis and are domain specific. As part of production process, there was wide range of consultation with various stakeholders, partners and other users. Feedback

from users are very carefully considered.[12] The results of the English Indices of Deprivation are presented in different measures such as average score, average rank, extent and local concentration.

While the IMD is a useful tool for measuring deprivation in England, several limitations should be considered: (1) the published ranks and deciles are purely relative, so the interpretation of the scores is not straightforward. No statistic is cardinal, so comparisons cannot be done on an absolute scale; (2) There are issues concerning dynamic comparisons: while the index for an area is comparable for one year, real comparisons over time are complicated by the relative nature of the index; (3) The data for each of the indicators are not from a single consistent point in time (however, most for the 2015 IMD are from the 2012/13 tax year). Furthermore, the data will always lag somewhat behind the current situation; and (4) because separate indices are produced for England, Northern Ireland, Scotland, and Wales, comparisons between the four are unfeasible.

Scotland. Scottish Index of Multiple Deprivations (SIMD) consists of seven domains and 38 indicators. The domains are; (i) Employment (3 indicators), (ii) Income (6 indicators), (iii) Health (7 indicators), (iv) Education, Skills and Training (5 indicators), (v) Geographic Access to Services (9 indicators), (vi) Crime (6 indicators) and (vii) Housing (2 indicators). The weighting of the domains, as a percentage of the overall weight is, current income (28%), employment (28%), health (14%), education (14%), geographic access (9%), crime (5%) and housing (2%). The index has been updated every two to three years since 2004, with latest version being released in 2012. SIMD 2012 covered 6505 localities and was used by local authorities for monitoring purposes, especially in regards to income and employment deprivations. The underlying frame of the index is based on the methodology developed by the Social Disadvantage Research Centre at the University of Oxford.

Germany. In Germany, area level deprivation at the level of districts was defined by the German Index of Multiple Deprivation (GIMD). The construction of the index was inspired by the work of United Kingdom. It appears that German index is more an academic exercise done by Dr. Werner Maier and his collaborators and is largely used for regional development policies. The first GIMD was produced in 2006 while the second was constructed in 2010. In a number of academic papers, the

[12] For example, for the weighting of the domains to create an overall Index of Multiple Deprivation, three empirical methods for deriving weights suggested switching the weights of the Employment Domain (from 22.5 per cent to 13.5 per cent) and Health and Disability Deprivation Domain (from 13.5 per cent to 22.5 per cent). However, consultations preceding the release of the Indices found that large majority of respondents were in favor of keeping the weights the same. Due to strong user support, the final decision was to remain using the existing weights.

GIMD is related to various health indicators such as obesity, hypertension, and diabetes (for example, Maier et al., 2015).

Turkey. Turkish Socio-economic Development Index ranks 81 provinces according to their socio-economic development levels. It is a single Index created by applying Principle Component Analysis using 61 indicators. Indicators are covering demography, education, health, employment, industry, finance, and other welfare indicators (Table 3). The results are published by the Turkish Ministry of Development.[13]

Table 3. Turkey: Socio-economic Development Index (SEDI), 2003

DEMOGRAPHIC	**AGRICULTURE**
Total Population	Agricultural production value per rural population
Proportion of the Population living in the city	Share of agricultural production in national production
Annual Growth Rate of Population	**CONSTRUCTION**
Population Density	Total number of housing units
Fertility Rate	Proportion of housing unit with piped water
Average household size	**FINANCIAL**
EMPLOYMENT	Share in total gross domestic product
Proportion of the persons employed in agricultural sector	Per capita gross domestic product
Proportion of the persons employed in industrial sector	Number of bank branches
Proportion of the persons employed in commercial sector	Bank deposits per capita
Proportion of the persons employed in financial sector	Share in total bank deposits
Proportion of regular or casual employee	Share in total bank credits
Proportion of regular or casual woman employee	Agricultural credits per rural population
Proportion of employer	Industrial, commercial and tourism credits per capita
EDUCATION	Municipal expenditures per capita
Literacy rate	Consolidated budged revenues per capita
Woman literate rate	Amount of income and corporation tax per capita
Proportion of higher education graduate population	Total public expenditures per capita
Schooling rates in primary education	Per capita amount of investments with incentive certificates
Schooling rates in high school	Total exports per capita
Schooling rates in vocational and technical high school	Total imports per capita
HEALTH	**INFRASTRUCTURE**
Infant mortality rate	Proportion of asphalt road in rural settlements
Number of medical doctors per 10000 person	Proportion of total asphalt road
Number of dentists per 10000 person	Share of population in rural settlements with adequate drinking water supply
Number of pharmacies per 10000 person	**INDUSTRY**
Number of hospital beds per 10000 person	Number of plots in organized industrial estates
OTHER WEALTH INDICATORS	Number of establishments in small industrial sites
Number of private cars per 10000 population	Number of establishments in manufacturing industry
Number of motor vehicles per 10000 population	Annual average number of employees in manufacturing
Total electricity consumption per capita	Capacity of power equipment installed at the end of year
Total telephone counters per person	Per capita value added in manufacturing industry
Share of population having a card for free health services	Per capita electricity consumption in manufacturing industry

Source: Özaslan, Dincer and Özgür (2006).

Moldova. Republic of Moldova uses the EU-SILC methodology and a slightly different version of the indicators used in Eurostat's index to measure material deprivation. The measure focuses on

[13] More information on the construction of the 2003 SEDI index can be found in Özaslan, Dincer and Özgür (2006).

whether households can afford to avoid arrears, face unexpected expenses, keep the house adequately warm, go on holiday for a week, eat protein (if desired), and have a personal car, washing machine, television, and telephone. Those who are able to afford at least three out of the nine items are considered materially deprived and people who cannot afford four out of the nine are deemed to be severely materially deprived. The 2014 estimates from Moldavia's Household Budget survey show that over half of the households are materially deprived.[14]

The different indices presented above, correspond to different countries and are at different levels of aggregation. Some are at the household level (Material Deprivation from Eurostat), while others are at a small area level (English Indices of Deprivation), yet all aim to capture standards of living of a population. In some instances, the interpretation of the index is not straightforward, and the index may not be comparable across time. While the Eurostat's material deprivation index may be useful for assessing deprivation at a national level, it has little relevance for small geographical areas. A desirable index should be comparable across time and space, as well as hold relevance for small geographical areas.

5. Proposal for Croatia's Revised Index of Multiple Deprivation

There is a considerable body of research on poverty and social exclusion in Croatia. The conclusions are very similar across sources: worse-than-average living standards in Eastern and Central Croatia are related to the poorer labor market outcomes of workers in these regions. Some, but by no means all, of the earnings differences across regions are explained by differences in workers' own underlying characteristics. [15] The impact of education on an individual's likelihood of finding a job is highest in the Eastern region, followed by the Adriatic South. Both these regions have among the lowest employment and highest unemployment rates in Croatia. Closer examination of workers' human capital endowments, proxied by their years of schooling or their highest educational attainment—reveals considerable variation in average attainment levels across regions. For example, workers in Zagreb have at least one year more of education, on average, than workers in the Eastern and Central regions.

[14] Bureau of The Conference of European Statisticians (2016) - Guide on Poverty Measurement (2016) Box 4.4 – Material Deprivation in the Republic of Moldova
[15] World Bank (2006) Croatia: Living Standards Assessment – Promoting Social Inclusion and Regional Equity

While a large part of the regional inequalities are explained by human capital endowment, the differences in characteristics across regions are also very important. The World Bank 2006 Living Standards Assessment showed that around 28 – 35 percent of the overall average wage differential between the Zagreb and Adriatic regions on the one hand, compared to the Central region on the other hand (which is mostly contained by the Eastern part of the country), can be attributed to individual characteristics of workers, such as higher educational attainment. However, 65 to 72 percent of the observed wage differentials across regions are explained only by "other regional factors." Adjusting for differences in worker characteristics across the public and private sectors increases the explanatory part to about 36–59 percent of the observed wage differential among regions. Since the share of employment in public sector firms tends to also be higher in the Zagreb and Adriatic regions, this may be partly responsible for the observed inequalities in earnings across regions.

Lagging regions have received much attention and concern from public policymakers across the world, but especially in Europe, where substantial European Structural and Investment (ESI) funds have been used in an effort to reduce regional inequalities and build cohesion. Lagging regions often have many similar features: slow economic growth, high unemployment and poverty, low efficiency and productivity, little external trade, and generally low fiscal capacity for local redistribution. In addition, they often share several physical characteristics, including being landlocked, having outdated industries, and often lacking (or having exhausted) natural resources. But while policymakers agree on the need for public intervention to tackle regional inequalities in living conditions, much less agreement prevails on how best to do this, even within relatively similar countries. For Croatia, regional development is an important element of the policy agenda, especially as extensive EU grants are available to help the country's lagging regions catch up, to support economic and social convergence in areas facing structural difficulties, and to modernize systems of training to promote employment.

A key requirement for better social and economic development planning and monitoring will be to develop a statistical database and a system for gathering the necessary reliable statistics. While the Central Bureau of Statistics is setting in place a framework for collecting more disaggregated statistics, information is not commonly collected on socioeconomic and demographic characteristics at LAU2 level. Even estimating poverty incidence at the regional level in Croatia is challenging, because the

total sample size of the Household Budget Survey within each county is too small to yield estimates with the desired level of precision. [16]

The development of the Index of Multiple Deprivations for small areas (LAU2) is based on available socioeconomic data and data on access to infrastructure from a variety of sources. The principal sources are selected administrative registries, the Central Bureau of Statistics, and the 2011 Census of Population, Housing, and Dwellings. The Index of Multiple Deprivations is designed as a complement to the information on monetary poverty from the poverty mapping exercise.[17]

A proposed IMD (Figure 1) is based on three Domains of deprivation:

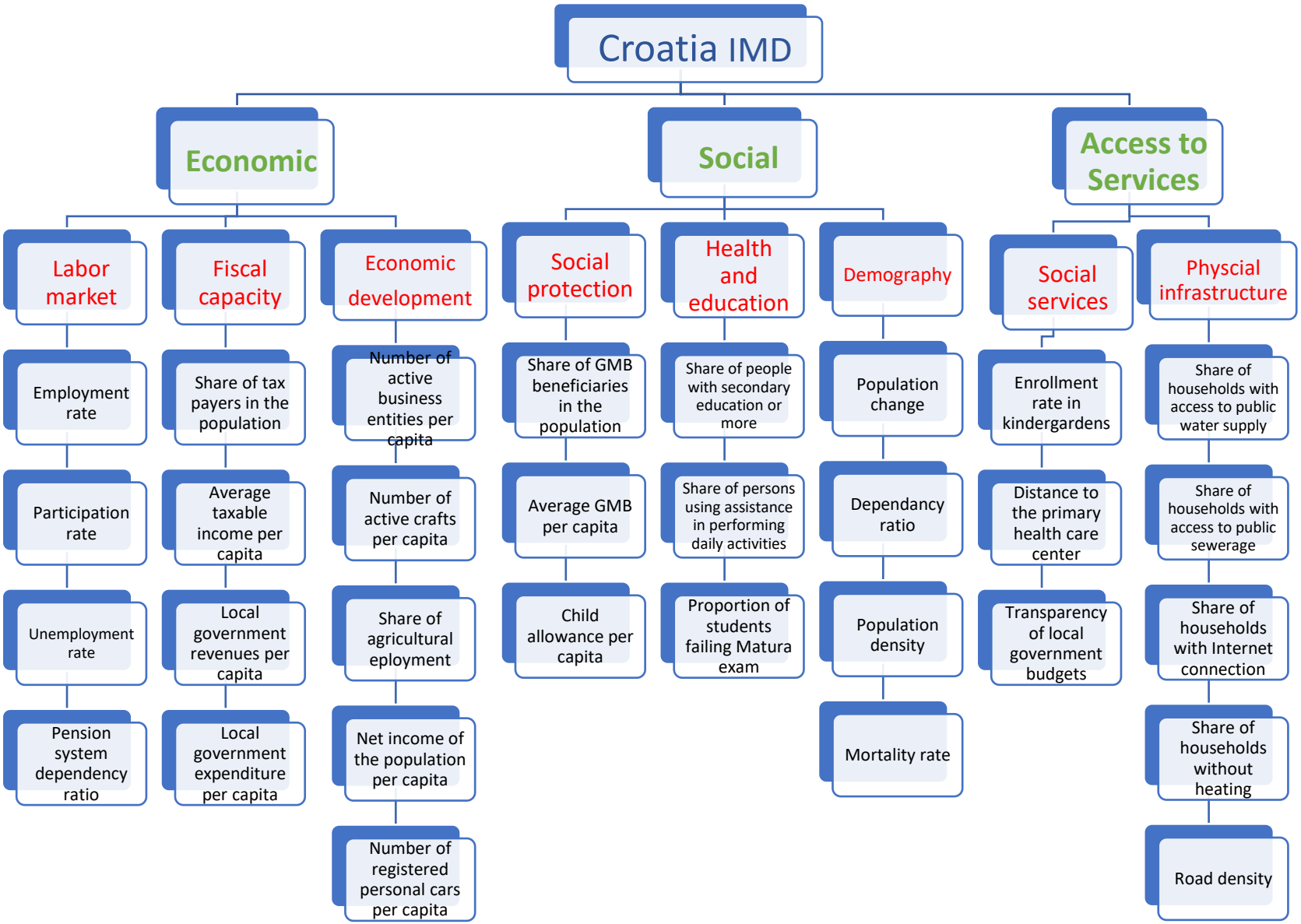
- Economic Deprivation;
- Social Deprivation;
- Access to Services Deprivation

The three domains, along with their respective subdomains, were chosen to reflect deprivations that can be addressed by municipalities through the examination of separate indicators and their overlap.

[16] For purposes of the index, consumption poverty is chosen due to the many drawbacks of income measurement. When informality and agriculture are widespread consumption poverty is a preferable measure. Consumption in more developed countries tends to be smoothened out, and information from short periods of time provide a relevant picture for a household's status.

[17] http://www.dzs.hr/ENG/DBHomepages/Personal%20Consumption%20and%20Poverty%20Indicators/Methodology_HBS_WB.pdf

Figure 1 Proposed Framework for the Croatia Index of Multiple Deprivation



Each Domain is further elaborated through a set of eight Subdomains. The list of Domains, Subdomains and Indicators is shown on Table 4. Indicators refer to the data from the most recent time point. Most indicators cover data for the 2011-15 period (Table 4) and there is a large panel of those used for development of the abbreviated IMD for the pilot areas. For some indicators, three years of data are used to reduce the fluctuation problem. Indicators selected are published on an annual basis and are available at the LAU2 level. Some important indicators considered for inclusion were not available; for example, the illiteracy rate was excluded due to many missing data at the household level, thus it was not possible to construct reliable LAU2 level data. Health-related indicators were also largely unavailable at the LAU2 level. However, several other indicators were used after careful consideration. For example, car registration, adult population with secondary education and higher, and students failing the Matura exam all showed a significant correlation with monetary poverty.

6. Methodology for construction of the IMD

There are many choices that one can make when designing an index. Such choices can be methodologically justified only if the user has a clear understanding on the expected use of the final measure, in this case the IMD. An index designed with the exclusive purpose to identify deprived or lagging regions, might choose certain indicators, standardization methods and aggregation procedures that will be significantly different from a measure that was designed with the explicit objectives to monitor or evaluate the implementation of a intervention. In this work, the guiding principles use for the production of the IMD was to design a measure that could be used to **identify** deprived or lagging region, to **assess** the nature of that deprivation and facilitate the diagnosis on the nature of interventions required, and **monitor** the implementation of the development strategies.

Critical concepts

Since Sen (1976), the measurement of poverty and other deprivations has been conceptualized under the following two main steps: identification of who the poor are, and aggregation of the information about poverty across society.

In a unidimensional space, the identification of who is poor is relatively straightforward: the poor are those whose overall achievement or resources fall below the poverty line U_z, where the subscript z simply signals that this is a poverty line used in the unidimensional space.

A common first step in multidimensional assessment in several of the methodologies requires defining a threshold in each indicator. Such a threshold is the minimum level someone needs to achieve in that dimension to be non-deprived. It is called the deprivation cutoff.

In the particular case in which weights are equal and sum to the number of dimensions, the score is simply the number of deprivations or deprivation counts that the municipality experiences. Whenever weights are unequal but sum to the number of dimensions, locality l's deprivation score is defined as the sum of its weighted deprivation counts.

Table 4. Croatia: Proposed Indicators for the Multiple Deprivation Index (IMD)

Domain	Subdomain	Indicator	Source
Economic	Labor Market	Employment rate	Tax administration, Croatian Bureau of Statistics
Economic	Labor Market	Participation rate	Tax administration, Employment Service
Economic	Labor Market	Unemployment rate	Tax administration, Employment Service
Economic	Labor Market	Pension system dependency ratio	Tax administration
Economic	Fiscal capacity	Share of taxpayers in the population	Tax administration, Croatian Bureau of Statistics
Economic	Fiscal capacity	Average taxable income per capita	Tax administration, Croatian Bureau of Statistics
Economic	Fiscal capacity	Local government revenues per capita	Ministry of Finance, Croatian Bureau of Statistics
Economic	Fiscal capacity	Local government expenditure per capita	Ministry of Finance, Croatian Bureau of Statistics
Economic	Economic development	Number of active business entities per capita	Croatian Bureau of Statistics
Economic	Economic development	Number of active crafts per capita	Croatian Bureau of Statistics
Economic	Economic development	Share of agricultural employment	Ministry of Agriculture, Croatian Bureau of Statistics
Economic	Economic development	Net income of the population per capita	Tax administration, Croatian Bureau of Statistics
Economic	Economic development	Number of registered personal cars per capita	Ministry of Interior, Croatian Bureau of Statistics
Social	Social protection	Share of GMB beneficiaries in the population	Ministry of Demography, Family, Youth and Social Policy, Croatian Bureau of Statistics
Social	Social protection	Average GMB per capita	Ministry of Demography, Family, Youth and Social Policy, Croatian Bureau of Statistics
Social	Social protection	Child allowance per capita	Croatian Pension Insurance Institute, Croatian Bureau of Statistics
Social	Health and education	Share of people with secondary education or more	Croatian Bureau of Statistics
Social	Health and education	Share of persons using the assistance in performing daily activities	Croatian Bureau of Statistics
Social	Health and education	Proportion of students failing Matura exam	National Centre for External Evaluation of Education, Croatian Bureau of Statistics
Social	Demography	Population change	Croatian Bureau of Statistics
Social	Demography	Dependency ratio	Croatian Bureau of Statistics
Social	Demography	Population density	Croatian Bureau of Statistics
Social	Demography	Mortality rate	Croatian Bureau of Statistics
Physical	Social services	Enrollment rate in kindergartens	Croatian Bureau of Statistics
Physical	Social services	Distance to the primary health center	Croatian Health Insurance Fund
Physical	Social services	Transparency of local government budgets	Institute of Public Finance
Physical	Physical infrastructure	Share of households with access to public water supply	Croatian Bureau of Statistics
Physical	Physical infrastructure	Share of households with access to public sewage	Croatian Bureau of Statistics
Physical	Physical infrastructure	Share of households with Internet connection	Croatian Bureau of Statistics
Physical	Physical infrastructure	Share of households without central heating	Croatian Bureau of Statistics
Physical	Physical infrastructure	Road density	OpenStreetMap, Croatian Bureau of Statistics

Data Availability and Selection of indicators

Constructing a multi-dimensional measure such as the IMD is a data hungry process since each indicator has to be available for all units of observation across multiple years. Ideally, the index should have indicators that cover every type of deprivation that fall under an exhaustive list of domains. However, the data availability in Croatia (a constraint that exists for every country to a different extent) limits the pool of statistics that can be used, the construction of the indicators, and the unit of observation.

Since there is no household survey representative at the municipal level, and contains all the necessary variables for a multiple deprivation index, a combination of administrative data, census data and small area estimation was used to consolidate a database of 53 indicators selected from an original pool of over 200 indicators.[18] The final index consists of 31 of these indicators.

The main criteria to select this subset was the prioritization of indicators produced from administrative records that could be updated on a yearly basis as well as the correlation of those variables with monetary poverty (see table Table 5 and Table 6 for details). The main reason for this choice was the need to create a measure that could be used to monitor and evaluate the implementation of the resources allocated to the regions which identified as deprived. Given these objectives, it was critical to prioritize data sources from which indicators could be frequently updated. However, it was not possible to select only indicators that could be updated annually, and 8 of the final indicators were produced through the population census, which is only updated every 10 years[19].

Given the emphasis on monitoring and evaluation, it was also important to identify indicators that would be more closely associated to expected outcomes and outputs for the expected interventions, and not just simple inputs.

[18] Indicators were selected based on their overall correlation to consumption poverty at the municipal level.
[19] Croatia still uses a de facto population census, while many EU member states such as Slovenia, have already adopted an administrative record based Population Census which can be updated on an annual basis

Table 5. Summary of selected indictors by Type, Periodicity, Domain, Subdomain and Source

Domain	Subdomain	Source	Outcome		Output		Input		Total
			10 years	Yearly	10 years	Yearly	Continuously	Yearly	
Economic	Labor Market	Tax administration, Croatian Bureau of Statistics		2					2
		Tax administration, Employment Service		1					1
		Tax administration				1			1
	Fiscal capacity	Tax administration, Croatian Bureau of Statistics				2			2
		Ministry of Finance, Croatian Bureau of Statistics				2			2
	Economic development	Croatian Bureau of Statistics						2	2
		Ministry of Agriculture, Croatian Bureau of Statistics		1					1
		Tax administration, Croatian Bureau of Statistics		1					1
		Ministry of Interior, Croatian Bureau of Statistics		1					1
Social	Social protection	Ministry of Demography, Family, Youth and Social Policy, Croatian Bureau of Statistics					2		2
		Croatian Pension Insurance Institute, Croatian Bureau of Statistics				1			1
	Health and education	Croatian Bureau of Statistics	1		1				2
		National Centre for External Evaluation of Education, Croatian Bureau of Statistics				1			1
	Demography	Croatian Bureau of Statistics		3	1				4
Physical	Social services	Croatian Bureau of Statistics				1			1
		Croatian Health Insurance Fund					1		1
		Institute of Public Finance						1	1
	Physical infrastructure	Croatian Bureau of Statistics			4				4
		OpenStreetMap*, Croatian Bureau of Statistics			1				1
Total			1	9	7	8	3	3	31

*Indicator Road Density is currently only available for 2016, and therefore listed under 10 Years but can be updated more frequently going into the future.

To test for robustness of the specification, two models for the IMD were used. The first one, Model 1, used 31 core indicators and when possible, used the three-year moving average of indicators for which data is available. The second specification, Model 2, used only annual values, and was primarily used to check the robustness of the result.

Table 6. Correlation of selected indicators with Monetary Poverty (Income and Consumption) for 2015 (3-year average)

Domain	Subdomain	Indlabel	Indtype	Cons FGT0	Cons FGT1	Cons FGT2	Inc FGT0	Inc FGT1	Inc FGT2
Economic	Economic development	Net income of the population per capita	Outcome	-0.565	-0.565	-0.554	-0.713	-0.684	-0.660
		Number of active business entities per capita	Input	-0.532	-0.489	-0.455	-0.520	-0.480	-0.452
		Number of active crafts per capita	Input	-0.542	-0.516	-0.492	-0.431	-0.414	-0.400
		Number of registered personal cars per capita	Outcome	-0.585	-0.575	-0.558	-0.693	-0.665	-0.641
		Share of agricultural employment	Outcome	0.431	0.433	0.426	0.359	0.349	0.340
	Fiscal capacity	Average taxable income per capita	Output	-0.577	-0.575	-0.562	-0.715	-0.683	-0.659
		Local government expenditure per capita	Output	-0.380	-0.346	-0.324	-0.324	-0.303	-0.290
		Local government revenues per capita	Output	-0.534	-0.494	-0.463	-0.461	-0.436	-0.417
		Share of taxpayers in the population	Output	-0.496	-0.487	-0.474	-0.604	-0.584	-0.569
	Labor Market	Employment rate	Outcome	-0.574	-0.577	-0.566	-0.716	-0.695	-0.673
		Participation rate	Outcome	-0.136	-0.140	-0.140	-0.257	-0.229	-0.211
		Pension system dependency ratio	Output	0.325	0.327	0.318	0.382	0.382	0.370
		Unemployment rate	Outcome	0.689	0.692	0.680	0.779	0.780	0.768
Social	Demography	Dependency ratio	Outcome	0.267	0.278	0.276	0.329	0.323	0.313
		Mortality rate	Outcome	0.341	0.334	0.321	0.271	0.257	0.242
		Population density	Output	-0.195	-0.185	-0.175	-0.209	-0.187	-0.173
		Population change	Outcome	-0.418	-0.401	-0.379	-0.410	-0.404	-0.390
	Health and education	Proportion of students failing Matura exam	Output	0.292	0.282	0.269	0.313	0.295	0.280
		Share of people with secondary education or more	Output	-0.622	-0.622	-0.613	-0.579	-0.561	-0.547
		Share of persons using the assistance in performing daily activities	Outcome	0.495	0.481	0.458	0.756	0.718	0.684
	Social protection	Average GMB per capita	Input	0.524	0.549	0.556	0.573	0.603	0.614
		Child allowance per capita	Output	0.579	0.568	0.550	0.580	0.563	0.548
		Share of GMB beneficiaries in the population	Input	0.436	0.436	0.430	0.559	0.575	0.575
Physical	Social services	Enrollment rate in kindergartens	Output	-0.442	-0.426	-0.407	-0.506	-0.472	-0.446
		Transparency of local government budgets	Input	-0.149	-0.143	-0.137	-0.218	-0.196	-0.183
		Distance to the primary health center	Input	0.099	0.107	0.107	0.198	0.181	0.167
	Physical infrastructure	Road density	Output	-0.116	-0.132	-0.137	-0.223	-0.221	-0.214
		Share of households with access to public sewage	Output	-0.330	-0.308	-0.288	-0.359	-0.326	-0.305
		Share of households with access to public water supply	Output	-0.322	-0.323	-0.319	-0.390	-0.375	-0.362
		Share of households with Internet connection	Output	-0.585	-0.571	-0.551	-0.550	-0.524	-0.502
		Share of households without central heating	Output	-0.149	-0.155	-0.148	-0.373	-0.348	-0.324

Standardization

Once indicators are selected, these must be standardized to make them comparable. Indicators are selected based on data relevance, availability, and quality. In this case, to increase the robustness of the IMD with respect to the presence of outliers and to facilitate the interpretation of our score by domains, subdomains and indicators, we standardize our indicators by the **percentile rank** of the municipalities. This indicator varies between 0 and 1, where 1 shows that the municipality is in the top 1 percent of deprivation for all municipalities in Croatia for this indicator, and conversely, 0 means that the municipally is in the bottom 1 percent of all municipalities of the country.

Most composite indices suffer from a dimensionality problem, given that different indicators are defined using distinct units, such as rates, densities, shares, or levels. Given those differences, it is critical to adopt a method to standardize all indicators towards a comparable dimension before

aggregating them. Given this objective, the team has explored multiple alternatives, and recommends the use of the percentile rank approach.

The main advantage of the rank percentiles approach is the accessibility of the results to multiple stakeholders such as policy makers, politicians, journalists, and experts; it is widely used both in the academic and corporate world, and provides an immediate interpretation on how each individual unit relates to a larger group. These are critical aspects to jumpstart reforms based on this indicator. Moreover, the percentile rank approach has a few technical advantages, such as: (1) Percentiles are not as strongly influenced by extreme values of the distribution; (2) They do not depend on the choice of specific probability density functions in comparison to the arithmetic mean and standard deviation, which require normally distributed data; and (3) Percentiles can be calculated even if data is skewed.

The main caution that one needs to keep in mind when interpreting percentile ranks is that although a municipality might occupy the very last place in the ranking (e.g., 1), this does not mean that it has a suboptimal level for this indicator. The position in the distribution simply ranks each municipality's level compared to others in the country.

Table 7 shows a simple numerical illustration of a country with 6 municipalities (i.e. A to F), for which we are building a multidimensional index based on 6 indicators (i.e. I1 to I6). As the example shows these different indicators have quite different scales, which reflect the fact that some of them are expressed in levels, others in shares, and others in ratios. The first step of any standardization is to make sure that all indicators have the same interpretation with respect to the concept that it tries to measure, in this case deprivation. The Croatian IMD could empirically drive this assessment given the availability of a recent poverty map, which was used to access the correlation of each indicator with respect to poverty (as presented in Table 6). This information is then used to define whether a high value is presumed to be a good indicator or a bad one, depending on the indicator's relationship to poverty. For example, high unemployment and high number of educated individuals, must be differenced when ranking municipalities based each indicator. A high value on unemployment will be related to high poverty, and thus considered to be in the upper percentiles of that deprivation. On the other hand a high value of educated individuals may be related to low poverty and thus the municipality will be in the lower percentiles of deprivation.

Table 7. Absolute Value of Indicators and Empirical Correlation with the Poverty Map

Indicator

Municipality	*I1*	*I2*	*I3*	*I4*	*I5*	*I6*
A	10	5	23.2	0.89	0.89	-0.9
B	8	5	34.6	0.1	0.1	-0.7
C	4	5	10.5	1	1	0.7
D	3	8	34.9	0.34	0.34	0.2
E	1	3	45.5	0.23	0.23	0.4
F	0.5	3	28	0.45	0.65	-0.3

Correlation with Poverty

I1	*I2*	*I3*	*I4*	*I5*	*I6*
-0.4	0.8	0.6	0.4	-0.1	0.03

Order (1=Positive; 0 Negative)

I1	*I2*	*I3*	*I4*	*I5*	*I6*
0	1	1	1	0	1

Using the Percentile Rank formula presented in Equation 1, all values presented in Table 7 were converted to a Percentile Rank. Table 8 shows final values for the percentile ranks of each municipality in our illustration. The percentile rank of an absolute value can be interpreted as the percentage of values in its distribution that are equal to or lower than it. For example, a municipal unemployment rate that is greater than or equal to the unemployment rate of 75% of Croatian municipalities is said to be at the 75th percentile, or 0.75 percentile rank. Percentile ranks indicate the percentage of municipalities that rank lower than the indicated municipality, so that higher values indicate worse level of deprivation, and will always fall between 0 and 1.

Equation 1. Percentile Rank Formula

$$PR = \left(\frac{X_p}{n} \right) 100$$

PR= Percentile Rank. The answer will be a percentage

$\mathbf{X_p}$= The position of the score within the distribution. Begin with the lowest value and count the number of cases until reaching the score under consideration. Be sure to include the

score under consideration and all those of equal value when determining $\mathbf{X_p}$

n= The total number of cases in the distribution

Table 8. Rank and Percentile Rank of Absolute Values presented in Table 7

	Rank						**Percentiles**					
	I1	*I2*	*I3*	*I4*	*I5*	*I6*	*I1*	*I2*	*I3*	*I4*	*I5*	*I6*
A	1	3	2	5	2	1	0.0	0.4	0.2	0.8	0.2	0.0
B	2	3	4	1	6	2	0.2	0.4	0.6	0.0	1.0	0.2
C	3	3	1	6	1	6	0.4	0.4	0.0	1.0	0.0	1.0
D	4	6	5	3	4	4	0.6	1.0	0.8	0.4	0.6	0.6
E	5	1	6	2	5	5	0.8	0.0	1.0	0.2	0.8	0.8
F	6	1	3	4	3	3	1.0	0.0	0.4	0.6	0.4	0.4

Identification and Aggregation

Given the interest in a **measure of deprivation**, the next step is to **censor each indicator** with respect to a cutoff value below which a municipality would be **identified as deprived** in that indicator. Cutoff values can be **absolute or relative**. Given our unit of the analysis, municipalities, it might be hard to think about a natural cutoff value, unless those are linked with policy targets (which could be introduced in the future). Hence, we have chosen at this stage a **relative cutoff** (median value of each indicator) (Table 9). From a policy point of view, the justification can be that those are municipalities in the bottom half of the country's distribution in that indicator.

Table 9. Cut-off Value for Each indicator

Cutoff (Relative [median])					
I1	*I2*	*I3*	*I4*	*I5*	*I6*
0.5	0.5	0.5	0.5	0.5	0.5

Once the indicator's cutoffs are chosen and applied to each indicator matrix, we move to the aggregation of the indicator. This is the last step, and is motivated by the fact that we are not simply interested in deprived municipalities, but on systematically deprived municipalities. The simplest way to aggregate the index of multiple deprivation is by counting the number of deprivation or taking the average of indicators in which a municipality is deprived. Table 10 illustrates the matrix of deprivations. The outcome is a product of rank percentiles presented in Table 8, converted into a matrix of deprivation after we apply the cutoff values presented in Table 9.

Correlation to poverty informs the direction of deprivation. If correlation of an indicator to poverty is negative, it suggests that higher values for that indicator are preferred. Consequently, if an indicator's

correlation to poverty is negative, an area will be considered deprived if the indicator's percentile rank is below the cutoff value. Thus, a municipality is considered deprived (I[x]=1) if any value is below 0.50 (below the cutoff in the case of negative correlation to poverty, above the cutoff if the correlation is positive), and non-deprived (I[x]=0) if the indicator is above the cutoff value of 0.50 (in the case of negative correlation to poverty, below the value if the correlation is positive). The final aggregation is presented in the last two columns and can be represented as a count or an average.

Table 10. Matrix of Censored Deprivation

	Matrix of Deprivation (Censored)						**Deprivation count**	**Deprivation Average**
	I1	*I2*	*I3*	*I4*	*I5*	*I6*		
A	1	0	0	1	1	0	3	0.50
B	1	0	1	0	0	0	2	0.33
C	1	0	0	1	1	1	4	0.67
D	0	1	1	0	0	1	3	0.50
E	0	0	1	0	0	1	2	0.33
F	0	0	0	1	1	0	2	0.33

One alternative approach is to report the **average deprivation gap**, which is computed as the **average distance of the percentile of each indicator in respect to its cutoff** for each deprived indicator. As before, this indicator can be weighted or not. The main difference of this approach, is that it makes the final index sensitive to the fact that **not all municipalities are equally deprived**, as some of them will be on average close to the cutoff value, while others are much farther from the cutoff value. Finally, we consider the **Average Deprivation Gap Squared**. In this case, the average deprivation gap, as previously defined, is squared. The main purpose of the procedure is to further **increase the sensitivity** of the final index to the differences on the level of deprivation among the selected municipalities.

Under the average deprivation gap method, the index is the average of, not only the number of deprivations, but of the average distance (or average distance squared) that a municipality is from the deprivation cutoff value presented in Table 9. The main difference between the Gap (Table 11) and Gap Squared (Table 12) measures is that the latter assigns greater weight to those municipalities which are more severely deprived. From a policy and communication perspective, we recommend the use of the Deprivation Gap measure, as it is a good compromise between being distributionally sensitive and easy to communicate.

Table 11. Matrix of Censored Deprivation Gap

	Matrix of Gap (Censored)						Deprivation gap
	I1	*I2*	*I3*	*I4*	*I5*	*I6*	
A	0.5	0.0	0.0	0.3	0.3	0.0	0.18
B	0.3	0.0	0.1	0.0	0.0	0.0	0.07
C	0.1	0.0	0.0	0.5	0.5	0.5	0.27
D	0.0	0.5	0.3	0.0	0.0	0.1	0.15
E	0.0	0.0	0.5	0.0	0.0	0.3	0.13
F	0.0	0.0	0.0	0.1	0.1	0.0	0.03

Table 12. Matrix of Censored Deprivation Gap Squared

	Matrix of Gap Squared (Censored)						Deprivation gap squared
	I1	*I2*	*I3*	*I4*	*I5*	*I6*	
A	0.3	0.0	0.0	0.1	0.1	0.0	0.07
B	0.1	0.0	0.0	0.0	0.0	0.0	0.02
C	0.0	0.0	0.0	0.3	0.3	0.3	0.13
D	0.0	0.3	0.1	0.0	0.0	0.0	0.06
E	0.0	0.0	0.3	0.0	0.0	0.1	0.06
F	0.0	0.0	0.0	0.0	0.0	0.0	0.00

Weighting of Indicators

The weighting mechanism of any multi-dimensional measure is a significant step with clear implications on the final ranking. Ideally, weights should correctly assign the intrinsic or conceptual value of indicators. Depending on the objective of the index, certain indicators could be weighted disproportionally to emphasize areas of concern or importance in a country. The communication of this weighting process, which impacts the presentation of the index, is another important factor to consider. Complicated weighting schemes can decrease the interpretability of results and the applicability of the measure from a policy making perspective.

The IMD uses a two-tiered weighting mechanism that assigns equal weights to each domain, and equal weights to every subdomain within a given domain. Conceptually, this allocation gives equal importance to Economic, Social and Access to services spheres which is aligned with the index's scope to comprehensively measure welfare in a straightforward manner that can be used by municipal authorities. The equal weight assignment to subdomains within each domain is motivated by the

distinct and complimentary nature of subdomains which theoretically have similar levels of importance. However, indicators within a sub-domain with more indicators carry a lower weight.

For example, in the public services domain, social services and physical infrastructure subdomains contain thematically different indicators that are all crucial for the proper functioning of the local government. The two-tier weighting arrangement results in indicators with different weights which makes the decomposition of the final product less straightforward. However, since the number of indicators do not substantially vary between the subdomains, and the quantity of subdomains is generally even, the discrepancy of weights at the indicator level is not unreasonable.

The main motivation for this choice of weights is to provide equal importance to the actions of all different line ministries that will ultimately be responsible for managing the interventions likely to impact the different domains and subdomains.

Table 13. Matrix of Weighted Censored Deprivation

Matrix of Deprivation (Censored)

	Domain 1a		Domain 2a				**Deprivation count**	**Weighted deprivation Average**
	I1	*I2*	*I3*	*I4*	*I5*	*I6*		
A	1	0	0	1	1	0	3	0.50
B	1	0	1	0	0	0	2	0.38
C	1	0	0	1	1	1	4	0.63
D	0	1	1	0	0	1	3	0.50
E	0	0	1	0	0	1	2	0.25
F	0	0	0	1	1	0	2	0.25
Domain weight	0.5		0.5					
Indicator weight (total)	0.25	0.25	0.125	0.125	0.125	0.125		

As an example, assume that indicators 1 and 2 in Table 10 belong to one domain (1a), and indicators 3, 4, 5, and 6 belong to another domain (2a). Each domain has an equal weight of ½. Within each domain every indicator carries an equal weight, hence indicators in domain 1a will each have a weight of ½; and their weight in the total IMD will be of ¼. For domain 2a, every indicator will have a weight of ¼, and their weight in the total IMD will be of 1/8th. Table 13 presents the resulting count deprivation index once weights are included.

Temporal Comparisons and the use of Anchored Percentiles Rank

IMD standardization relies on percentile ranks to overcome the problem of the dimensionality across different indicators. As such, for any given indicator, the value attributed to each municipality is converted to their relative position in the municipal percentile rank of the indicator. It is important to note that each percentile rank of any given indicator is associated with an absolute cut off value for each specific percentile. Using a traditional percentile rank approach would be problematic from a temporal perspective given its relative nature, which could mask important absolute improvements over time that would not be reflected on the percentile rank measure.

To tackle this issue, we have chosen to anchor (or fix) the absolute cut-off values of each percentile rank, for any given indicator to a point in time (e.g. 2011; or the moving average between 2009-2011). This method has the advantage of allowing the use of the percentile rank standardization of the indicator, while persevering the ability to measure progress over time. From an interpretation point of view, it is important to note that any anchored percentile rank measure should be interpreted in terms of the performance vis-à-vis the reference year, while preserving comparisons for any given year. For example, if the cut-off (the median municipal value) in 2011 for unemployment is 20 percent, a municipality with an unemployment above that value in any year will be considered deprived.

Table 14 provides a numeric example of the concept of an anchored percentile rank. For illustration purposes, one can simulate the temporal variation of an IMD indicator (single dimension) between 2011 and 2013 for a group of municipalities. For both years (Panel 1 and Panel 2), we report the value as well as year specific rank, percentile rank and IMD (using a cutoff of 0.5). Panel 3 presents the value of the 2011 Anchored Percentile Rank using the 2013 values, and the resulting IMD for 2013 using this anchored percentile rank. Panel 4 shows the change of the IMD using both the Relative and the Anchored Relative approaches. First, it is important to notice that during the period, the average value of the indicator dropped from 35% to 5%. This is a massive reduction; however, not all municipalities moved in the same direction. While municipalities A and H increased their value (worsening of the indicator) all other municipalities are better or remained at the same level of the indictor of interest. The main difference between the Anchored and Relative approaches can be found precisely for the values of Municipalities A and H, which in 2013 had an indicator value of 31% and 11%. Using the percentile rank of 2013, these municipalities were on the 1.00 and 0.88 rank percentiles, and 0.63 and 0.50 anchored rank percentiles, respectively. Thus, the IMD for 2011 (Gap measures) is 0.16 and if we use the relative rank percentile measure, the equivalent IMD for 2013 is 0.11. Meanwhile, the same

IMD measure for 2013, using the rank percentile anchored using 2011 cut-off values, drops to 0.02. This numeric example demonstrates the importance of using the anchored rank percentile when the objective is to monitor progress over time.

Table 14. Numerical Illustration of the impact of the change of the percentile rank and anchored percentile rank between 2011 and 2013 for simulated municipalities.

	Panel 1				Panel 2				Panel 3		Panel 4	
Municipality	2011				2013				2013 in anchored in 2011		Change	
	Value	Rank	Percentile Rank	Relative IMD	Value	Rank	Percentile Rank	Relative IMD	Anchored Rank Percentile	IMD	Relative IMD	Anchored IMD
A	11%	4	0.50	0.00	31%	8	1.00	0.50	0.63	0.13	-0.50	-0.13
B	31%	5	0.63	0.13	0%	1	0.13	0.00	0.13	0.00	0.50	0.50
C	51%	6	0.75	0.25	0%	1	0.13	0.00	0.13	0.00	0.63	0.62
D	9%	3	0.38	0.00	0%	1	0.13	0.00	0.13	0.00	0.25	0.25
E	78%	7	0.88	0.38	0%	1	0.13	0.00	0.13	0.00	0.75	0.75
F	100%	8	1.00	0.50	0%	1	0.13	0.00	0.13	0.00	0.88	0.87
G	0%	1	0.13	0.00	0%	1	0.13	0.00	0.13	0.00	0.00	-0.01
H	0%	1	0.13	0.00	11%	7	0.88	0.38	0.50	0.00	-0.75	-0.38
Averages	35%		0.55	0.16	5%		0.33	0.11	0.24	0.02	0.22	0.31

7. Using the IMD to Identify, Assess and Monitor the implementation of interventions on deprived regions

As mentioned above, the guiding principle followed on the design of the IMD was to create a multidimensional index to measure the level of deprivation at the municipal level. Its main purpose is to facilitate the identification of priority areas, help the assessment of types of deprivation faced by each municipality in terms of the domains and subdomains, and to monitor over time how much improvement is achieved.

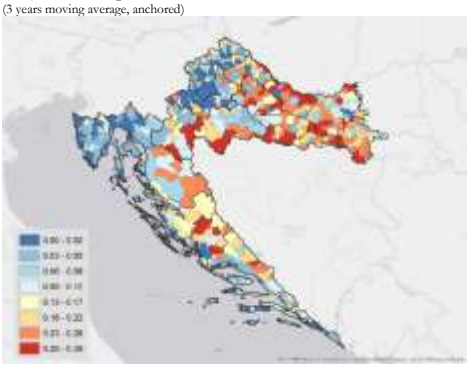
The most obvious and natural example of use of the IMD is to identify deprived and lagging regions. In this respect the analyst can focus on either the spatial nature of the indicator. Much of the interactive dashboards has been produced with that application in mind (see Annex 1 and webinars online). Regarding the spatial-temporal patterns of multiple deprivation, Figure 2, reports the IMD Gap score using the three years moving average of the 2011 anchored percentiles both for the 2009-2011 period (Figure 2.a.1) and 2013-2015 period (Figure 2.a.2). The individual scores of the IMD can be used either in a continuous, as the direct value of the indicator, or a categorical form, as MRDEUF have used its Regional Development Index by grouping the indicator in a few categories of choice.

It is also possible to use the same measures to identify the patterns of spatial agglomeration of deprivation in Croatia, in which case the focus is no longer on the scores or categories of such scores but on the spatial weighted value of the index, and to what extent it is above or below the national average. Figures 2.b.1 and 2.b.2 show in red the areas in a hot spot, meaning with a spatial weighted IMD value statistically significantly below the national average, and in blue the regions in which the spatial weighted IMD is statistically significant above the national average (Box 1 introduces the method used). In the context of this exercise, municipal scores will be affected not only by the deprivation of itself, but by its neighbors, given that social-economic opportunities are likely to differ depending on the externalities of being in buoyant or depressed region. Such approach can also be of use when designing certain types of interventions in which positive externalities are likely to take place. In those circumstances, policy makes might want to define the catchment area of each interventions on be basis of agglomeration patterns which would allow the maximum internalization of any positive externality that the desired intervention might pose.

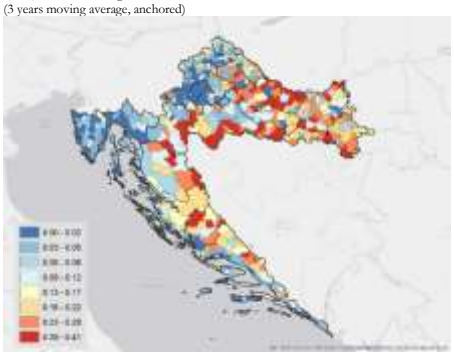
The IMD score can also be used for the identification of spatial outliers. It is often the case, that in decentralized systems, the solutions of certain development challenges might already exist, as certain local authorities might have already found a way to improve their performance. In those circumstances, it is critical to have a system in place to help identify who and where those champions might be. The spatial heterogeneity on the IMD performance can be a valuable source of insights for policy makers to identify municipalities that seem to be performing exceptionally better or worse than expected. Such insights can be valuable to identify municipalities for case studies and deep dives. Figures 2.c.1 and 2.c.2 show in blue municipalities with an IMD score substantially higher (positive outliers) than its neighbors, and in red those that have a lower IMD than its neighboring municipalities (negative outliers)

Figure 2 Using the IMD to Identify Spatial Patterns of Deprivations and Outliers

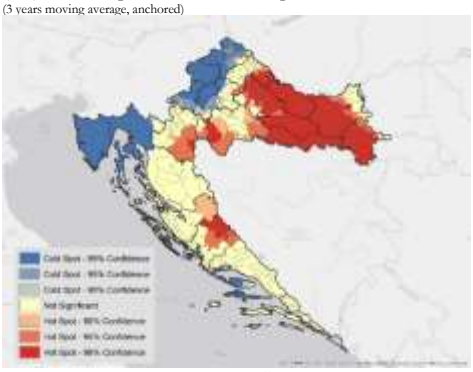
(a.1) IMD Gap Score 2011
(3 years moving average, anchored)



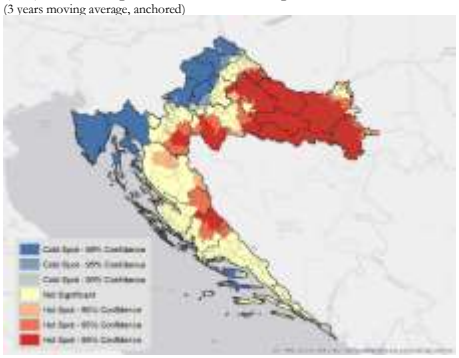
(a.2) IMD Gap Score 2015
(3 years moving average, anchored)



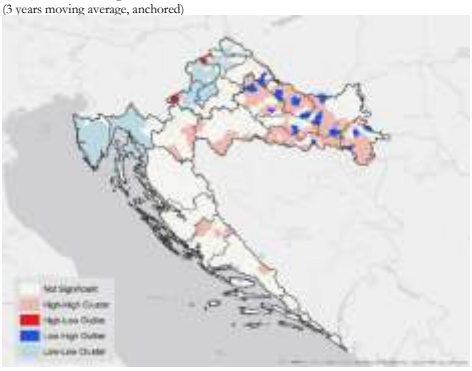
(b.1) IMD Gap Score 2011 Hot Spot
(3 years moving average, anchored)



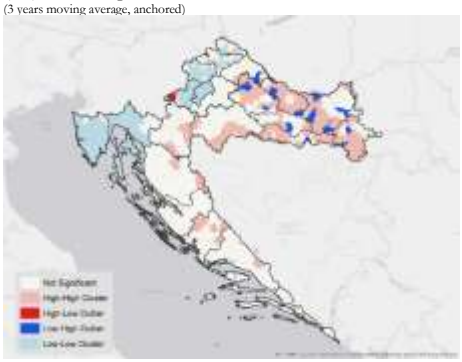
(b.2) IMD Gap Score 2015 Hot Spot
(3 years moving average, anchored)



(c.1) IMD Gap Score 2011 Outliers
(3 years moving average, anchored)



(c.2) IMD Gap Score 2015 Outliers
(3 years moving average, anchored)



Box 1. Getis – Ord G_i^* Hot and Cold Spot Analysis

Spatial patterns of deprivation and program distribution are unlikely to be random. One of the purposes of this analysis is to show how deprivation or any other attribute is agglomerated across space, and detects spatial clusters for every single location (Kondo, 2016). In the context of analyzing the outputs of a IMD map, the Getis-Ord statistic allows researchers to detect where the IMD is concentrated, and provides actionable information on where to allocate funds.

The statistic compares the values for a location and its neighbors up to a defined radius, with the expected value of all locations in the study area. A high value is a local unit will not be a hot spot unless it is surrounded by other units with similarly high values.

The Getis-Ord statistic is given by:

$$G_i^* = \frac{\sum_{j=1}^{N} w_{ij} x_j - \bar{x} \sum_{j=1}^{N} w_{ij}}{S \sqrt{\frac{N \sum_{j=1}^{N} w_{ij}^2 - \left(\sum_{j=1}^{N} w_{ij}\right)^2}{N-1}}}$$

where x_j is the value of the attribute (for example IMD) of location *j,* and where w_{ij} is the distance between location i and location j, and N is the total number of locations in the analysis. Finally:

$$\bar{x} = \frac{\sum_{j=1}^{N} x_j}{N}$$

$$S = \sqrt{\frac{\sum_{j=i}^{N} x_{ij}^2}{N} - (\bar{x})^2}$$

The statistic's distribution approaches a standard normal distribution as the number of locations increases (Kondo, 2016). Hence, the result of the statistic is a Z-score which allows for the identification of significant clustering of cold-spots (negative Z-scores less than -1.645) and hot-spots (positive Z-scores greater than 1.645). Values of greater magnitude suggest higher intensity of the spatial agglomeration.

Source: Box 1 of the RAS project report „Croatia: Profiles of the Poor in Subnational Areas"

As seen, the IMD score can be used for the identification of spatial patterns of deprivation, by either directly classifying municipalities, or its hot and cold spots or outliers. However, the multidimensional nature of the IMD and its aggregation allow policy makers to explore which domains or subdomains of the IMD are of greater relevance to assess the nature of deprivations faced by each municipality. Hence, it is possible to apply all the spatial-temporal approaches presented in Figure 2, at each domain, subdomain or indicator used in the construction of the IMD. It is also possible to access the differences on the level of the IMD across regions in the country. Figure 3 shows how each IMD subdomain in Slavonia and the rest of Croatia differ. Values to the right show an increase in the level of deprivation vis-à-vis the rest of the country, and values to the left show lower levels of deprivation. The Figure shows that the levels of multiple deprivation across several subdomains is systematically higher in Slavonia, and those are municipalities are particularly worse in terms of their dependency level to the social protection system, as well as health and

Figure 4 Average Level of Multiple Deprivation by Subdomain and Region

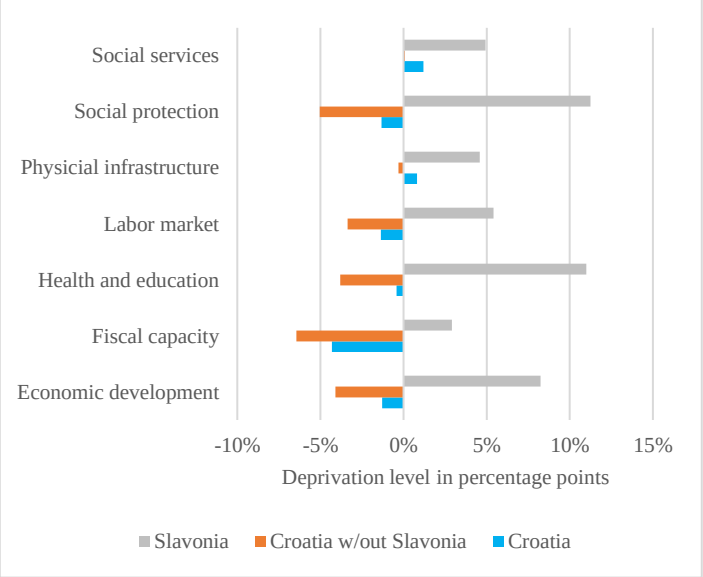
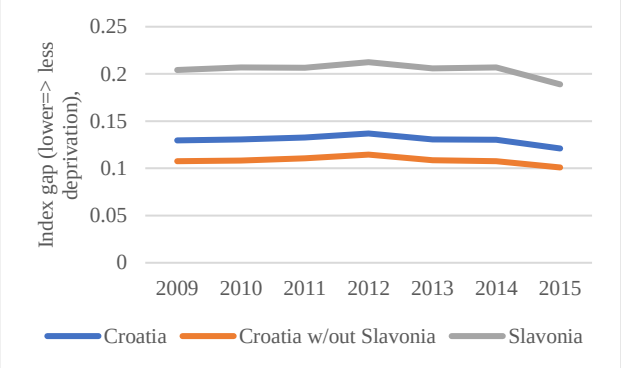


Figure 3 Average Level of Multiple Deprivation by Subdomain and Region



education indicators. The gap on the domain of Fiscal capacity between Slavonia and the Rest of Croatia is also worrisome.

The IMD can also be used to monitor the temporal evaluation of deprivation. As Figure 4 shows, over time, multiple deprivation has persisted at a higher level in Slavonia relative to the rest of the country, though some progress has been made recently. Such evolution can also be produced at each Domain, Subdomain and Indicator level.

8. Final remarks

Multiple deprivation indices can complement monetary poverty measures by bringing into view different but related measures of deprivation. The EU-2020 measure of poverty will be based on material deprivation, quasi-joblessness and at-risk-of-poverty-and-exclusion indicators. Indices that convey this information have, thus, gained prominence and serve a purpose in the country's evidence based policy making. Several EU member states have complemented their territorial policy with development indexes of a spatial nature. When well designed, such measures can be used to not only to identify deprived or lagging regions, but also to assess the nature of its deprivations and monitor progress over time. In order to be effective, the process of designing such indicator is as important as the indicator itself. The both technical and pollical ownership of any of this measures is paramount.

The Croatian Index of Multiple Deprivation shows the levels of deprivation in different dimensions, grouped by subdomains that aggregate individual indicators. The development of comparable dashboards requires first the identification of an agreed set of indicators and definitions. In the case of Croatia, the IMD creation was led by MRDEUF, which organized consultation meetings with multiple stakeholders across the government and national academia.

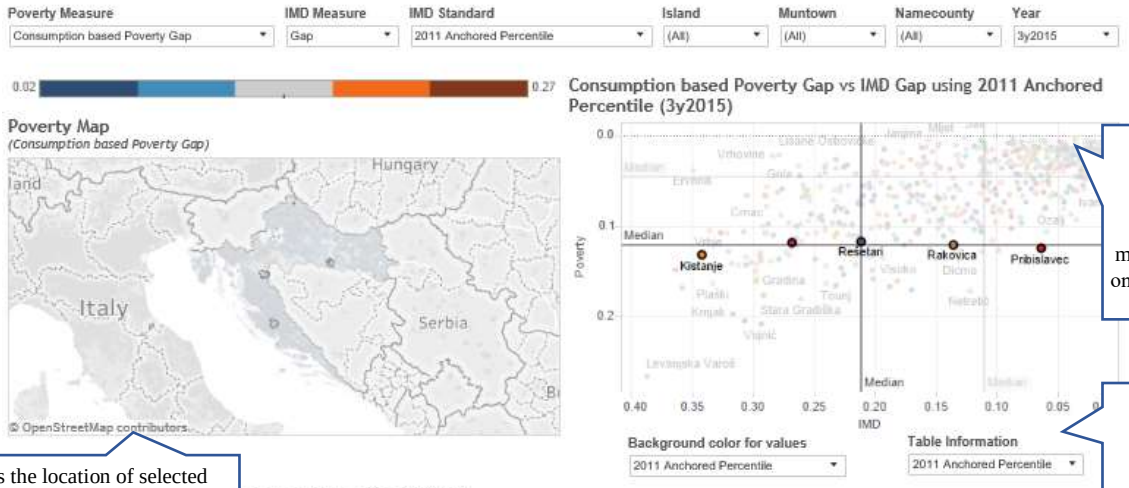
Going forward it is critical to continue to improve the quality of underlying data used for the IMD calculation as well as explore the possibility to include additional indicators as their policy relevance arise.

Annex 1. Dashboards

IMD Scorecard: Shows the IMD scores of selected municipalities for domains, subdomains and indicators of interest.

Step 1: Select the specifications for the **IMD MEASURE**, **IMD STANDARD**, and the **POVERTY MEASURE**. Preferred options are respectively Gap Squared, 2011 Anchored Percentiles and Consumption based Poverty Gap.

Step 2: Choose **COUNTIES** or **AREAS** of interest and specify the **YEAR OF ANALYSIS**. The year of analysis could be for a **SINGLE YEAR** or a **3 YEAR MOVING AVERAGE**, which is the preferred option.



Step 3: Click on the municipalities to populate the table below. To select multiple counties, press on "Ctrl" while clicking.

Step 4: Select the preferred type of values to be displayed in the table

Shows the location of selected municipalities on the Croatian map

chored Percentile (3y2015)

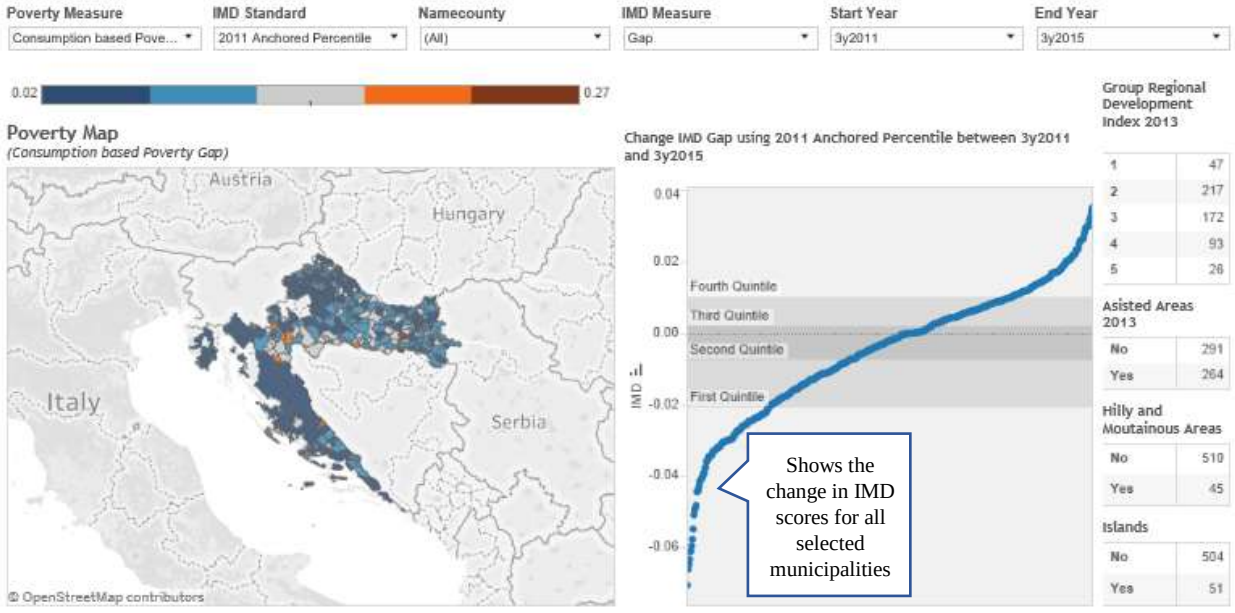
Domain	Subdomain	Indlabel	Kistanje	Staro Petrovo Selo	Rešetari	Pribislavec	Rakovica
Economic	Economic development	Net income of the population	0.99	0.79	0.74	0.60	0.22
		Number of active business ent	0.87	0.84	0.81	0.21	0.61
		Number of active crafts per ca	0.26	0.66	0.67	0.90	0.63
		Number of registered personal	0.99	0.75	0.69	0.49	0.16
		Share of agricultural employm	0.88	0.74	0.43	0.26	0.48
	Fiscal capacity	Average taxable income per c	0.99	0.80	0.76	0.62	0.19
		Local government expenditure	0.60	0.91	0.92	0.87	0.24
		Local government revenues p	0.99	0.73	0.67	0.70	0.30
		Share of taxpayers in the pop	0.94	0.55	0.52	0.28	0.00
	Labor Market	Employment rate	0.99	0.91	0.84	0.48	0.17
		Participation rate	0.83	0.54	0.48	0.39	0.02
		Pension system dependency r	0.99	0.93	0.85	0.16	0.66
		Unemployment rate	1.00	0.97	0.95	0.64	0.68
Social	Social protection	Average GMB per capita	1.00	0.78	0.81	0.62	0.57
		Child allowance per capita	0.76	0.83	0.76	0.01	0.53
		Share of GMB beneficiaries in	1.00	0.95	0.95	0.75	0.74
	Health and education	Proportion of students failing	0.86	0.82	0.82	0.37	0.96
		Share of people with secondar	0.92	0.77	0.67	0.55	0.57
		Share of persons using the as	0.92	0.99	0.92	0.65	0.63
	Demography	Dependency ratio	0.99	0.79	0.82	0.62	0.75
		Mortality rate	0.95	0.79	0.40	0.10	0.61
		Population change	0.97	0.88	0.77	0.26	0.59
		Population density	0.92	0.64	0.32	0.05	0.96
Physical	Social services	Distance to the primary health	0.92	0.73	0.25	0.25	0.45
		Enrollment rate in kindergarte	0.56	0.65	0.99	0.55	0.99
		Transparency of local govern	0.33	0.33	0.47	0.47	0.12
	Physical infrastructure	Road density	0.78	0.60	0.06	0.17	0.94
		Share of households with Inter	0.96	0.72	0.67	0.37	0.44
		Share of households with acc	0.40	0.99	0.35	0.37	0.99
		Share of households with acc	0.33	0.99	0.92	0.56	0.28
		Share of households without c	0.99	0.53	0.30	0.03	0.20

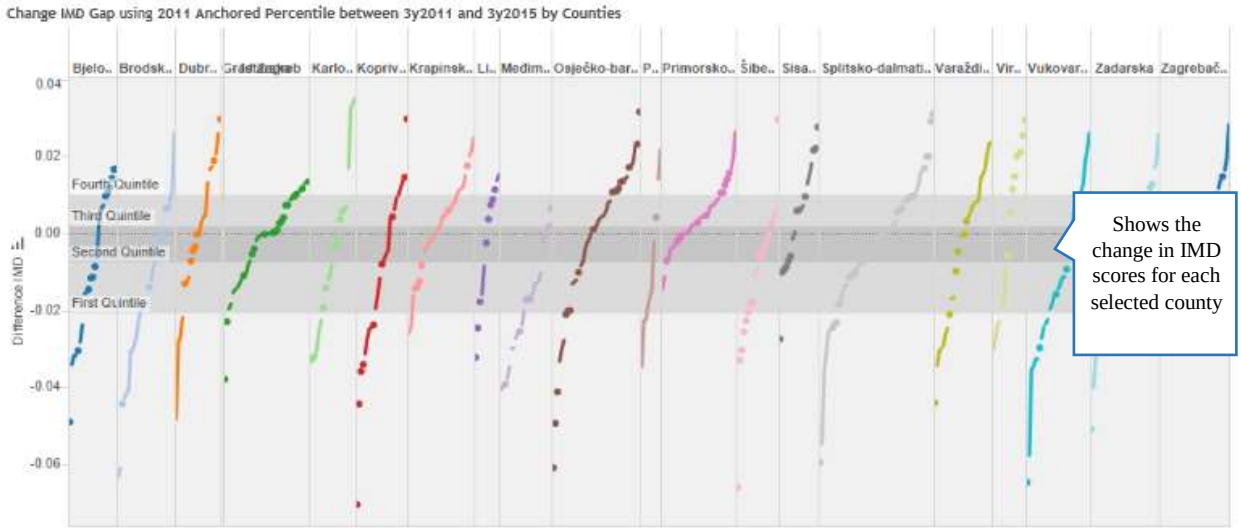
Displays the percentile ranking of each selected municipality and colors each cell based on the performance. Green indicates higher ranking while red signifies lower ranking.

IMD Change by County: Shows the change in overall IMD scores of selected municipalities over the preferred period of time.

Step 1: Select the specifications for the **IMD MEASURE**, **IMD STANDARD**, and the **POVERTY MEASURE** for preferred counties. Preferred options are respectively Gap Squared, 2011 Anchored Percentiles and Consumption based Poverty Gap.

Step 2: Choose the **PREFERRED TIMESPAN** by selecting the start year and end year.





Note: Dashboard and indexes prepared by the World Bank with data provided by CROSTAT and MRDEF. Project co–financed by the European union from the European fund for Regional development.

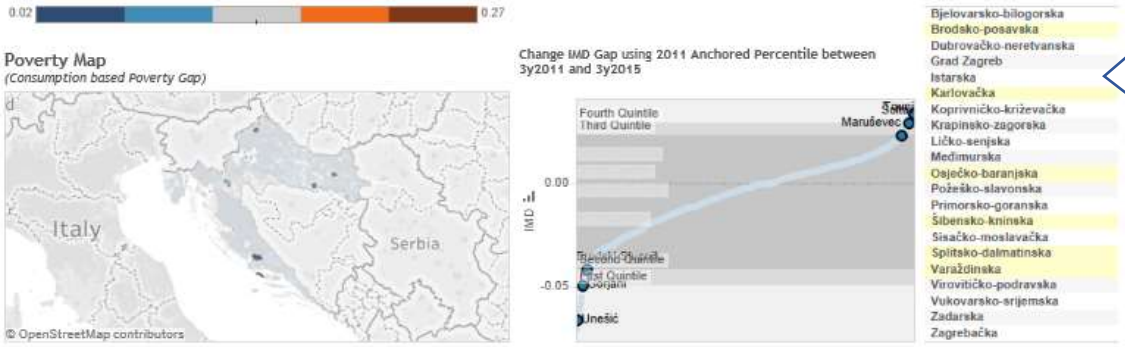
IMD Change Scorecard: Shows the change in IMD scores of selected counties for domains, subdomains and indicators of interest.

Step 1: Select the specifications for the **IMD MEASURE**, **IMD STANDARD**, and the **POVERTY MEASURE**. Preferred options are respectively Gap Squared, 2011 Anchored Percentiles and Consumption based Poverty Gap.

Step 2: Choose the **PREFERRED TIMESPAN** by selecting the start year and end year.

Step 3: Select preferred **COUNTIES**

Change of the 2011 Anchored Percentile IMD Gap between 3y2011 and 3y2015



Step 3: Click on **MUNICIPALITY NAMES** to select on them on the **GRAPH** and **TABLE** below

Change of the Indicators use to contruct the 2011 Anchored Percentile IMD Gap between 3y2011 and 3y2015

IMD Input Standard: 2011 Anchored Percentile

IMD Input Standard color for val...: 2011 Anchored Percentile

Domain	Subdomain	Indlabel	Brodski Stupnik	Tounj	Gorjani	Unešić	Šolta	Maruševec
Economic	Economic development	Net income of the population per capita	-0.10	0.00	-0.04	-0.08	-0.03	-0.03
		Number of active business entities per capita	-0.26	-0.02	-0.20	-0.24	-0.03	-0.11
		Number of active crafts per capita	-0.04	-0.03	-0.01	0.00	0.11	0.14
		Number of registered personal cars per capita	-0.17	-0.14	-0.06	-0.24	-0.01	-0.20
		Share of agricultural employment	0.00	0.00	-0.01	-0.03	-0.01	0.00
	Fiscal capacity	Average taxable income per capita	-0.11	0.02	-0.04	-0.07	-0.03	-0.01
		Local government expenditure per capita	-0.14	0.21	0.01	-0.25	-0.06	0.04
		Local government revenues per capita	-0.12	-0.02	-0.34	-0.28	0.00	0.05
		Share of taxpayers in the population	-0.53	-0.35	-0.52	-0.47	-0.07	-0.30
	Labor Market	Employment rate	-0.16	0.11	-0.06	-0.35	0.16	-0.04
		Participation rate	-0.20	0.05	-0.21	-0.37	0.14	-0.10
		Pension system dependency ratio	0.07	0.07	0.04	-0.01	0.02	0.02
		Unemployment rate	-0.05	0.09	0.04	0.04	0.12	0.06
Social	Demography	Dependency ratio	0.00	0.00	0.01	0.01	-0.01	0.00
		Mortality rate	0.43	-0.03	-0.24	-0.01	0.03	0.19
		Population change	0.28	0.22	-0.25	0.08	0.00	0.32
		Population density	0.06	0.02	0.03	0.01	-0.04	0.01
	Health and education	Proportion of students failing Matura exam	0.50	0.77	-0.02	0.29	0.61	0.33
		Share of people with secondary education or ..	0.00	0.00	0.00	0.00	0.00	0.00
		Share of persons using the assistance in perfo..	0.00	0.00	0.00	0.00	0.00	0.00
	Social protection	Average GMB per capita	0.06	0.01	0.00	0.00	-0.01	-0.01
		Child allowance per capita	-0.09	-0.07	-0.05	0.05	-0.03	-0.05
		Share of GMB beneficiaries in the population	-0.05	-0.05	0.05	0.03	0.08	-0.01
Physical	Social services	Distance to the primary health center	0.00	0.00	0.00	0.00	0.00	0.00
		Enrollment rate in kindergartens	-0.17	0.00	-0.10	-0.37	0.11	0.04
		Transparency of local government budgets	-0.23	0.00	0.00	-0.29	0.00	0.00
	Physical infrastructure	Road density	0.00	0.00	0.00	0.00	0.00	0.00
		Share of households with access to public sew..	0.00	0.00	0.00	0.00	0.00	0.00
		Share of households with access to public wat..	0.00	0.00	0.00	0.00	0.00	0.00
		Share of households with Internet connection	0.00	0.00	0.00	0.00	0.00	0.00
		Share of households without central heating	0.00	0.00	0.00	0.00	0.00	0.00

Step 4: Select preferred **IMD IMPUT STANDARDS** to be displayed on the table

Displays the percentile ranking change in each selected municipality and colors each cell based on the performance. Green indicates higher ranking while red signifies lower ranking.

Note: Dashboard and indexes prepared by the World Bank with data provided by CROSTAT and MRDEF. Project co–financed by the European union from the European fund for Regional development.

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Annex 1. Description of the indicators used for the IMD construction

The IMD consists of 31 indicators covering the period of 2009-2015. Regarding periodicity, the IMD is calculated in two ways. One way is by using indicator values for each year, and the other is by using three-year moving averages of indicators. If data for particular indicator is not available for each year, we take available data from the nearest year. All the data are available at the municipality/town level.

Indicators used for construction of the IMD and sorted by the domains and subdomains are described below.

Domain: Economic

Subdomain: Labor Market

Employment rate is calculated as the number of employed persons divided by the population aged 15-64 years. The number of employed is an indicator taken from the Tax Administration records on income tax payers in given year (number of employees based on the ID/JOPPD forms plus the number of the self-employed based on the Annual Tax Returns). Population of 15-64 years of age in each year is estimated on the basis of the 2011 Census and end-year estimates of the population by municipality/town in the way that the proportion of working age population (15-64) in total population from the 2011 Census is applied to the estimated total population in given year.

Participation rate is calculated as the active population (employed plus unemployed population) divided by the population aged 15-64 years. The number of employed is an indicator taken from the Tax Administration records on income tax payers in given year (number of employees based on the ID/JOPPD forms plus the number of the self-employed based on submitted Annual Tax Returns). The number of unemployed is based on the Croatian Employment Service on unemployment, year-average. Population of 15-64 years of age is estimated on the basis of the 2011 Census and end-year estimation of total population by municipality/town. Proportion of working age population (15-64) from the 2011 Census is applied to the estimated population in given year to get the estimated number of residents of working age.

Unemployment rate is calculated as the number of unemployed divided by the active population. The number of unemployed is taken from the Croatian Employment Service as the average for the year. Active population is the sum of employed and unemployed. The number of employed is an indicator taken from the Tax Administration records on income tax payers (employees plus the self-employed).

Pension system dependency ratio is the ratio between the number of pension system contributors and the number of pensioners. The number of contributors is approximated by the number of employed as recorded in Tax Administration registers (number of employees based on the ID/JOPPD forms plus the number of the self-employed based on the Annual Tax Returns). The number of pensioners is also taken from the Tax Administration records based on the ID/JOPPD forms.

Subdomain: Fiscal Capacity

Share of taxpayers in population is an indicator based on data prepared by the Tax Administration on the total number of income tax payers divided by the population in given year. Population data are provided by the Croatian Bureau of Statistics.

Average taxable income per capita refers to the total taxable income earned by residents of municipality divided by the population in given year. Taxable income is income after social security contributions and before personal income tax is paid. It includes earnings subject to personal income taxation plus profits earned by the self-employed (for cases when the self-employed are obliged to pay the profit tax). Data on taxable income by municipality/town is provided by the Tax Administration, and population data came from the Croatian Bureau of Statistics.

Local government revenues per capita refers to total budget revenues of local government units reduced by values of grants and donations, as well as revenues based on special contracts such is co-financing of residents for special projects, additional revenues based on transfers from central government budget for decentralized functions or asset sales money inflow) divided by the population. Data on budget revenues are prepared by the Ministry of Finance. Population estimations are provided by the Croatian Bureau of Statistics.

Local government expenditure per capita is calculated on the basis of Ministry of Finance data on local government budget outturns. This indicator takes the value of total expenditure, which includes current government expenditure and net acquisition of non-financial assets (investments). Total expenditures are divided by the population size as estimated by the Croatian Bureau of Statistics.

Subdomain: Economic Development

Number of active business entities per capita is calculated as total number of active business entities (data from the Business Register) divided by the population. Data are provided by the Croatian Bureau of Statistics.

Number of active crafts per capita is calculated as total number of active craft units divided by the population. Data are provided by the Croatian Bureau of Statistics.

Share of agricultural employment refers to the number of employed in agriculture divided by the population. Number of employed in agriculture is taken from the register of the Ministry of Agriculture and included those whose main or only source of income is agriculture. Population estimates are prepared by the Croatian Bureau of Statistics.

Net income of the population per capita is an indicator based on data prepared by the Tax Administration on the after-tax income of the population (personal income tax database based on ID/JOPPD forms), and divided by the population (Croatian Bureau of Statistics data) in a given year.

Number of registered personal cars per capita is calculated as the number of registered cars divided by population in a given municipalities. Source of data on registered cars is the Ministry of Internal Affairs while population data are provided by the Croatian Bureau of Statistics.

Domain: Social

Subdomain: Social protection

Share of GMB beneficiaries in total population is an indicator based on data provided by the Ministry of Demography, Family, Youth and Social Policy. It is calculated on the basis of the number of social welfare beneficiaries (beneficiaries of the Guaranteed Minimum Benefit (GMB) in 2014 and later and beneficiaries of the Support Allowance prior to 2014) registered in each local center for social welfare. A local center usually covers several municipalities. Population size is constructed for each area covered by the local center and the number of beneficiaries is divided by the population. The beneficiary share is then attributed to each municipality/town covered by the center. Alternatively, the same indicator is extracted from the Management Information System (MIS) of the Ministry. MIS data are reliable for 2014 and later and can be used instead of data based on social centers' information.

Average GMB per capita per month is calculated by the team on the basis of microdata provided by the Ministry of Demography, Family, Youth and Social Policy. The total benefit bill for Guaranteed Minimum Benefit (GMB) per month per municipality/town is divided by the population estimated by the Croatian Bureau of Statistics. Data are available for 2014 and later.

Child allowance per capita is calculated on the basis of information on the number of children receiving child allowance and the average benefit amount per municipality/town (Croatian Pension Insurance

Institute data) which gives the total allowance bill per local unit which is then divided by the estimated population (data provided by the Croatian Bureau of Statistics).

Subdomain: Health and education

Share of people with secondary education or more in working age population is calculated on the basis of the 2011 Census data. The source is the Croatian Bureau of Statistics.

Share of persons using the assistance of another person in performing daily living activities is calculated on the basis of the 2011 Census. Data are extracted from the CBS Census micro data, Questionnaire 1, question number 44.

Proportion of students failing Matura exam is taken from the database maintained by the National Center for External Evaluation of Education. Data refers to the first appearance at the Matura exam and extracts students that failed (score 1) at least one test out of three main tests (mathematics, Croatian language, foreign language). The indicator is proportion of students failing exams in total number of students taking the Matura exam for the first time. The indicator is extracted from the database by the project team.

Subdomain: Demography

Population change refers to the change in population from year to year. Population data for 2011-2015 are estimated on the basis on the 2011 Census and available data on natural population changes. Data for 2009-2011 are population estimations based on the 2001 Census and information on subsequent population changes. Yearly changes between 2011 and 2012 and afterwards are calculated by using population estimates based the 2011 Census, while changes for earlier years are calculated by using population estimates based on the 2001 Census.

Dependency ratio is a demographic indicator calculated as the dependent population (non-working-age population) divided by the working age population. The dependent population is defined as the population 0-14 years of age plus the population aged 65 and more, while the working age population is the population aged 15-64 years. Proportion of each age group in total population is calculated on the basis of the 2011 Census. Figures are provided by the Croatian Bureau of Statistics.

Population density refers to the 2011 Census data on total population per square kilometer. Data are provided by the Croatian Bureau of Statistics.

Mortality rate is the number of deaths per year in proportion to total population of municipality/town. Deaths and population data are provided by the Croatian Bureau of Statistics.

Domain: Access to Services

Subdomain: Social services

Enrollment rate in kindergartens is a derived indicator calculated by dividing the number of children enrolled in kindergarten in each municipality/town by the estimated number of children of kindergarten age. Number of children in kindergarten is an indicator provided by the Central Bureau of Statistics. Observations refers to period of enrollment (for example, 2015/2016), but the values are assigned to the starting year (for example, 2015). Number of children of kindergarten age is estimated on the basis of their population share in 2011 (Census data). Kindergarten age in Croatia is assumed to be 2 to 6 years of age. Population proportion of that cohort in 2011 is applied to total population estimated for each year (Croatian Bureau of Statistics data) to get the estimated number of children of kindergarten age.

Distance to the primary health care center is a variable that shows a distance to the closest primary health care center. The variable is created on the basis of addresses of these health centers (data taken from the Health Insurance Fund). Distances are calculated by the team as the Euclidean distance of each municipality's centroid from a business zone or health center. The unit of measurement is meters.

Transparency of local government budgets is assessed by the Budget Transparency Index constructed by the Institute of Public Finance. Index takes values from 0 to 5 indicating the number of the key budget documents that are published on official website of municipality/town. The Index is the result of research project „Understanding, Monitoring and Analyzing Local Government Budget Transparency: Case study of Croatia and Slovenia - Open Local Budget Index (OLBI) "financed by the Croatian Science Foundation (IP-09-2014). The results are published in http://www.ijf.hr/hr/publikacije/casopisi/12/newsletter/110/proracunska-transparentnost-zupanija-gradova-i-opcina-studeni-2015-8211-ozujak-2016/1158/ and http://www.ijf.hr/upload/files/file/newsletter/97.pdf. Currently, there are comparable observations for two years. Data are collected at the turn of the year (2014/2015 and 2015/2016), while the values are assigned to the first point of observation (i.e. years 2014 and 2015).

Subdomain: Physical infrastructure

Share of households with access to public water supply is calculated on the basis of the 2011 Census. Data are extracted by the project team from the CBS Census micro data (Questionnaire 2, Information on housing, question 9)

Share of households with access to public sewage is calculated on the basis of the 2011 Census. Data are extracted by the project team from the CBS Census micro data (Questionnaire 2, Information on housing, question 9)

Share of households with Internet connection is calculated on the basis of the 2011 Census. Data are extracted by the team from the CBS Census micro data (Questionnaire 2, question 4)

Share of households without central heating is calculated on the basis of the 2011 Census. Data are extracted from the CBS Census micro data (Questionnaire 2, Information on housing, question 10)

Road density refers to the density of road network calculated as the length of the roads (kilometers) divided by the area of the municipality (kilometers squared). The roads data is for 2016 data, acquired by OpenStreetMap by the team. Area of the municipality/town is taken from the Croatian Bureau of Statistics.

Indicator	***Positive/negative correlation***	
	The higher the indicator, the higher poverty rate	***The higher the indicator, the lower poverty rate***
1. *Employment rate*		-
2. *Participation rate*		-
3. *Unemployment rate*	+	
4. *Pension system dependency ratio*	+	
5. *Share of taxpayers in population*		-
6. Average taxable income per capita		-
7. *Local government revenues per capita*		-
8. *Local government expenditure per capita*		-
9. *Number of active business entities per capita*		-
10. *Number of active crafts per capita*		-
11. *Share of agricultural employment*		-
12. *Net income of the population per capita*		-
13. *Number of registered personal cars per capita*		-
14. *Share of GMB beneficiaries in total population*	+	
15. Average GMB per capita	+	
16. *Child allowance per capita*	+	
17. Share of people with secondary education or more in working age population		-

18. *Share of persons using the assistance of another person in performing daily living activities*	+	
19. *Proportion of students failing Matura exam*	+	
20. *Population change*		-
21. *Dependency ratio*	+	
22. *Population density*		-
23. Mortality rate	+	
24. Enrollment rate in kindergartens		-
25. Distance to the primary health care center	+	
26. *Transparency of local government budgets*		-
27. *Share of households with access to public water supply*		-
28. *Share of households with access to public sewage*		-
29. Share of households with Internet connection		-
30. Share of households without central heating		-
31. Road density		-

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