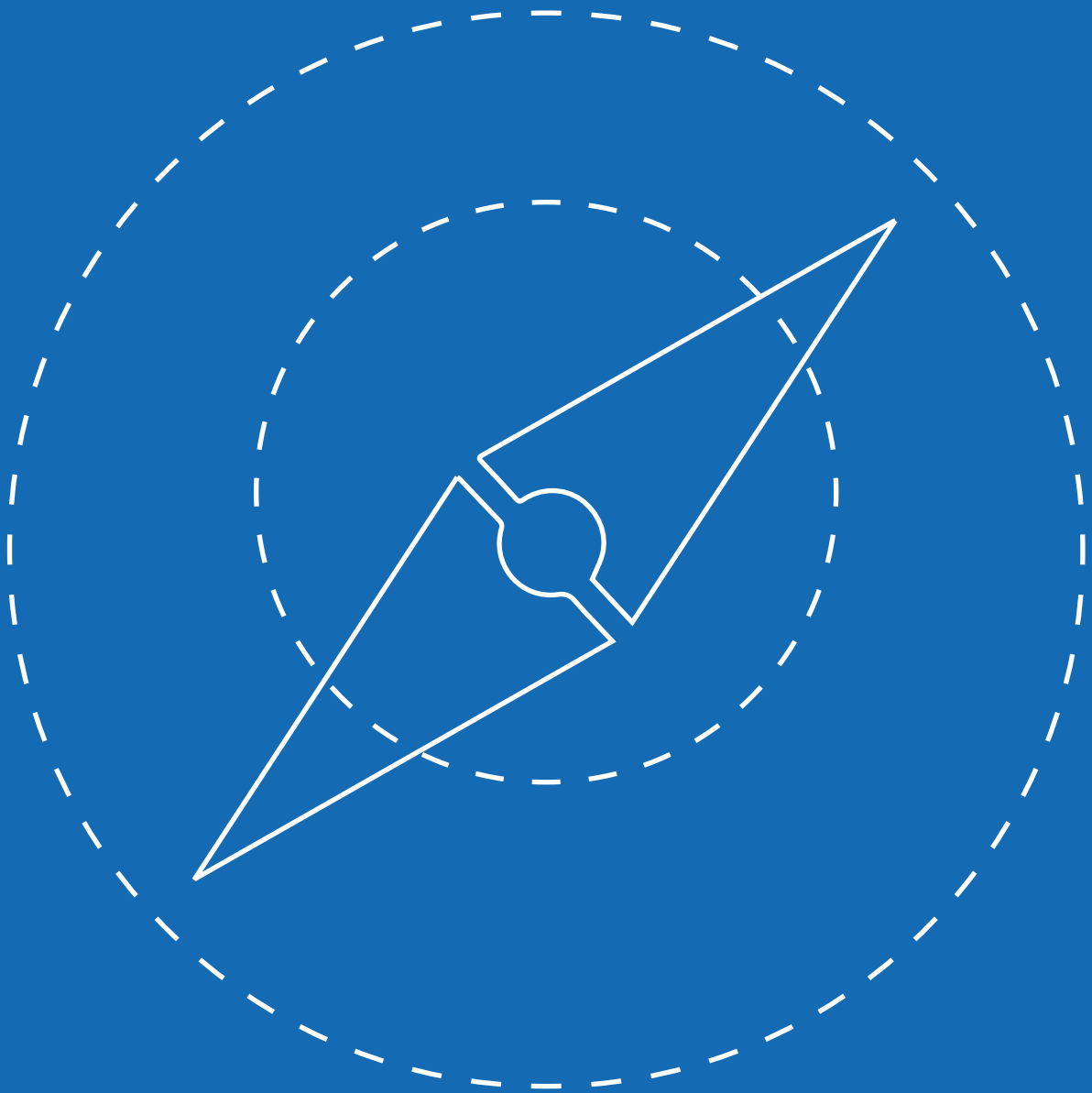


COMPASS FOR SUSTAINABLE CITIES



FINAL REPORT

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1.

COMPASS FOR SUSTAINABLE CITIES



The **Compass for Sustainable Cities** (hereinafter “the Compass”) has been created as part of the Sustainable Urban Development Guidelines. It is a planning tool designed to model the possibilities and needs of the development of urbanised territories and determine the directions of territorial development more clearly when planning urban territories. The Compass is a planning tool that responding to urban sustainability goals. With the help of territorial indicators and spatial data, the Compass allows to form territorial challenges for the development of specific cities and guidelines for sustainable development. It also compares the sustainability of cities with the help of the results of sustainability indices and indicators. **It is noted that the Compass is a limited planning tool due to the limited availability of territorial data and needs to be improved with new indicators.**

A study of good practice examples (see, Annex No 1) demonstrates how individual planning tools can significantly contribute to increasing the sustainability of individual cities. Different planning tools compare the sustainability of cities with each other, identify specific problem areas, and based on their conclusions and results, recommendations and guidelines for the development of more sustainable cities are formed. Constant monitoring of urban sustainability allows to see when the city made an error and to determine a new development direction that would solve specific sustainability problems by assessing possible future problems and strengthening the weakest areas.

Data collected from spatial data and indicators allow to assess the level of urban sustainability in individual areas of sustainability in general terms, to compare the development of different areas of sustainability in the city, to compare the level of sustainability of different cities, and to determine a variable urban sustainability “standard”. However, the overall final result of the level of sustainable cities is only conditional. In order to solve specific problems, each indicator and its values should be analysed separately.

1.1 METHODOLOGY OF THE COMPASS FOR SUSTAINABLE CITIES

1. **Establishing sustainability criteria.** The first step is to define sustainability criteria that are used to compare different cities. The sustainability criteria are defined in the scope of the Sustainable Urban Development Guidelines.
2. **Data update and collection.** The Compass for Sustainable Cities requires territorial spatial data about cities, which are analysed in the Compass map diagrams. These data must be constantly updated for monitoring and surveillance. The data is collected from public sources, such as statistical departments, city authorities, etc.
3. **Data analysis.** In the third step is analysis of the collected data and the determination of conditional current level of urban sustainability. During the analysis, the main challenges related to sustainable urban development are identified in general terms.
4. **Comparison between cities.** Sustainability indices are presented in map diagrams, urban sustainability tables and radial diagrams. This makes it possible to compare different aspects of sustainability of different cities in different sections (territorial, according to specific data, etc.).
5. **Identification of challenges and opportunities.** Based on the analysis of the Compass derived schemes and diagrams, it is possible to identify the most important territorial challenges and opportunities for each city. This makes it possible to determine more detailed measures according to different typologies of cities.
6. **Engagement of stakeholders.** For the interpretation of the Compass data, it is suggested to involve the local government, residents, business sector and other stakeholders in the process of specific sustainable city development.

1.2. METHODOLOGICAL STEPS FOR THE DEVELOPMENT OF THE COMPASS FOR SUSTAINABLE CITIES

1. The **list of 103 Lithuanian cities has been compiled**, which are divided into four groups: metropolitan centres, regional centres, local regional centres and local centres. The administrative boundaries of cities (not municipalities) in the territory of the Republic of Lithuania and their category are marked.
2. The entire territory of the Republic of Lithuania is divided into **1x1 km grids**; the grids that include the administrative boundaries of cities are assigned to the territory of that city. Lithuania is divided into a total of 66,251 grids; city boundaries fall into 2,900 grids.
 - The indicator averages are taken only from the territories of administrative boundaries of cities;
 - Grid colouring within 20 km radius from metropolitan centres, 15 km radius from regional centres and 1 km from local centres.

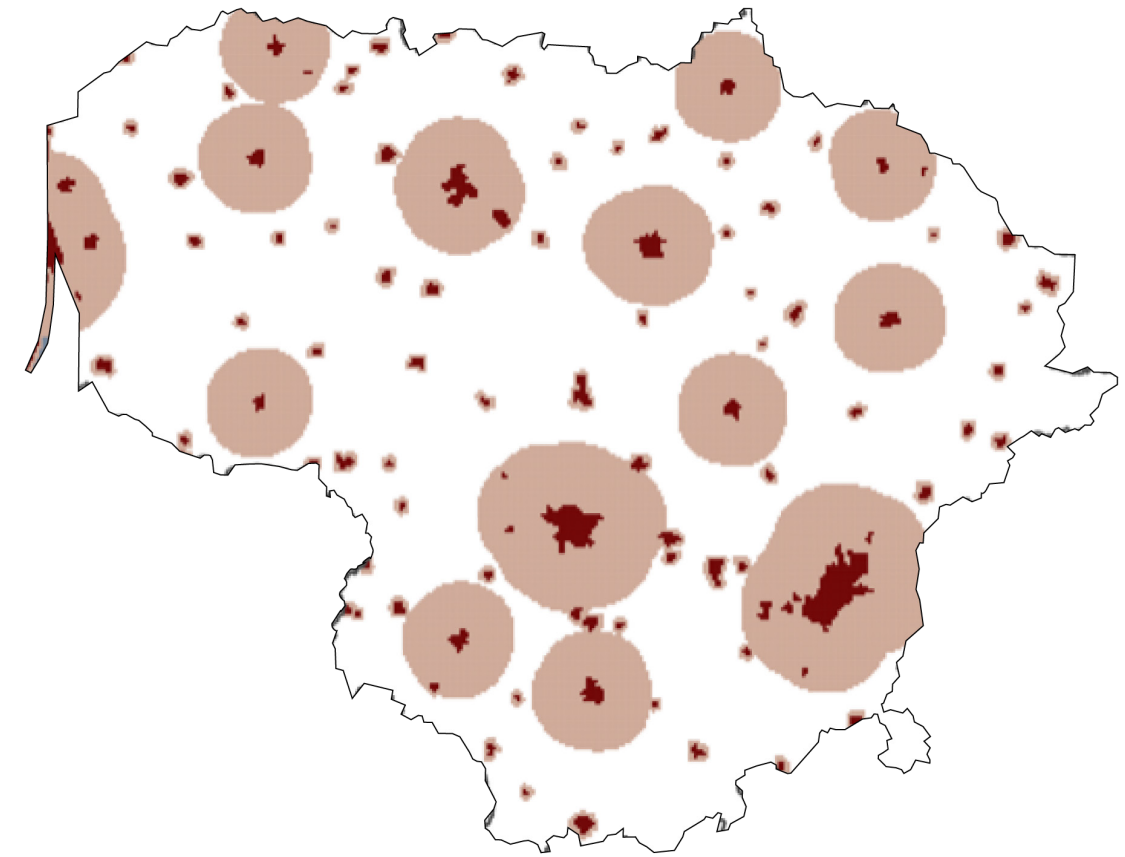


Fig. 1. Sample data (1x1 km)

- All spatial data are cut into grids and if they fall within the administrative boundaries of cities, they are assigned to a specific city.
3. The data of a specific indicator from all grids falling within the city boundaries are summarized and their average is derived. Average values of indicators for specific cities are also derived.
4. The grids are compared with each other along with the average values, the city closest to the average value of the cities is given a 0 evaluation, other grids are evaluated positively and negatively by ranking them according to the indicators.
5. A radar chart is created for each city: the red dotted colour represents the average values of all city indices, where 0 is the mean value of the cities, while the comparison city shows deviations from the mean values.

1.3. USING THE COMPASS FOR SUSTAINABLE CITIES

Spatial data, measurement and monitoring of cities allow to determine trends in the development of urban structures. By analysing spatial data it is possible to determine the development challenges of specific cities and form guidelines for the sustainable development of cities.

Collected data are exported to a graphical report. The tool allows to convey indicator data in readable and understandable diagrams and maps. This material is compared between the analysed cities; discussions and planned changes could be initiated on the basis of these data.

Different types of spatial data can help answer the following questions:

- In which city territories are the most prominent challenges observed and what spatial data allow for this to be measured?
- Which areas and territories need additional funds for balanced sustainable urban development?
- Which city territories are the most sustainable?
- Maybe it is necessary to initiate separate territory planning and urban planning projects for the most problematic areas in order to achieve sustainable development?

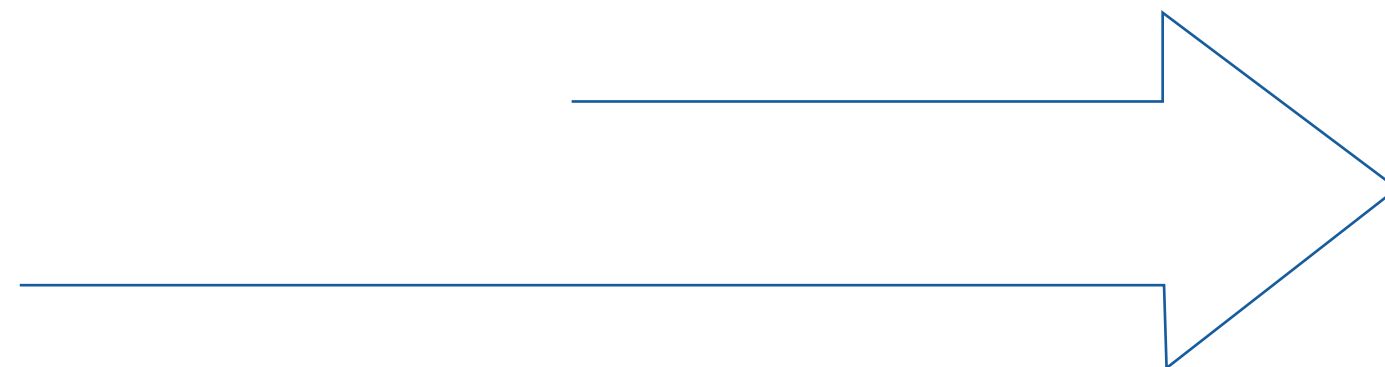
These data could be used for various purposes:

- During the preparation stage of the analysis of city master plans as a recommendatory planning tool;
- Sustainability indicators can be used for the monitoring of city master plans;
- As a tool to help create a sustainable city by making data-based, reasoned decisions;
- For preparation of urban sustainability reports and presentations;
- As a development tool for monitoring urban change and analysing changing indicators on city maps;
- To increase the efficiency of work performance;
- For the identification of priority problems not only in the text, but also in specific urban areas;
- Etc.

1.4. SPATIAL DATABASE AND COMPARISON OF NORMALISED INDEX VALUES

The **Urban Sustainability Table** was prepared on the basis of all the collected data to compare sustainability between cities. The table compares the cities with the highest and worst levels of sustainability according to the main sustainability topics.

This table allows to compare data on various sustainability topics in different cities and identify in which area of sustainability a certain city leads or lags far behind. The value of normalised urban sustainability indices ranges from 0 to 100. Cities with higher values are considered the most sustainable (green colour). In contrast, cities with lower values are less sustainable and have greater development potential (red colour). The city with the best specific indicator or index result is assigned a maximum sustainability value of 100. Lower score values represent a theoretical lower level of sustainability.



No.	City	Anthropogerm environment				Natural environment			
		Compact city		Sustainable transport city		Green city		Clean and climate change, resistant city	
		Compactness	Urban sprawl (no suitable territorial data)	Conditions for sustainable transport	Population mobility size (no suitable territorial data)	Urban green-ness index	Ecology and biodiversity	Climate change adaptation	Water and air quality
1.	Vilnius	62		67		50	41	7	52
2.	Kaunas	65		70		34	39	6	46
3.	Klaipėda	51		57		41	29	6	43
4.	Šiauliai	36		34		26	36	2	0
5.	Panevėžys	50		54		16	23	8	0
6.	Alytus	41		37		43	44	6	12
7.	Marijampolė	41		29		20	25	9	0
8.	Mažeikiai	45		29		29	17	5	0
9.	Utena	30		30		33	13	8	20
10.	Telšiai	33		26		39	13	12	0
11.	Ukmergė	30		45		32	30	11	10
12.	Tauragė	46		65		24	17	13	0
13.	Rokiškis	33		32		20	13	3	0
14.	Biržai	23		31		3	15	15	0
15.	Jonava	46		40		25	46	16	0
16.	Kėdainiai	29		12		36	32	3	0
17.	Visaginas	37		22		53	69	2	0
18.	Plungė	31		28		6	10	23	9
19.	Kretinga	32		29		30	9	8	0
20.	Palanga	17		10		56	69	27	0
21.	Šilutė	25		14		8	24	3	4
22.	Radviliškis	23		12		38	48	3	0
23.	Gargždai	23		14		15	48	6	5
24.	Druskininkai	19		20		81	67	72	4
25.	Elektrėnai	19		11		8	21	3	0

Sociocultural environment				Economic environment				General sustainabi- lity balance
Vibrant city		Inclusive citv		Productive city		Circular economy city		All guidelines
Human capital	Demogra- phic index	Social inclusion	Public activity	Resources and energy	Business and investment development	Zero waste (no suitable territorial data)	Climate change mitigation (no suitable territorial data)	All indicators used in the Sustainability Compass
82	8	51	78	5	100			54
86	5	33	76	8	74			49
73	4	66	70	9	55			45
64	5	12	68	4	43			30
85	11	56	69	14	50			38
75	4	38	71	9	34			37
81	5	65	64	17	40			34
86	0	19	70	10	48			32
84	1	34	83	15	25			33
76	2	46	67	22	26			31
72	2	4	74	20	19			30
81	-3	100	73	26	40			42
75	4	9	76	6	24			26
71	21	13	81	30	11			26
79	4	8	63	32	29			32
61	7	17	79	5	17			27
60	100	0	58	1	20			38
77	-2	6	66	46	32			26
76	7	1	68	15	24			26
55	10	1	76	7	6			30
69	0	3	67	6	27			22
70	10	1	71	4	12			26
79	3	22	72	10	25			26
57	0	1	79	43	16			38
55	15	2	75	2	6			20

Fig. 2. Urban sustainability comparison table by main sustainability topics.

2.

RESULTS OF THE COMPASS FOR SUSTAINABLE CITIES

The results of the Compass for Sustainable Cities are linked to the eight main sustainability guidelines for the development of sustainable cities. Insights and observations on where individual cities or groups of cities are leading or lagging behind in terms of sustainability are formulated accordingly. The results of the Compass territorial indicators can be useful for city authorities, citizens and businesses to better understand the state of the city's sustainability and the areas of sustainable development that need the most attention. During the analysis, the aim was to identify areas of sustainability that require more attention and investment in order to increase the level of sustainability of individual cities.



2.1. COMPACT AND IDENTITY-STRENGTHENING CITY

The following territorial indicators were used to form the **compactness index**: population density in the administrative territory of the city (number / sq km), population density in built-up area, ratio of continuously built-up area to built-up area.

The following territorial indicators were used to form the **conditions for compactness index**: accessibility of green areas and forest areas within 15 minutes on foot, accessibility of kindergartens within 15 minutes on foot, accessibility of schools within 15 minutes on foot, accessibility of public transport and housing area per inhabitant

The following insights can be made according to the available (to date) data on the results of the indicators of **compactness and conditions for compactness indices**:

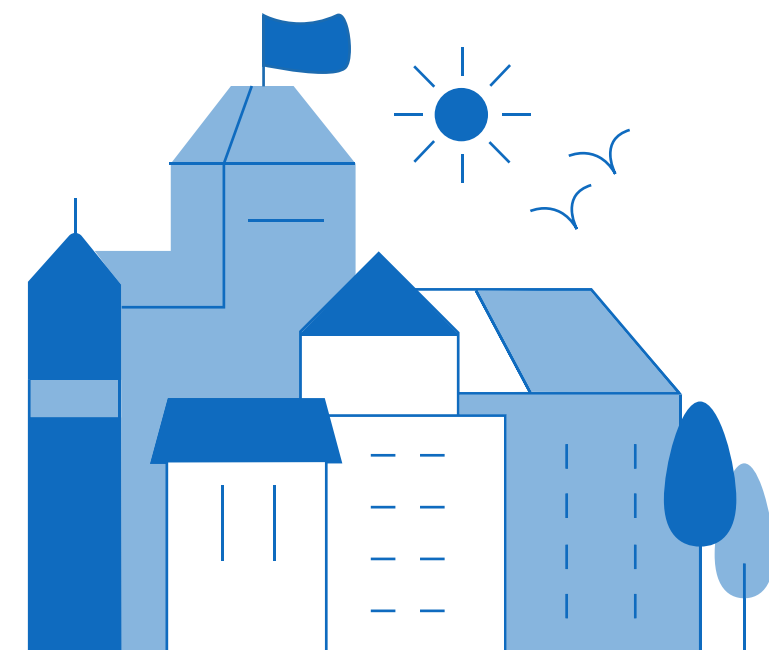
- When evaluating compact city indices separately, in terms of values of compactness index and conditions for compactness index, the most sustainable are the metropolitan cities of Lithuania.
- High values of compactness index results are registered in: Grigiškės, Visaginas, Mažeikiai, Panevėžys, Garliava, Jonava and Tauragė. Similarly, although on average the values of the conditions for compactness index for cities are barely above the average, high results are registered in: Marijampolė, Kupiškis, Jonava and Tauragė.
- When evaluating all available Compactness and Conditions for Compact City indices, Kaunas received the highest positive values, but the values of the cities of Vilnius and Klaipėda are not far behind.
- Metropolitan centres are distinguished by the highest values of the indicator of territorial population density in the administrative territory of the city (number / sq km), while the highest values in Lithuania are registered in Kaunas.
- The values of the indicator of population density in the built-up area are very similar among all Lithuanian cities and are almost always less than the average or very low, but Visaginas stands out with a very high result of this indicator. In general, Visaginas is the only city in Lithuania with all high values for compact cities.
- The least sustainable, i.e., the cities with the lowest compactness index and

conditions for compactness index are the cities of the group of local urban centres. The available data show that these two indices are often correlated and have very similar values. The lowest Compact City values are in the following cities: Pandėlys, Palanga, Rietava, Birštonas and Tytuvėnai.

- When analysed territorially, the highest compactness of cities is registered in the central parts of cities, in some residential areas of multi-apartment houses, while in peripheral parts of cities and territories affected by suburbanisation, compactness registered is much lower. The data of the territorial conditions for compactness index correlates with these data – central parts of cities and certain apartment building districts stand out as the best.
- When evaluating and analysing population density data in the grids, one can see that in different cities territories with less than 30 inhabitants per hectare dominate. In nearly all cities, the homestead type of construction dominates in terms of territory. These territories are not sustainable.
- One can also see the territories where the population exceeds 150 inh./ha. This is not a sustainable territory on a theoretical level. However, each situation must be evaluated individually and according to the specific type of construction, context, etc.

It is important to mention that the values of the Compact City index are compiled only from data sets that are collected and available, therefore, the insights presented above are not conclusions, and the Compass for Sustainable Cities is an auxiliary material for a more detailed analysis of the situation of each city. For a more accurate representation of the situation, it is suggested to collect more indicators.

Full compact city Index results can be found in the Index Results Table of the Compass for Sustainable Cities. Link to the full data table [here](#).



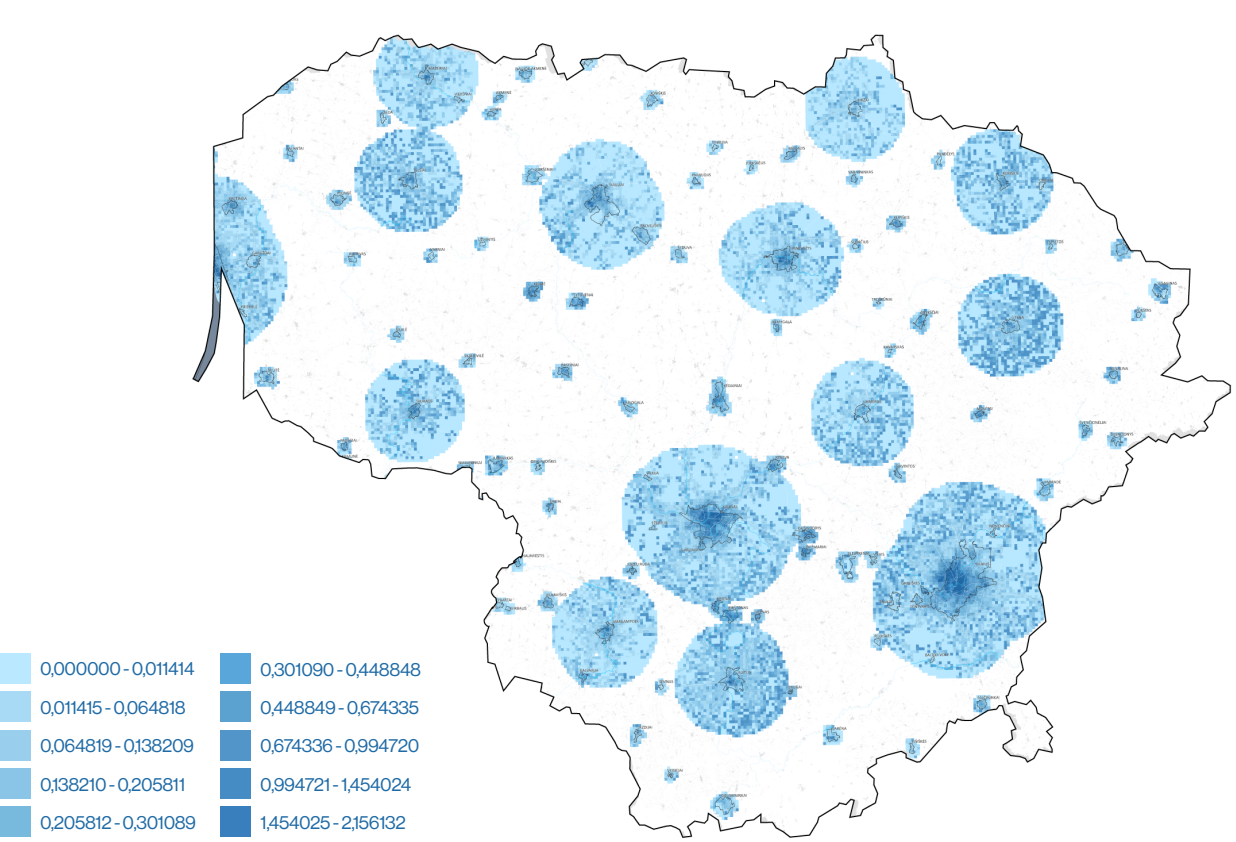


Fig. 3. Compactness index map (darker colour indicates relatively more sustainable results).

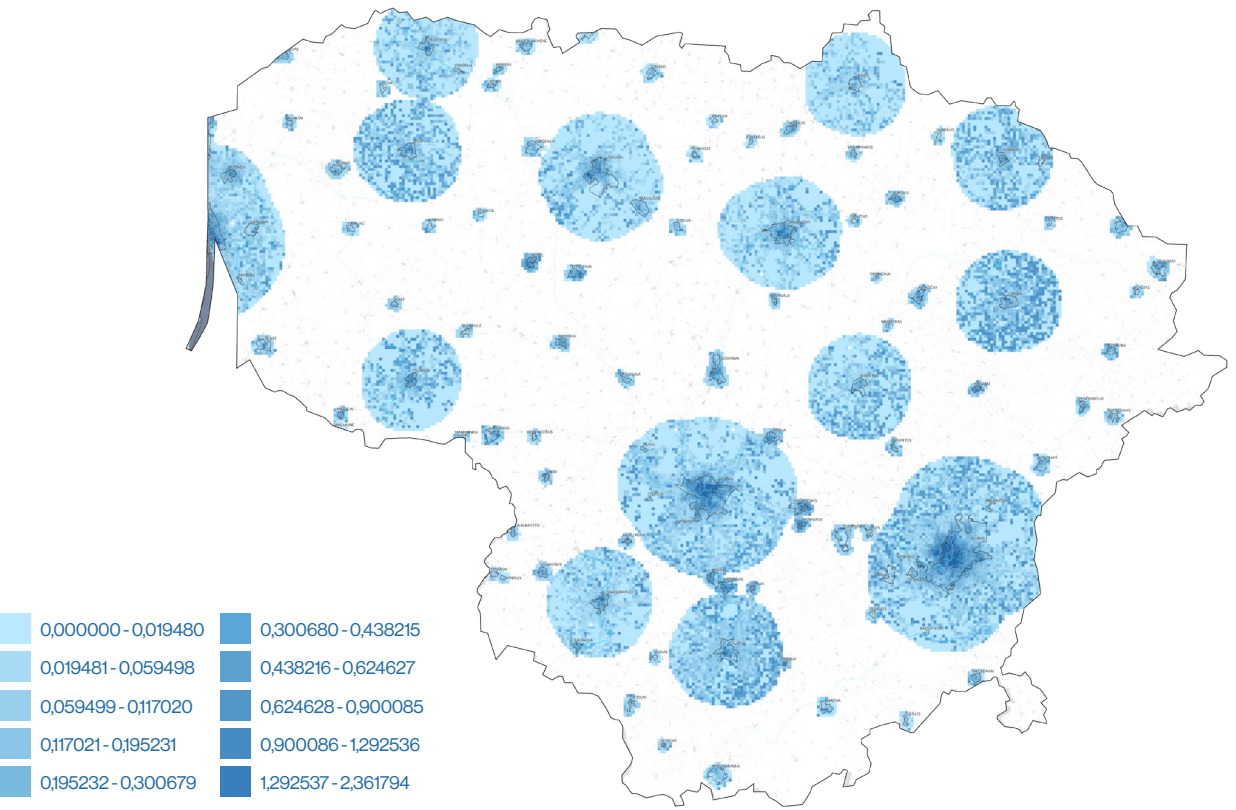
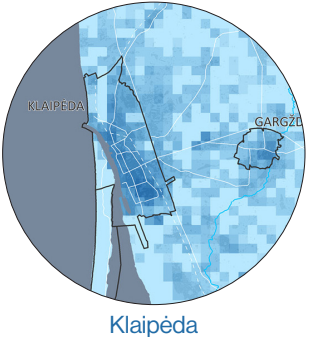
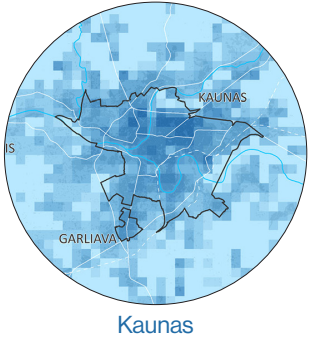
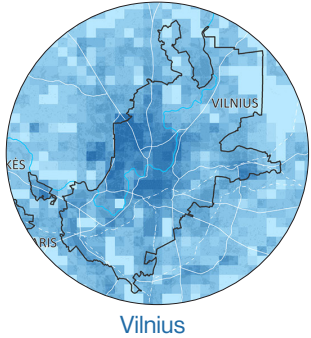
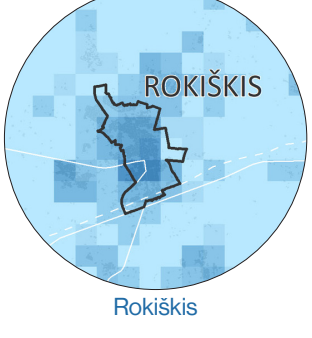
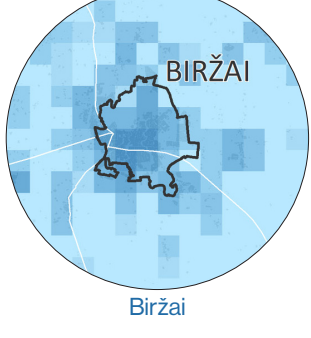
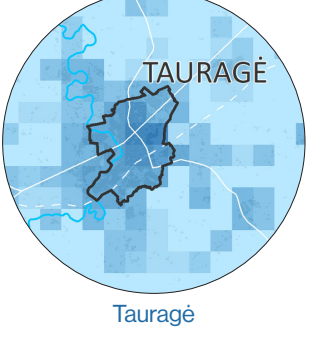
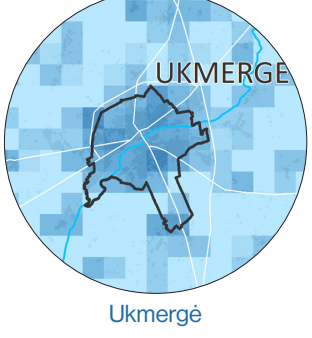
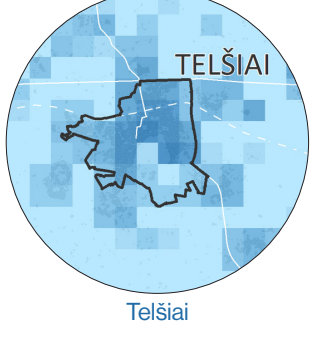
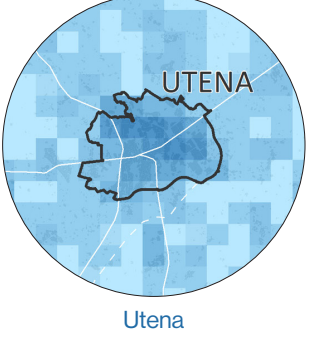
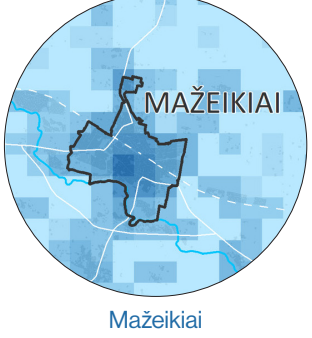
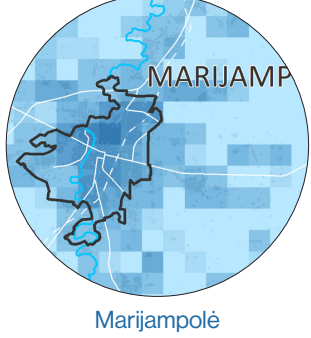
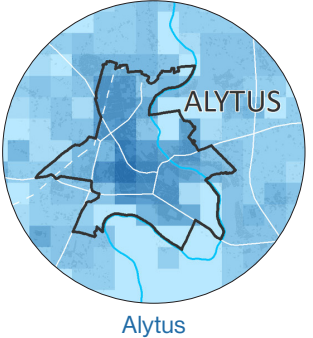
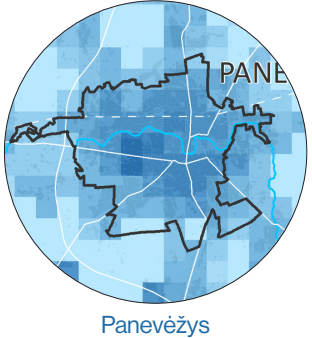
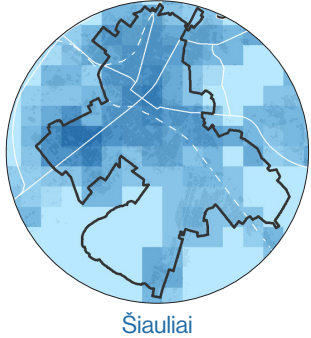


Fig. 4. Conditions for compactness index map (darker colour indicates relatively more sustainable results).

METROPOLITAN URBAN CENTRES

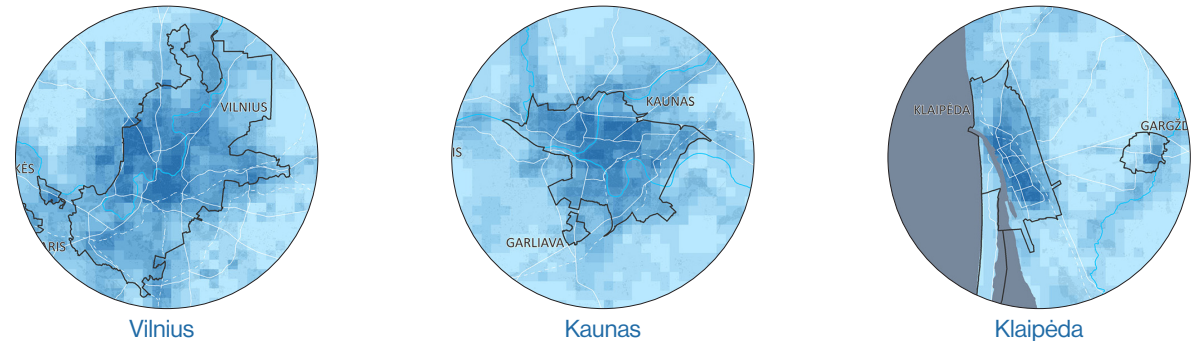


REGIONAL URBAN CENTRES

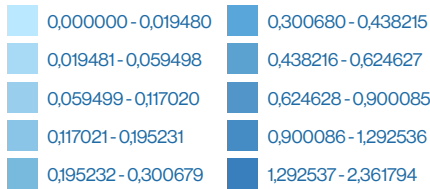
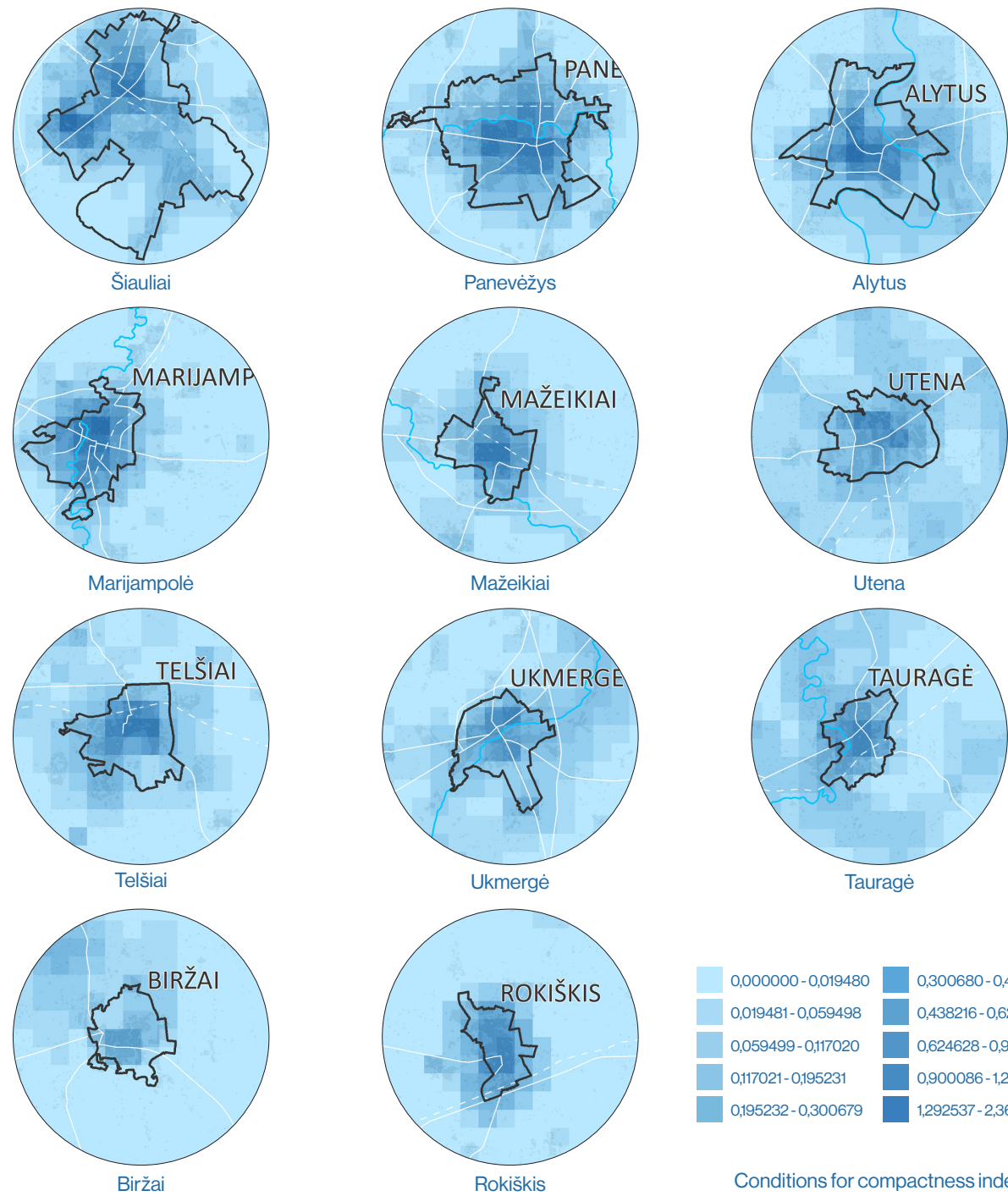


Compactness index

METROPOLITAN URBAN CENTRES

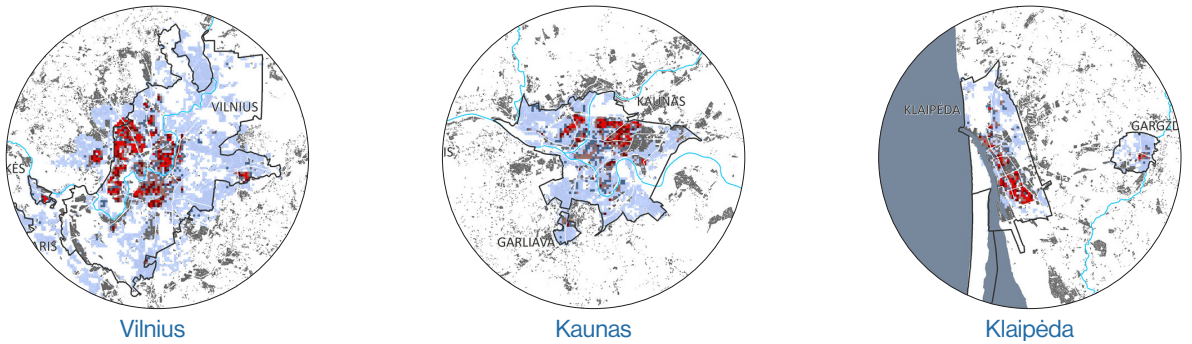


REGIONAL URBAN CENTRES

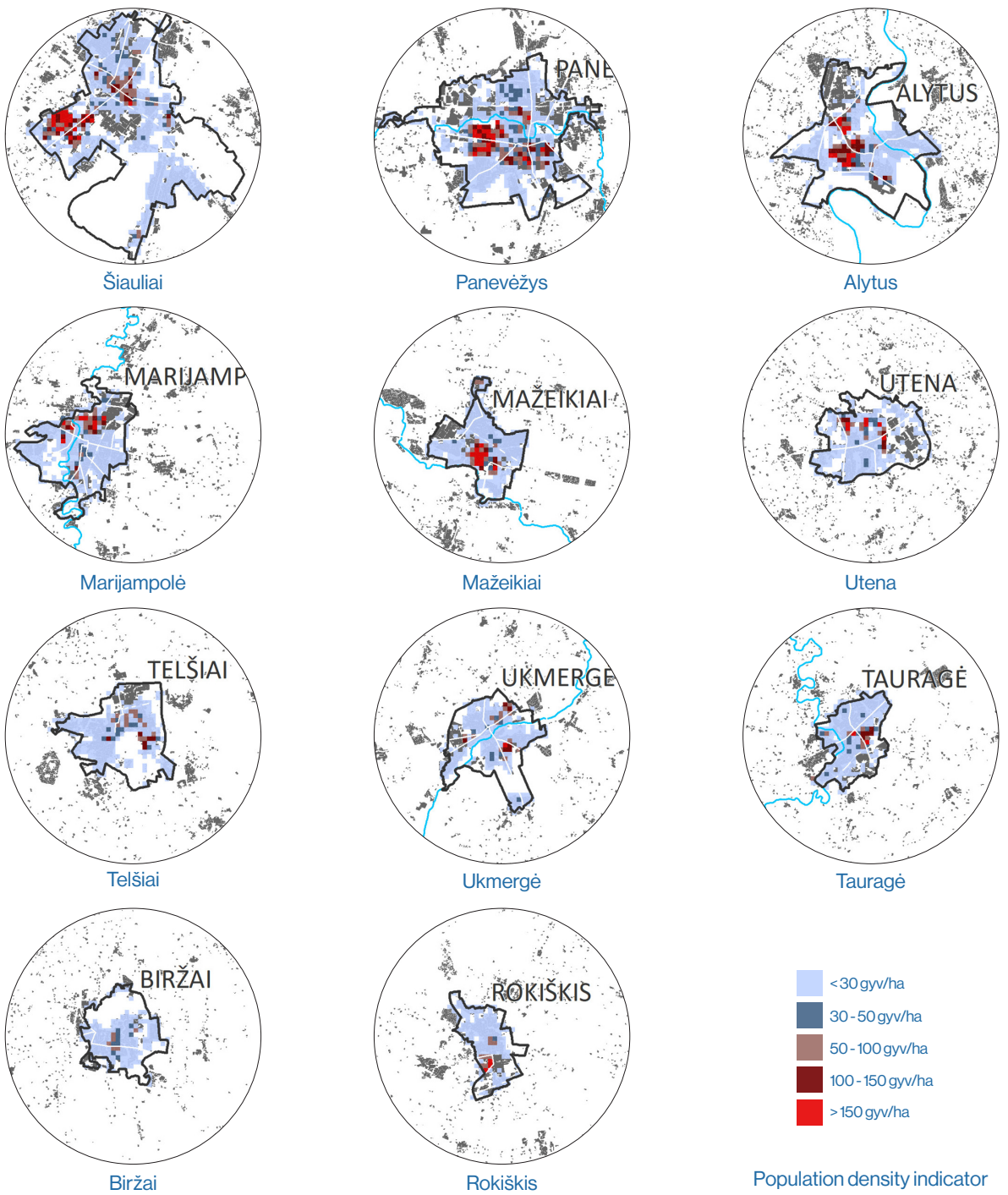


Conditions for compactness index

METROPOLITAN URBAN CENTRES



REGIONAL URBAN CENTRES



Population density indicator

2.2. SUSTAINABLE TRANSPORT CITY

The following insights can be made based on the available data on the results of the **sustainable transport city index** indicators:

- The best conditions for sustainable transport, based on currently collected and available data, among metropolitan urban centres are registered in Kaunas and Vilnius, the value of the index in Klaipėda is somewhat lower, but exceeds the values of most regional centres. Metropolitan centres stand out from other urban centres due to higher quality public transport services, which are reflected in indicators of public transport accessibility and intensity.
- In the regional urban centres, the best conditions for sustainable transport are registered in Tauragė (the value of the index is determined by the indicators of accessibility of electric vehicle charging stations and non-motorised transport infrastructure), Panevėžys and Ukmergė. The worst conditions are in Telšiai, Marijampolė and Mažeikiai (index values are determined by low public transport intensity, indicators of availability of electric vehicle charging stations and non-motorised transport infrastructure indicators).
- In local urban centres, the conditions for sustainable transport are very different. Only 3 local urban centres exceed the average index values of regional centres: Garliava, Grigiškės and Jonava – the high index result of these cities is due to the good accessibility of public transport, but only in Garliava and Grigiškės the intensity of public transport is higher than average, because both cities have an operating public transport of metropolitan centres (Kaunas and Vilnius respectively).
- According to the available data, the best conditions for sustainable transport are present in the central parts of cities and deteriorate as you move away from them. The values of this index correlate with the population density, thus, although based only on the available data it cannot be stated that the conditions for sustainable transport are ensured, the distribution of investments in this infrastructure corresponds to the distribution of the population.

- Around the borders of large cities, better conditions for sustainable transport are registered near national roads. Comparing all three large cities, the largest number of rural areas with better-than-average conditions for sustainable transport are registered in Vilnius (for example, in Pilaitė, Tarandė, Balsiai, Kalnėnai, etc.).
- When assessing the conditions for transport only through the public transport accessibility indicator, it can be seen that the quality of the public transport service is not fully reflected – a short walking distance to the stops does not indicate whether the infrastructure for pedestrian access has been equipped and is suitable for people with special needs, nor does it specify whether the stop is efficient. In order to more accurately assess the availability of the public transport service, it is recommended to evaluate only the stops that meet more quality criteria, for example, the infrastructure to access the stop is ensured, public transport stops at the stop regularly (more often than several times an hour).
- The results of the public transport intensity indicator show that the possibility to travel by public transport at a suitable and convenient time (weekdays and weekends, all day and more often than once an hour) is facilitated only in metropolitan and several regional urban centres with operating public transport.
- Currently, data on non-motorised transport infrastructure collected in most cities is not differentiated according to different types of infrastructure, comfort (straightness, path width) or safety (separation of paths for bicycles and pedestrians, separation of non-motorised transport infrastructure from vehicles) aspects and does not evaluate the connectivity and consistency of non-motorised transport infrastructure, therefore, the conditions for communication with non-motorised transport in cities are not accurately reflected. Evaluating the data currently collected by the Lithuanian Road Administration, there are only a few regional urban centres and not a single metropolitan centre among the cities with the best ratings for this indicator. For the purpose of a more accurate assessment of mobility conditions, it is proposed to assess the length of streets adapted for non-motorised vehicles and pedestrian traffic (through infrastructure adequacy for the needs of all road users and conformity to the requirements of the Construction Technical Regulations). The indicator measured this way could more accurately reveal whether the infrastructure installed makes communication on foot or by bicycle competitive with the vehicles for short distances.

— The indicator of the availability of electric vehicles charging stations reveals that the best conditions are currently available in Tauragė, Vilnius, Ukmergė and Kaunas, however, the data of the indicator do not accurately reflect the actual availability of the service, as some of the registered electric vehicle charging stations cannot be used by all groups, for example, by only employees of a specific company. In order to obtain more accurate results of the indicator, it is suggested that in the future only electric vehicle charging stations conveniently accessible to all users be evaluated.

It is important to mention that the values of the Conditions for Sustainable City index are compiled only from data sets that are collected and available, therefore, the insights presented above are not conclusions, and the Compass for Sustainable Cities is an auxiliary material for a more detailed analysis of the transport situation of each city. For a more accurate representation of the situation, it is suggested to collect more indicators and ensure the quality and accuracy of the collected data.

Link to the full data table [here](#).

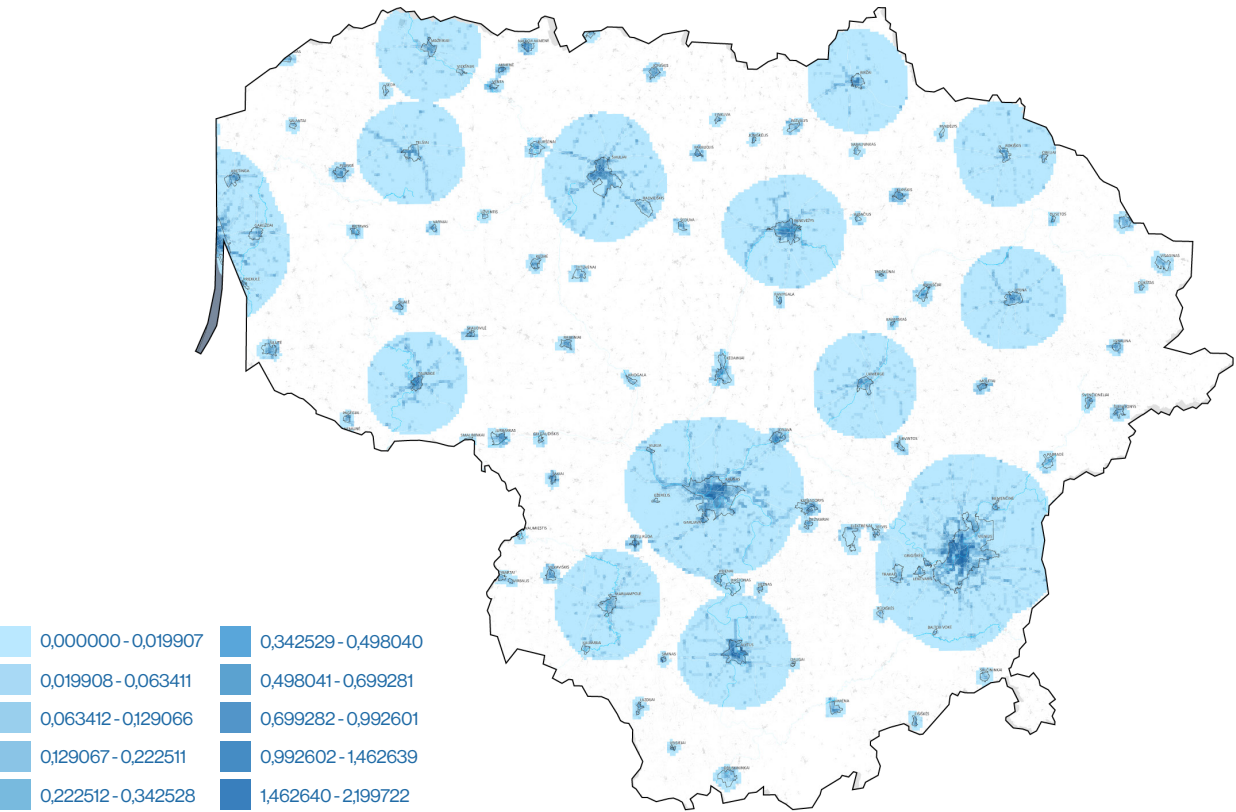
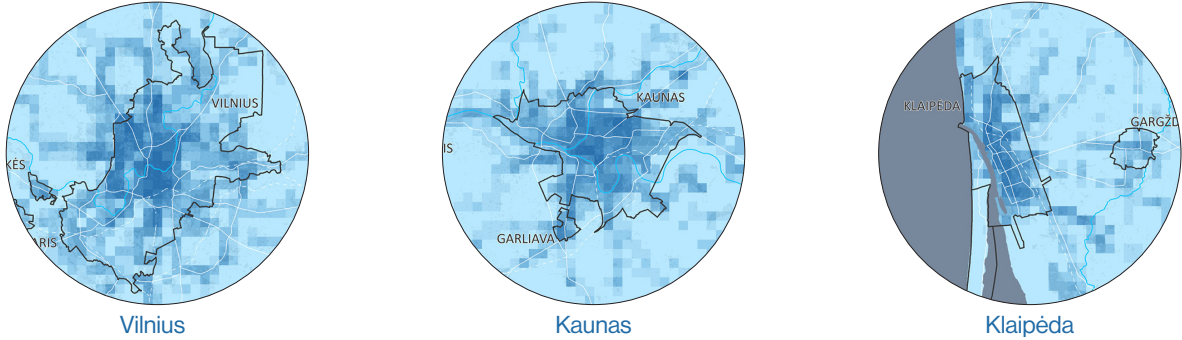
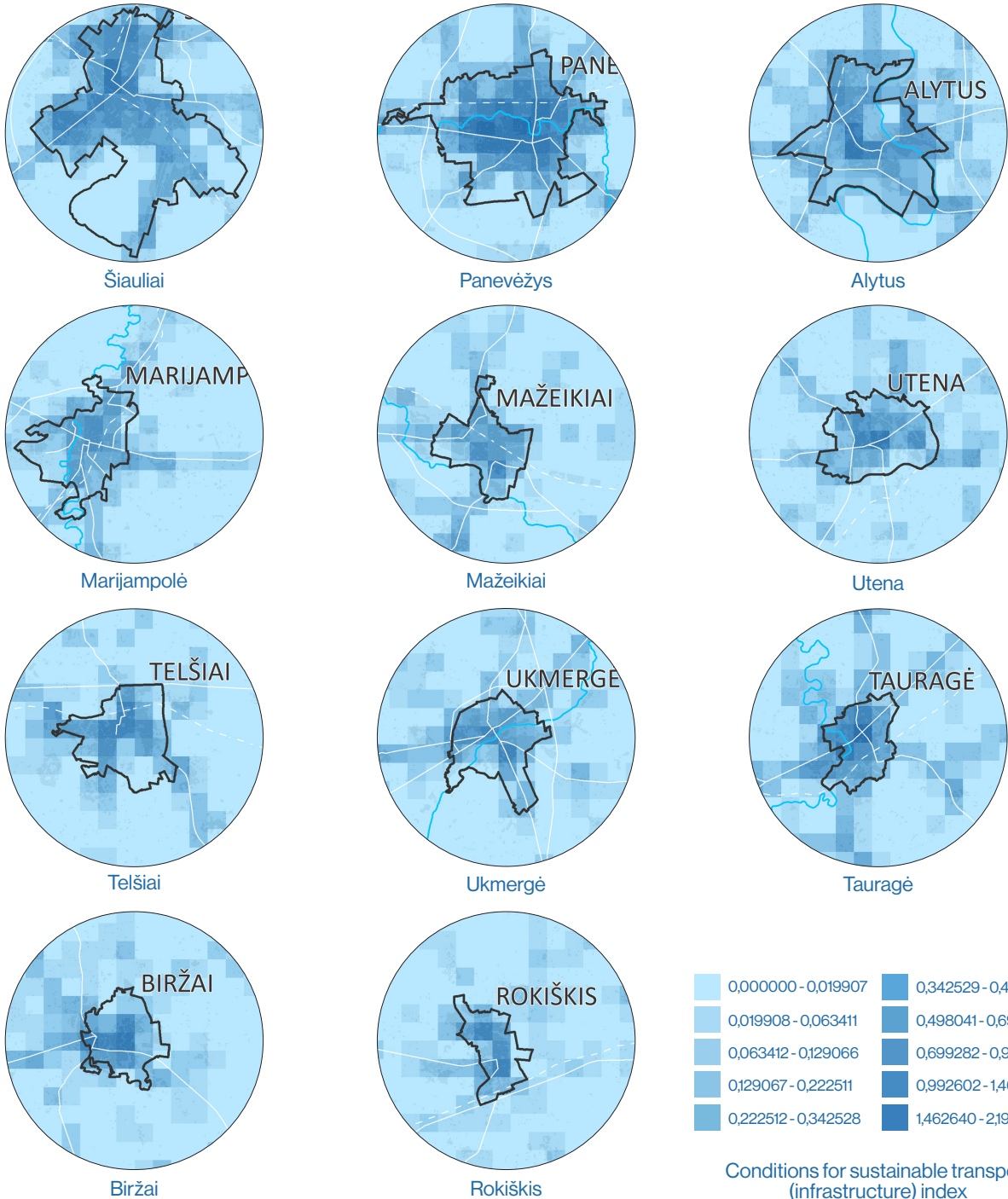


Fig. 5. Conditions for sustainable transport (infrastructure) index map (darker colour indicates relatively more sustainable results).

METROPOLITAN URBAN CENTRES



REGIONAL URBAN CENTRES



Conditions for sustainable transport (infrastructure) index

2.3. GREEN CITY

(ECOLOGICALLY RESILIENT AND BIODIVERSE)

The following insights can be drawn from the available results for **urban greenness index** and **ecology and biodiversity index** indicator data:

- According to the available data, the best indicators of the urban greenness index are registered in the group of local urban centres specifically in the resort cities of Lithuania. The best index values are observed in Druskininkai, Neringa and Birštonas. The highest ecology and biodiversity index values are also observed in resort cities: Neringa, Birštonas, Trakai, Palanga and Druskininkai. Other cities in the group of local urban centres with index values significantly higher than the overall city average: Prienai, Varėna, Kazlų Rūda and Ignalina. Joniškis, Plungė, Kretinga and Šilalė are the least green cities in this group of cities.
- Among the largest cities in Lithuania, Vilnius can be singled out as the city with the best conditions for urban greenness index. In Vilnius, the indicator “forests in urban areas, not classified as green spaces” is one of the highest among all Lithuanian cities. This indicator is higher only in Neringa, Birštonas, Visaginas and Kazlų Rūda.
- When comparing city groups with each other, metropolitan urban centres show the highest urban greenness index indicators, while regional and local urban centres have very low indicators. The lowest indicators are registered in Joniškis, Eišiškės (comparable to 0), Vievis, Lazdijai, Biržai and Plungė.
- Indicators for ecology and biodiversity index are low in almost all cities of Lithuania. When comparing groups of cities with each other according to the available data, it is possible to single out the group of metropolitan urban centres by recording the highest average value of this index.
- The data of the urban greenness index and ecology and biodiversity map show that these two indices overlap spatially, and the natural framework and green urban infrastructure are marked most distinctly in all cities.

It is important to mention that the values of the urban greenness index and ecology and biodiversity index are compiled only from data sets that are collected and available, therefore, the insights presented above are not conclusions, and the Compass for Sustainable Cities is an auxiliary material for a more detailed analysis of the transport situation of each city. For a more accurate representation of the situation, it is suggested to collect more indicators with higher quality.

See Section 3 for all results of the urban greenness index and ecology and biodiversity index: Index Results Table of the Compass for Sustainable Cities.

Link to the full data table [here](#).

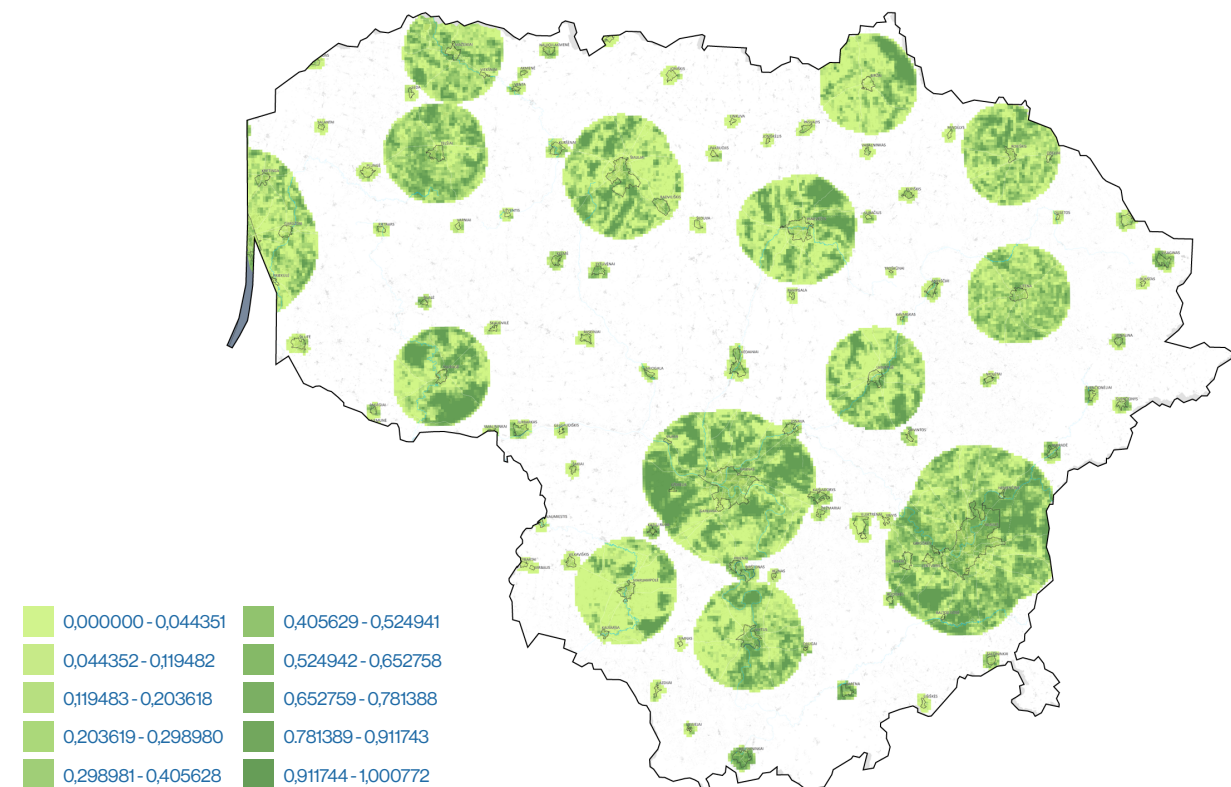


Fig. 6. Urban greenness index map (darker colour indicates relatively more sustainable results)

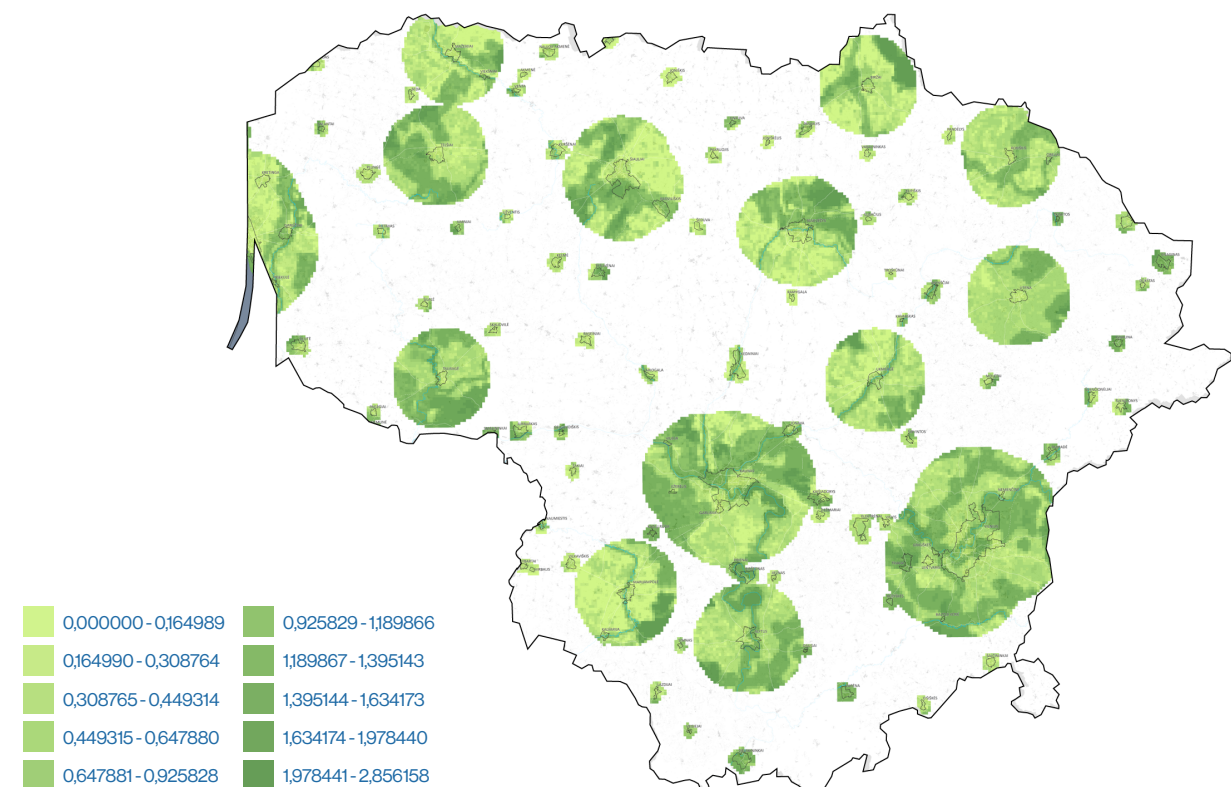
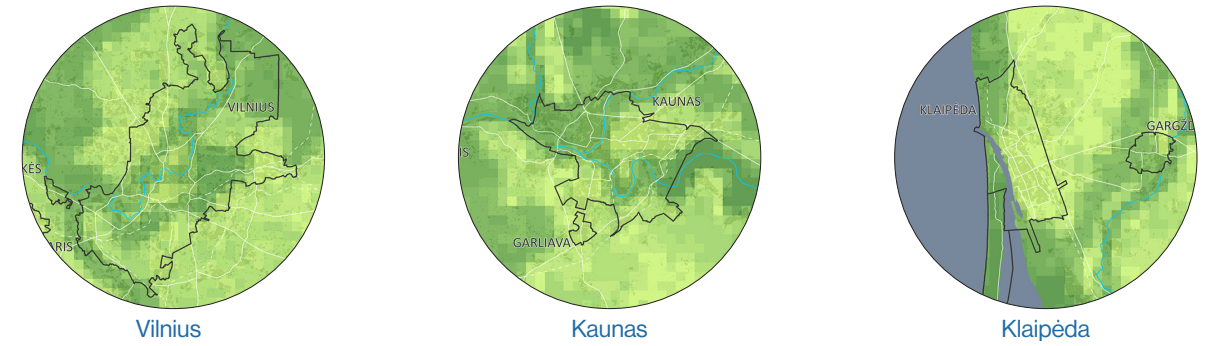
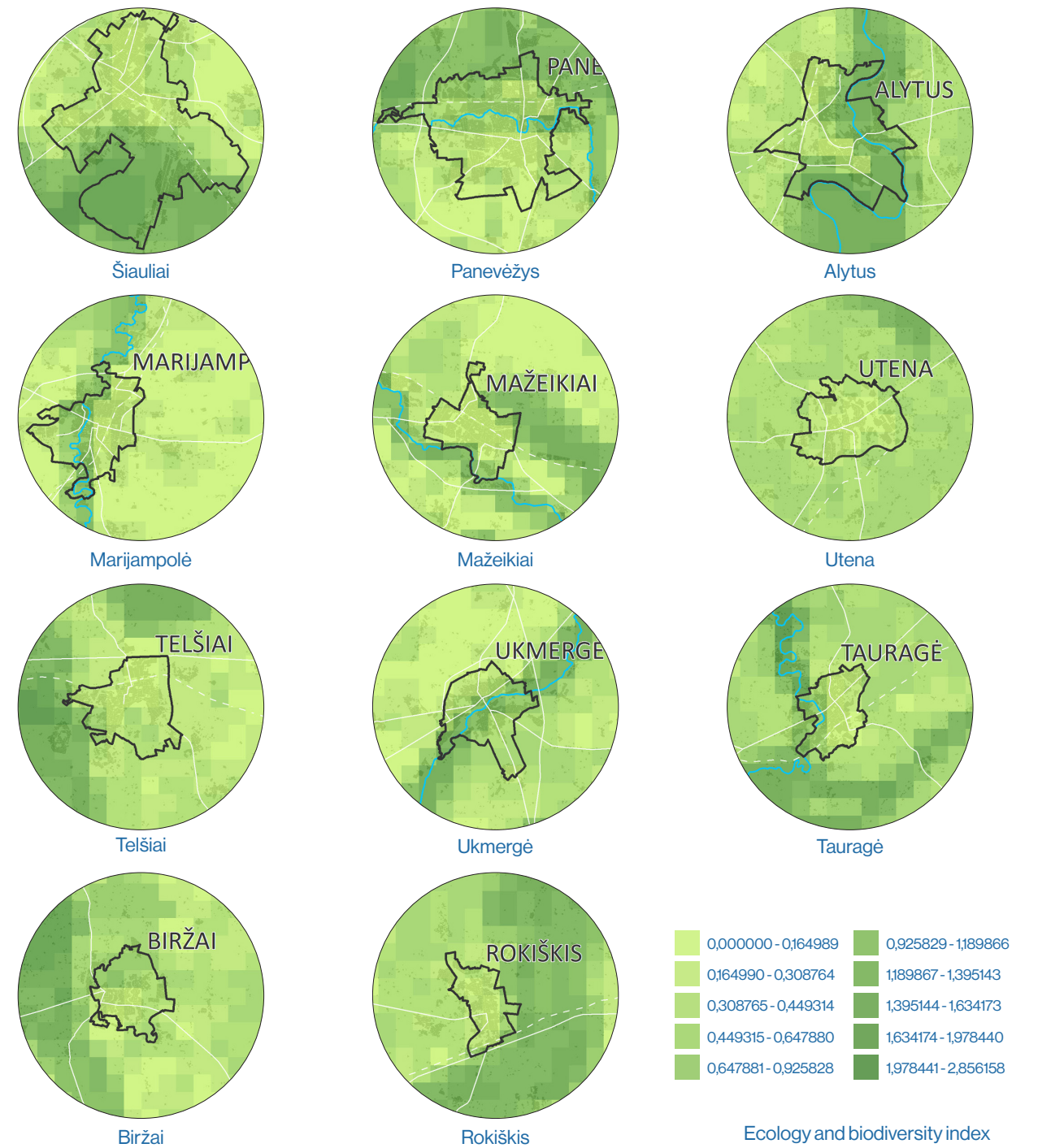


Fig. 7. Ecology and biodiversity index map (darker colour indicates relatively more sustainable results)

METROPOLITAN URBAN CENTRES



REGIONAL URBAN CENTRES



2.4. CLEAN AND CLIMATE CHANGE-RESISTANT CITY

The following insights can be drawn based on the available data on the results of the **climate change adaptation index** and the water and air quality index indicators:

- The indicators of adaptation to climate change index and the water and air quality index for Lithuanian cities are very low, not a single group of cities can be singled out, which has higher indicator values;
- According to the collected indicator data, the best conditions for the adaptation to climate change index are in Druskininkai, Neringa and Palanga – resort towns;
- Based on the indicators of adaptation to climate change index, poor conditions exist in many cities of Lithuania, such as in Ukmergė, Jonava, Kėdainiai, Šilutė, Kuršėnai, etc.;
- Lack of water and air quality index equivalent indicator data for all cities makes it difficult to provide qualitative insights. According to the available data, it is possible to compare only metropolitan urban centres (Vilnius, Kaunas and Klaipėda) with high values of indicators. In Vilnius, according to the measured indicators, the best quality of water and air has been recorded.
- Average values of CO (carbon monoxide) in Klaipėda in 2021 have been registered as the largest, i.e., the least sustainable compared to Vilnius and Kaunas;

It is important to mention that the values of the climate change adaptation index and the water and air quality index are compiled only from data sets that are collected and available, therefore, the insights presented above are not conclusions, and the Compass for Sustainable Cities is an auxiliary material for a more detailed analysis of the transport situation of each city. For a more accurate representation of the situation, it is suggested to collect more indicators with higher quality.

See, Section 3 for all results for clean and climate change-resistant city's **adaptation to climate change index and water and air quality index**: Index Results Table of the Compass for Sustainable Cities. Link to the full data table [here](#).

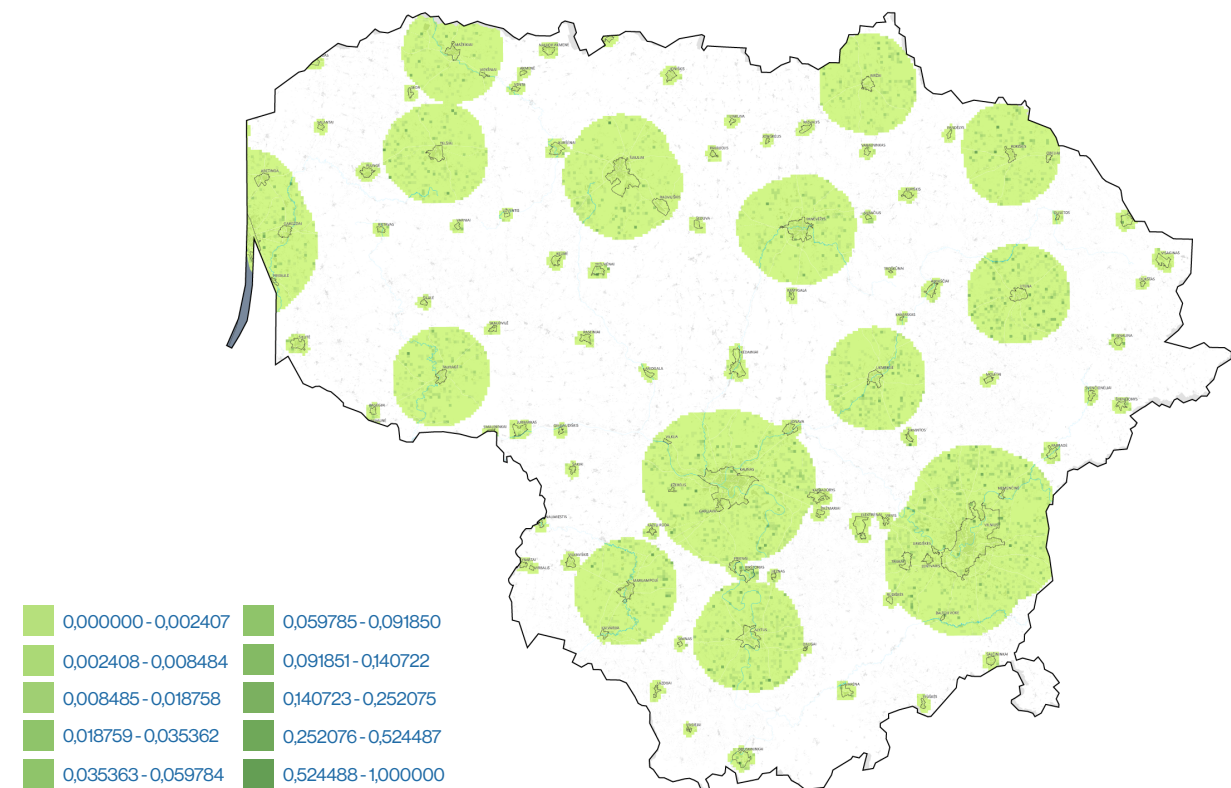


Fig. 8. Adaptation to climate change index map (darker colour indicates more sustainable results)

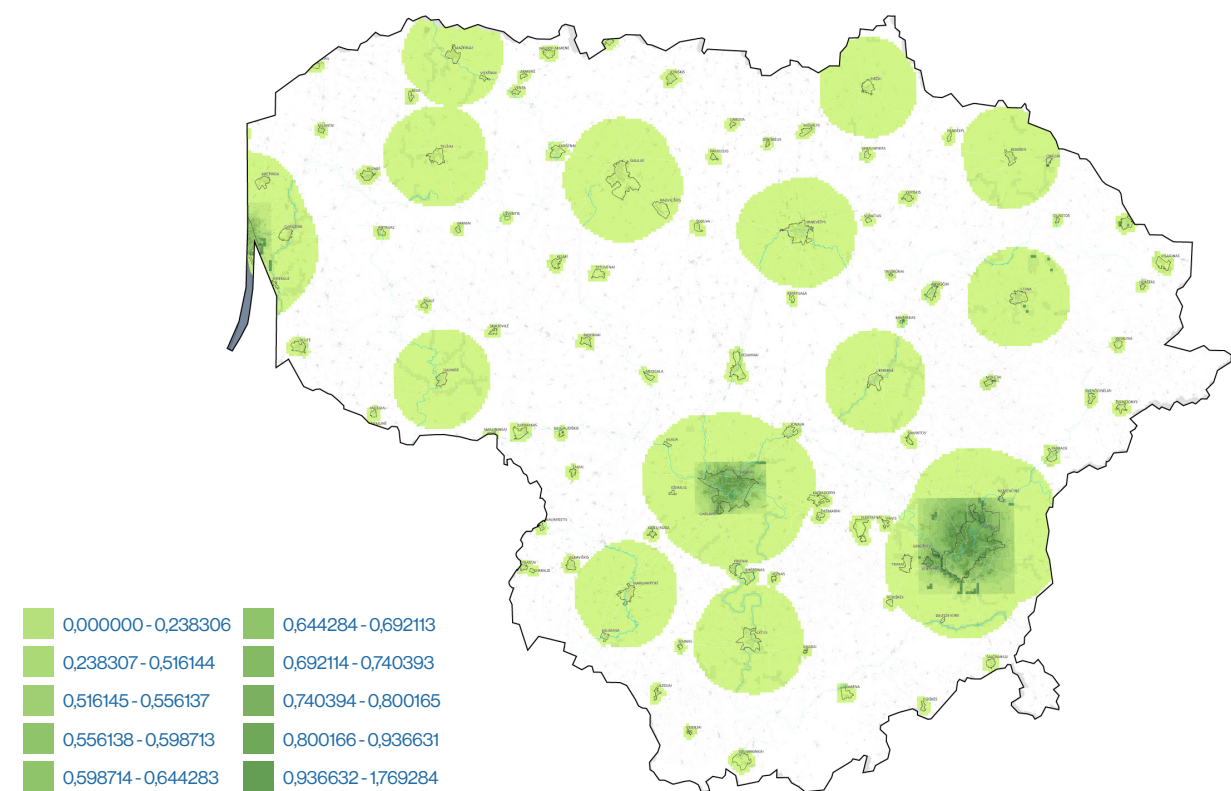
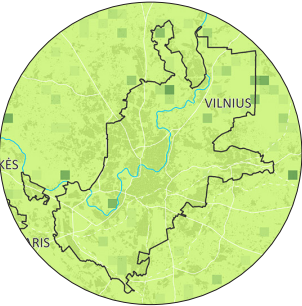
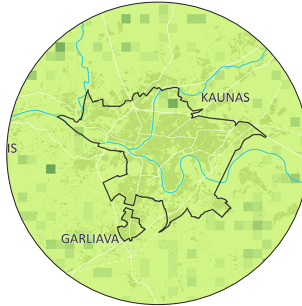


Fig. 9. Water and air quality index map (darker colour indicates relatively more sustainable results)

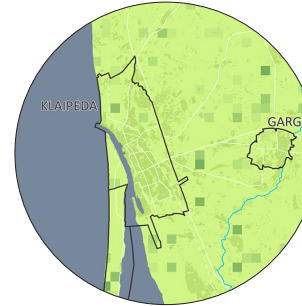
METROPOLITAN URBAN CENTRES



Vilnius



Kaunas

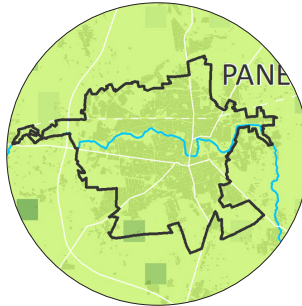


Klaipėda

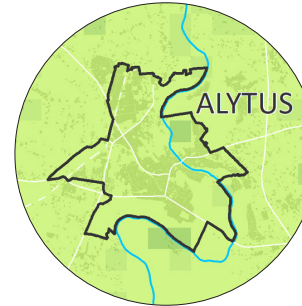
REGIONAL URBAN CENTRES



Šiauliai



Panevėžys



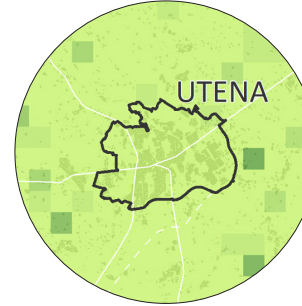
Alytus



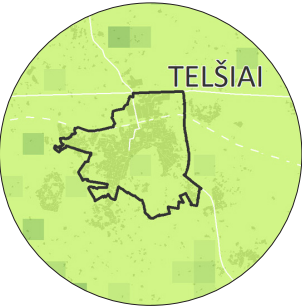
Marijampolė



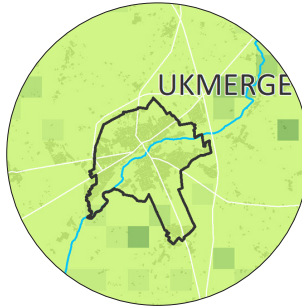
Mažeikiai



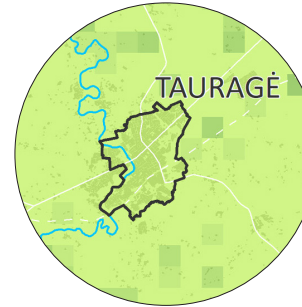
Utena



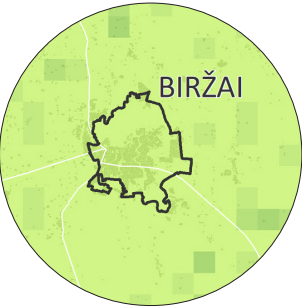
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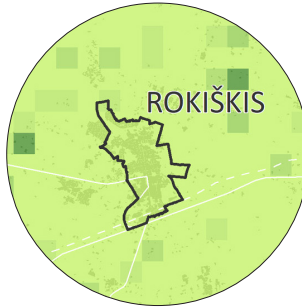
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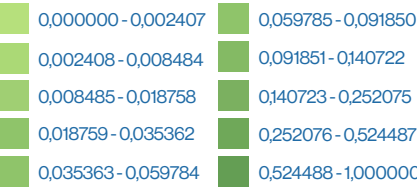
Tauragė



Biržai

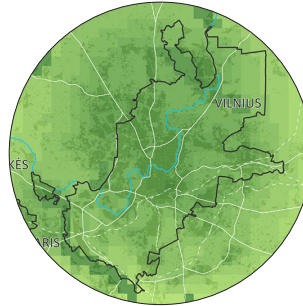


Rokiškis

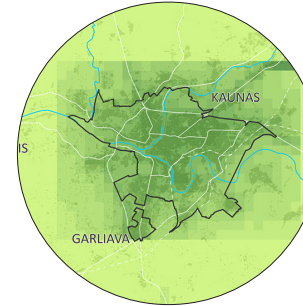


Adaptation to climate change index

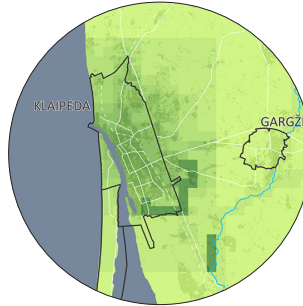
METROPOLITAN URBAN CENTRES



Vilnius



Kaunas

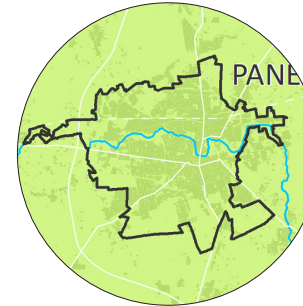


Klaipėda

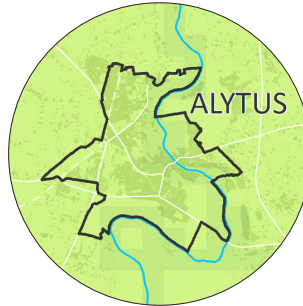
REGIONAL URBAN CENTRES



Šiauliai



Panevėžys



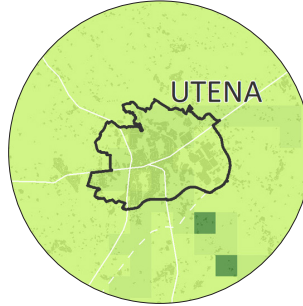
Alytus



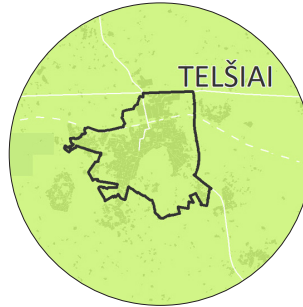
Marijampolė



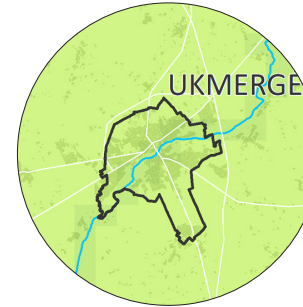
Mažeikiai



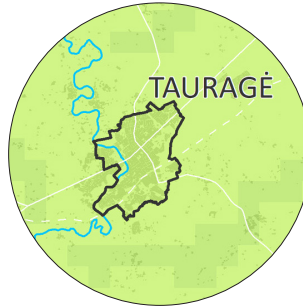
Utena



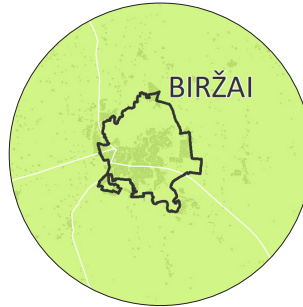
Telšiai



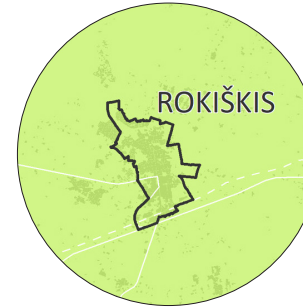
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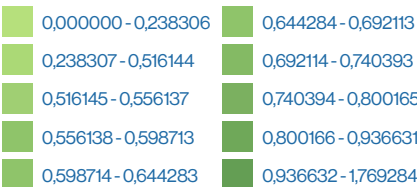
Tauragė



Biržai



Rokiškis



Water and air quality index

2.5. VIBRANT CITY

The following insights can be made based on the available data on the results of the **human capital and demographic indices**.

- Based on the available data, the best indicators of the human capital index are registered in Birštonas, Utena, Ignalina and Pagėgiai. In general, Lithuanian cities show higher than average indicators of human capital – 45 out of 65 Lithuanian cities exceed the average, i.e., are more sustainable than the rest of the cities when evaluating the values of this index;
- Equivalent indicators of the demographic index are registered in Lithuanian cities. The overall result of this index for Lithuanian cities is barely higher than 0 (no changes registered), while analysis of local urban centres separately yields an obvious negative value, i.e., the inhabitants of these cities rapidly migrated either to other cities or abroad. This is the only index that has negative values;
- The best and clearly distinguished values of the demographic index are registered in Biržai, Panevėžys and Elektrėnai. Among metropolitan urban centres, the highest indicator for this index is registered in Vilnius, i.e., intensive internal population migration to the suburbs took place;
- According to the available index map data, the best conditions for human capital in the big cities of Lithuania are not in the central parts of the cities, but in denser districts where the residential and commercial functions of the centres dominate. However, the human capital index values of both city centres and residential districts are significantly higher compared to other urban areas;
- According to the available data of the demographic index map, the greatest change in the demographic situation occurs in the districts that border the administrative boundaries of the cities. For example, in Vilnius, the change is recorded in Didieji and Mažieji Gulbinai, in Kaunas – in Romainiai, in Šiauliai – in the former territory of Margių Sodai. Thus, it can be said that demographic changes in cities do not take place in city centres, but in new parts of cities;
- The poorest indicators of the human capital index comparing the 3 large cities of Lithuania are recorded in Klaipėda. According to the values of the demographic index indicators, the worst indicators in this group of cities are also in Klaipėda;
- Among the regional centres, the poorest conditions for human capital are registered in Šiauliai and Alytus, while the indicators of other cities are similar. In this group of cities, the worst values of the demographic index are observed in Tauragė;
- Comparing all the cities of the regional centres in the territorial map diagrams, it can be seen that some urban areas reach the highest number of human capital, they are often located in the territories of residential districts (Mažeikiai, and Utena). Very low numbers are recorded within the city limits, however, these diagrams represent the current situation – the main directions of urban development;

It is important to mention that the values of the human capital index and the demographic index are compiled only from data sets that are collected and available, therefore, the insights presented above are not conclusions, and the Compass for Development of Sustainable Cities is

an auxiliary material for a more detailed analysis of the situation of each city. For a more accurate representation of the situation, it is suggested to collect more indicators.

See Section 3 for all results of the human capital index and demographic index: Index Results Table of the Compass for Sustainable Cities. Link to the full data table [here](#).

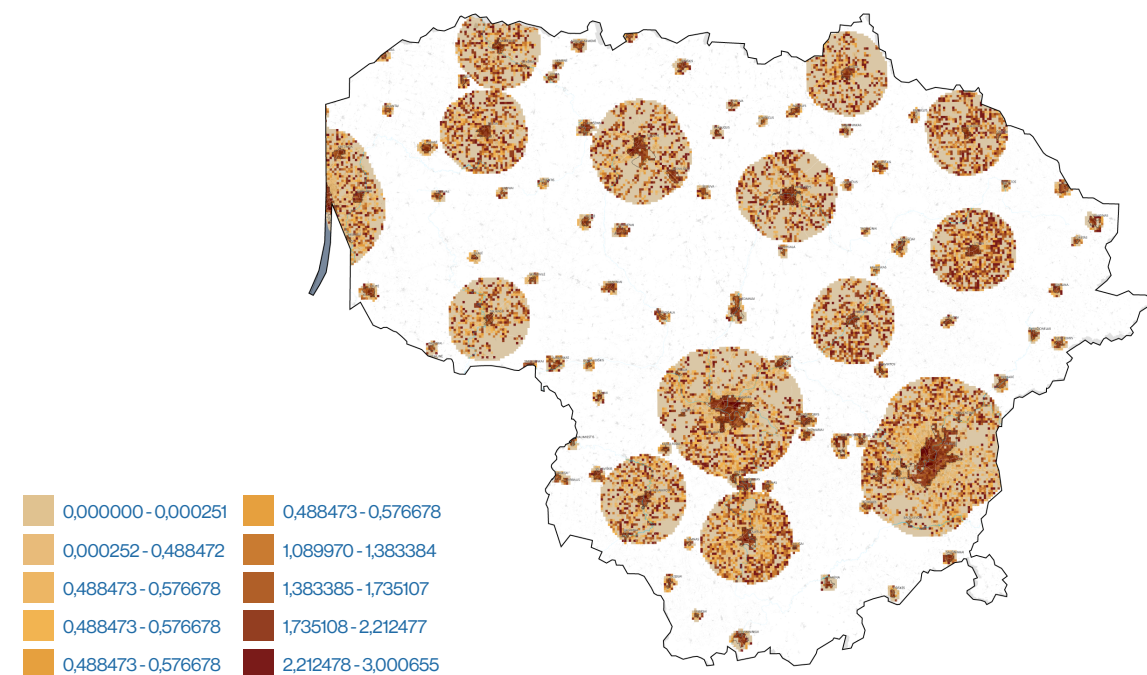


Fig. 10. Human capital index map (darker colour indicates relatively more sustainable results)

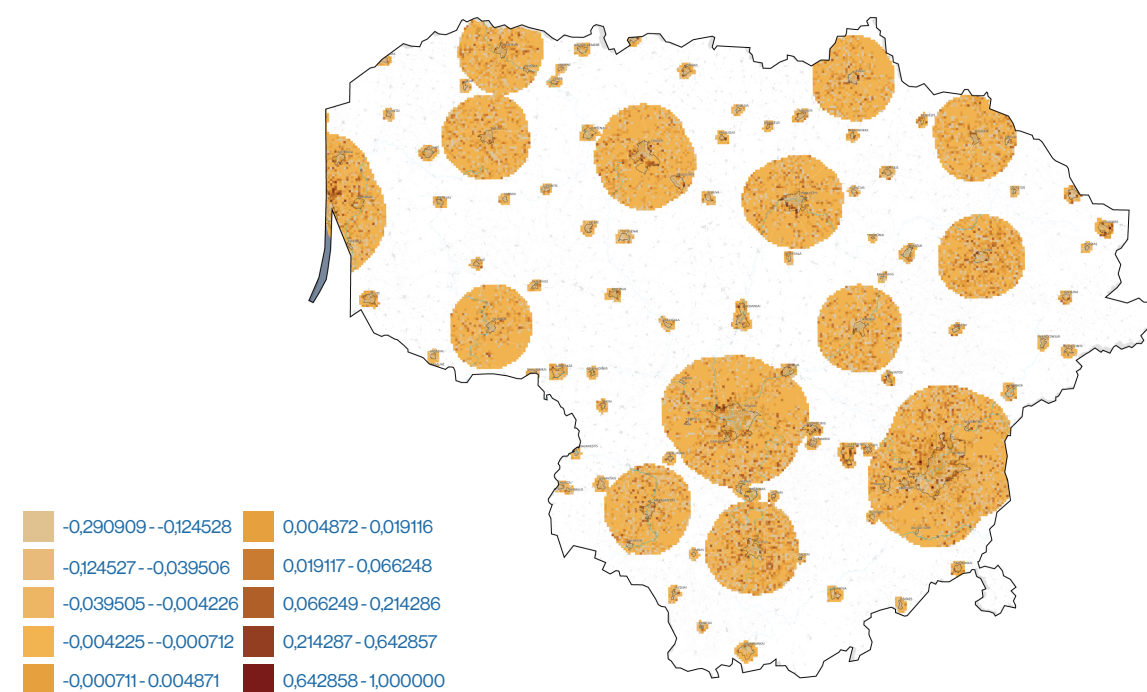
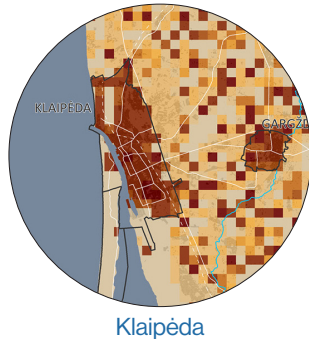
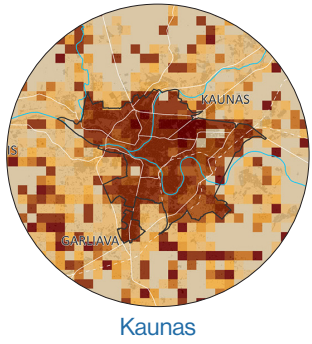
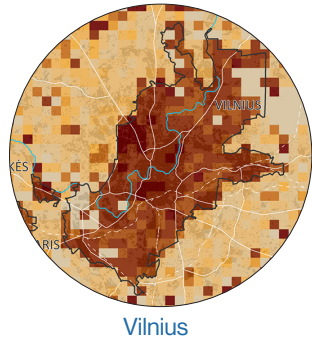
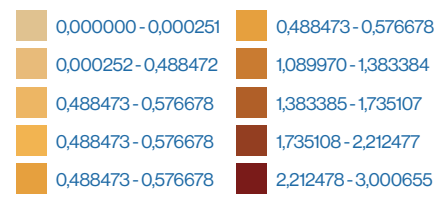
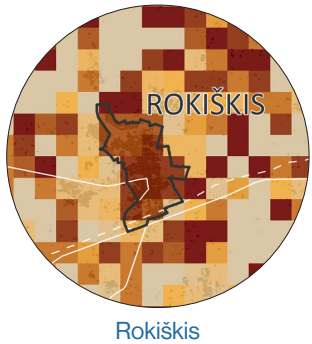
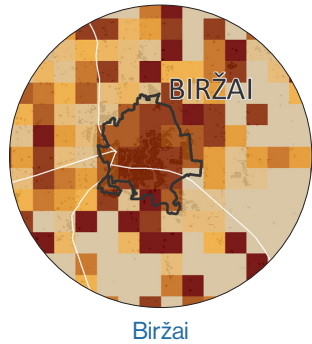
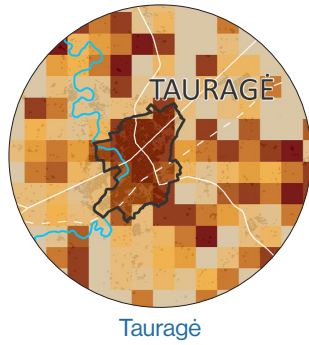
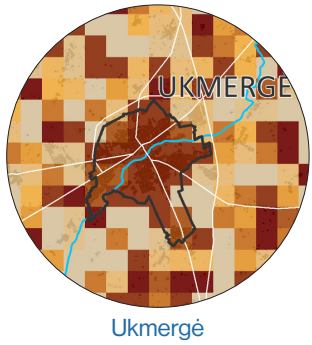
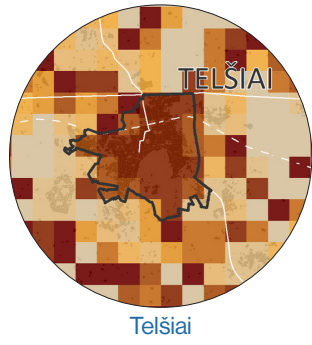
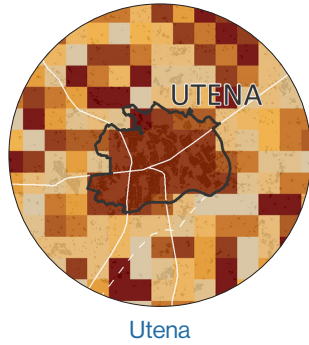
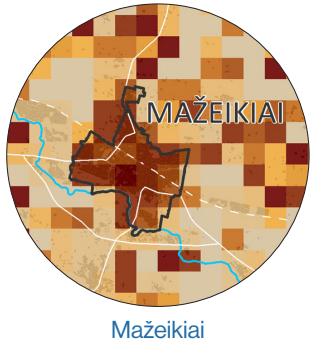
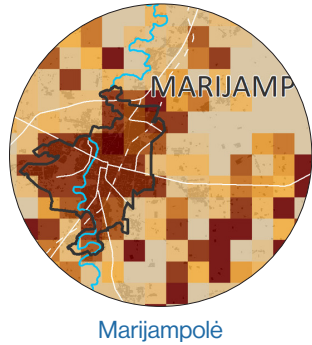
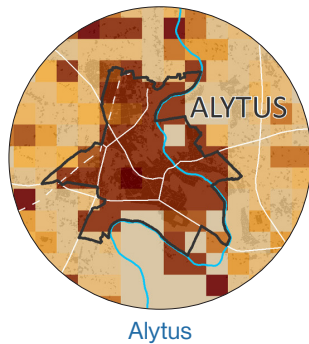
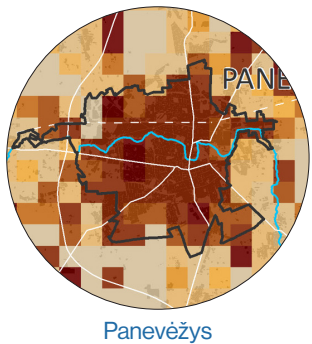
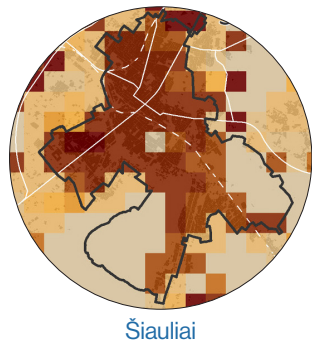


Fig. 11. Demographic index map (darker colour indicates relatively more sustainable results)

METROPOLITAN URBAN CENTRES

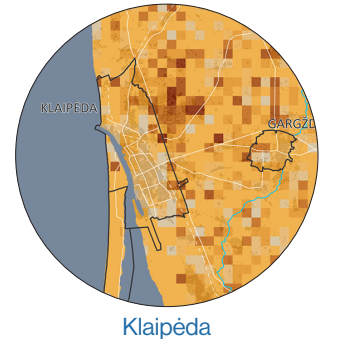
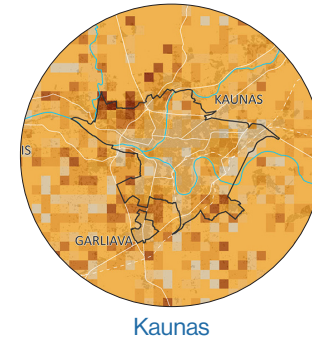
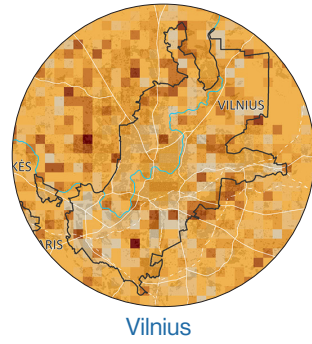


REGIONAL URBAN CENTRES

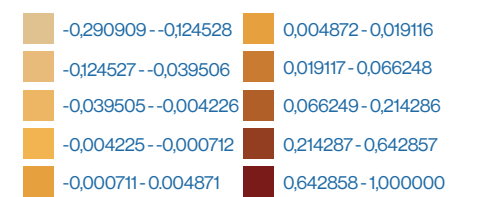
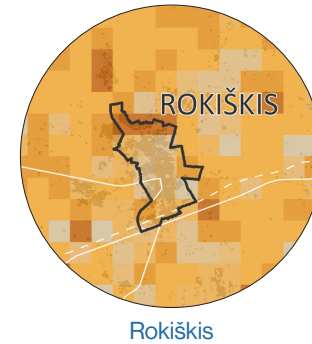
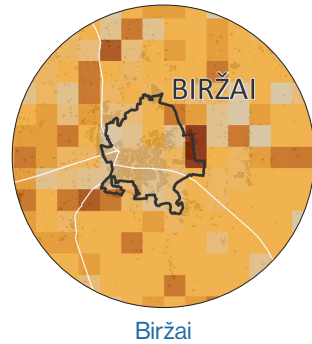
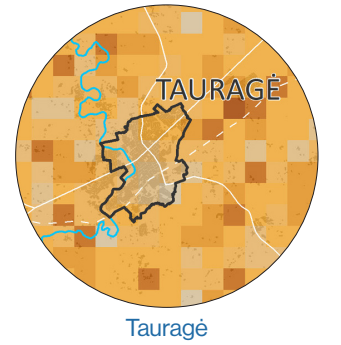
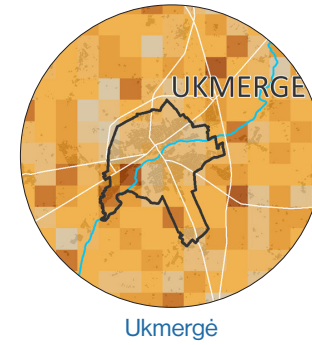
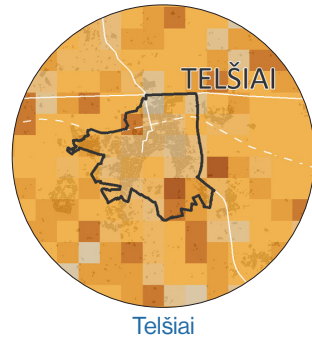
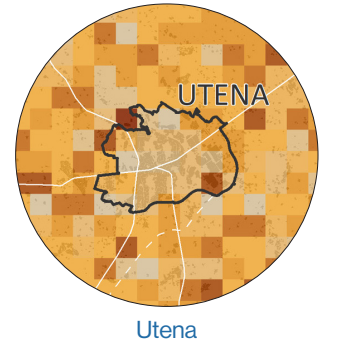
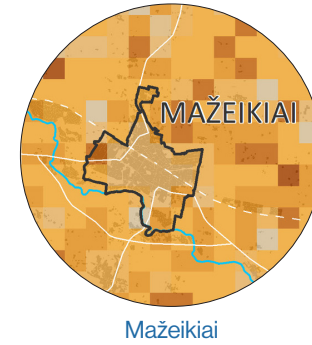
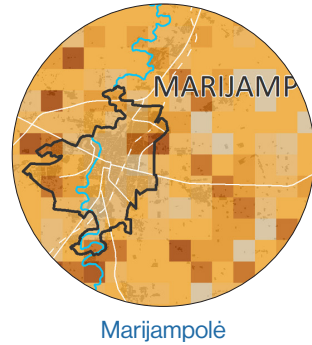
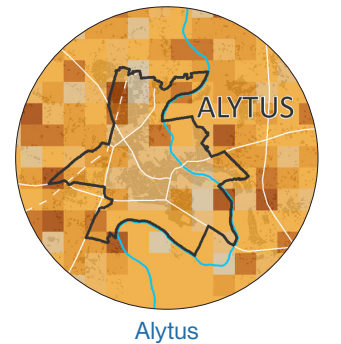
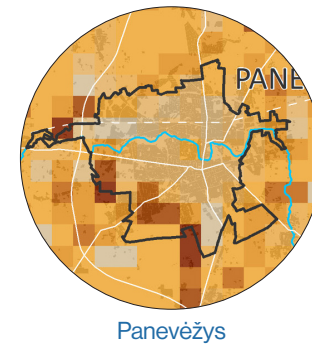
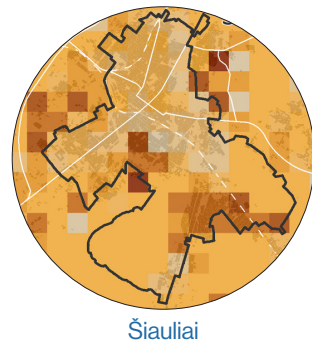


Human capital index

METROPOLITAN URBAN CENTRES



REGIONAL URBAN CENTRES



Demographic index

2.6. INCLUSIVE CITY

The following insights can be made based on the available data on the results of **social inclusion and public activity** indices:

- According to the available data, the best indicators of the social inclusion index are registered in the metropolitan cities of Lithuania (Vilnius, Kaunas and Klaipėda) and in Alytus. The value of the indicator “Normalised accessibility of bus stops within 500 m on foot” distinguishes the city of Alytus from the rest of Lithuania, other cities are lagging behind;
- Clusters of cities in regional and local urban centres show very low indicators of social inclusion. The smaller the city, the lower the values of this indicator;
- All Lithuanian cities show high and very similar public activity index indicators. When comparing groups of cities, based on the available data, it can be stated that somewhat higher values of the indicators are registered in metropolitan urban centres. Among metropolitan urban centres, the highest indicator of this index is observed in Vilnius, however, the values of this city's index do not significantly distinguish it among other Lithuanian cities;
- The best and clearly distinguished values of the public activity index are recorded in Ignalina. High public activity is also observed in Birštonas, Lazdijai, Šilalė, Trakai and Širvintos; the public in these cities is more active compared to the metropolitan cities of Lithuania. The values of this index do not correlate with the values of the social inclusion index, where smaller cities show very low values.
- The poorest public activity index indicators are observed in Visaginas, Pabradė and Kybartai. In these cities, the values of the social inclusion index are also among the lowest.
- Available social activity index map data show that the most active areas in the cities are the central parts of cities and the most densely populated districts. For example, in Vilnius – New Town, Old Town and Antakalnis, in Utena – the central and western parts of the city, in Klaipėda – the old town and the northern part of the city. Comparing these data with the data of the social inclusion index map singles out only the central parts of the cities of the group of metropolitan urban centres as demonstrating the best values of the indicators. The social inclusion maps of other groups of cities register equally distributed low values of the index.

It is important to mention that the values of the social inclusion index and public activity index are compiled only from data sets that are collected and available, therefore, the insights presented above are not conclusions, and the Compass for Development of Sustainable Cities is an auxiliary material for a more detailed analysis of the situation of each city. For a more accurate representation of the situation, it is suggested to collect more indicators.

See Section 3 for all results of the social inclusion index and public activity index: Index Results Table of the Compass for Sustainable Cities. Link to the full data table [here](#).

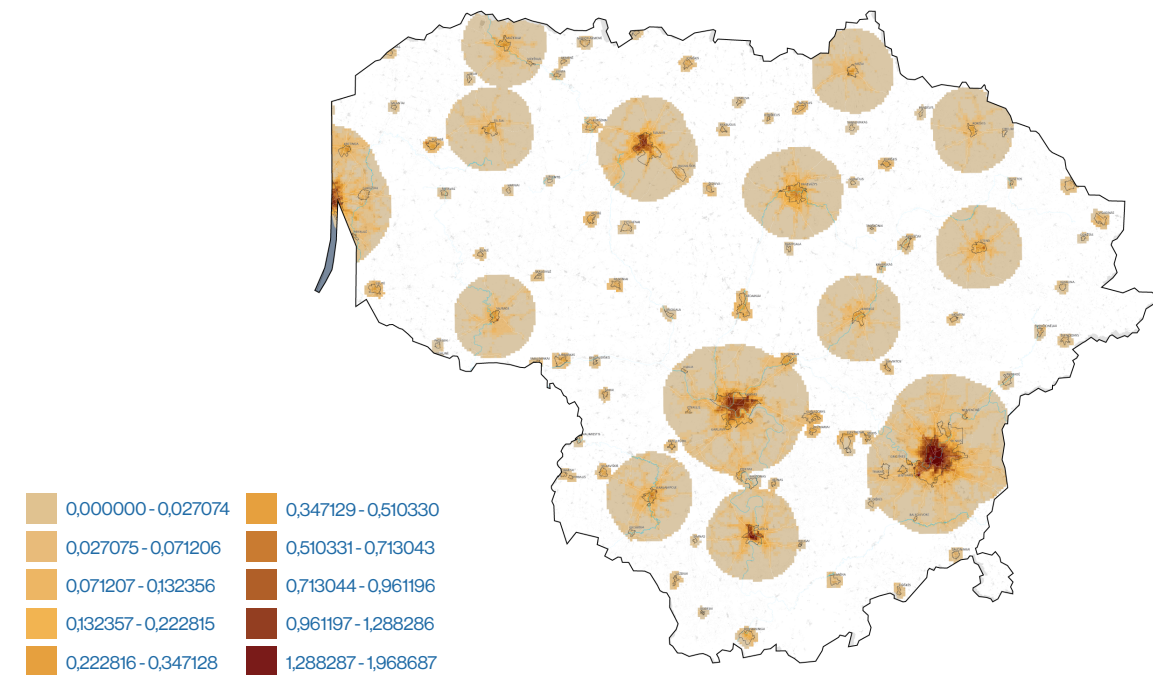


Fig. 12. Social inclusion index map (darker colour indicates relatively more sustainable results)

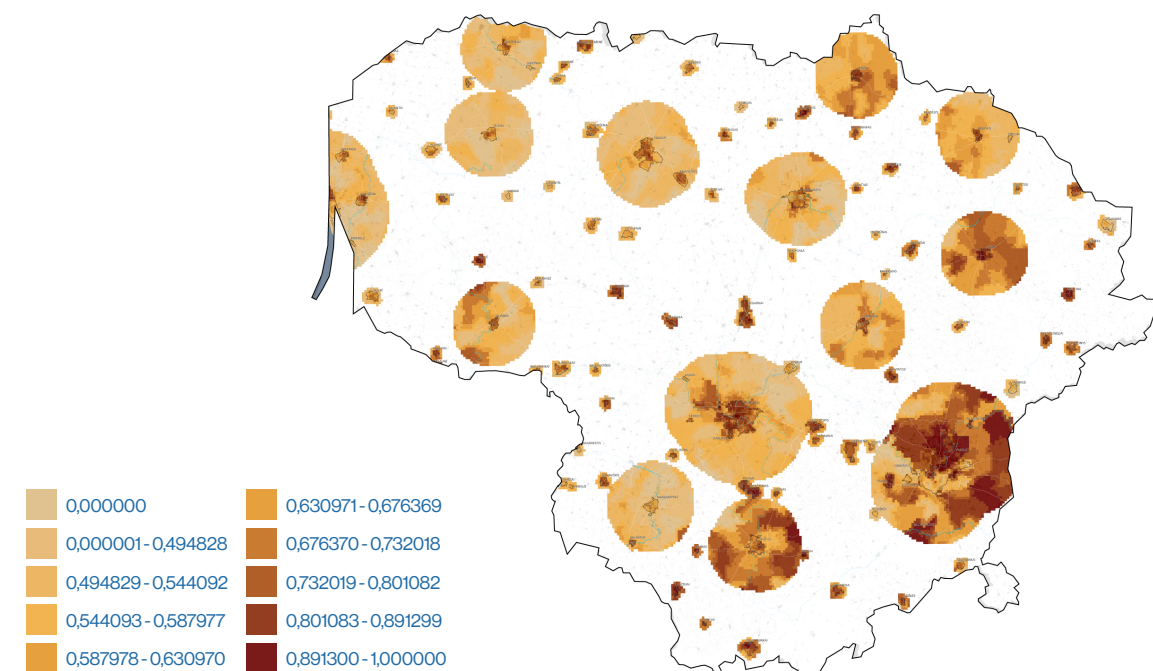
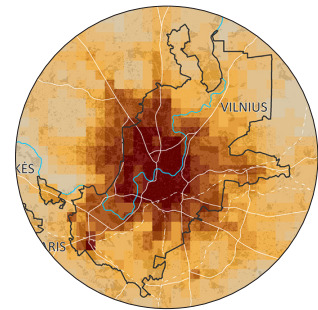
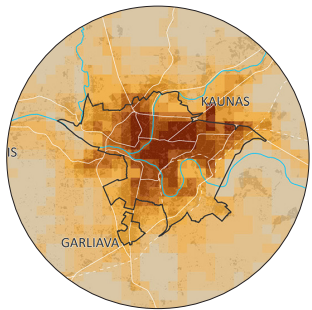


Fig. 13. Public activity index map (darker colour indicates relatively more sustainable results)

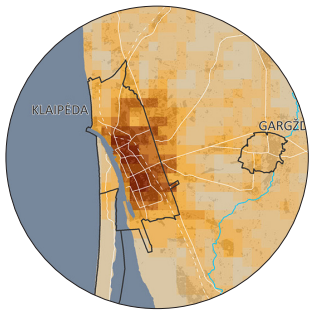
METROPOLITAN URBAN CENTRES



Vilnius

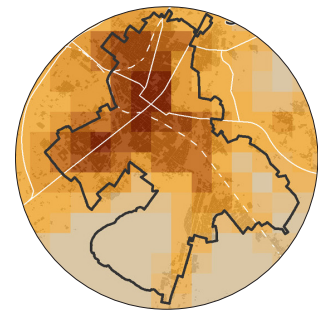


Kaunas

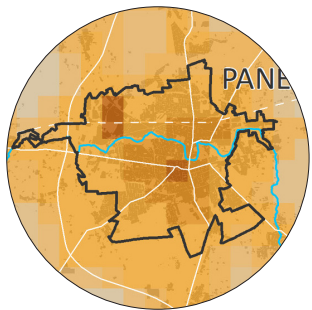


Klaipėda

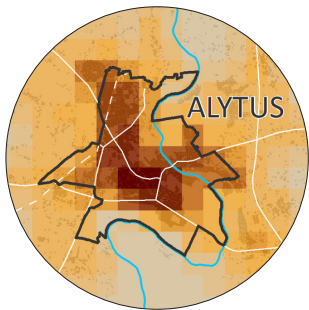
REGIONAL URBAN CENTRES



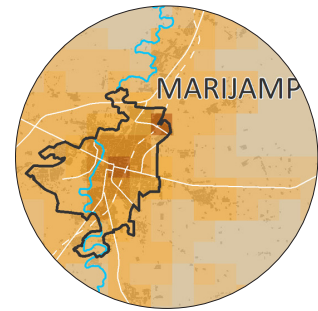
Šiauliai



Panevėžys



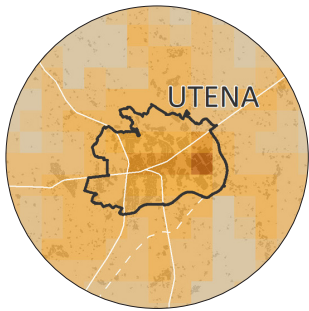
Alytus



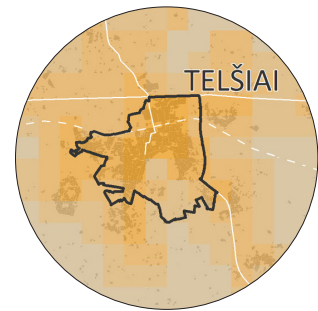
Marijampolė



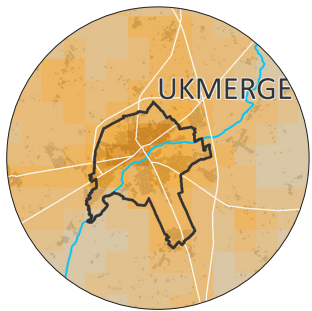
Mažeikiai



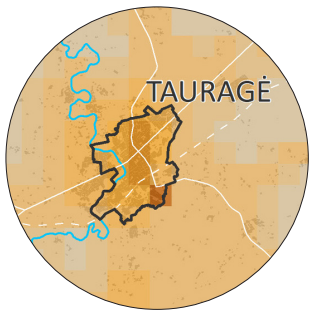
Utena



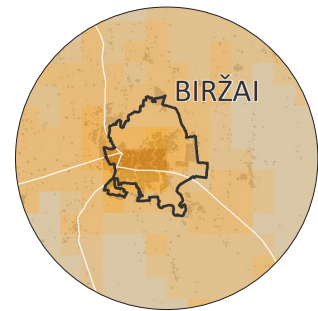
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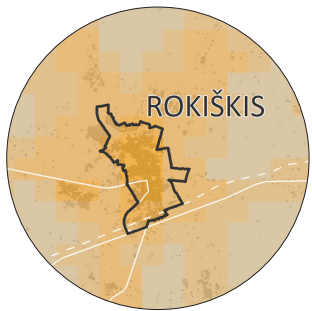
Ukmergė



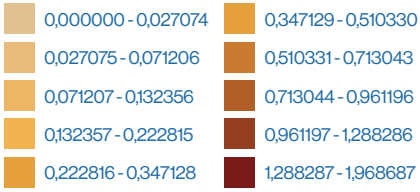
Tauragė



Biržai

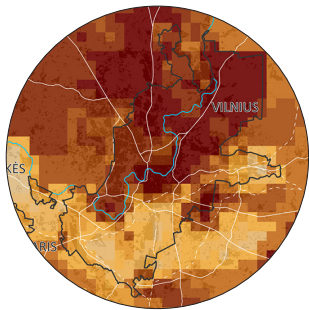


Rokiškis

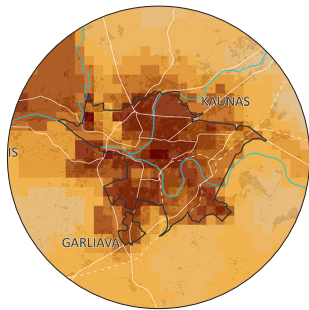


Social inclusion index

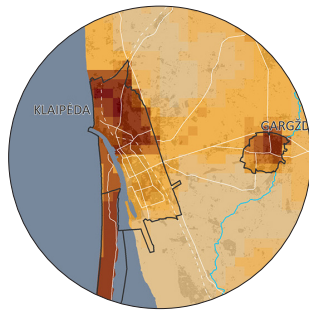
METROPOLITAN URBAN CENTRES



Vilnius

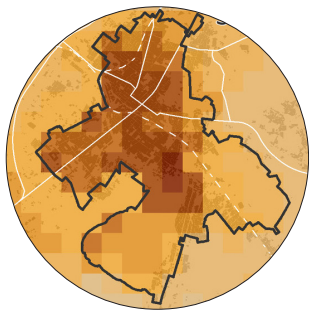


Kaunas

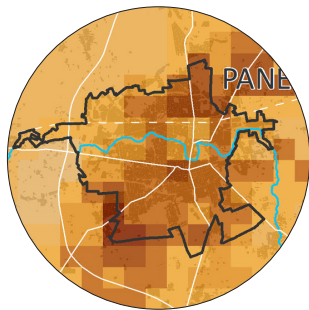


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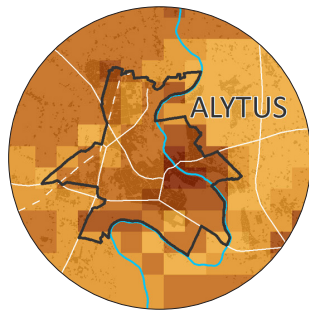
REGIONAL URBAN CENTRES



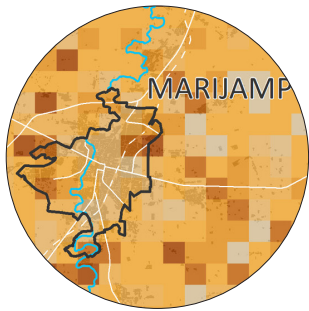
Šiauliai



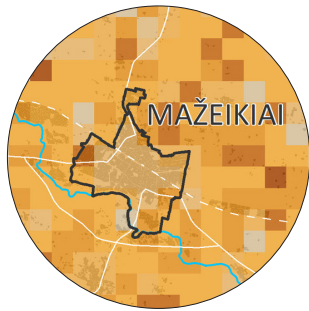
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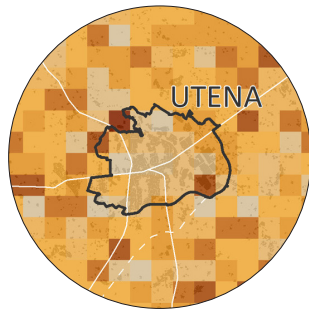
Alytus



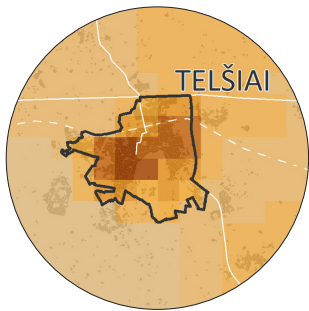
Marijampolė



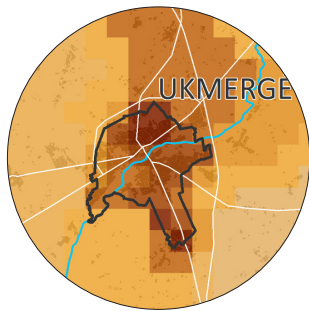
Mažeikiai



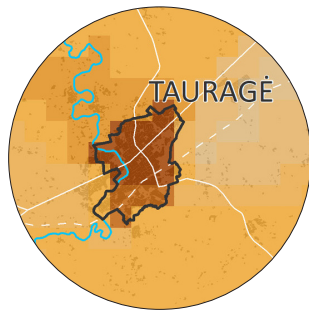
Utena



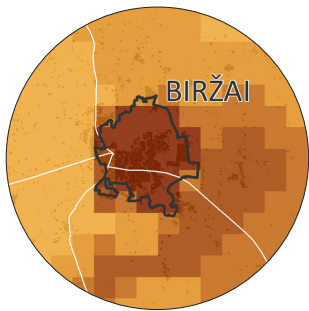
Telšiai



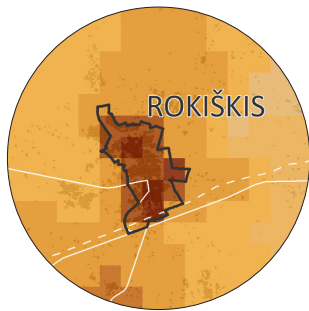
Ukmergė



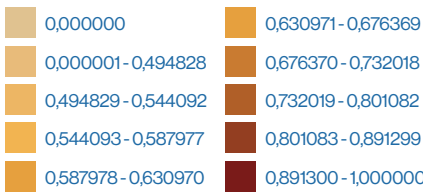
Tauragė



Biržai



Rokiškis



Public activity index

2.7. PRODUCTIVE CITY

The following insights can be drawn from the available results for **resource and energy index** and the business and investment development index indicator data:

- The indicators of the resource and energy index of Lithuanian cities are very low. Some of the lowest values of this index are recorded in the group of metropolitan urban centres (the lowest being in Vilnius), and the highest values – in the group of regional urban centres.
- According to the collected data on the resource and energy index indicators, the highest values are registered in the cities of the group of local urban centres: Pakruojis, Molėtai and Ignalina. Meanwhile, the values of other cities of this group are also the poorest values of the indicators – Visaginas, Elektrėnai, Žiežmariai and Kazlų Rūda.
- In the cities of the group of metropolitan urban centres, very high values of business and investment development indicators have been registered, where Vilnius and Kaunas stand out. The index values of local urban centre groups are very low. The lowest value of the index is observed in Žiežmariai (the resource and energy index values of this city are also the lowest), Birštonas and Kybartai.
- The available spatial data of the resource and energy index map show in which urban areas the installed power of facilities (kW/m² of all buildings) of prosumers is the highest. For example, in Vilnius, the greatest values are registered in the industrial district of Vilkipėdė and the residential district of Visoriai; in Pakruojis – in the residential area in the north of the city (Pašilis); in Kaunas – the territory of individual houses in Romainiai.
- The lowest resource and energy index values are registered in the central parts of the cities of the group of metropolitan urban centres. The map of the business and investment development index displays a different result – the highest values of the index. Similar situation is observed in the cities of groups of regional and local urban centres.

It is important to mention that the resource and energy index and the business and investment index are compiled only from data sets that are collected and available, therefore, the insights presented above are not conclusions, and the Compass for Development of Sustainable Cities is an auxiliary material for a more detailed analysis of the situation of each city. For a more accurate representation of the situation, it is suggested to collect more indicators.

See Section 3 for all results of the resource and energy index and the business and investment index: Index Results Table of the Compass for Sustainable Cities. Link to the full data table [here](#).

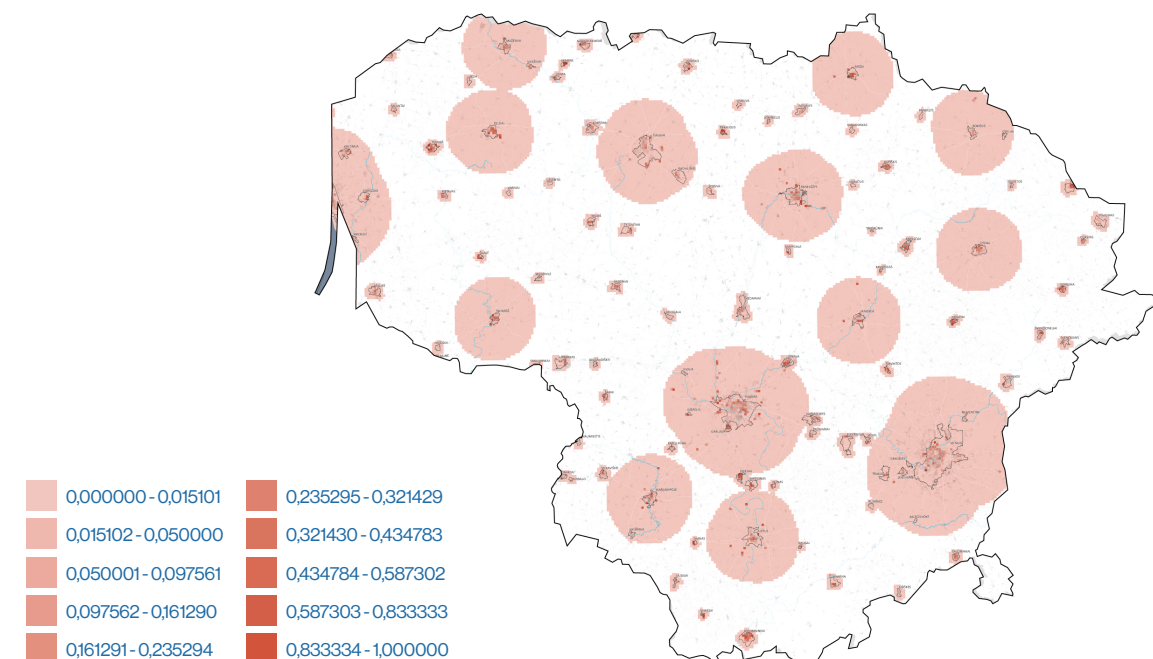


Fig. 14. Resource and energy index map (darker colour indicates relatively more sustainable results)

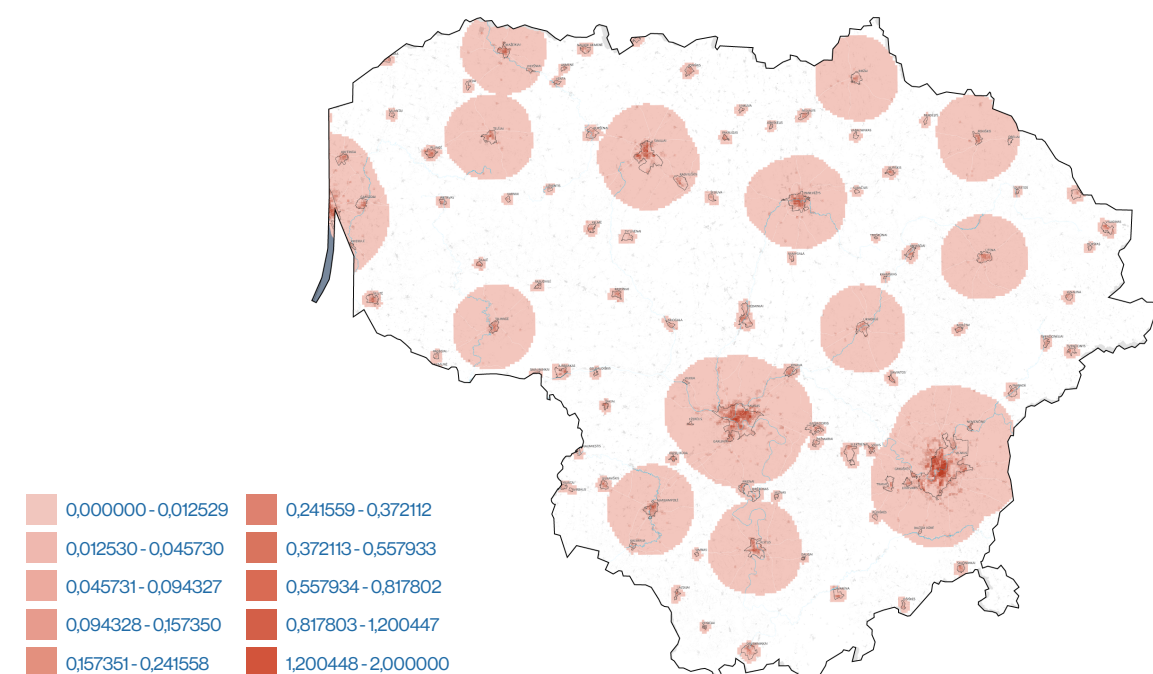
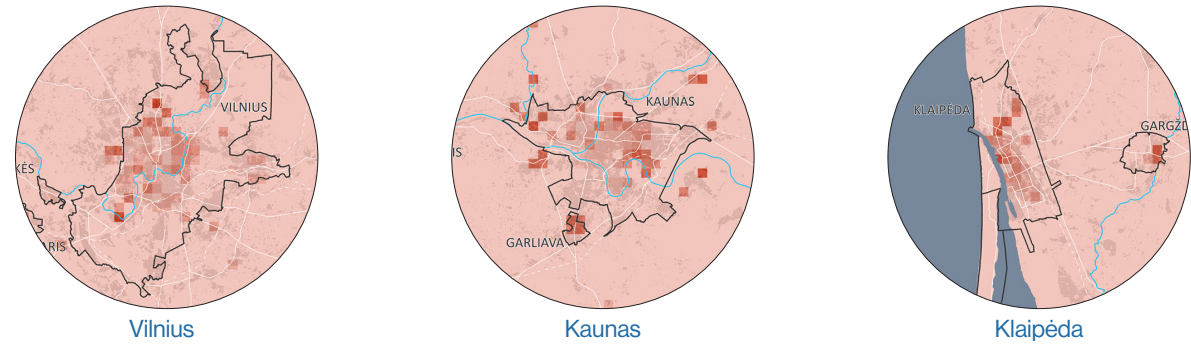
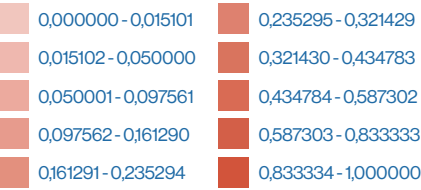
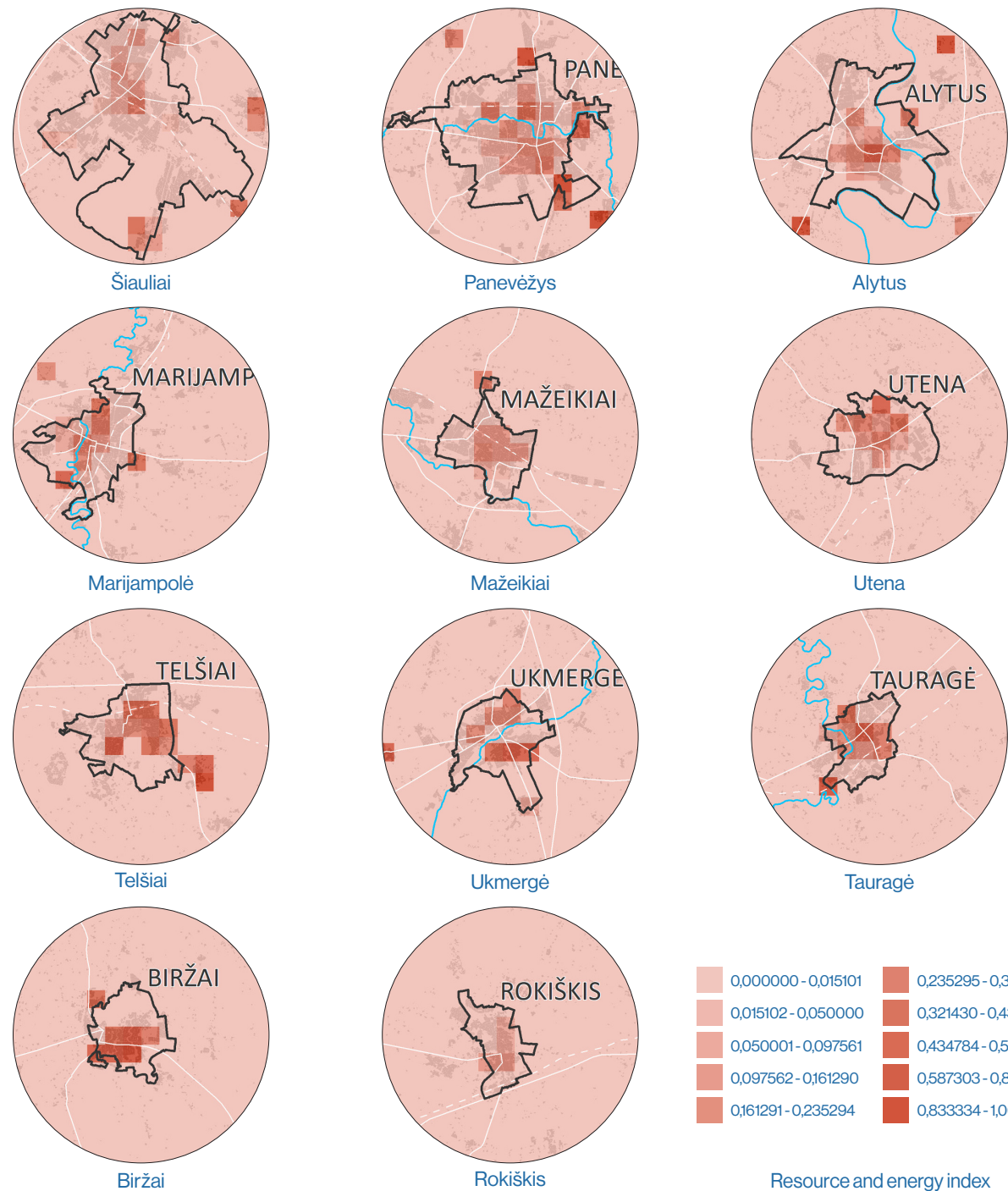


Fig. 15. Business and investment index map (darker colour indicates more sustainable results)

METROPOLITAN URBAN CENTRES

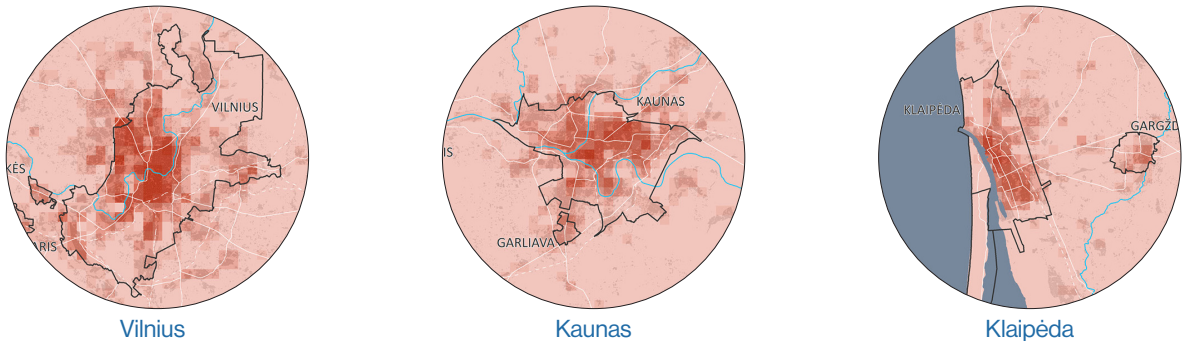


REGIONAL URBAN CENTRES

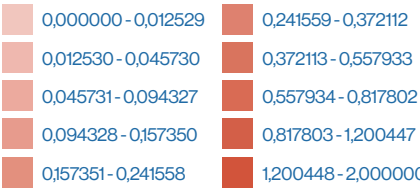
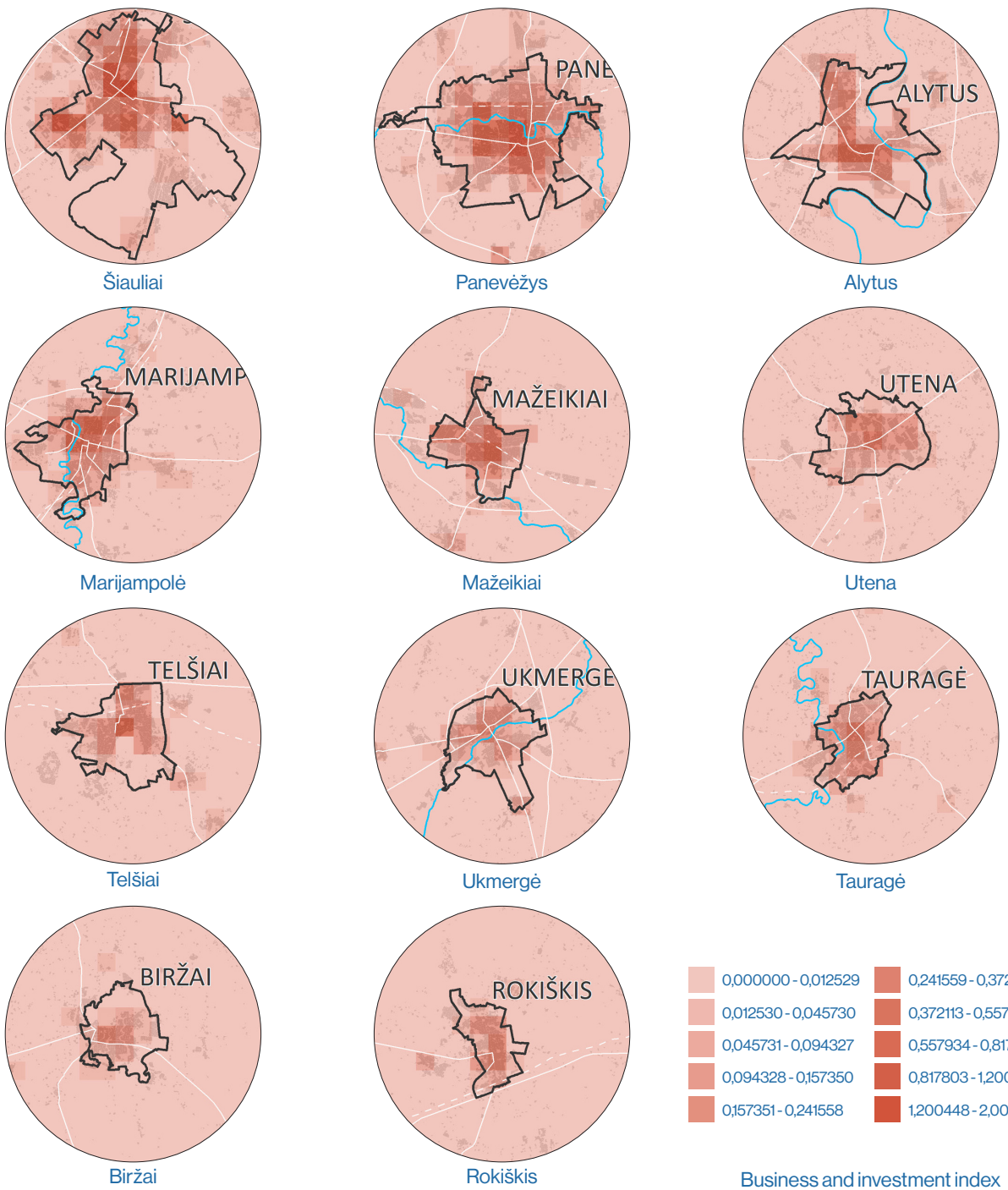


Resource and energy index

METROPOLITAN URBAN CENTRES



REGIONAL URBAN CENTRES

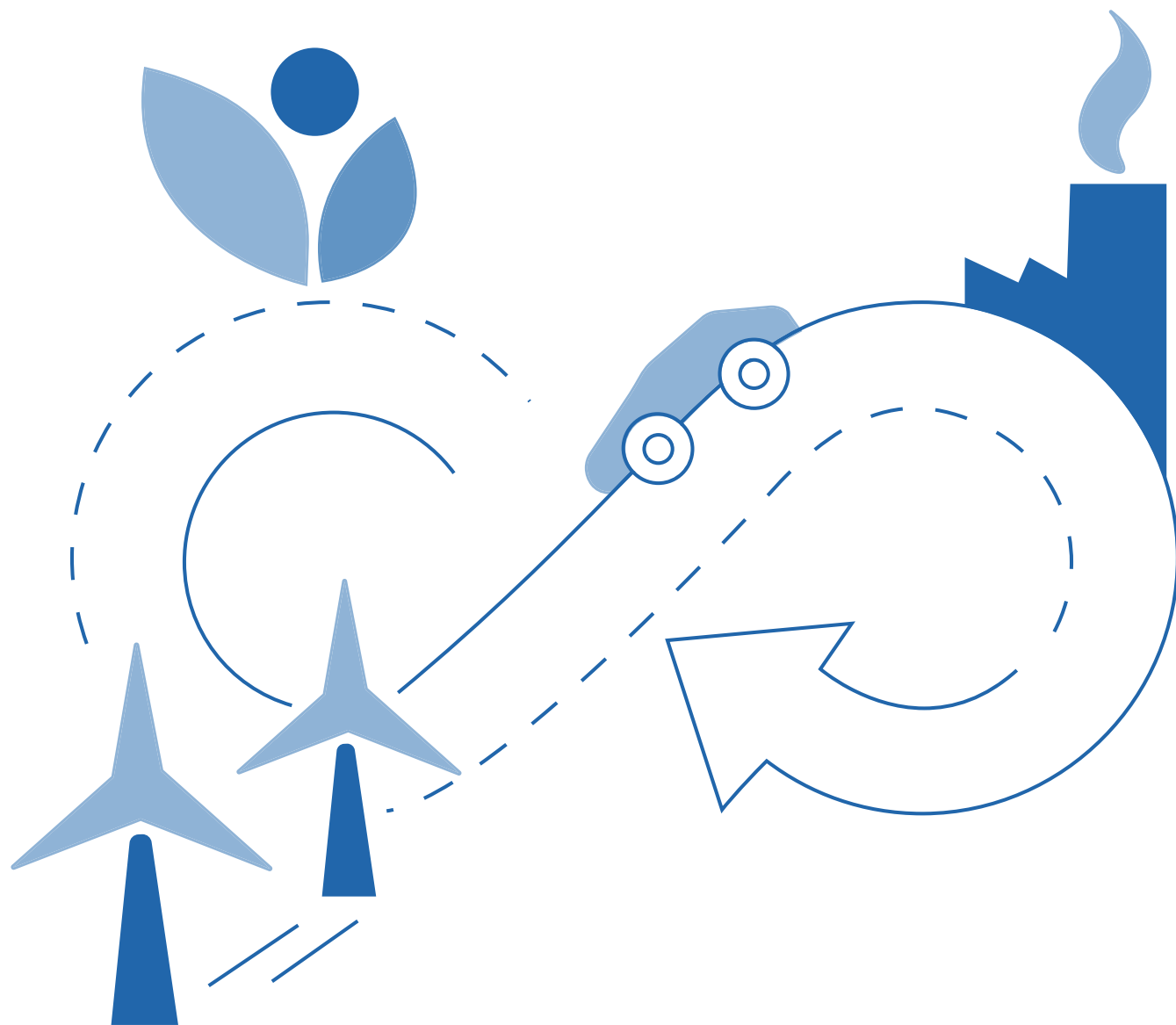


Business and investment index

2.8. CIRCULAR ECONOMY CITY

See Section 3 for all results of the circular economy city zero waste index and climate change mitigation index: Index Results Table of the Compass for Sustainable Cities. Link to the full data table [here](#).

Note: There are insufficient territorial spatial data to display the zero waste index map and climate change mitigation index map diagrams.



3.

URBAN
SUSTAINABILITY
INDEX
DERIVATIVE MAP



All the territorial indicators and indices collected by the Compass for Sustainable Cities have been summarised in the derived Sustainable Cities index. The relatively most sustainable urban territories can be seen in dark green colours when evaluating all indicators of sustainability indices. In order to display a more accurate sustainability map, there is a lack of territorial indicators of the urban sprawl, population mobility size, zero waste and climate change mitigation indices. However, the general picture and less sustainable or more sustainable urban areas are conditionally depicted.

The sustainability map can help authorities, residents and other stakeholders understand urban development issues and identify problematic urban territories that should be improved in order to achieve urban sustainability. It also helps to compare different cities with each other and make more informed decisions that promote sustainable and responsible urban development.

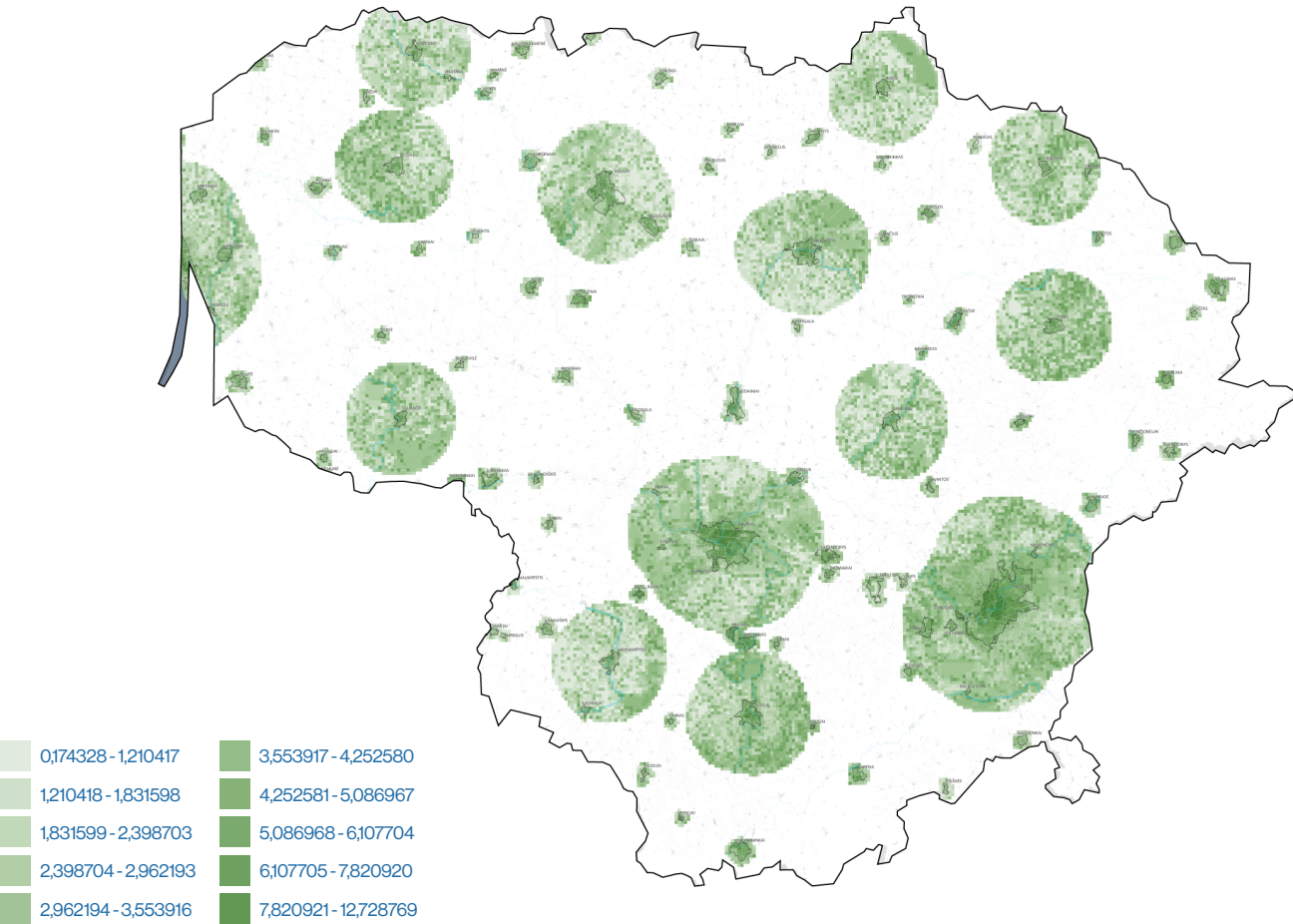
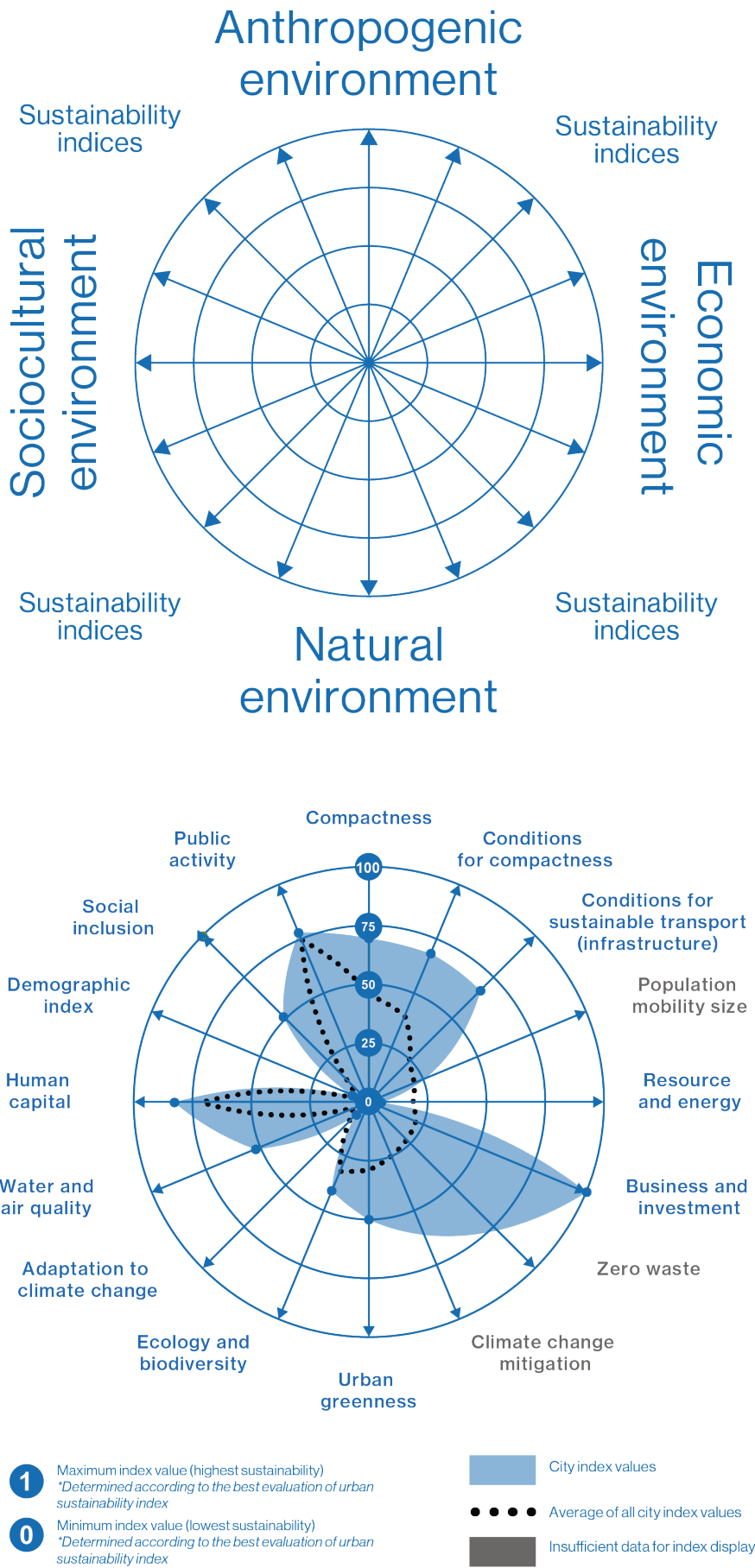
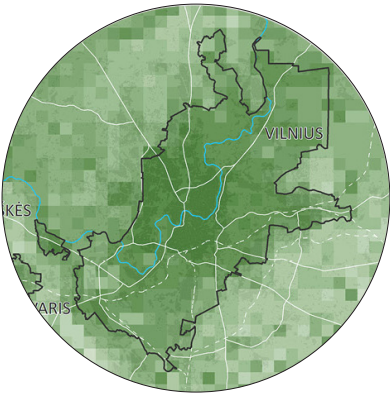


Fig. 16. Urban sustainability derivative map

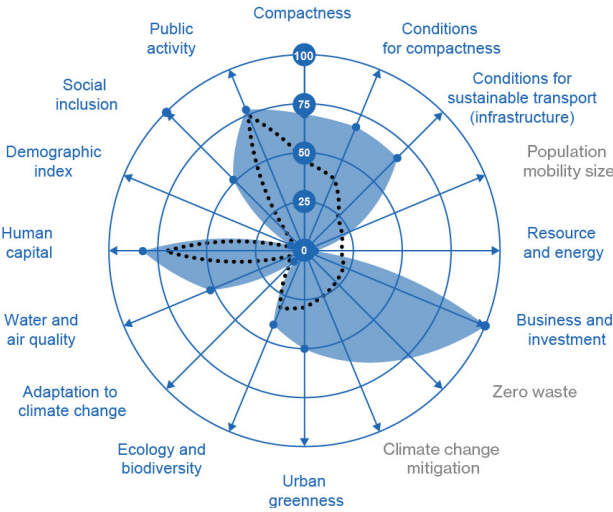
Fig. 17. Explanatory scheme of radial urban sustainability diagrams



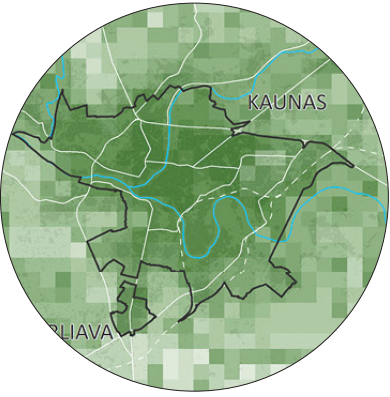
METROPOLITAN URBAN CENTRES



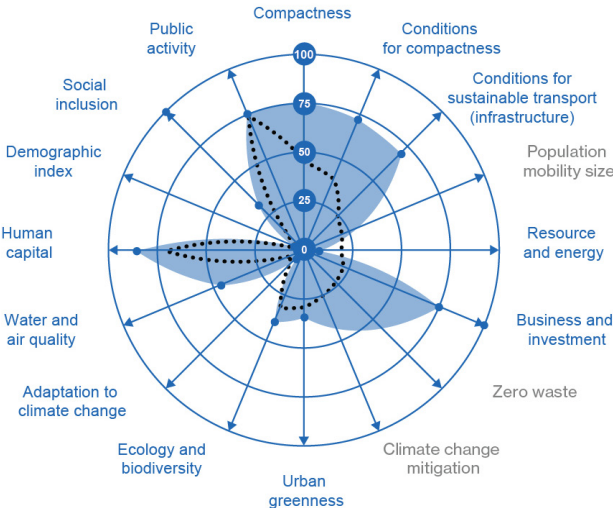
Vilnius



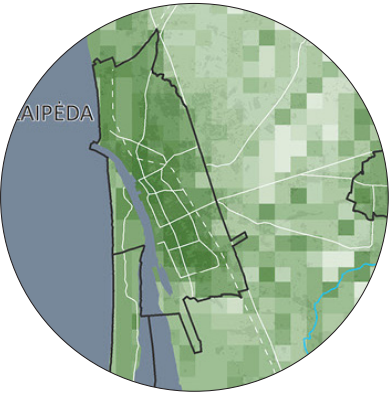
Vilnius



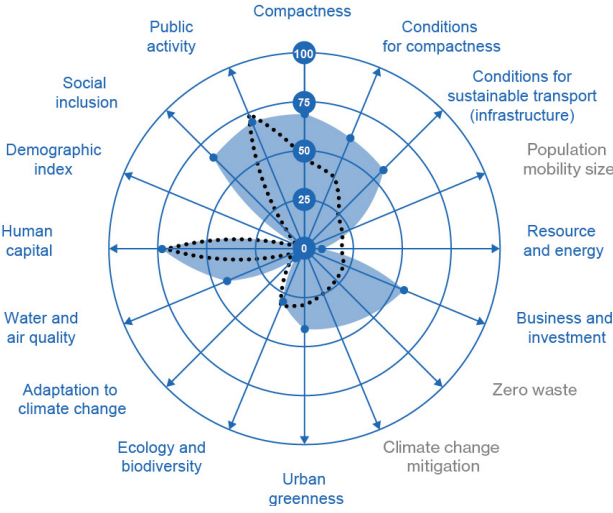
Kaunas



Kaunas

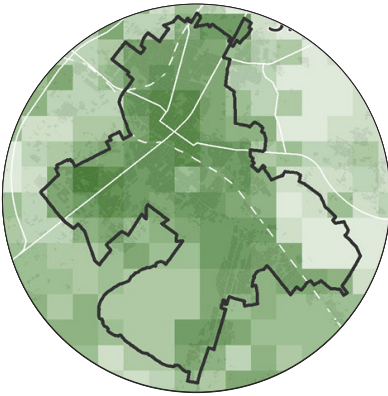


Klaipėda

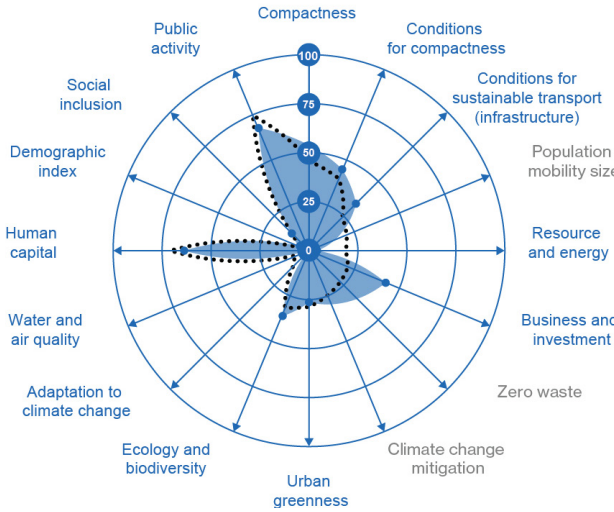


Klaipėda

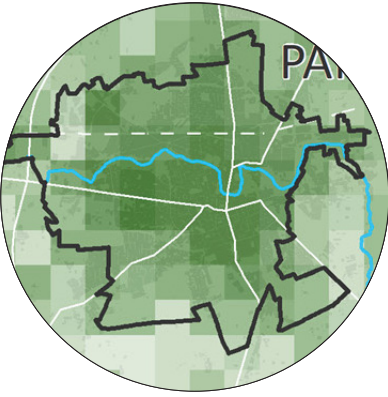
REGIONAL URBAN CENTRES



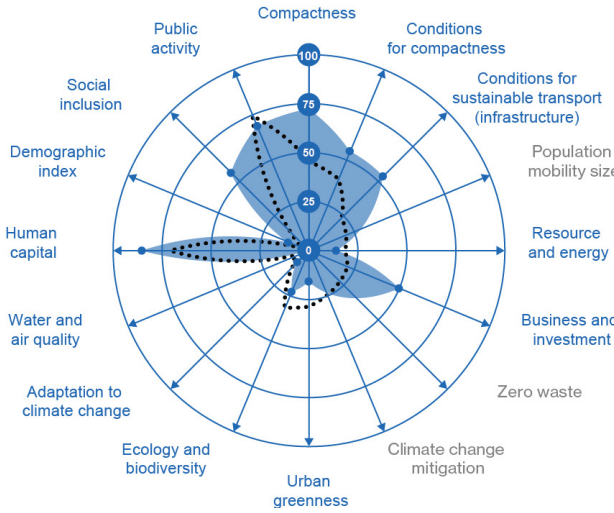
Šiauliai



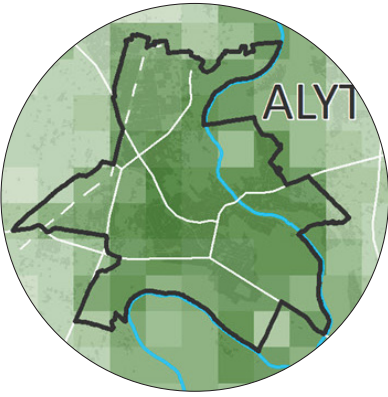
Šiauliai



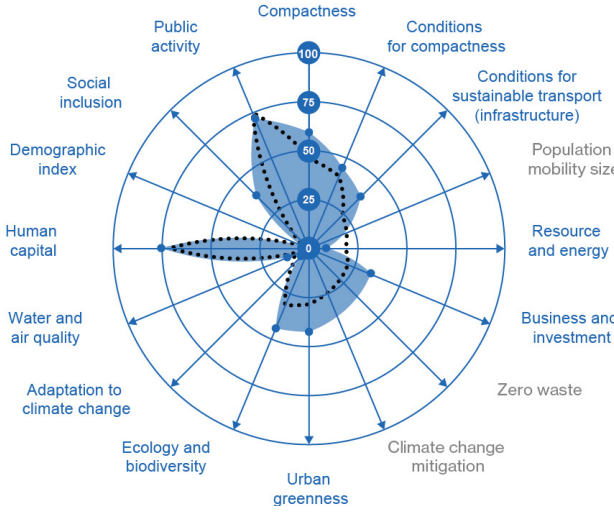
Panevėžys



Panevėžys



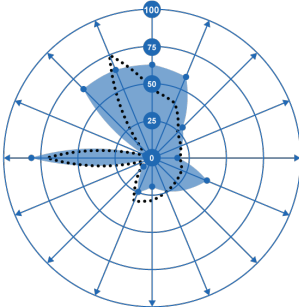
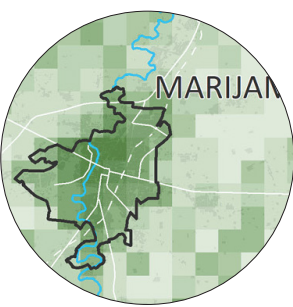
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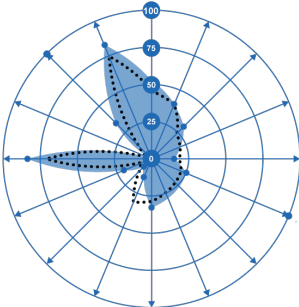
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REGIONAL URBAN CENTRES

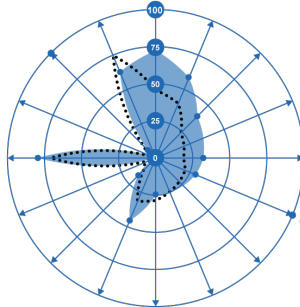
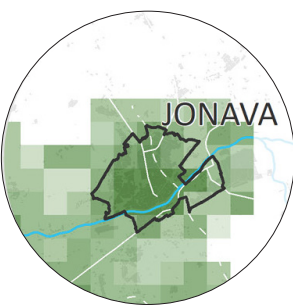
LOCAL URBAN CENTRES



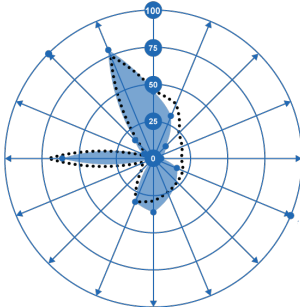
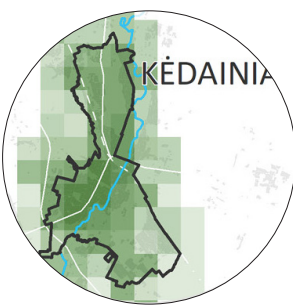
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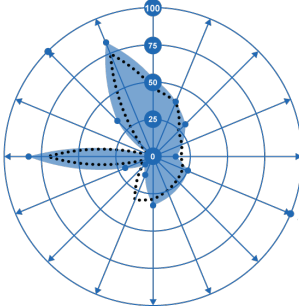
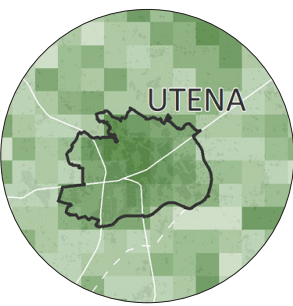
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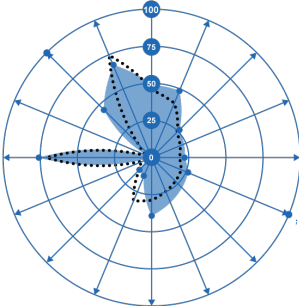
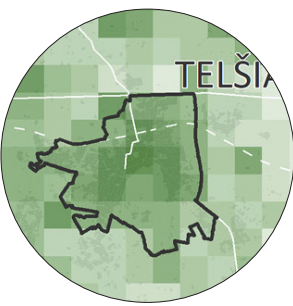
Jonava



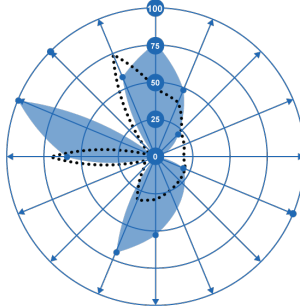
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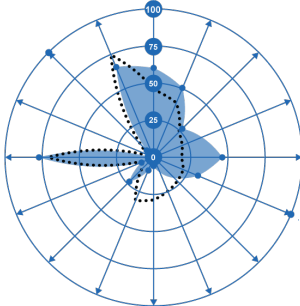
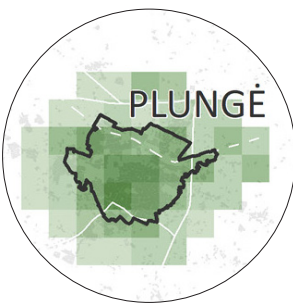
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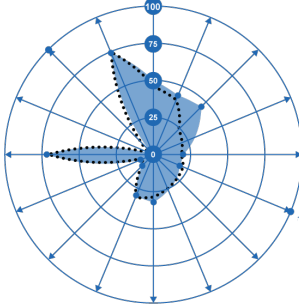
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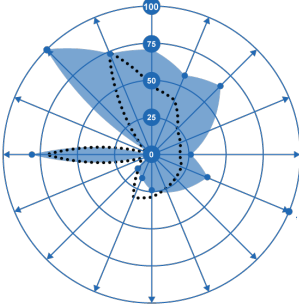
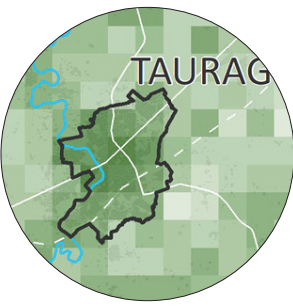
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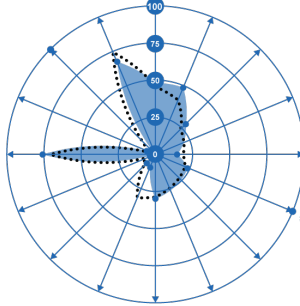
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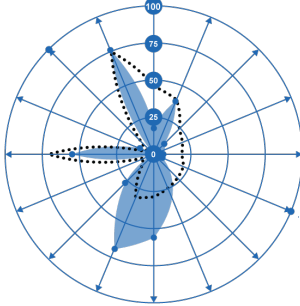
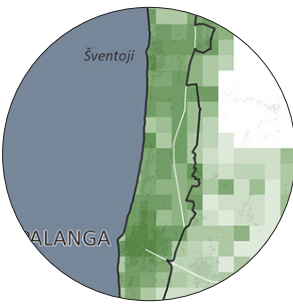
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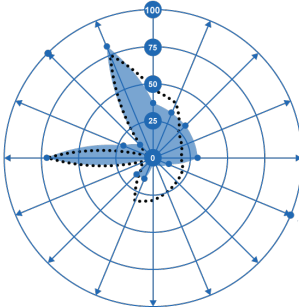
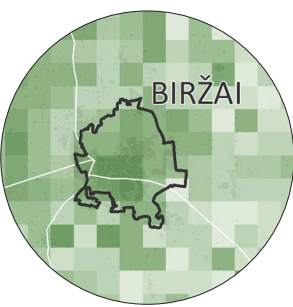
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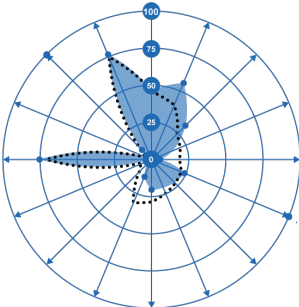
Kretinga



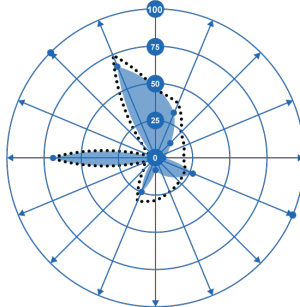
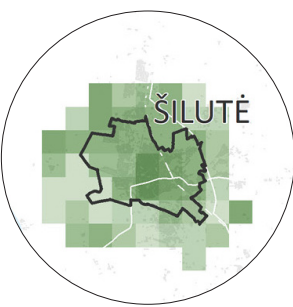
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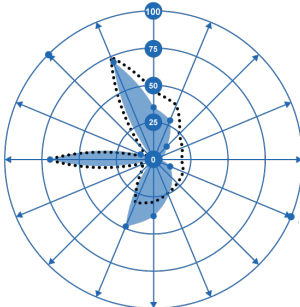
Biržai



Rokiškis

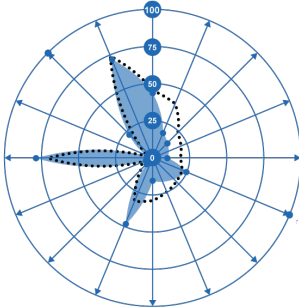
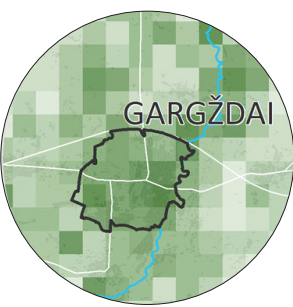


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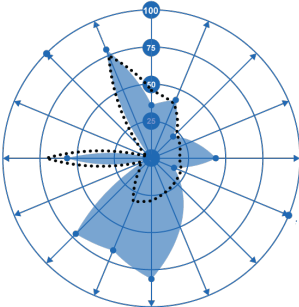


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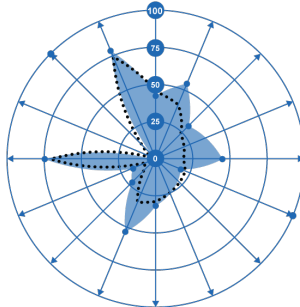
LOCAL URBAN CENTRES



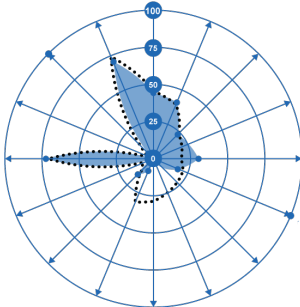
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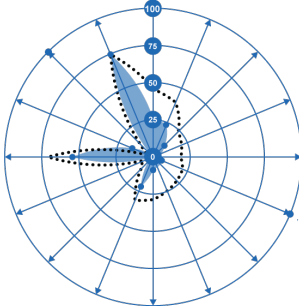
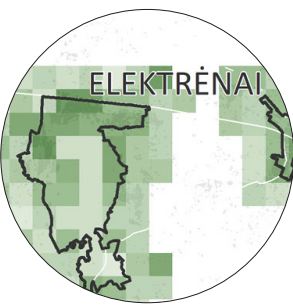
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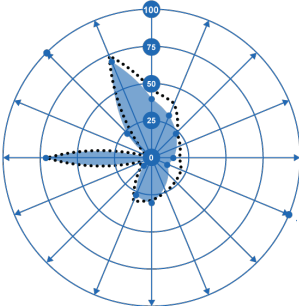
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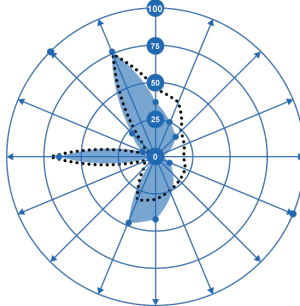
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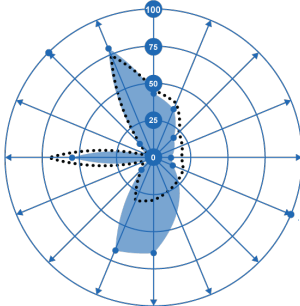
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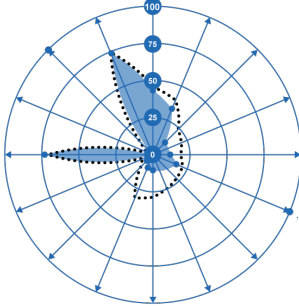
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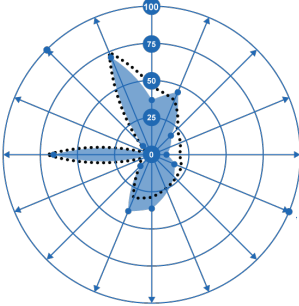
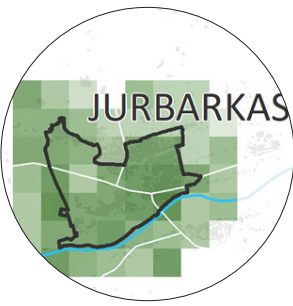
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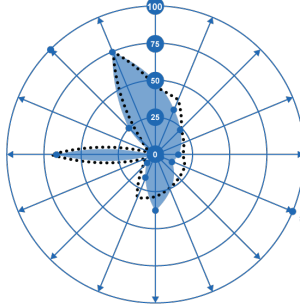
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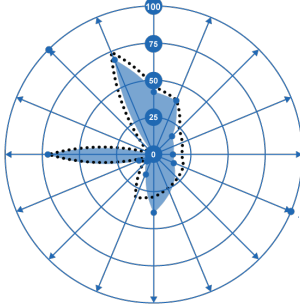
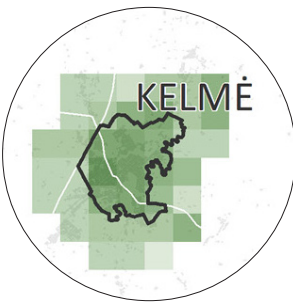
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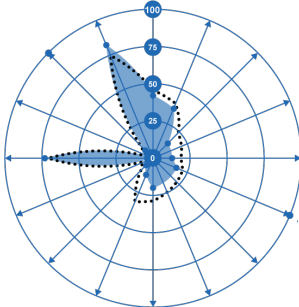
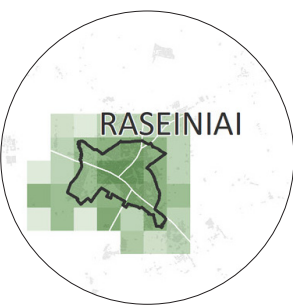
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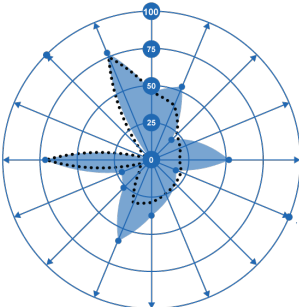
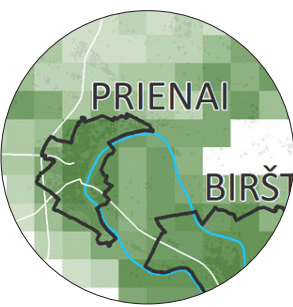
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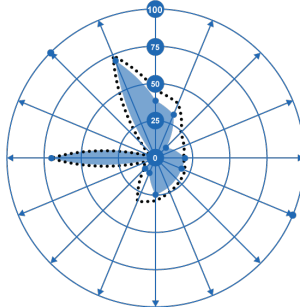
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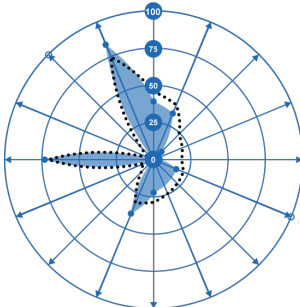
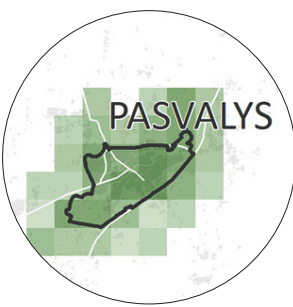
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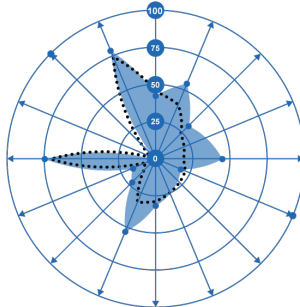


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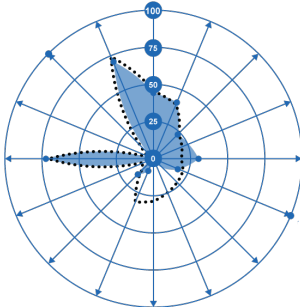


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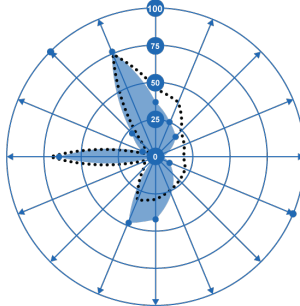
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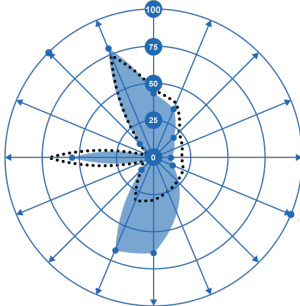
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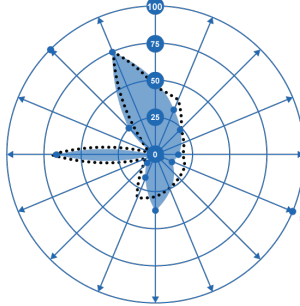
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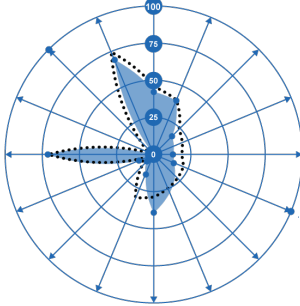
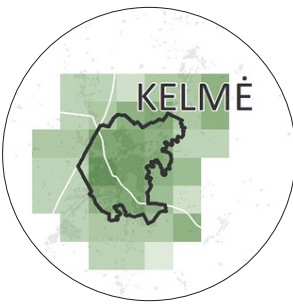
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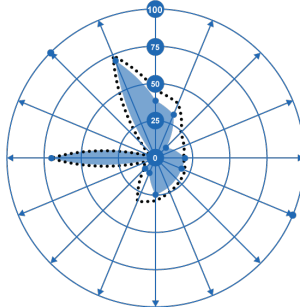
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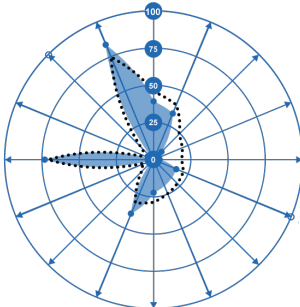
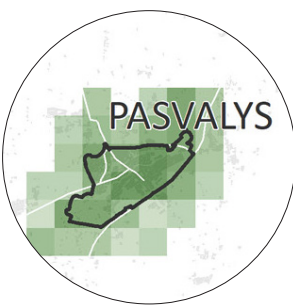
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Kelmė



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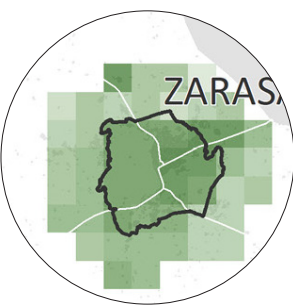
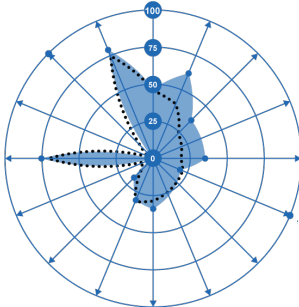


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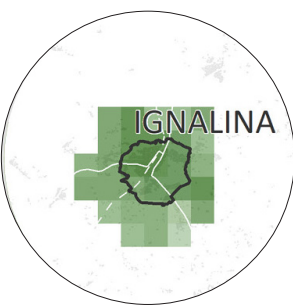
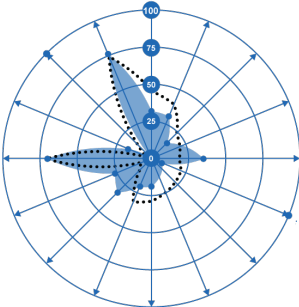
LOCAL URBAN CENTRES



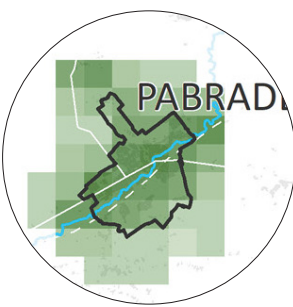
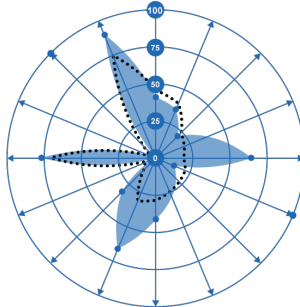
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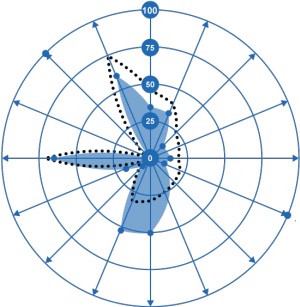
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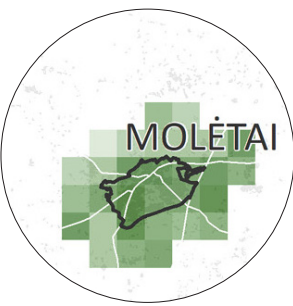
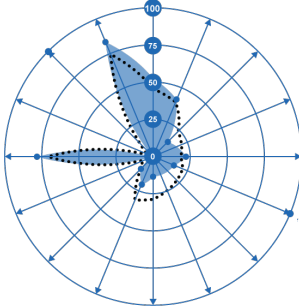
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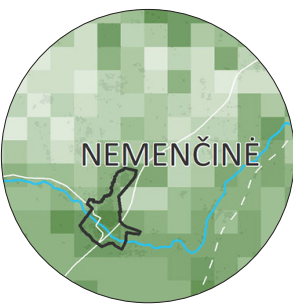
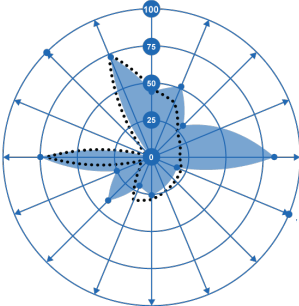
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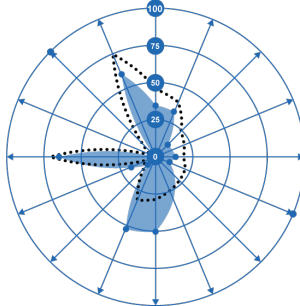
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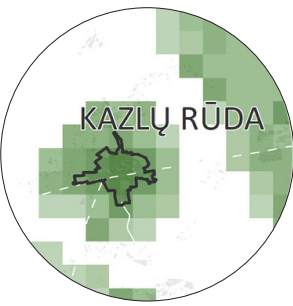
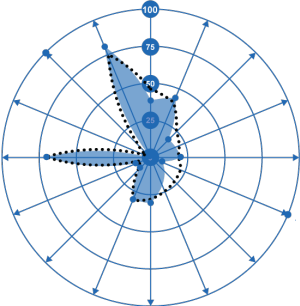
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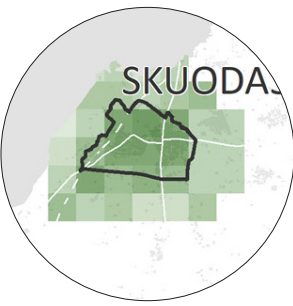
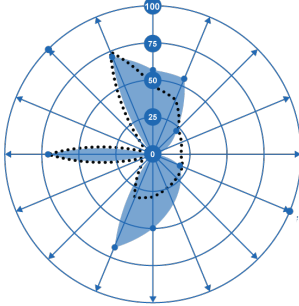
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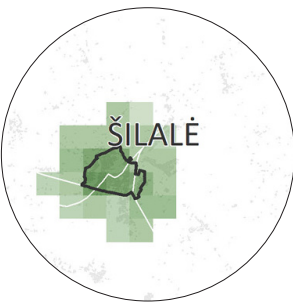
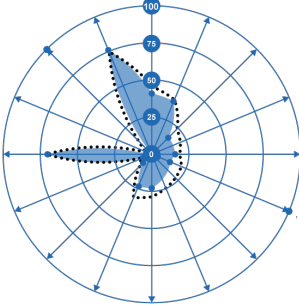
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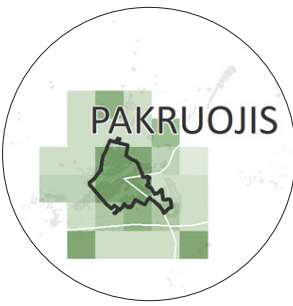
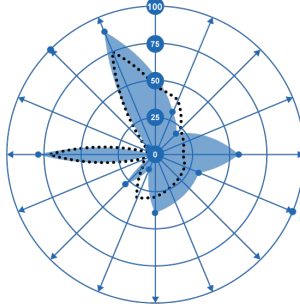
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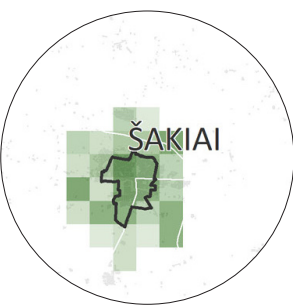
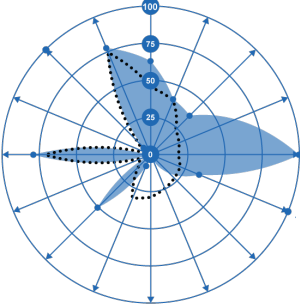
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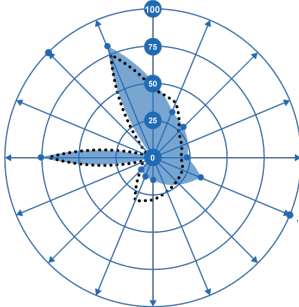
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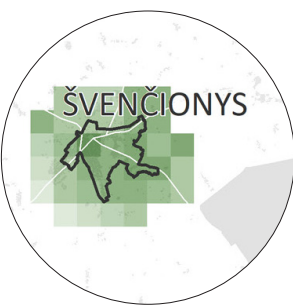
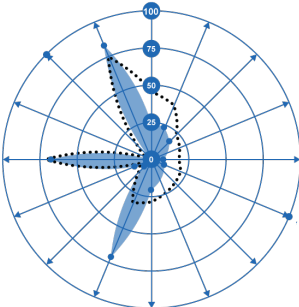
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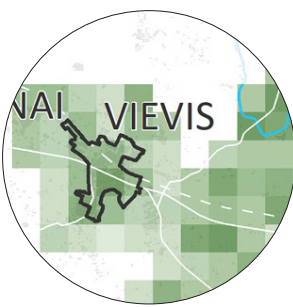
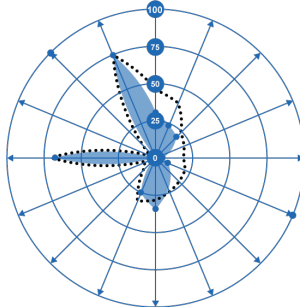
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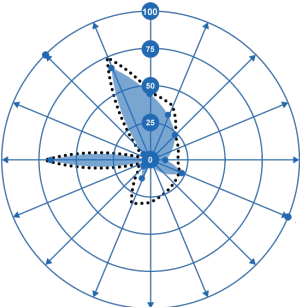
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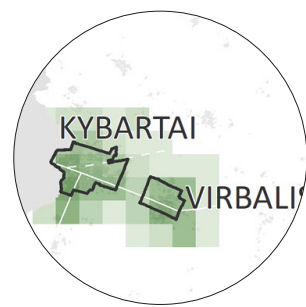
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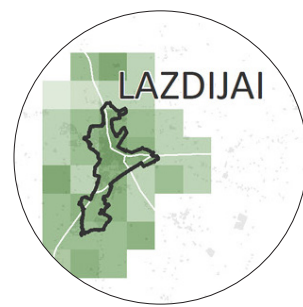
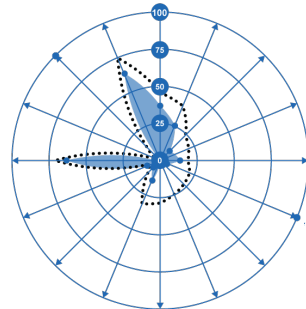
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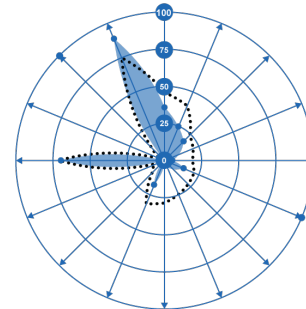
LOCAL URBAN CENTRES



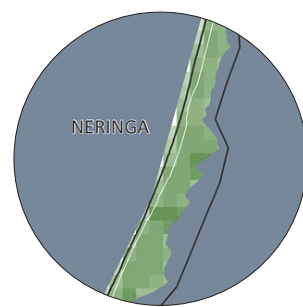
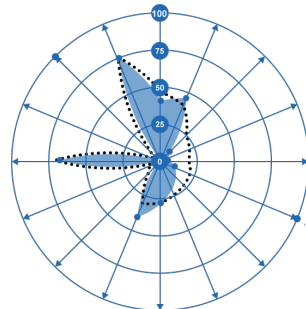
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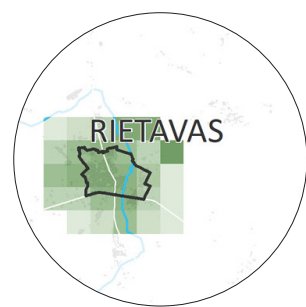
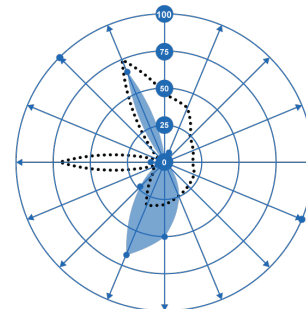
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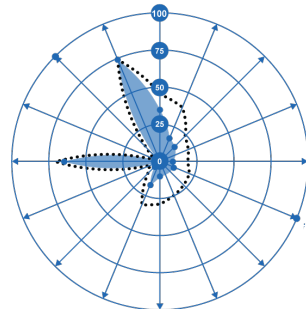
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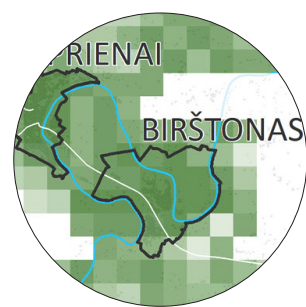
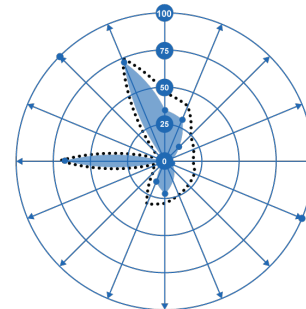
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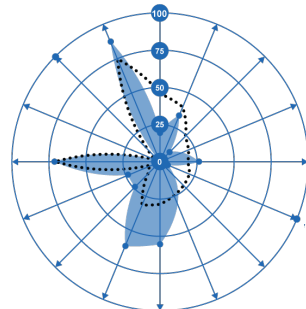
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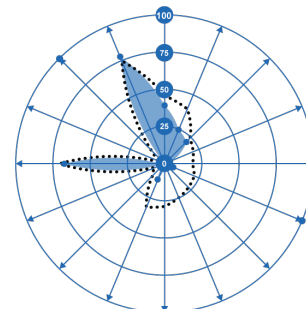
Žiežmariai



Birštonas



Eišiškės



GENERAL CONCLUSIONS ON THE DATA DERIVED FROM THE COMPASS FOR SUSTAINABLE CITIES

Analysing and evaluating the outputs of the Compass for Sustainable Cities, map diagrams and sustainability radial diagrams, the following actions can be carried out:

- 1. Comparison of the sustainability level.** It is possible to compare different cities by evaluating their sustainability indices. This way, it is possible to determine which cities are the most sustainable and which have a greater potential for improvement.
- 2. Priority sustainability aspects.** By analysing data for different cities, it is possible to determine which aspects of sustainability are prioritised in each city. It can be efficient transport, renewable energy sources, waste management systems or ensuring social justice.
- 3. Risk zones.** The risk zones have been identified where the level of urban sustainability is lower and where additional steps are needed to strengthen urban sustainability efforts.
- 4. Planning future actions.** Based on the conclusions, it is possible to form more specific means of implementing the goal for each city individually, as well as future action plans in order to improve the city's level of sustainability. This can include investments in sustainable transport, energy saving measures or other projects that increase the level of sustainability of cities.
- 5. Social and economic impact.** Analysing urban sustainability data can help identify the social and economic impact of sustainability on city residents and businesses. This can also help identify ways in which sustainability can promote urban growth and the well-being of residents.

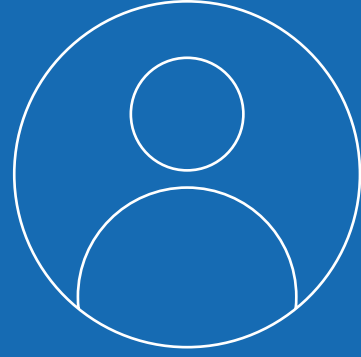
Gairių principai, priemonės ir įgyvendinimo veiksmai buvo suformuoti remiantis Tvaryų miestų kompaso rezultatų duomenimis.

The principles, measures and implementation actions of the guidelines were formed based on the results of the Compass for Sustainable Cities.

The sample of publicly available territorial data is 1x1 km., more detailed and specific guidelines and measures for the development of sustainable cities based on the results of the Compass can be determined only after reducing the size of the data grid, updating the database of territorial indicators by selecting more high-quality indicators that were not collected during the preparation of the project.

The indicators used in the Compass are directly linked to the guidelines, principles, measures, indicators and implementation measure for the development of Sustainable Cities. Therefore, it is proposed to use this planning tool, together with the selected sustainability indicators, for monitoring urban master plans.

It is important to emphasise that the Compass for Sustainable Cities as a planning tool must be used as an auxiliary measures and its results must be combined with the individual characteristics of cities and the opinion of experts.



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