CONTENTS

A. General

The Peripherality Index described in this publication characterizes localities and local authorities in Israel by geographic location, relative to population concentrations and centres of economic activity in the country. This characterization allows comparisons among various regions according to their development potentials. It is assumed that regions with high accessibility to centres of economic activity are more creative and competitive, and therefore also more attractive to investors and migrants compared to more distant and isolated regions.

The Peripherality Index 2015 is an update of the Peripherality Index 2004 of Local Authorities (Central Bureau of Statistics, 2008). In addition, for the first time, the index was constructed at the level of locality. There were many changes in the 2015 index compared to the 2004 index, as a result of changes in the composition of the local authorities and in the population and infrastructure, but mainly due to methodological changes in the calculation of the index.

The index was constructed under the advisement of a steering committee that included representatives of academia, government ministries, local authorities, and various research bodies.

1. Definition and Method of Calculation

A peripheral region is defined as a region distant from opportunities (e.g., markets, jobs, and health services), activities (e.g., work, education, shopping, and leisure), or assets existing in all the regions, including the given region itself. The Peripherality Index brought here was constructed according to this definition, with the goal of characterizing the localities and the local authorities by geographic location, ranging from the most peripheral to the most central.

The value of the Peripherality Index 2015 for a locality was calculated as a weighted total of the standardized values of two components: the potential accessibility index (2/3 weight) and proximity to the boundary of the Tel Aviv District (1/3 weight).

A. **The potential accessibility index**, which is calculated according to the gravity model, reflects the proximity of the given locality to each of the localities in Israel weighted by the size of their populations, with the size of the population indicating the intensity of the opportunities, activities, and assets in each locality.

B. **The proximity to the boundary of the Tel Aviv District** is calculated as the distance from the boundary of the Tel Aviv District multiplied by (-1), and reflects the monocentric structure of Israel, where the Tel Aviv District constitutes an economic and business centre.

The distances in each of the components of the index were calculated as the shortest distance over the road network (updated to January 2016) under constraints of roads closed due to construction or security reasons.

The lowest value of the index indicates the most peripheral locality, and the highest value indicates the most central locality.

The **value of the Peripherality Index 2015 of local authorities** is the value of the index of a municipality, local council, or regional council, as obtained from the index of localities. The value of the Peripherality Index of a regional council was calculated as the average of the values of the indices for the localities in the council, weighted by their population size.

The **local authorities were divided into 10 homogeneous groups (clusters)** unequal in size, according to the values of their peripherality indices. The division was performed by use of the hierarchical cluster analysis method, such that for a given number of clusters, the variance of the index values within the clusters was minimized, and the variance between the clusters was maximized. Cluster 1 contains the most peripheral authorities, and Cluster 10 contains the most central authorities.

The l**ocalities within the regional councils were classified into 10 clusters** according to the values of their peripherality indices and according to the boundaries of the local authority clusters.

2. Stages of the Research

The research included 6 main stages:

1) Review of the international literature on the measurement of peripherality (see Section 4 in this Chapter);

2) Selection of a basic model for calculating the Peripherality Index (see description in Chapter C);

3) Construction of the base for calculating the distances between the geographic units (see details in Chapter D);

4) Examination of the data sources for estimating the parameters in the potential accessibility index, planning of the estimation process, and comparison of the obtained results based on the various sources. A summary of this process is presented in Chapter C, Section 2;

5) Calculation of several versions of the Peripherality Index, at the level of localities, and at the level of local authorities. Presentation of the results to the steering committee, comparisons and discussion for the purpose of obtaining the final model;

6) Calculation of the final model for localities and local authorities (see Chapter D).

3. Applications of the Index

The Peripherality Index is one of the measures aimed at characterizing the local authorities in Israel according to various dimensions that might influence their functioning (along with the Socio-Economic Index and the Index of Compactness [Central Bureau of Statistics, 2014, 2017]). As of 2015, these indices have been included in the basic statistics produced by the Central Bureau of Statistics (CBS). The Peripherality Index will be updated and published every 5 years.

- Government ministries and other central bodies use the Peripherality Index to formulate their policy and allocate resources to the local authorities and residents of the localities (for example, the Balance Grant provided by the Ministry of Interior and the Ministry of Finance's Tax Benefit Law).
- The CBS uses the Peripherality Index in defining sampling processes for various surveys, and as a basis for presentation of socio-economic data (for example, the *Society in Israel* publication [Central Bureau of Statistics, 2010]).
- The Index can be used by Israeli academic and research institutions as a basis for additional research projects on various social topics.

4. Previous Research on Measurement of Peripherality

4.1 International Research

Since the 1990s, the measurement of geographic peripherality has generated much attention in theoretical and applied international research. New countries joined the European Union, necessitating the allocation of resources to areas remote from the centre of Europe. In addition, during the same period, projects were developed that analysed the influence of new transportation systems on social and economic activity in various regions. All of this generated much interest in methods for measuring the peripherality of regions from the perspective of geographic location.

The literature review (Tsibel & Burck, 2005) presents many approaches and methods for measuring peripherality. Below is a partial list of applications in which the peripherality of various regions was measured using a potential accessibility index, described below in Chapter 3:

- Frost and Spence (1995) – construction of a peripherality index for regions in Britain; analysis of the influence of various definitions of self-distance in the model of potential accessibility.
- Copus (1999) – measurement of the peripherality of regions in the European Union.

- Fürst et al. (1999), SASI Project – use of the potential accessibility index in the analysis of the influence of development of transportation systems in Europe on socio-economic aspects (on-going project that started in the 1990s).

- Accessibility/Remoteness Index of Australia (Hugo Centre for Migration and Population Research, 2001–2016) – in use since 2001 by the Australian Bureau of Statistics as a basis for classification of regions by their level of centrality.

- Shurmann and Talaat (2000, 2002) – measurement of the peripherality of European Union countries and candidate countries for admission; comparison between the potential accessibility indices calculated based on the population and those calculated based on the gross domestic product; discussion of the influence of the European transportation system on regional development.

- Spiekermann and Neubauer (2002) – measurement of the peripherality of large European cities and various regions in the European Union; comparison among different types of accessibility indices.

- Wang and Minor (2002) – construction of potential accessibility indices for the employed population in the city of Cleveland, Ohio, in the United States, in order to analyse the influence of accessibility to workplaces on the crime rate.

4.2 Methods Applied in Israel

- In August 2008, for the first time, the CBS published a peripherality index for local authorities in Israel (Central Bureau of Statistics, 2008) which was based on population data for 2004 and on the road network in 2006. The index values were calculated as the average of the standard deviations of two components: the potential accessibility index (in accordance with the international research described in Section 4.1), and proximity to the boundary of the Tel Aviv District.

- In the social report published by the CBS for 2000 and 2001 (Central Bureau of Statistics, 2002), a division of the sub-districts in Israel into 4 regions according to 2 variables was presented. The variables were proximity to Tel Aviv (close/medium distance/far) and level of urbanization (percentage of localities with 2,000 or more residents and population density). In addition, the social indicators for these regions were compared.

- Since the early 2000s, Israel's state lottery has granted development budgets to the local authorities (Mifal HaPayis, 2002) according to a formula that includes distance from the centre of the country as one of the components. The distance component is calculated by means of dividing the area of the country into 10 radial rings, each 10 km wide, from the vertices of the triangle formed by the metropolitan blocs of Jerusalem, Tel Aviv, and Haifa and the Krayot. The more distant a local authority is from the triangle of large cities, the larger the amount allocated to the authority according to this criterion, because its residents need a

larger variety of public buildings, compared to residents of authorities located closer to the facilities in the centre.

- Since the 1990s, the Ministry of Education has constructed a Care Index (Ministry of Education, n. d.) which is used for differential allocation of resources in the school system. The index includes a school peripherality component that has two aspects: the distance between the locality where the school is located and the closest of the three large cities, and the relevant population density (Jewish or Arab) in a radius of 20–25 km from the locality. As of the 2014/15 school year, the Ministry of Education has used the Peripherality Index 2015 of the CBS presented in this publication.

B. Geographical Basis

1. General Definitions and Explanations

- **Locality –** A permanently inhabited place that meets the following criteria:

  a. It is usually inhabited by 40 or more adult residents;

  b. It has self-administration;

  c. It is not included within the municipal boundaries of another locality;

  d. Its establishment was approved by the planning institutions.

  Locality code – The locality coding system (a 4 digit-code assigned to each locality in Israel) was created in the 1950s by the Ministry of Interior and is maintained today by the Population and Immigration Authority, mainly to aid in the computerized operations of the Population Register system and in the recording of the addresses of the residents in Israel. The system is dynamic and is updated in coordination with the CBS.

  Changes in the localities – Each year, the list of localities of the CBS undergoes changes due to a number of reasons (in addition to the establishment of new localities):

  a. Merging of a number of small localities into one locality. For example, Bu’eine and Nujeidat were merged into one locality, Bu’eine-Nujeidat.

  b. Linkage of one or more small localities with a large locality. For example, Nahalat Yehuda was linked with Rishon Leziyyon, Moza Tahtit was linked with Jerusalem, and Zur Yig’al was linked with Kokhav Ya’ir.

  c. Splitting of localities. For example, Ilut was split from Nazareth; Isifya was split from Daliyat Al-Karmel; and Majd Al-Kurum, Deir Al-Asad, and Bi’ne were split from Shagor.

d. Elimination of localities: localities that do not meet the definition of locality, or localities that were eliminated according to government decisions. For example, since 2005, the Israeli localities that were located in Gaza and four more localities in Northern Samaria are no longer included in the list of localities due to the evacuation of those localities under the implementation of the Disengagement Law, 2005.

The changes result from decisions approved by the Minister of Interior.

Type of locality – Classification of the localities into urban and rural, in accordance with the number of residents in the locality. The type of locality is determined, as far as possible, according to the actual situation and according to the following definitions. The localities are divided into two major groups: **urban** localities and **rural** localities. The distinction between them is based on the size of the locality.

a. **Urban localities** include all localities with 2,000 or more residents, and are classified by size groups.

b. **Rural localities** include all localities with fewer than 2,000 residents, and are sub-divided as follows:

   Moshav – A rural locality organized as a cooperative society, which has the right to agricultural farm land (as defined by the Israel Land Administration). These localities consist of family units, each of which is an independent economic entity. Part of the production and economic administration is carried out by the cooperative association, the degree of cooperation being determined by the members.

   Collective moshav – A rural collective locality where production and marketing are collective and consumption is private.

   Kibbutz – A collective rural locality where production, marketing, and consumption are collective.

   Institutional locality – An institution that has the characteristics of a locality and is not located within the municipal boundaries of another locality.

   Communal locality – A locality organized as a cooperative society, which has no right to agricultural farm land, and where the extent of cooperative activities (production, consumption, municipal and social activities) is determined by the members.

   Other rural locality – A locality numbering less than 2,000 residents, which is not included in any of the other categories described above.

Living outside localities – Population groups living outside the boundaries of the recognized localities. In the places inhabited by this population, not all the

definitions that characterize a locality (presented above) apply. Populations living outside localities also include the populations of places (see definition below), of Bedouin tribes, and the populations of prisons located outside the municipal area of the locality.

Place – A new area that has begun to be populated, but still does not meet the criteria for being defined as a locality, or an area that was once a locality and was removed from the list of localities.

Bedouin tribes – The Bedouin tribes are not included in the count of localities, although they are listed in the File of Localities published by the CBS each year. The Bedouin tribe population is included in the summary tables of the population living outside localities.

- **Municipal status of localities –** in accordance with legislative and administrative regulations, local authorities are divided into three types:

  a. **Municipality –** Refers to one local authority only, which has received the status of a municipality.

  b. **Local council –** A local authority of one locality only, which has not received the status of a municipality.

  c. **Regional council –** Includes several rural localities. Sometimes, urban localities are also included, e.g., Qesaryya (included in the regional council Hof HaKarmel), Kefar Habad (included in the regional council Emek Lod). Some of these urban localities are later granted the status of a local council.

  Included in regional councils are localities which have a representative on the council, as well as localities that are within the municipal jurisdiction of the council but are not represented on it.

In addition to the above, there are localities **with no municipal status**, i. e., located in an area that does not belong to any municipal authority.

The **municipal status of a locality may change** over the years. A local council may receive the status of a municipality, a locality within a regional council may receive the status of a local council, and it is even possible for a locality to transfer from one regional council to another.

Changes in the list of regional councils over the years can occur due to the following reasons:

a. Merging of regional councils – For example, the regional council Lev HaSharon merged the former regional councils Hadar HaSharon and HaSharon HaTzefoni.

b. Elimination of regional councils – For example, the regional council Merkaz HaGalil was eliminated in 1990, and all of the localities in that regional council were granted the status of local councils. In 2008 the regional council Ef'al was eliminated, and all of the localities in that regional council were annexed to nearby localities.

c. Splitting of regional councils – For example, the regional council Nof HaGalil was split in 2000 into two regional councils: Bustan El-Marj and Al-Batof.

d. Creation of new regional councils – New regional councils are usually established in areas that had no municipal status. In some cases, localities within existing regional councils are transferred to the new regional councils. For example, Jewish localities in the Golan Heights and the Judea and Samaria Area had no municipal status in the past. Later, they were ascribed to the new regional councils established in those regions.

2. Geographical Basis of the Study

The Peripherality Index 2015 was calculated for 1,210 localities. These included 201 municipalities and local councils, and 1,009 localities within 54 regional councils, according to their municipal status updated to the end of 2015 (Central Bureau of Statistics, 2016).

Localities with no municipal status were not included in the calculation. In addition, the calculation of the index did not include populations living outside localities, such as Bedouin tribes, places, employment centres, and collective codes.

The following is a list of the changes that took place in the municipal status of localities and local authorities since the construction of the Peripherality Index 2004:

- In 2006, the locality Menahemya was annexed to the regional council Emeq HaMa'ayanot.
- In 2008, the regional council Ef'al was eliminated; 3 of its localities were annexed to Ramat Gan, and one locality was annexed to Or Yehuda.
- In 2009, the locality Daliyat Al-Karmel–Isifya was split into 2 localities: Daliyat Al-Karmel and Isifya.
- In 2009, the locality Shagor was split into 3 localities: Deir Al-Asad, Bi'ne, and Majd Al-Kurum.

- In 2011, the locality Baqa-Jatt was split into 2 localities: Baqa Al-Gharbiyye and Jatt.
- In 2012, the locality Qazir-Harish was split into 2 localities: the locality Harish, and the locality Qazir, which was annexed to the regional council Menashe.
- In 2012, the regional council Abu Basma was split into two regional councils: Neve Midbar and Al-Kasum.

C. Potential Accessibility Index

From a geographical perspective that also includes an economic aspect, a peripheral region is defined as a region distant from (in other words, characterized by low accessibility to) opportunities (e.g., markets, jobs, and health services), activities (e.g., work, education, shopping, and leisure), or assets existing in all the regions, including the given region itself (Shürmann & Talaat, 2000, 2002; Spiekermann & Neubauer, 2002; Wegener, Eskelinen, Fürst, Schürmann, & Spiekermann, 2000). Thus, the concept of peripherality is the opposite of the concept of accessibility, which reflects the advantages of a location of the region relative to other regions.

1. Basic Model

The literature includes many types of accessibility indices. Most can be presented as a construct of two functions: one representing goals (activities or opportunities) that can be reached, and the other representing the effort (in units of time, distance, or cost) required to reach them. In most of the approaches applied worldwide, the functions are associated multiplicatively, i. e., they are weights to each other:

(1) $$A_i = \sum_{j=1}^{n} g(W_j)\, f(c_{ij})$$

where:

A_i – accessibility of region i

n – total number of regions, including the region itself

W_j – intensity of the activity to be reached in region j

$g(W_j)$ – activity function

c_{ij} – impedance (cost, distance, time) of reaching region j from region i

$f(c_{ij})$ – impedance function from region i to region j

Different assumptions regarding the activity and impedance functions lead to different types of accessibility indices: travel cost, daily accessibility, and potential accessibility.

- The **travel cost** indicator measures accessibility to a specified set of destinations, for example, central destinations or large cities. The indicator is used under the assumption that only a specified set of destinations is relevant to the region's accessibility. The higher the travel cost to that set of destinations, the lower the accessibility.

  The formula for the indicator is obtained by defining $f(c_{ij})$ equal to c_{ij} , and W_j equal to 1 if W_j passes the threshold of the intensity of the activity (for example, a minimum population size). Otherwise, it is equal to zero. The value of the index depends on the set of destinations defined by the cut-off point, which is chosen according to subjective criteria. In addition, the linear impedance function does not take into account sensitivity to distance, which is reflected in the fact that more distant destinations tend to be visited less frequently.

- The **daily accessibility** indicator measures the intensity of activity that can be reached given a fixed amount of time or money. The indicator is used under the assumption of a limited travel budget, a maximum reasonable distance to reach the destination, or a maximum length of time during which the destination must be reached. The higher the value of the indicator, the higher the accessibility.

  The formula for the indicator is obtained by defining $g(W_j)$ equal to W_j , and $f(c_{ij})$ equal to 1 if c_{ij} does not pass the budget limit for the trip (money, distance, or time). Otherwise, it is equal to zero. The value of the index depends on a limitation that is determined according to subjective criteria. In addition, the impedance function does not distinguish between closer and more distant destinations.

- The **potential accessibility** indicator measures the accessibility of the region according to the most general form of Formula (1), with the impedance function defined as a decreasing function. The value of the accessibility of each region is calculated as a function both of its proximity to other activity regions, and of the intensity of activities in the regions, under the assumption that the attractiveness of a destination increases with the intensity of activities in it and decreases with the distance from it (in terms of time or travel cost).

  The formula can be interpreted as follows: **The more attractive (large, active) regions j are, and the easier it is to reach these regions from region i, the greater the accessibility of region i.**

  Measuring accessibility by means of an accumulated total of intensity of activities weighted by the ease of reaching them is based on Newton's law: The force of attraction between two bodies is proportional to the product of their masses

divided by the square of the distance between them. During the 1940s, the physical terms were translated into terms of regional science (Stewart, 1947). Similar to potential in physics, the population potential (the influence of P persons at a distance d) is defined as P/d . The same ideas led to spatial interaction models, also known as gravity models, which are used to identify the magnitude and direction of a flow of persons between different regions based on their population sizes and on a decreasing function of the distance between them (Thomas & Huggett, 1980).

The potential accessibility index is generally used in applied projects.

The index formula includes parameters that must be set or estimated.

2. Units of Measurement and Parameters

2.1 Intensity of Activities at the Destination

The intensity of activities in a region is customarily represented by the size of a population or by one of the economic efficiency indicators such as gross domestic product. Very high correlation coefficients (Spiekermann & Neubauer, 2002) were found between the indicators of potential accessibility calculated using population size and the indicators calculated using gross domestic product, for various areas in the European Union. Note that in most cases, the size of the population constitutes a good approximation to a large variety of parameters, such as accessibility to services and markets, employment opportunities, and other economic characteristics.

In the index presented in this publication, **the intensity of activities in a locality is measured by its population size (P)**. Proximity to the population concentrations reflects proximity to economic activity or to possibilities of economic activity.

2.2 Travel Impedance

The most general definition of the impedance of traveling from one region to another takes into account both spatial and non-spatial impedance (Wegener et al., 2000).

- Spatial impedance refers to impedance of time, space, and cost of the trip between two regions. The calculation of travel time takes into account the integration of vehicles along the way, various regulations and constraints such as speed limit, waiting time in traffic, accessibility to transportation networks at each end of the trip, and so on. The ease of traveling from home or office to the closest train can be more important in measuring accessibility than the speed of the inter-regional train. The influence of various factors can be asymmetric, such that the value of the impedance between each two regions can depend on the direction of travel.

Calculation of travel time is a complicated process that is based on searching for the fastest transportation route in the multi-mode transportation network, which also requires analysis of the influences of time of day. If the extent of transportation infrastructure and the quality of transport services between the regions are more or less uniform, the distance on the transportation routes is a reliable tool for the purpose of measuring accessibility (Portnov & Erell, 2001).

- Non-spatial impedance refers to political, economic, and cultural links or barriers that influence the decision to travel from one region to another, and thus increase or decrease the regions' accessibility. Non-spatial factors can also be asymmetric, for example, knowledge of the language of another region, or the economic and political rules and regulations of another region.

  It is emphasized in the literature (Copus, 1999) that a decision to invest or settle in a particular region is not necessarily affected by the actual cost of a trip, but rather by the perceived cost and the convenience and ease of travel to the centres of economic activity. The choice of impedance variable should therefore take into account the prevalent perceptions of distance among the local population or among potential investors and immigrants.

Based on data availability, in the index presented in this publication, **travel impedance is measured by distance (d), which is the travel distance via the shortest route on roads open to traffic (and not closed due to reasons of security or construction)** (see explanation in Chapter D).

2.3 Internal Impedance

The potential accessibility formula for a region includes the component of the economic intensity of the region itself weighted by a decreasing function of the internal impedance (the self-distance d_{ii})

The theoretical literature contains various approaches for the definition of self-distance. These approaches are divided into two main definitions:

1) Self-distance is defined as the same average value for all the investigated units (Shürmann & Talaat, 2000; Wang & Minor, 2002).

   According to this definition, self-distance serves as a balance parameter that maintains proportionality between economic intensities represented by different population sizes.

2) Self-distance is defined as a function of the region's area.

   For example, one-third of the length of the major axis of the minimum rectangle that contains the region, or half the radius of the circle with the same area (Copus, 1999; Frost & Spence, 1995; Stewart, 1947). According to these definitions, when constructing the index at the level of the localities in Israel, one

would increase the intensity of a small local population (which usually lives in a relatively small area) and decrease the intensity of a large local population.

As part of the construction of the Peripherality Index 2004, the influence of different definitions of the self-distance on the rankings of the local authorities was analysed (Tsibel, 2009). A uniform self-distance of 3 km yielded the best balance. After several more tests, this definition was used for the Peripherality Index 2015 presented in this publication as well.

2.4 Impedance Function

An impedance function is defined as a decreasing function that describes the ease of moving from one region to another.

Out of a number of models (Hansen, 1959; Portnov & Erell, 2001; Wilson, 1967), two were recognized as the most consistent in describing human behaviour and are commonly used in applied contexts: a two-parameter negative exponential function and a one-parameter inverse power function.

In the construction of the Peripherality Index 2004, an inverse power function was chosen for the model:

$$f(d_{ij}) = d_{ij}^{-\theta};\ \theta > 0.$$

The parameter θ, which reflects the human tendency to avoid long-distance trips, is called the distance decay parameter or the distance sensitivity parameter. As this parameter increases (i. e., the sensitivity to distance is greater), close destinations receive a greater weight in the accessibility formula (1) relative to the weight of remote destinations. In other words, the contribution of the remote destinations to the region's accessibility becomes even smaller.

2.5 Distance Decay Parameter

Estimation of the parameter in the impedance function is based on the use of spatial interaction models. The commuting model was chosen because it deals with the main destination of the daily trips. This model links between the number of persons who travel each day to work and the number of workers in the region of residence, the number of workplaces in the region of work, and the distance between them.

(2) $$T_{ij} \approx qE_i M_j f(d_{ij})$$

where:

T_{ij} – interaction between i and j, defined as the number of commuters from residential region i to work region j

q – constant value

E_i – number of workers who are residents of region i

M_j – number of workplaces in region j

$f(d_{ij}) = d_{ij}^{-\theta}$ – travel impedance function (trip distance function) from region i to region j

If T_{ij}, E_i, M_j, and d_{ij} are known, one can estimate θ as the slope coefficient in the regression model that is obtained by means of a logarithmic transformation of (2):

$Y_k \approx \alpha - \theta x_k$

where: $x_k = \ln d_{ij}$, $\alpha = \ln q$, $Y_k = \ln(T_{ij} / E_i M_j)$, $i = 1 \ldots I$, $j = 1 \cdots J$, $k = 1 \cdots I * J$

and the set of work regions J to which the workers travel is different for the different residential regions.

The calculation of the Peripherality Index 2004 yielded the value θ equal to 1.19, based on commuting data from the Travelling Habits Survey 1996/97 (Central Bureau of Statistics, 2001; Tsibel, 2009).

In the calculation of the Peripherality Index 2015, due to the lack of an up-to-date nationwide survey of travelling habits, an attempt was made to revise the parameter using the data on places of work and residence obtained in the 2008 Population Census and in the 2014–2016 Labour Force Surveys. However, use of these data did not yield a reliable and unambiguous statistical estimator, and the value of the parameter was not changed.

D. Calculation of the Peripherality Index

The index was calculated at the level of locality for the 1,210 localities having municipal status at the end of 2015. These included 201 municipalities and local councils and 1,009 localities within 54 regional councils. The index was also calculated at the level of the 252 local authorities.

The value of the Peripherality Index 2015 was calculated as a weighted total of two components: the potential accessibility index and proximity to the boundary of the Tel Aviv District.

1. Calculation of the Index for Localities

1.1 Value of the Potential Accessibility Index

The construction of the formula for the potential accessibility index is described in Chapter C.

The value of the potential accessibility index for given locality is calculated as the sum of the potentials of the populations of all 1,210 localities. The potential of the population of the locality (relative to the given locality) reflects the influence of the distant population and is calculated as the size of the population divided by the function of the distance to that locality from the given locality.

(3) $$A_i = \sum_{j=1}^{1,210} \frac{P_j}{d_{ij}^{1.19}}$$

where:

A_i – potential accessibility of locality i

P_j – population size of locality j

d_{ij} – distance in kilometers from locality i to locality j , $d_{ij} \geq d_{ii}$

d_{ii} – defined as 3 kilometers for each locality, and serves as the balance parameter for the self-population sizes

1.19 – estimate of the distance decay parameter

The larger the localities j, and the closer they are to locality i, the greater the accessibility of locality i and the less peripheral it is.

The location of the localities was determined according to a layer of points of all localities in Israel, updated to the end of 2015. In this layer, the coordinates of the point indicating the location of the locality were obtained as the average of the x–coordinates and the average of the y–coordinates of the middle points of all the buildings located within the jurisdiction of the locality. In a few cases, in which the calculated point fell outside the jurisdiction of the locality, a different point was determined, close to the calculated point and within the jurisdiction of the locality.

The distances were calculated between the centroids of the localities (the indicator points), according to the shortest distance through the road network. The road network was defined based on the road layer of the “Mapa” company as of January 2016, after deleting the following types of roads:

- Roads not suitable for car traffic (such as a bicycle path, path for pedestrians, pedestrian mall, a road for 4 x 4 vehicles, or a dirt road).

- Roads on which travel is permitted only with a military escort.
- Roads in the Judea and Samaria Area in Areas A and B, and roads in Area C[1] on which travel by Israeli citizens is not permitted according to army regulations.

In addition, when the points of origin and destination were not within the Judea and Samaria Area, roads that pass through the Judea and Samaria Area were not taken into account even if this would shorten the route. Nonetheless, the major roads 1, 90, 50, and 443 were included even though parts of them pass through the Judea and Samaria Area.

The determination of locations of localities and calculation of the distances was performed by the GIS-Geography Sector at the CBS.

Calculation of the potential accessibility index includes **two parameters**: self-distance, which serves as the balance parameter for the self-population sizes, and the power in the distance function that constitutes the distance decay parameter. The values of these parameters remained the same as in the Peripherality Index 2004.

1.2 Proximity to the Boundary of the Tel Aviv District

The Tel Aviv District constitutes a national economic and business centre. Although the population of the localities in the Tel Aviv District is included in the calculation of the potential accessibility index, proximity to this district has additional importance in the sense of its economic opportunities.[2] The value of the proximity was calculated as follows:

- Each locality in the Tel Aviv District, which is also the core and the inner ring of the Tel Aviv metropolitan area, was assigned a zero for this component. The **localities included in the Tel Aviv District** are: Tel Aviv-Yafo, Kefar Shemaryahu, Herzliyya, Gelil Yam, Ramat HaSharon, Bene Beraq, Giv'atayim, Ramat Gan, Kiryat Ono, Or Yehuda, Azor, Holon, and Bat Yam.
- For each locality outside the Tel Aviv District, the shortest distance in kilometers from the centre of the locality to the district boundary, on the road network, was calculated. This value was multiplied by minus one so that the higher the value of the component, the more central the locality.
- The distances were calculated by the GIS–Geography sector of the CBS, using the same criteria that were applied in the calculation of the distances between localities for the potential accessibility index.

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[1] The division of the territories in the Judea and Samaria Area according to the Oslo Accords. Area A – areas under both civil and military Palestinian Authority control. Area B – areas under civil control of the Palestinian Authority and military control of Israel. Area C – areas under Israeli civil and military control.

[2] Note that this component is a type of travel cost index (see Section 1 in Chapter C)

1.3 Weighting of the Components

The value of the Peripherality Index for a locality was obtained as a weighted average of the standardized values of the two components, with a weight of two-thirds for the potential accessibility index and a weight of one-third for the proximity to the Tel Aviv District boundary.[3]

The lowest value of the index indicates the most peripheral locality and the highest value indicates the most central locality.

2. Calculation of the Index for Local Authorities

The Peripherality Index of a municipality or local council was obtained from the processing of the localities. The Peripherality Index of a regional council was obtained as an average of the index values of the localities in the council, weighted by their population size.

3. Allocation Into Clusters

The **local authorities were divided into 10 homogeneous groups (clusters)** that were not equal in size, based on the values of their Peripherality Index. The allocation to groups was produced using the hierarchical cluster analysis method, so that the variance of the index values within clusters is minimized and the variance between clusters is maximized. Cluster 1 contains the most peripheral authorities, and Cluster 10 contains the most central authorities.

Table A displays the number of local authorities, the range of the ranks, and the population size and percentage in each peripherality cluster at the level of local authority.

[3] In the 2004 Peripherality Index, the components were weighted at one-half each.

Table A. Distribution of Local Authorities by Peripherality Cluster, 2015

Peripherality Cluster	Number of Local Authorities	Range of Ranks	Total Population	Percentage of Population
1	2	1 – 2	53,293	0.63
2	16	3 – 18	113,509	1.35
3	57	19 – 75	689,226	8.21
4	45	76 – 120	751,046	8.95
5	60	121 – 180	1,777,535	21.18
6	27	181 – 207	779,385	9.29
7	21	208 – 228	930,778	11.09
8	14	229 – 242	723,164	8.62
9	8	243 – 250	1,724,475	20.55
10	5	251 – 255	851,093	10.14
Total	**255**		**8,393,504**	**100.00**

The **localities within the regional councils were allocated to 10 clusters** according to the values of their Peripherality Index and according to the boundaries of the clusters of the local authorities.

Table B displays the number of localities, the range of the ranks, the population size, and the population percentage in each peripherality cluster at the level of locality.

Table B. Distribution of Localities by Peripherality Cluster, 2015

Peripherality Cluster	Number of Localities	Range of Ranks	Total Population	Percentage of Population
1	16	1 – 16	54,411	0.65
2	95	17 – 111	113,634	1.35
3	341	112 – 452	659,460	7.86
4	217	453 – 669	818,394	9.75
5	278	670 – 947	1,730,698	20.62
6	137	948 – 1084	823,006	9.81
7	76	1085 – 1160	885,635	10.55
8	35	1161 – 1195	731,560	8.72
9	10	1196 – 1205	1,725,613	20.56
10	5	1206 – 1210	851,093	10.14
Total	**1,210**		**8,393,504**	**100.00**

Table C displays the changes that took place in the allocation of local authorities to 10 peripherality clusters according to the 2015 index compared to the 2004 index. The count also included local authorities that were split after the calculation of the previous index (see Section 2 in Chapter B), such that for these local authorities, the comparison is to the 2004 cluster of the unsplit authority.

Table C. Changes in Peripherality Cluster, 2015 Compared to 2004

2015 Cluster Minus 2004 Cluster	Number of Local Authorities
-2	3
-1	133
0	118
1	1

Similar to the calculation made for the Peripherality Index 2004, one can group the 10 clusters into 5 levels of peripherality: very peripheral, peripheral, intermediate, central, and very central. The groups were obtained using the same method (hierarchical cluster analysis) so that the variance of the index values within the groups is minimized and the variance between groups is maximized. **Table D** displays the results of the allocation. Note that the grouping of 10 clusters to 5 levels obtained according to the Peripherality Index 2015 is different from the grouping obtained according to the Peripherality Index 2004.

Table D. Distribution of Population of Local Authorities by Level of Peripherality, 2015 Compared to 2004

Percentage of Population 2004	Peripherality Cluster 2004	Level of Peripherality	Peripherality Cluster 2015	Percentage of Population 2015
4.1	1, 2, 3	Very peripheral	1, 2	2.0
11.1	4	Peripheral	3, 4	17.2
29.3	5, 6	Intermediate	5	21.2
13.3	7	Central	6, 7	20.4
42.2	8, 9, 10	Very central	8, 9, 10	39.3

E. Description of Attached Tables, Diagrams and Maps, and Summary

1. Description of Attached Tables, Diagrams, and Maps

Table 1 displays the local authorities in ascending order of Peripherality Index 2015, with ranks (from 1 for the most peripheral local council to 255 for the most central one) and allocation to clusters (from 1 to 10). Also displayed are the values and ranks according to the potential accessibility index and to the proximity to the boundary of the Tel Aviv district.

The value of the Peripherality Index, and the value of each of its two components for a municipality or a local council are the locality characteristics displayed in Table 2. The value of the Peripherality Index and the values of each of its components for a regional council were calculated as the average of the values of the localities in the regional council, weighted by their population size.

The 11 most central local authorities are: Giv'atayim, Tel Aviv-Yafo, Ramat Gan, Bene Beraq, Givat Shemu'el, Jerusalem, Qiryat Ono, Holon, Petah Tiqwa, Azor, and Ganei Tiqwa. The 11 most peripheral local authorities are: Elat, regional council Hevel Elot, regional council HaArava HaTikhona, Ein Qinyye, Mizpe Ramon, Majdal Shams, Ghajar, Buq'ata, Mas'ade, Metula, and the regional council Tamar.

The large cities numbering more than 200,000 residents are found in the middle to high clusters: Tel Aviv-Yafo is in Cluster 10; Jerusalem, Rishon Leziyyon, and Petah Tiqwa are in Cluster 9; Ashdod and Netanya in Cluster 7; Haifa in Cluster 6, and Be'er Sheva in Cluster 5.

In addition, **Table 1** displays the Peripherality Index 2004. Changes in the allocation to clusters according to the Peripherality Index 2015 compared to the 2004 Index are due mainly to methodological changes in the construction of the index. Note that for local authorities that were created after 2004 as a result of splitting local authorities (see Section 2 in Chapter B), there is no peripherality cluster for 2004. In these cases, the 2004 peripherality cluster for the unsplit local authority is displayed (see notes to Table 1).

Table 2 displays the localities in ascending order of the Peripherality Index 2015, with ranks (from 1 – the most peripheral, to 1120 – the most central) and allocation to clusters (from 1 to 10). Also displayed are the values and ranks for the potential accessibility index and proximity to the boundary of the Tel Aviv District. The values of the two components are standardized, such that the average value over all localities is zero and the standard deviation is 1.

Table 3 displays the localities within the regional councils, with the regional councils appearing in Hebrew alphabetical order and localities within each regional council

appearing in ascending order of the Peripherality Index 2015. This table allows one to see the variablility of the localities' clusters within each regional council.

Diagrams 1 and 2 show the distributions of the population and of the number of local authorities by 2015 peripherality cluster, respectively.

Diagrams 3 and 4 show the distributions of the population and of the number of localities by 2015 peripherality cluster, respectively.

The **map of local authorities** shows a distribution of the local authorities by Peripherality Cluster 2015. Each local authority is represented by its area of jurisdiction, except the regional councils in the Judea and Samaria Area, which are represented by circles.

The **map of localities** shows a distribution of the localities by Peripherality Cluster 2015. Each locality is represented by a circle, the size of which indicates the size of its population, according to 3 size groups: (1) less than 20,000 residents; (2) between 20,000 and 99,999 residents, and (3) 100,000 or more residents.

2. Summary of Revisions and Forecast of Future Developments

The Peripherality Index 2015 is an update of the Peripherality Index 2004 of Local Authorities. In addition, for the first time, the index was constructed **at the level of locality**. Significant changes in the 2015 index compared to the 2004 index are a result of changes in the composition of the local authorities and in the population and infrastructure data, but mainly are due to methodological changes in the calculation of the index.

A. Revision of population data and changes in the municipal map

Data on the population sizes of the localities was updated to the end of 2015.

In addition, since the construction of the Peripherality Index 2004, a number of changes have occurred in the municipal status of localities and local authorities, mainly splitting of local authorities (see Section 2 of Chapter B).

B. Methodological changes in calculation of the index

- **The Peripherality Index 2015 was constructed at the level of locality**, in contrast to the Peripherality Index 2004, which was calculated at the level of local authority. The value of the Peripherality Index 2015 of a regional council is calculated as the average of the index values of the localities in the council, weighted by their population size.

- **The weighting of the components of the Peripherality Index changed**: two-thirds for the potential accessibility index and one-third for the proximity to

the Tel Aviv District boundary, compared to one-half for each component in the 2004 index.

C. Changes in infrastructure and in the calculation of distances

- In the calculation of the Peripherality Index 2004, the centres of the local authorities were determined as follows: The centre of a municipality or local council was determined as the centroid of the polygon, and the centre of a regional council was determined as the location of the council offices. Because the Peripherality Index 2015 was calculated at the level of locality, there was no need to define centres of regional councils. **The distances were calculated between the centres of the localities (the indicator points)**, which were determined according to the average of the co-ordinates of the buildings located within the jurisdiction of each locality.

- Regarding the calculation of the shortest distance on the road network, new roads were added. In addition, the **criteria for calculating the distances were revised**, especially regarding roads that pass through the Judea and Samaria Area.

D. Future Developments

The CBS will revise the peripherality indices for localities and local authorities in Israel **once every 5 years**.

Improvement of the calculation of the index in the future requires supplementation of missing data at the locality level, such as data on residence locality and work locality, origin and destination of daily trips, use of various means of transportation, travel time using various means of transportation, and cost of trip. For this purpose, a national survey of travel habits and use of big data are necessary.

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