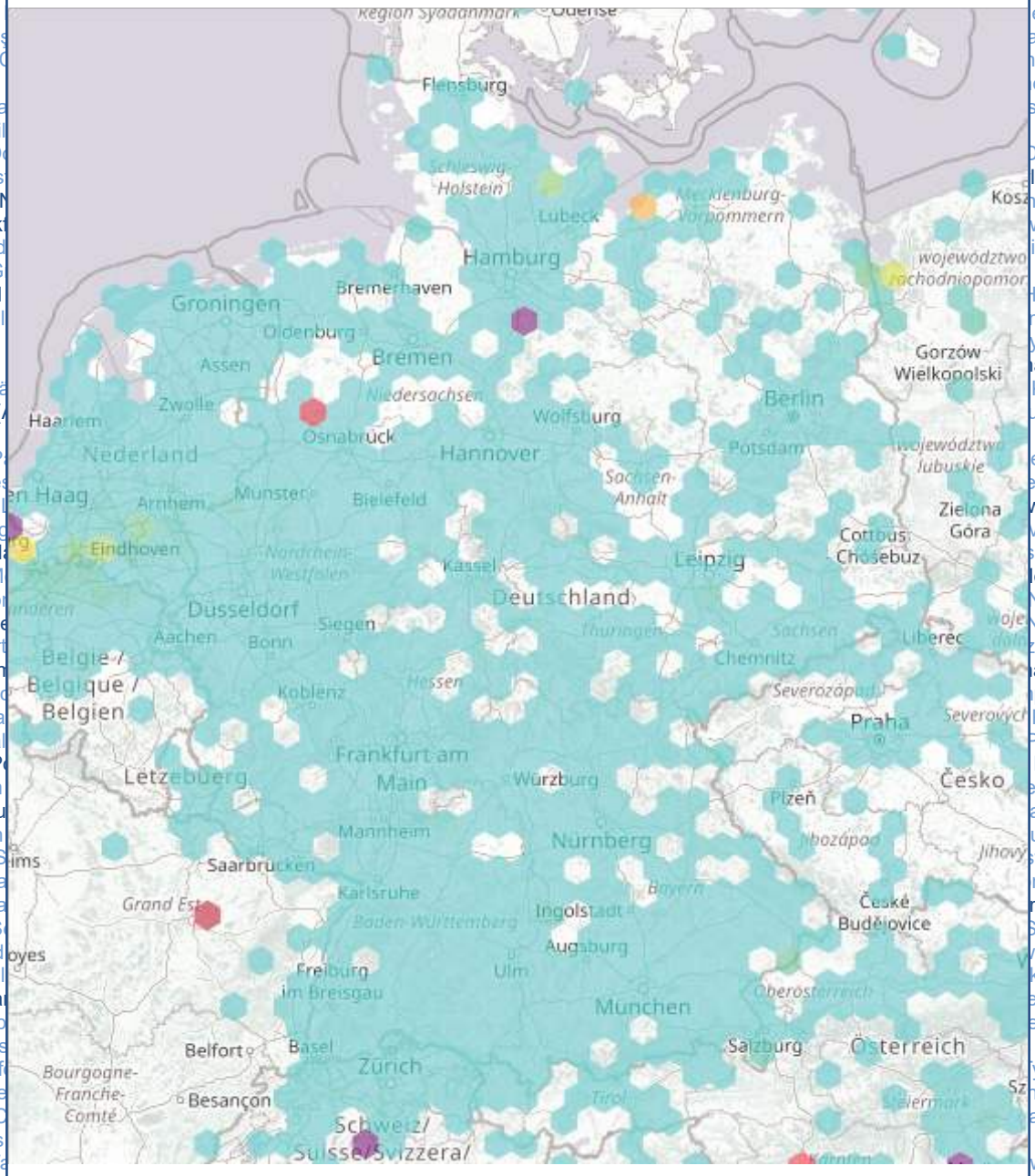
KOSIS Association Urban Audit

URBAN AUDIT

The German Urban Audit



New Data and Methods for Cities and their Functional Urban Areas

Joint project with the German Federal Statistical Office and the Statistical Offices of the Federal States (Länder)

Supported by Eurostat, the Statistical Office of the European Union

Imprint

URBAN AUDIT

Title

New Data and Methods for
Cities and their Functional Urban Areas

Published by

KOSIS Association Urban Audit
c/o City of Mannheim, Municipal Statistics Office
PO Box 101832
68018 Mannheim

November 2023

Conception, editorial work, and layout

Tobias Link, Nassima Ouaarous and Ellen Schneider,
KOSIS Association Urban Audit

Production

City of Mannheim, city printing house

Grant-funded by the European Union

Circulation and source

Print edition in German (200 copies), PDF version (available in German and English):
Copies may be requested at no charge from urbanaudit@mannheim.de

Cover

Illustration: Sensor.Community, https://sensor.community/de/
Cities participating in the EU City Statistics project are listed on the back cover.

Contents

Introduction

For 25 years now, German cities, together with the Federal Statistical Office, have been systematically collecting statistical data for comparing European cities. The Managing Office of the KOSIS Association Urban Audit has been based in city of Mannheim for ten years now. A large part of our work lies in the collection, plausibility checking and provision of comparative urban data for the European Union, as well as in the research of new data sources and methods. With our current brochure, we are pleased to bring the collection of urban data to life for you and to introduce you in particular to innovations regarding the data as well as the redrawn functional urban areas. As in previous years, our brochure is published parallel to the Urban Audit Workshop with the same content, which can be held in Mannheim with people in attendance for the first time since 2019.

The first part is dedicated to inter-municipal integration. The German functional urban areas (FUAs) that were redrawn around two years ago in collaboration with the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) and the Federal Statistical Office have now found their way into the data provided. Even if the acquisition of the data tended to become more complex, the formation of FUAs at the municipality rather than the district level reflects the reality of commuter movements much more precisely and also increases the value of future assessments as a result. A first brochure article illustrates this using selected age indicators in the old and new functional urban areas.

As integration increases, commuter connections in the European Union naturally do not end at national borders, which is why in this brochure we would like to introduce the European project ‘Cross-border cities and FUAs’, which is relevant in particular for the German cities of Konstanz, Weil am Rhein, Kehl, Aachen, Herzogenrath, Frankfurt (Oder) and Görlitz. Finally, the Heidelberg-Mannheim Neighbourhood Association, an alliance of 18 cities and municipalities whose central task as an institution responsible for land use planning is the cross-community development of the spatial and settlement structure in the area where two regional centres interconnect, introduces itself.

The second part of our brochure is dedicated to the development of new and alternative data (sources) and methods for recording and monitoring the quality of life in cities, which has now become a permanent topic in the City Statistics project. An early example of such an approach are the microcensus estimates made at the beginning of the millennium and refined for decades, which were originally developed out of necessity in order to be able to provide important comparative urban data, without in Germany

– unlike in other EU member countries – being able to rely on a census. These estimates have now become established and are made centrally by the Federal Statistical Office. The redesign of the microcensus from 2020 and its effects on the collection of urban data will be shown in another workshop presentation.

We had already made a distinction between new data or big data and transaction-generated, user-generated and sensor-generated data in our Urban Audit Brochure 2019. The GESIS Leibniz Institute for the Social Sciences is currently building a research infrastructure for digital behavioural data, i.e. for digital observations of human and algorithmic behaviour, as recorded by for example online platforms, devices or special software. There will also be an overview of this process in the Urban Audit workshop.

Many European cities have adopted climate action plans in recent years and want to use digitalisation or intelligently networked data to implement them. In one of the articles, the extent to which the sensor data on air quality obtained through a so-called citizen science project can be used for comparative urban analyses is therefore analysed. The fact that the issue of the environment concerns many cities is also shown in the fifth article, in which the results of the Darmstadt Citizen Survey regarding mobility transition and climate protection are presented. This may also provide inspiration for the nationwide Urban Audit survey on the quality of life in German cities, which the final article in the brochure is dedicated to. I would like to thank all the colleagues who have contributed directly or indirectly to the success of the Urban Audit Workshop and this brochure and I hope you enjoy reading it!

Dr. Ellen Schneider
City of Mannheim
Head of Municipal Statistics and Urban Research Unit

Mannheim, 24 October 2023

Part I

Cities and their Functional Urban Areas

1 Cross-border Cities and Functional Urban Areas[1]

Tobias Link

1.1 The expansion of European City Statistics to include a cross-border perspective

EU funding programmes for cross-border cooperation

For some time, the EU has provided funding for cross-border cooperation programmes. These programmes have financed thousands of projects and initiatives that have helped to improve European integration in areas affected by border obstacles such as territorial, legal and administrative discontinuities. Interreg is one such collection of programmes to promote cooperation between regions inside and outside the European Union (EU), which is financed by the European Regional Development Fund. The European Grouping of Territorial Cooperation (EGTC) enables public bodies from different Member States (regional or local authorities, associations and other public bodies) to join forces to form a new entity with full legal personality. Through an EGTC, the authorities of several Member States can set up a single common structure to implement projects, investments or political measures in the area covered by the EGTC, regardless of whether they are co-financed by the EU budget or not. In addition to these programmes, there are many others, some of which were founded outside the spectrum of European institutions in order to support networking within the EU.

With increasing European integration as a response to globalisation, national actors have also come to realise that countries are not isolated islands that can each act on their own without taking external influences into account. This can be seen most clearly in the respective border regions which are most affected by the regulations adopted at EU level to strengthen integration. This is the best place to identify the opportunities and challenges of cross-border policies and it turns out that national stakeholders need this information in order to adequately evaluate the consequences of this policy.

[1] This article is a summary based on presentations given as part of the 'Breaking barriers to cross-border statistical cooperation – challenges and opportunities' workshop at the European Week of Regions and Cities 2023. The presenters were Aleksandra Galić (Eurostat), Johan van der Valk (CBS – Statistics Netherlands) and Tobias Link (KOSIS Association Urban Audit).

Figure 1.1: Commuter integration between Germany and the Netherlands

Cross-border statistics not taken into account

However, it is precisely here where the City Statistics project, which is the only survey of comparable city statistics in the European Statistical System, has had a blind spot. Although commuter integration areas (so-called functional urban areas (FUAs)) of the cities included in the data collection are created within the EU Member States and some EFTA and candidate countries and data is then provided for these units, cross-border commuter flows have not yet been taken into account. However, especially in border regions with distinctive urban areas, these can play an important role and are extremely relevant for the labour market and the economic success of border municipalities.

1.2 Definition and implementation

Cross-border cities and functional urban areas

While the promotion of cross-border integration and cooperation has long been a high priority in the EU's political agenda, this has not yet been reflected in the nomenclature of territorial units on which the data of the European Statistical System (ESS) is based. In the case of City Statistics, consistent application of the concept of the degree of urbanisation[2], on which the European definition of a city is based, would clearly result in cross-border 'Greater Cities'[3] (and thus also cross-border commuter integration areas (so-called functional urban areas (FUAs)). Only the inclusion of national borders as artificial restrictions has so far prevented this. Of course, this prioritisation of nation-statehood has its justification and it is not intended to replace the previously defined border cities with an urban continuation on the other side of a national border. Instead, with the help of the definition of cross-border cities and their functional urban areas, it will be possible to understand statistically the reality experienced on the ground.

[2] See Alexandra Dörzenbach, Tobias Link. Definition of an Urban Audit city and its functional urban area by the degree of urbanisation In: KOSIS Association Urban Audit (publisher): The German Urban Audit - Quality of Life in the City and Suburban Areas (2017). Mannheim, p. 9-12.

[3] Greater City is the former name for a city that, as defined by the degree of urbanisation, includes more than one municipality. The term is no longer used in European City Statistics, since if a Greater City exists, only this territorial unit is designated as a city.

Working Group on Regional, Urban and Rural Development Statistics

In 2020, Eurostat placed the topic of cross-border cities and FUAs on the agenda of the Working Group on Regional, Urban and Rural Development Statistics, where delegates agreed to set up an informal project team. The aim of the initiative is to explore options for how cross-border cities and FUAs can be recorded, how they are coded, how data about them is collected, and how this information can be presented in databases and publications.

The project team was formed in January 2021 and took the form of a subgroup of the Working Group on Regional, Urban and Rural Development Statistics in November 2021. The working group assigned the subgroup 'Cross-border cities and FUAs' the task of taking over and formalising the work of the project team by discussing and providing a harmonised methodology for cross-border cities and FUAs. The duration of the first mandate was set at two years.

The subgroup agreed to use for the definition of cross-border cities the harmonised definition of cities based on high density clusters as set out in the NUTS Regulation[4] and its implementing regulation on the uniform conditions for the harmonised application of territorial typologies[5]. The subgroup reiterated that no population threshold should be applied to individual municipalities that are part of a cross-border combination, so that even a small municipality on one side of the border with a larger city on the other side together can form a cross-border city, as is the case, for example, with Strasbourg and Kehl. In general, as stipulated in the definition of a city by the degree of urbanisation, at least 50% of the population of the municipalities concerned along one (or more) border(s) combined have to live in the respective identified cross-border cluster with high population density (high density cluster or urban centre) (see Figure 1.2).

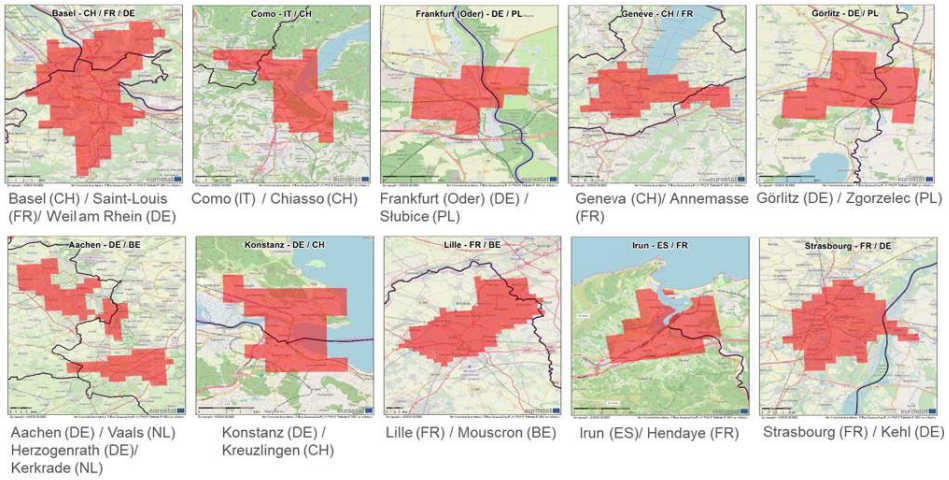


Figure 1.2: Cross-border urban centres

[4] Regulation (EC) No 1059/2003 of the European Parliament and of the Council of 26 May 2003 on the establishment of a common classification of territorial units for statistics (NUTS), Official Journal L 154 of 21.6.2003.

[5] Commission implementing regulation (EU) 2019/1130 of 2 July 2019 on the uniform conditions for the harmonised application of territorial typologies pursuant to Regulation (EC) No 1059/2003 of the European Parliament and of the Council, Official Journal L 179 of 3.7.2019.

Table 1.1: Overview of cross-border cities

Countries concerned			Code	Municipalities involved
DE	NL		CB001C	Aachen / Vaals
CH	FR	DE	CB002C	Basel / Saint-Louis / Weil am Rhein
IT	CH		CB003C	Como / Chiasso
DE	PL		CB004C	Frankfurt (Oder) / Słubice
CH	FR		CB005C	Geneva / Annemasse
DE	PL		CB006C	Görlitz / Zgorzelec
DE	NL		CB007C	Herzogenrath / Kerkrade
ES	FR		CB008C	Irun / Hendaye
DE	CH		CB009C	Konstanz / Kreuzlingen
FR	BE		CB010C	Lille / Mouscron
FR	DE		CB011C	Strasbourg / Kehl

The method provided 11 cross-border cities in EU and EFTA countries, which were selected as pilot projects: Aachen (DE)/ Vaals (NL), Basel (CH)/ Saint-Louis (FR)/ Weil am Rhein (DE), Como (IT)/ Chiasso (CH), Frankfurt (Oder) (DE)/ Slubice (PL), Geneva (CH)/ Annemasse (FR), Gorlitz (DE)/ Zgorzelec (PL), Herzogenrath (DE)/ Kerkrade (NL), Irun (ES)/ Hendaye (FR), Konstanz (DE)/ Kreuzlingen (CH), Lille (FR)/ Mouscron (BE), Strasbourg (DE)/ Kehl (DE). Data for these should be provided as far as possible from the next funding period, which starts in June 2024.

The most difficult aspect was the discussion of the options for a definition of cross-border FUAs. It was agreed that the definition of cross-border FUAs should follow as far as possible the national definition of FUAs. The methods manual for the territorial typologies specifies that FUAs are defined commuter zones (LAUs) that surround a city and in which at least 15% of the working population commute to work in the city. Experience has shown that data at LAU level for cross-border commuting is difficult to obtain or non-existent. The subgroup examined the commuter data from the EU labour force survey, albeit with sparse results, before examining the definition of FUAs in the international context using modeling, as proposed in Moreno-Monroy et al. (2021)[6]. Due to the complexity of the analytical work in defining the cross-border FUAs, the subgroup decided to request an extension of its mandate from the Working Group in order to be able to define the cross-border FUAs on the basis of balanced, thorough and result-oriented analytical work.

1.3 The reality of cross-border cooperations on the ground

With the advanced stage of the work in the subgroup and the 11 cross-border cities that have emerged from it, especially as a member of a network of city statisticians, it is necessary to question the level of cooperation

[6] Ana I. Moreno-Monroy, Marcello Schiavina and Paolo Veneri. Metropolitan areas in the world. Delineation and population trends. Journal of Urban Economics 125 (2021) 103242.

on the ground. What level of exchange and integration is there in the municipalities of these newly defined cross-border spatial units?

Germany's cross-border cities

For this purpose, the seven defined cross-border cities along the German border will be considered. Starting at the southern border with Switzerland, we have the cross-border cities of Konstanz/Kreuzlingen and Basel/Saint-Louis/Weil am Rhein (three countries involved). Moving northwards, we have Strasbourg/Kehl on the border with France and Aachen/Vaals and Herzogenrath/Kerkrade on the border with the Netherlands. On the eastern border with Poland we have the cross-border cities of Frankfurt (Oder)/Słubice and Görlitz/Zgorzelec.

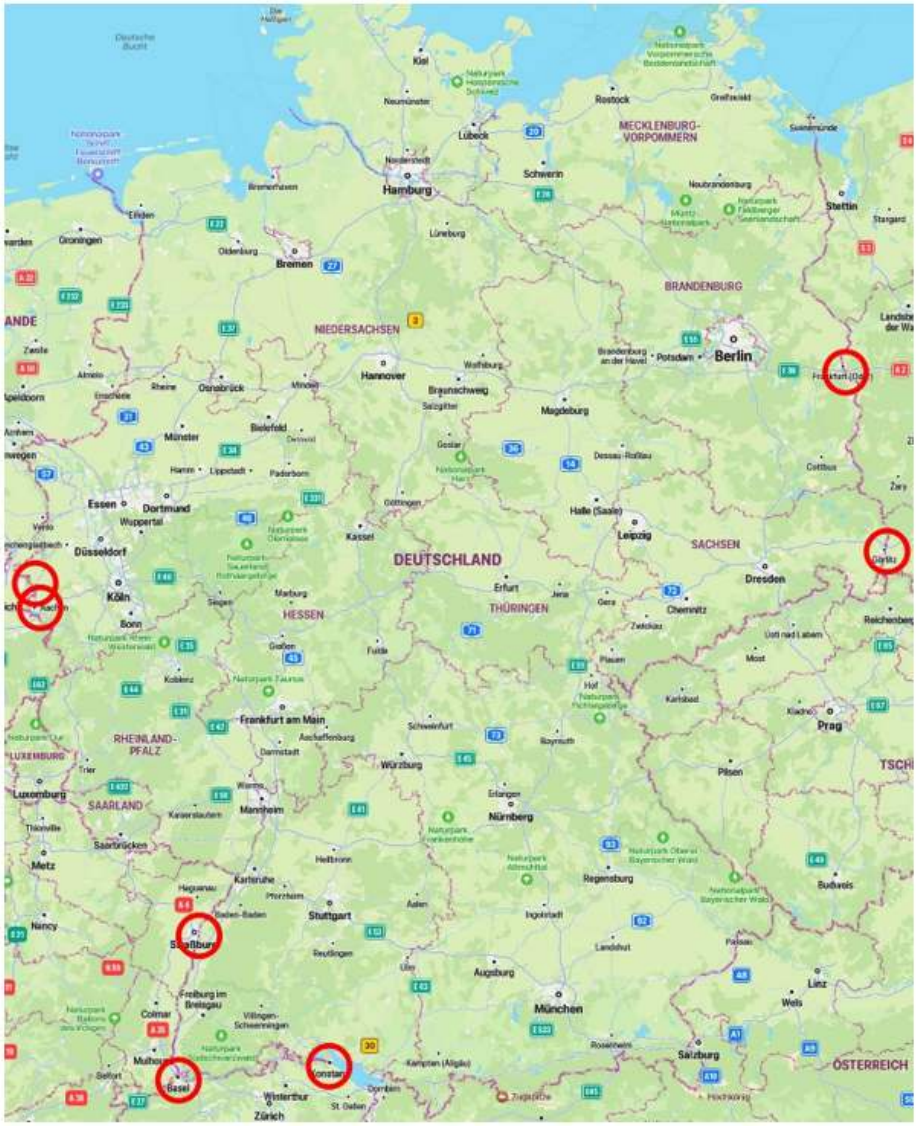


Figure 1.3: Location of the cross-border cities along the German border

Even with a cursory search of the internet, it can quickly be established that there is an extensive level of cross-border cooperation in the cities and municipalities mentioned. Culture and tourism are areas with a low threshold for cooperation because there are comparatively fewer regulations and administrative obstacles, which is why this type of cooperation

can be found in almost every cross-border city. The highest degree of integration is found where central tasks of the sovereign administration are opened up for collaboration. This is the case in the areas of transport, public safety, education, health and regional development.

Figure 1.4: Examples of cross-border cooperation

Cross-border cooperations

Examples of extensive integration, which includes cooperation in several areas of administration and public life and is based on far-reaching agreements, can be found in some of the cross-border cities mentioned:

- The Eurode project between Kerkrade and Herzogenrath
- The Charlemagne border region, consisting of Aachen, the German-speaking border region of Belgium, Heerlen and Vaals in the Netherlands
- The agreement on cooperation in all areas of life between Strasbourg and Kehl
- The cooperation centre for inter-municipal cooperation between Frankfurt (Oder) and Słubice
- The Kreuzlingen-Konstanz agglomeration charter

All of these cooperations include many individual projects in the areas of culture, tourism, transport, education and regional planning.

In the other cities there is also a high level of cooperation, which is reflected in a variety of programmes, such as Eurocity Görlitz-Zgorzelec, a company to promote the growth and image of the business and tourism location. The aim here is not to provide a complete description of the existing cooperation structures, but rather to provide an impression of the local realities experienced. Under this impression, it can be stated that there is a large number of cross-border cooperation projects. Cross-border cities as a clearly defined spatial unit in the data collection of urban statistics can support both local cooperation partners and political actors in the EU in decision-making.

1.4 Conclusion

The cross-border cities defined so far will already be part of the data collection for the upcoming funding period of the City Statistics project, which will start in June 2024. This involves numerous challenges that can only be shouldered in cooperation with the project partners in the neighbouring countries. In a cross-border context, it is even more important that the methods used to calculate the different variables are comparable between the countries involved. It will also be difficult to cover all of the variables included in the European City Statistics data catalogue as data availability varies in different countries, especially at this low level. It is important for local decision-makers that the data provided relates to existing 'cooperation areas' as recognised by the local partners involved. The focus must be on contact and exchange with the local actors, as their data needs for the implementation of projects on the ground can be seen as a test for the practicality of data collection for cross-border cities. This might be a longer term process, but there is always the chance to learn from each other.

Tobias Link is the executive secretary of the managing office for the KOSIS Association Urban Audit.
✉ urbanaudit@mannheim.de

2 The new and old Functional Urban Areas compared

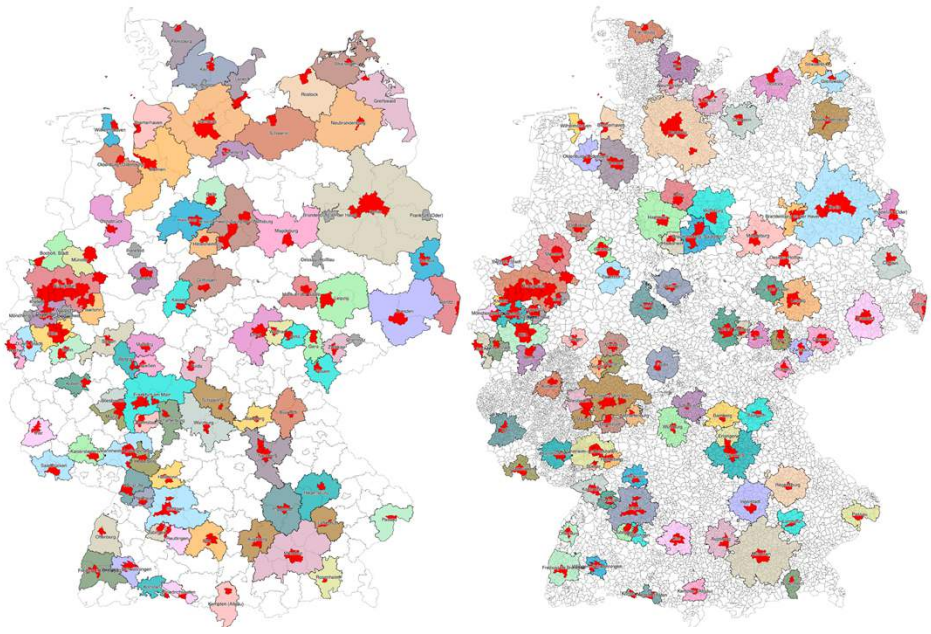
Nassima Ouaarous

2.1 The redrawing of the functional urban areas

Background of the new FUAs

The functional urban areas form alongside the cities the second territorial unit on the basis of which data is collected for the City Statistics project. While the provision of data at this level was optional in the past, it is now a mandatory part of the project. They represent the so-called commuter integration areas of the 127 German Urban Audit cities and are by definition dynamic. The basis for definition and calculation of the functional urban areas was explained in more detail in an article in the Urban Audit Brochure 2021[1] by Tobias Link. For this reason, it makes sense to review the boundaries of these areas on a regular basis and possibly change them.

Figure 2.1: Comparison of new and old FUAs



An important step to bring the functional urban areas closer to the EU definition was to no longer form them at the district level as before, but to use commuter flows from the individual municipalities. The FUAs are formed

[1] https://www.staedtestatistik.de/fileadmin/media/Kosis/Urban_Audit/PDF/Broschueren/UA_Broschuere_2021_EN.pdf

based on the criterion that at least 15% of the employees subject to social insurance contributions work in a municipality in the Urban Audit city. If this criterion is met between two participating cities, they are linked to each other. A special case in Germany can be found in the Ruhr area. The high concentration of cities results in a commuter flows being spread across many individual cities, which is why the Ruhr area is viewed as a single functional urban area. The following maps remind once again of the boundary changes of the individual FUAs. In general the FUAs have become smaller.

The current FUAs can also be viewed in the so-called FUA visualiser. This tool was developed as the websites evolved and provides a cartographic representation of all of the FUAs and the municipalities in them (https://apps.urbanaudit.de/fuavis.html).

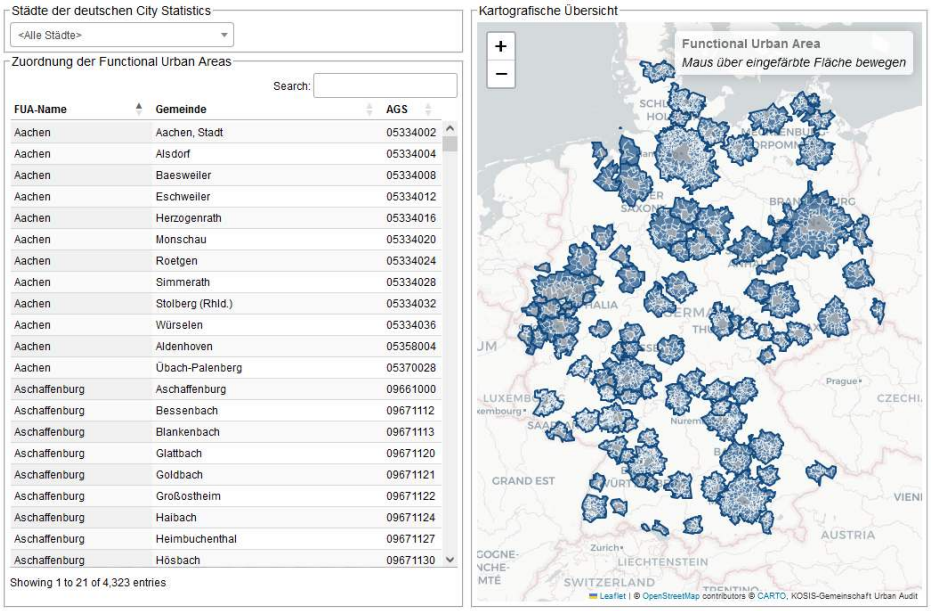


Figure 2.2: The FUA visualiser

Due to the lower aggregation level, the new FUAs better reflect the 'real' integration areas. It is to be expected that the transformation will also have some impact on the data provided. After all, a primary goal of the redrawing was to improve the meaningfulness of data; due to the high level of aggregation of the previous FUAs the data was less meaningful.

Data preparation involves more work

Since the reference year 2021, these new functional urban areas have now formed the basis of the German data provided for the City Statistics project. The data preparation involves more work due to the redrawing of the boundaries. While the data for the demographic variables was previously available online in the regional database of the statistical offices, it now has to be requested from the managing office of the individual state statistical offices. The Statistical Office of Bavaria kindly coordinated this special analysis.

The following will show whether and to what extent individual key figures differ from each other, depending on whether the old FUAs based on the district level or the new FUAs based on the municipal level are considered.

For this purpose, the absolute population size is first considered in order to show to what extent this has changed as a result of the redrawing. Then differences in the age structure are examined based on the youth and old-age dependency ratios. The period analysed covers 2018 to 2021, which means that for the analysis the new FUAs were applied in part retroactively and old FUAs were applied to newer data sets. It is important to note that the number of FUAs has increased from 96 to 98 areas, because the cities of Speyer, Wolfsburg and Erlangen now each form their own commuter integration area, while the former FUA Lüneburg is now part of the FUA Hamburg.

2.2 Population as a whole

Since the majority of FUAs have lost area due to the redrawing, the population numbers have also fallen. On average, the commuter integration areas have 66,000 fewer residents after the redrawing. The most populous FUAs remain Berlin, the Ruhr area and Hamburg, although after the redrawing the FUA Berlin now has fewer residents than the Ruhr area. If the FUAs in which an Urban Audit city has been lost completely or added are excluded, the largest population increases are found in the FUAs Bielefeld, Chemnitz and Cologne. The largest decreases are found in the FUAs Berlin, Dresden and Heidelberg. It can therefore be seen that the major effects are not concentrated in one region, but are spread geographically.

'Shrinkage' of FUAs

Figure 2.3 shows the degree by which the population numbers of old and new FUAs differ. The population numbers are as at 31/12/2021. The logarithmised values allow a clear representation despite outlying values. The dots represent the respective FUAs. The closer the dots are to the diagonal line, the smaller the difference between the new and old FUA. Dots on the diagonal line therefore mean that the population number has not changed with the redrawing. This is only the case with the FUA Solingen, which is the only FUA that did not lose or gain any municipalities as a result of the redrawing. It is noticeable that the FUAs that have seen the greatest loss of residents are located in the German border areas. These are the FUAs Bocholt, Konstanz, Görlitz and Offenburg. The population numbers in these FUAs fell by 60 to 73 percent after the redrawing. This finding may indicate the importance of considering FUAs across national borders (see Chapter 1), because it shows that the aggregation at district level tended to overestimate commuter flows in border areas and the FUAs were therefore significantly larger. Even though the majority of FUAs have shrunk due to the redrawing, there are also FUAs that are larger and as a result now contain significantly more residents. The largest increases are found in FUAs that, based on the old calculation method, consisted only of their own urban area. This was particularly the case for cities that were surrounded by larger districts and were not far from one or more major cities, with the result that these large cities included all surrounding districts in their FUA. For example, municipalities in the new FUA Frankfurt (Oder) and the FUA Chemnitz were previously part of the FUA Berlin.

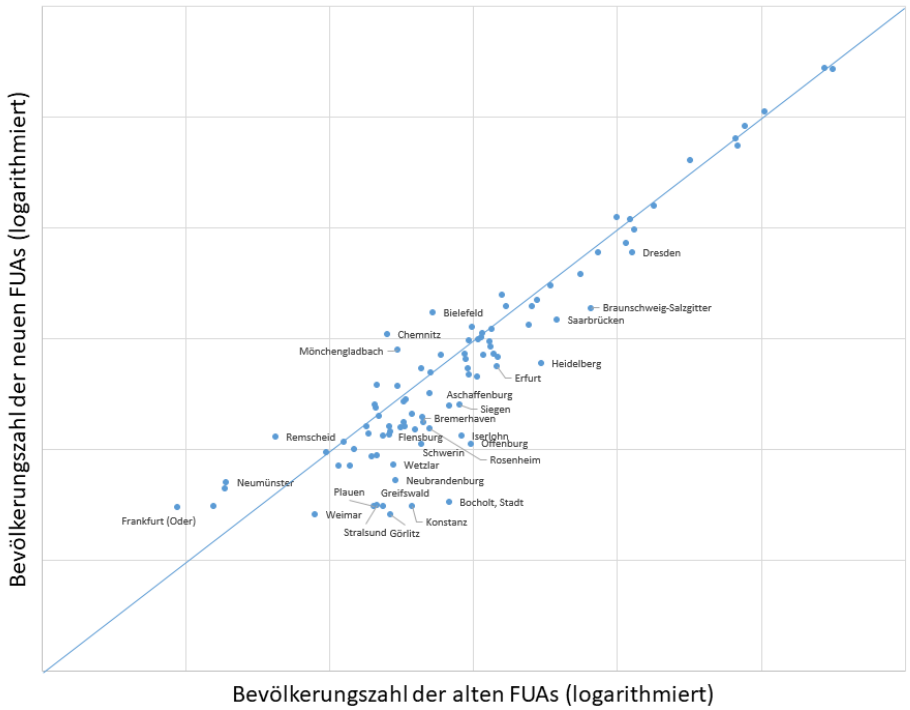


Figure 2.3: The degree by which the population numbers of old and new FUAs differ

2.3 Youth and old-age dependency ratios

The youth dependency ratio is the ratio of the young generation, who tend to be not yet working, to the population of working age. Both the EU and the Federal Statistical Office define this age group as under 20. Conversely, the old-age dependency ratio is the ratio of the population aged 65 and older, who tend to be of retirement age, to the population of working age. After the population numbers were discussed in the previous section, below changes in the age structure due to the redrawing of the functional urban areas will be highlighted.

Change in the age structure

On average, the ratio of children and young people to the population of working age remains unchanged despite the redrawing. The average value in the reference year 2021 is 31.1% for both the old and redrawn FUAs. The average values are also around the same level over time. As the chart below shows, the youth dependency ratio increased slightly on average between 2018 and 2021. This change can be seen using both types of FUA calculations. The respective maximum values also only differ minimally over the years and converge, while the lowest values of the youth dependency ratio diverge slightly. These values concern the old FUA Bayreuth (28.0) and the new FUA Konstanz (27.1).

The average values of the old-age dependency ratio have also changed slightly. This value has also generally increased slightly over this period. While the minimum values are almost identical, the difference in the maximum values is more pronounced. Between the highest values of the old-age dependency ratio of the old and new FUAs there is a difference of

around 3 percentage points. However, it can be seen that both curves climb in the same way.

Figure 2.4: Average youth dependency ratio in old and new FUAs compared over time

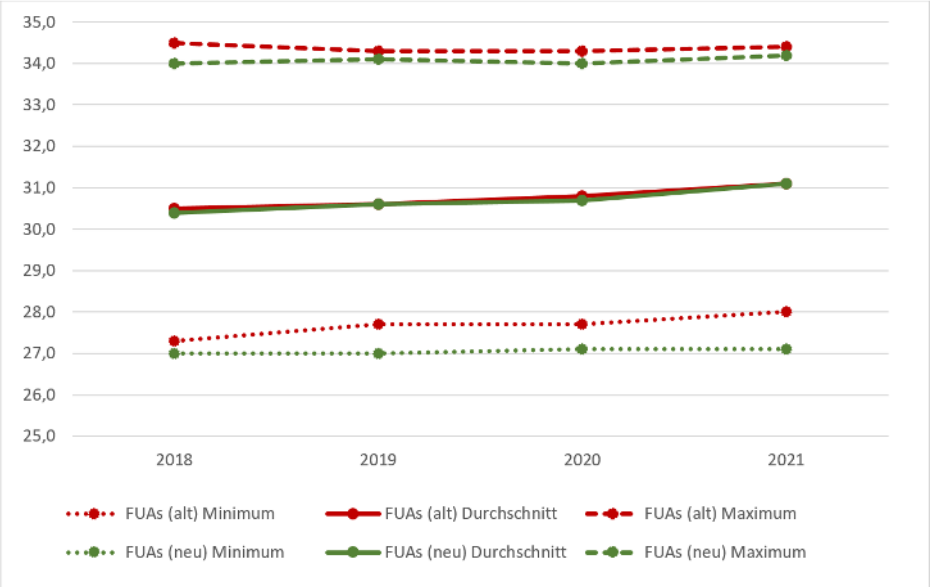
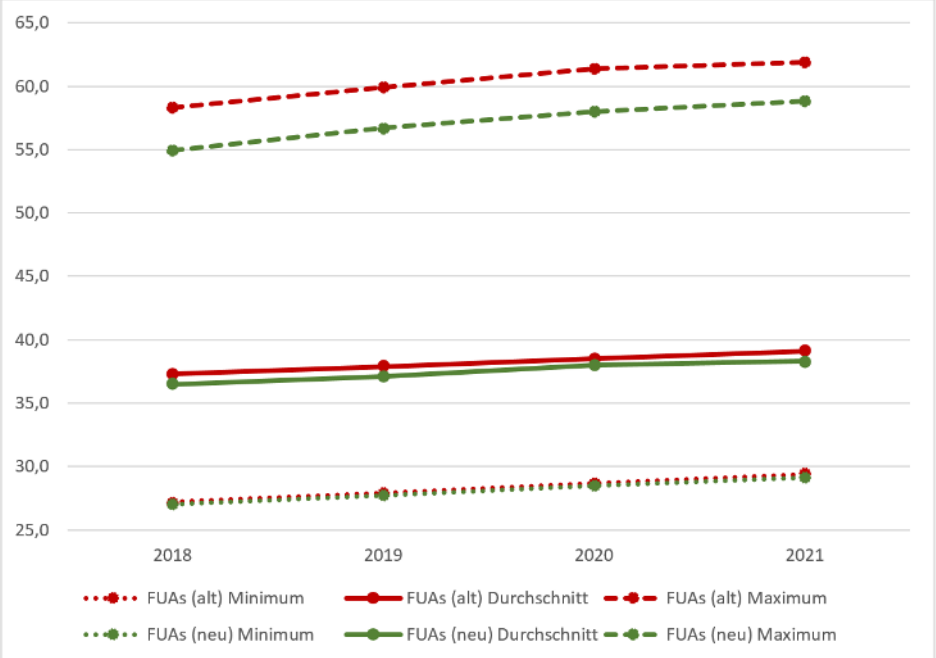


Figure 2.5: Average old-age dependency ratio in old and new FUAs compared over time



The highest increase in the youth dependency ratio is found in Weimar. Here the ratio of children and young people increased by 3.7 percentage points after the redrawing of the FUAs As in Weimar, the loss of peripheral areas in Wiesbaden has also led to an increase in the youth dependency ratio. In the case of Wiesbaden, some municipalities have been transferred to the FUA Frankfurt am Main. In Dresden there is a special case in that both the youth dependency ratio (+3.0) and the old-age dependency ratio (+3.3) have increased. In most cases, changes in the youth dependency ratio of a FUA are accompanied by the opposite change in the old-age dependency ratio, as in the example of the FUA Konstanz, which, due to

the remodelling, has recorded a lower youth dependency ratio (-4.3) and an equally high increase in seniors (+4.4).

2.4 Conclusion

It should be noted that there are certainly differences in the data, but these variances are limited for the indicators considered here. The comparison shows that major differences in terms of demographics are limited to individual FUAs. In general, the key figures of the FUAs have not changed or differ slightly; in any case, no jumps in the figures can be detected in the comparisons over time. With increasing differentiation of the data that can also be supplied to the EU for the level of the FUAs, this picture could change of course. The inclusion of cross-border commuter flows would certainly make the drawing of commuter integration areas or FUAs and the related assessments even more realistic.

Nassima Ouaarous is a member of the project staff at the Managing Office for the KOSIS Association Urban Audit.
✉ urbanaudit@mannheim.de

3 Heidelberg-Mannheim Neighbourhood Association – Inter-municipal cooperation in the area where two regional centres connect

Anna George und Martin Müller

3.1 Classification of the association as an institution and land use planner

Interface between municipalities and regional and state planning

The Heidelberg-Mannheim Neighbourhood Association is an alliance of 18 cities and municipalities in the central area of the Rhine-Neckar metropolitan region. Its central task is the development across municipalities of the land use and settlement structure in an area of 488 km² for around 700,000 residents. The Neighbourhood Association is responsible for land use planning pursuant to the Building Code and has the task of working to balance the interests of its members. The Association is therefore at the interface between the individual municipalities and regional and state planning. The Neighbourhood Association is also responsible for landscape planning and coordinates inter-municipal landscape development projects such as the 'Living Neckar' project.

The Heidelberg-Mannheim Neighbourhood Association was established by the state government of Baden-Württemberg as part of the fourth administrative reform with the Neighbourhood Association Act of 9 July 1974. The task of the Neighbourhood Association is 'to promote the orderly development of the neighbourhood area and to work towards balancing the interests of its members, taking into account the objectives of regional and state planning' (section 4 Neighbourhood Association Act). According to the Neighbourhood Association Act, the association area consists of the two regional centres of Heidelberg and Mannheim as well as 16 other cities and municipalities in the surrounding area.

There are more Neighbourhood Associations in Baden-Württemberg in the urban areas of Karlsruhe, Pforzheim, Reutlingen-Tübingen and Ulm.

Organisation

The executive bodies of the Neighbourhood Association are the Association Meeting and the Association Chairman. The Association Meeting is the Neighbourhood Association's decision-making body. It decides on

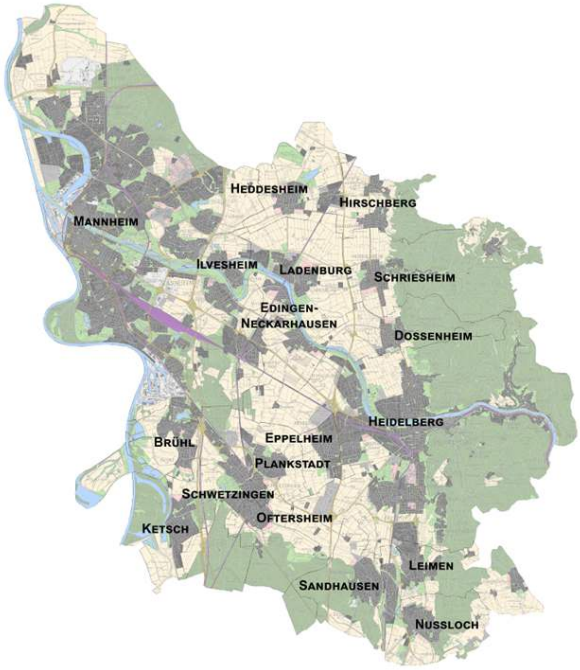


Figure 3.1: Heidelberg-Mannheim Neighbourhood Association area

Source: Heidelberg-Mannheim Neighbourhood Association

all important matters of the Neighbourhood Association. The Association Meeting of the Neighbourhood Association consists of in total 63 representatives who are sent from the 18 member municipalities. 40 votes go to the city of Mannheim, 20 votes to the city of Heidelberg and 40 votes to the remaining member municipalities. According to the Association's statutes, resolutions require a two-thirds majority.

In order to fulfil the planning tasks, the Neighbourhood Association uses a planning group consisting of employees of the two core cities and the Rhine-Neckar district. The Association Administration also has its own employees.

3.2 Settlement structural connections

The main reason for the institutionalised cooperation is that the cities and municipalities around the two regional centres of Heidelberg and Mannheim are closely intertwined in many ways.

Dealing with population growth

The area of the Neighbourhood Association is characterised by dynamic growth in many ways: the population in the area of the Neighbourhood Association has been increasing steadily for many years. This growth is due in particular to large-scale migration gains, which essentially has to do with the good range of training and jobs available. This is associated with a high demand for living space and continuous new construction activity. Not least due to increased growth in recent years, this has led to noticeable tension in the housing market. It has therefore become increasingly difficult for broad sections of the population to find adequate housing. At the

same time, the Association area is already one of the most densely built-up regions in Baden-Württemberg. In this respect, future growth must be organised in the long term in less and less space.

The closely connected settlement structures mean that this development affects all cities and municipalities in the Neighbourhood Association. The connections concern a variety of land-use-related issues. Below, the inter-municipality migration and commuter connections are examined in greater detail by way of example:

The geographical proximity of the member municipalities means that people looking for housing do not just look at areas where they have previously lived when there is a shortage of housing. If a more attractive offer is found in a neighbouring town, people will usually move town.

Example of Edingen-Neckarhausen

Below, the migration movements in Edingen-Neckarhausen, a place located centrally in the association area, are analysed by way of example. There have been comparatively few newly built apartments here in recent years, with the result that the migration movements can be viewed without the effect of a larger supply of new housing.

The population of Edingen-Neckarhausen was 14,173 in 2022. In the period from 2011 to 2022, a total of 12,229 people moved to Edingen-Neckarhausen, while 11,231 people moved away. Around 45 percent of the migration movements took place within the Neighbourhood Association. The greatest connections are with the neighbouring regional centres of Heidelberg and Mannheim as well as with the geographical neighbours Ladenburg, Ilvesheim and Eppelheim.

Figure 3.2: Migration movements Edingen-Neckarhausen 2011-2022

Data source: Statistical Office of Baden-Württemberg

Edingen-Neckarhausen - Wanderungen 2011 bis 2022			
Verbandsmitglied	**Zuzug**	**Wegzug**	**Summe**
Brühl	46	108	154
Dossenheim	124	91	215
Eppelheim	220	187	407
Heddesheim	123	133	256
Heidelberg	1.424	1.010	2.434
Hirschberg	35	51	87
Ilvesheim	256	246	502
Ketsch	29	69	99
Ladenburg	269	325	594
Leimen	89	119	208
Mannheim	2.530	2.090	4.620
Nußloch	35	31	66
Oftersheim	56	66	122
Plankstadt	69	99	168
Sandhausen	35	73	109
Schriesheim	117	133	250
Schwetzingen	121	181	302
Summe NV	5.580	5.014	10.594
Summe außerhalb NV	6.649	6.217	12.866
Summe	**12.229**	**11.231**	**23.460**

Regional housing market

These close connections are not least important for prices on the real estate market. According to the findings of the Neighbourhood Association, the offers for moving into apartments in the association area are consistently very close to one another in terms of price. Every new offer on

the housing market throughout the association area is used within a short period of time. This applies both to offers in multi-storey housing as well as to the development of new building land with single-family houses in the outskirts.

The settlement structural connections and the comparable property prices across regions indicate that the housing market is a regional market and a purely local consideration is not appropriate.

The inter-municipal connections concern not only housing, but also other areas affecting land use. In terms of traffic, for example, the number of commuters during rush hour is a determining factor. The number of commuters to locations in the Neighbourhood Association totalled 214,988 in 2017. This is an increase of 14.3 percent compared to 2011. In Mannheim, the largest employment centre in the association area, the number of commuters is 112,164, 11.8 percent above the 2011 figure. 63,075 commuters came to Heidelberg in 2017, which equates to an increase of 13.2 percent compared to 2011.

Beschäftigte und Berufspendler

Verbandsmitglied	2011		2017		Veränderung in Prozent	
	Beschäftigte	Einpendler	Beschäftigte	Einpendler	Beschäftigte	Einpendler
Brühl	1.958	1.416	2.415	1.804	23,3	27,4
Dossenheim	1.839	1.412	1.914	1.452	4,1	2,8
Edingen-Neckarhausen	2.343	1.756	2.591	1.921	10,6	9,4
Eppelheim	3.434	2.781	4.057	3.359	18,1	20,8
Heddesheim	2.580	2.028	4.944	4.311	91,6	112,6
Heidelberg	80.866	55.694	91.173	63.075	12,7	13,3
Hirschberg	2.561	2.234	3.894	3.473	52,0	55,5
Ilvesheim	717	514	912	679	27,2	32,1
Ketsch	2.505	1.831	2.724	2.041	8,7	11,5
Ladenburg	4.832	3.952	4.773	3.897	-1,2	-1,4
Leimen	4.202	3.036	4.505	3.172	7,2	4,5
Mannheim	167.867	100.346	185.371	112.164	10,4	11,8
Nußloch	1.993	1.566	2.158	1.715	8,3	9,5
Oftersheim	822	518	1.177	842	43,2	62,5
Plankstadt	1.039	757	1.144	862	10,1	13,9
Sandhausen	1.684	1.115	2.068	1.496	22,8	34,2
Schriesheim	2.153	1.485	2.557	1.834	18,8	23,5
Schwetzingen	6.987	5.642	8.361	6.891	19,7	22,1
Summe	**290.382**	**188.083**	**326.738**	**214.988**	**12,5**	**14,3**

Figure 3.3: Employees and commuters

Data source: Federal Employment Agency

3.3 Tasks and projects

The tasks of the Neighbourhood Association primarily comprise the preparation of the inter-municipal land use plan for all 18 member municipalities. In addition, the member municipalities cooperate to find good solutions to the diverse land use planning challenges. Selected topics are presented in more detail below.

3.3.1 Inter-municipal land use plan

The Heidelberg-Mannheim Neighbourhood Association is responsible for land use planning for its 18 member municipalities.

The land use plan represents the basic principles of the intended urban development for the entire area of the Neighbourhood Association. It is particularly important for the development of new building areas, as the municipal development plans must be developed from the land use plan (section 8 (2) of the Building Code). It shows comprehensively where building areas and uses are possible and which areas should remain free of development.

According to section 5 of the Building Code, the land use plan is one of the mandatory tasks of municipal land-use planning and is prepared for the 18 association members by the Heidelberg-Mannheim Neighbourhood Association. The building areas shown in the land use plan represent a medium to long-term possible development framework for the member municipalities.

The aim of the joint land use plan is to direct structural development to areas that are as compatible as possible and thus ensure the sustainable development of the association area.

Special feature of military conversion areas

The current land use plan was updated towards the end of the 2010s due to the extensive release of military conversion areas for civilian use with a total area of approx. 300 hectares. This process was completed on 7 July 2020. Since then, the land use plan has included a binding concept of the areas intended for development and the areas for open space, nature conservation, local recreation and agriculture that must be kept free from development.

As part of the preparation process for the current land use plan, the Neighbourhood Association held, among other things, an extensive public participation: the development trends shown and their importance for the future development of the land use and settlement structure were a key topic in this participation. Many citizens have dealt with these questions in different ways. The ongoing pressure for growth in the association area is understandable for many people. However, the public is very concerned about how this should be dealt with and what long-term effects this could have on the existing character of the association area. Although a wide variety of statements were made, there were a few topics that were mentioned comparatively frequently. Accordingly, the main results for the entire planning area can be summarised as follows:

- Preserve the settlement structure and do not designate larger building areas (123 statements)
- Take into account demand pressure for living space and provide space for housing construction (97 statements)
- Increased exploitation of potential in existing settlements (36 statements)

The conflict of objectives between preserving established settlement structures, protecting open spaces and the desire for more living space also becomes clear as a result of the public participation. It is obvious that these objectives cannot be easily reconciled. The current land use plan is based on a detailed examination of all possible building areas and, with

its settlement development concept, now ensures the most compatible and sustainable settlement development possible, also in the sense of the summarised results of the public participation.

3.3.2 Inter-municipal cooperation on housing construction

In addition to the formal land use planning, the 18 member municipalities of the Neighbourhood Association also work together informally on space-saving concepts for housing construction. This goes back to a policy decision in 2018.

During the 2010s, demand for housing in the region increased significantly and led to considerable tension in the housing market. This development was not expected in this form and was only gradually noticed. At the beginning of the 2010s the Statistical Office of Baden-Württemberg expected the population in the area of the neighbourhood association to reduce by 4.5 percent by 2030. Now it is beyond dispute that there will also be a significant increase in the population in the medium to long term and that demand for housing is expected to remain high. In recent years in particular, it has become increasingly difficult for large sections of the population to find living space.

The aforementioned framework conditions in the association area between settlement pressure and protection of open spaces mean that more compact structures should be aimed for, as these provide living space for more people and demand groups and make a significantly greater contribution to sustainable and long-term settlement development.

In this context, the Neighbourhood Association has prepared the study 'Housing construction in the Heidelberg-Mannheim Neighbourhood Association 2005-2021 – An analytical view and prospects for future housing construction'. In particular, urban development and the structural densities of residential area developments were surveyed and specific adjustment measures for space-saving settlement concepts were derived. The study was presented as an information paper to the Association Meeting of the Neighbourhood Association in March 2022 and was presented by the Association Administration to the local committees of the member municipalities. The common goal of the member municipalities is to achieve denser settlement structures in housing construction.

Project 'Regional control of settlement and open space development'

Building on this preparatory work, the Neighbourhood Association is implementing a model project funded by the Federal Ministry of Housing, Urban Development and Construction (BMWBS) and the Federal Institute for Building, Urban and Spatial Research in the period from 2023 to 2025 in cooperation with the Rhine-Neckar Region Association of spatial planning (MO-RO) 'Regional control of settlement and open space development'. The aim of the two associations' model project is to bring space-saving settlement concepts as close as possible to municipal decision-making processes. In particular, new residential areas in the model region should be designed to be more compact and more space-saving in the future.

Figure 3.4: Mannheim – Franklin Mitte

Source: Heidelberg-Mannheim Neighbourhood Association

3.3.3 'Living Neckar' landscape development project

In addition to the questions of structural development, it is also about the qualification of open spaces. The Heidelberg-Mannheim Neighbourhood Association is responsible for landscape planning for its 18 member municipalities. The landscape plan specifies in particular the goals of nature conservation and landscape management. The legal basis is provided by the Federal Nature Conservation Act (section 9 BNatschG ff.) and the Nature Conservation Act of Baden-Württemberg (section 10 NatschG ff).

In addition to landscape planning, the Neighbourhood Association has set itself the goal of visibly developing selected landscape areas. For this purpose, various cross-district landscape development projects were launched to improve the environment and local recreation facilities.

Importance of leisure space

The landscape development projects were initiated because the landscape plan proved to be unsuitable on its own for visibly developing nature and the landscape. The goals were not implemented sufficiently and, above all, were not implemented coherently. At the same time, there was increasing awareness of the growing importance of open space for local recreation and the attractiveness of the region as a whole. This is how the idea of moving from landscape planning to landscape development came about in the mid-1990s. The Neckar between Heidelberg and Mannheim is the central, natural axis in the Neighbourhood Association and was an obvious choice for landscape and environmental improvements.

Although the river landscape on the Lower Neckar is characterised by particularly densely populated settlement areas, the Neckar had for years played almost no role in the public consciousness. Twenty years ago it was hardly integrated into the open space and settlement structure and was primarily used as an infrastructure route for shipping and water drainage. The population had virtually no access to the water, because the

Figure 3.5: Edingen-Neckarhausen fish nursery

Source: Heidelberg-Mannheim Neighbourhood Association

stone-fill embankment formed a barrier and the water was considered dirty and contaminated with pollutants anyway.

In 1996, the 'Living Neckar' landscape development project was launched to develop the Neckar from Heidelberg to Mannheim in the long term into a twenty-kilometre-long blue-green belt for nature and local recreation. The Neighbourhood Association was one of the first initiatives in the state to take on the topic of 'Neckar'.

Since then, with the support of the Neighbourhood Association, 18 measures have been implemented with funding totalling EUR 6.3 million. New accesses to the river, environmentally valuable shallow water zones, habitats for fry and beavers as well as natural local recreation facilities for the population were created. In addition, there were awareness-raising measures such as the 'Schools for a Living Neckar' project. At state level, the Neighbourhood Association plays an active part in the state initiative 'Our Neckar' from the source to the mouth.

Anna George is a consultant for land and settlement development at the Neighbourhood Association Heidelberg-Mannheim.
✉ Anna.George@mannheim.de

Martin Müller is the managing director of the Heidelberg-Mannheim Neighbourhood Association.
✉
Martin.Mueller@mannheim.de

Part II

New Data and Methods

4 Crowdsourcing Data on Air Quality in Cities

Tobias Link

4.1 Introduction

Air pollutants are bad for health, especially the respiratory tract, cardiovascular system and metabolism, and they also damage child development. In mid-September 2023, the majority of the European Parliament voted for stricter limit and target values for various pollutants, including fine dust, nitrogen dioxide, sulphur dioxide and ozone. This should improve air quality, and at the same time additional measuring stations should take air samples (see European Parliament 2023[1]). The requirement of at least one measuring point per two million residents in urban areas, or one per million residents in places with high concentrations of air pollutants, does not seem particularly groundbreaking. In Germany, this requirement is generally exceeded by the data from the measuring networks of the federal states and the Federal Environment Agency. However, it is far from guaranteed that the quality of the air is monitored adequately. An article in the Urban Audit Brochure 2019 promoted the use of crowd data for urban climate issues in order to close gaps in certified measuring stations in cities (see Barron 2019[2], 51-52). A brochure from the Federal Environment Agency shows that the possibilities and limits as well as information on the use of sensors to measure air pollutants. Air quality sensors (AQS) can therefore be used, among other things, for supplementary monitoring, for trend analysis, for characterising emission sources and monitoring the effects on areas near sources as well as for identifying local pollution hotspots (see Schneider et al. 2023[3], 22-23). Citizen science projects, as a form of open science in

Range of air pollutants

Air quality monitoring

Crowd data for urban climate issues

Citizen science projects

[1] European Parliament, 2023: Air pollution: MEPs want stricter limits to achieve zero pollution by 2050. In: Press release 20230911|PR04915. Available at https://www.europarl.europa.eu/news/en/press-room/20230911IPR04915/air-pollution-meps-want-stricter-limits-to-achieve-zero-pollution-by-2050.

[2] Barron, Christopher, 2019: Mannheim, the university city: Using crowd data for examining the urban climate. In: KOSIS Association Urban Audit (publisher): The German Urban Audit. Quality of Life: Establishing New Data Sources. Available at https://www.staedtestatistik.de/fileadmin/media/Kosis/Urban_Audit/PDF/Broschueren/UA_Broschuere_2019_eng_web.pdf.

[3] Schneider/Sauter/Venkatraman Jagatha/Vogt, Chacón Mateos, 2023: Sensoren zur Messung von Luftschadstoffen: Möglichkeiten und Grenzen sowie Hinweise zu deren Einsatz. Umweltbundesamt, Texte 77/2023. Available at https://www.umweltbundesamt.de/sites/default/files/medien/11850/publikationen/77_2023_texte_sensoren_zur_messung_von_luftschadstoffen.pdf.

which data is collected, observed and assessed with the help of interested, trained laypeople, can significantly increase the amount of air quality data available: 'This is important particularly for areas away from state measuring points or in areas where the spatial and temporal heterogeneity of air quality is high, for example in cities, commercial areas and in areas with great topographical variability' (see Schneider et al. 2023, 22). The limitations of the use of AQS lie in particular in poorer quality measurements in the event of rapid changes in relative humidity and temperature, the limited lifespan and the power requirements of the sensors, the need to calibrate the measurements to a reference and the use by people without specialist knowledge (see Schneider et al. 2023, 26).

In this article the air quality data from the citizen science project Sensor.Community for eleven selected German Urban Audit cities will be assessed and compared with those from official measuring stations. The focus here is initially on fine dust, where a distinction is made between different particle size ranges. For reasons of data availability, in this article the inhalable coarse dust with a particle diameter between 2.5 and 10 µm (PM10, see German Weather Service 2017[4], 5) is assessed. Since many AQS do not consistently provide measured values, a comparatively short observation period of two months, namely January and February 2023, was chosen. In the next section, the data export procedure is described in detail before the results are briefly presented and a conclusion is drawn.

4.2 Procedure

Big data in the form of sensor-generated data

Data on air quality is collected automatically using measuring stations set up at different locations that are equipped with appropriate sensors. It can therefore be classified within the realm of big data as sensor-generated data that can be accessed via the Internet using an Application Programming Interface (API). Every major provider has combined the sensors in their measuring stations to form a sensor network and offers access to their data via their own API. In Germany, these include the Federal Environment Agency[5] (487 stations) and the European Environment Agency[6], which integrates the sensors of the large state providers into its network along with some of its own (54 own stations). There are also regional actors such as the State Office for the Environment of Baden-Württemberg[7] (LUBW, 47 stations).

Sensor networks

The average quality of the technical infrastructure and the costs for the sensor hardware have now reached a level where interested private individuals can also buy the appropriate components for their own meas-

[4] Deutscher Wetterdienst, 2017: Messen – Bewerten – Beraten: Luftqualität unter der Lupe. Available at https://www.dwd.de/SharedDocs/broschueren/DE/medizin/broschuere_luftqualitaet.pdf?__blob=publicationFile&v=2.
[5] https://luftqualitaet.api.bund.dev
[6] https://www.eea.europa.eu/en/datahub/datahubitem-view/778ef9f5-6293-4846-badd-56a29c70880d
[7] https://www.lubw.baden-wuerttemberg.de/luft/messwerte-immissionswerte#karte

uring station and assemble them themselves. The citizen science platform Sensor.Community is an association of private individuals who network their self-built measuring stations with each other and enable access via a public API[8]. In addition, instructions on how to build own measuring stations and links to recommendations for the right sensor hardware to purchase are provided. Over time, a privately operated sensor network has developed, the size of which (over 17,000 locations in the data set as at 30/10/2023) far exceeds that of the large official providers (see Figure 4.1).

Sensor.community

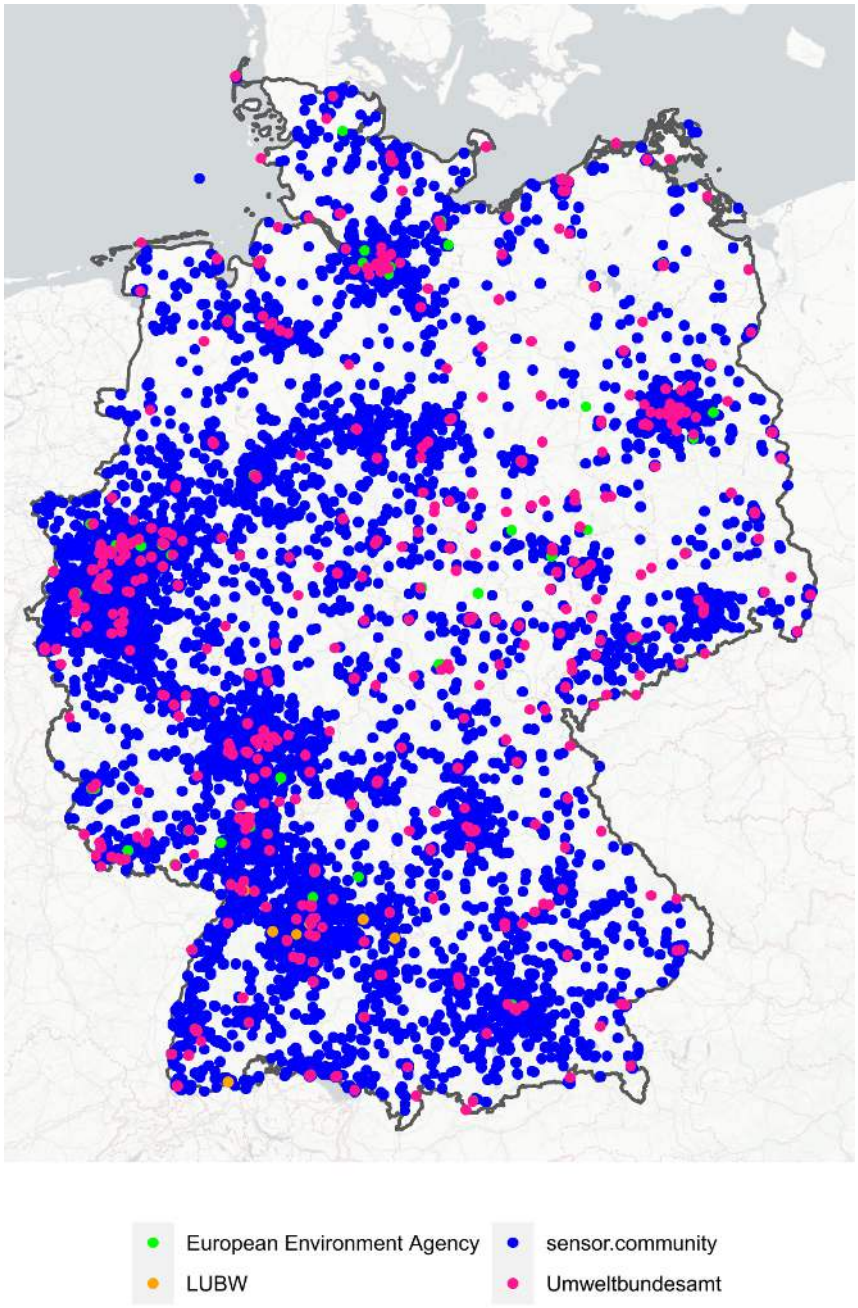


Figure 4.1: Air measuring stations in Germany by network affiliation

Source: Open Sensor Web (https://www.opensensorweb.de)

In order to enable a comparison of the data from the individual providers,

[8] https://github.com/opendata-stuttgart/meta/wiki/APIs

the data would have to be exported and merged using the respective API in the same temporal resolution. Since each API has different syntactic address requirements and the data has to be requested separately for each sensor, this is a very complex procedure. It is easier to access the data via a service provider who abstracts the different APIs via its own uniform interface and thus enables access via uniform syntactic rules. The startup PIKOBYTES has created such a product with the Open Sensor Web platform, which combines global sensor data from open data networks on a wide range of environmental issues. In this way, the air quality data from the Federal Environment Agency, the European Environment Agency, the State Office for the Environment of Baden-Württemberg and also the data from the Sensor.Community can be exported via a uniform interface.

Access via a uniform interface

In order to keep the complexity of the following assessments within reasonable limits for an initial test of this data, the following restrictions should apply. Only the data from the aforementioned measuring networks (Federal Environment Agency, European Environmental Agency, LUBW and Sensor.Community) is considered, i.e. other smaller providers, such as 'Stadtklima Heidelberg', which are also represented on the Open Sensor Web platform, should not be considered. Since the sensors of the measuring stations, despite the uniform interface via Open Sensor Web, each have to be addressed in a way that is specific to the respective network, only measured values for fine dust with particle size PM10 will be discussed in the following, since the sensor for PM10 measurement seems to be the most common among the sensors in the Sensor.Community when it comes to air pollution. Many sensors only measure air humidity, air pressure, air temperature or other measured values. As a result, particularly given the large number of sensors in the Sensor.Community network, a very high proportion is not included in the later analysis.

Restrictions

As a first step, the data from the measuring stations of the European Environment Agency, which overlap with the measuring stations of the Federal Environment Agency, is cleansed from the exported information on the German measuring stations. Next, the point coordinates of the measuring stations required for cartographic representation and calculation of spatial proximity are exported via the API. Buffer geometries are then calculated for all official measuring stations of the Federal Environment Agency, the European Environmental Agency and the State Office for the Environment of Baden-Württemberg that cover a radius of 500 meters around the respective measuring station. All measuring stations in the Sensor.Community that fall within this radius should be used as potential suppliers of comparative measurement data. The radius was chosen based on pragmatic considerations in order to obtain a sufficient number of comparison measurements. When interpreting the measured values, it must of course be taken into account that the concentration of pollutants in the air decreases with increasing distance, especially from an emission generator such as traffic.

Analysis steps

The corresponding measuring stations are then assigned to each city to be examined and their sensors are examined with regard to the collection of PM10 measurement data. If a PM10 sensor is available, the measurement

Assignment to the individual cities

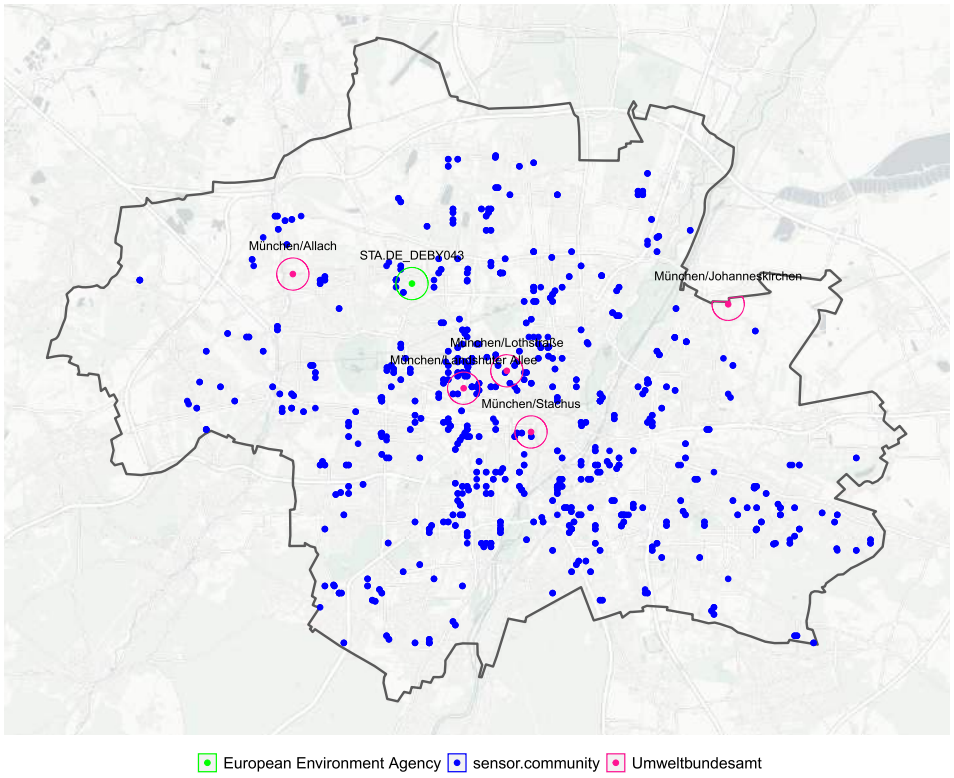


Figure 4.2: Official and private air quality measuring stations of the city of Munich

Source: Open Sensor Web (https://www.opensensorweb.de)

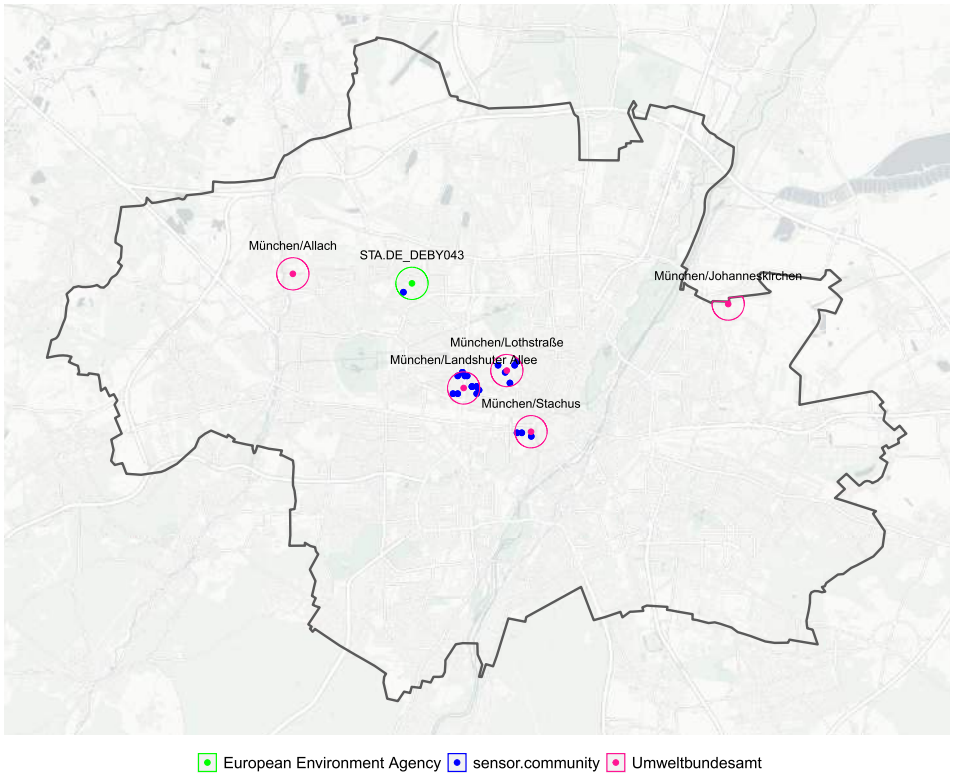


Figure 4.3: Private air quality sensors in the city of Munich within 500m of official measuring stations

Source: Open Sensor Web (https://www.opensensorweb.de)

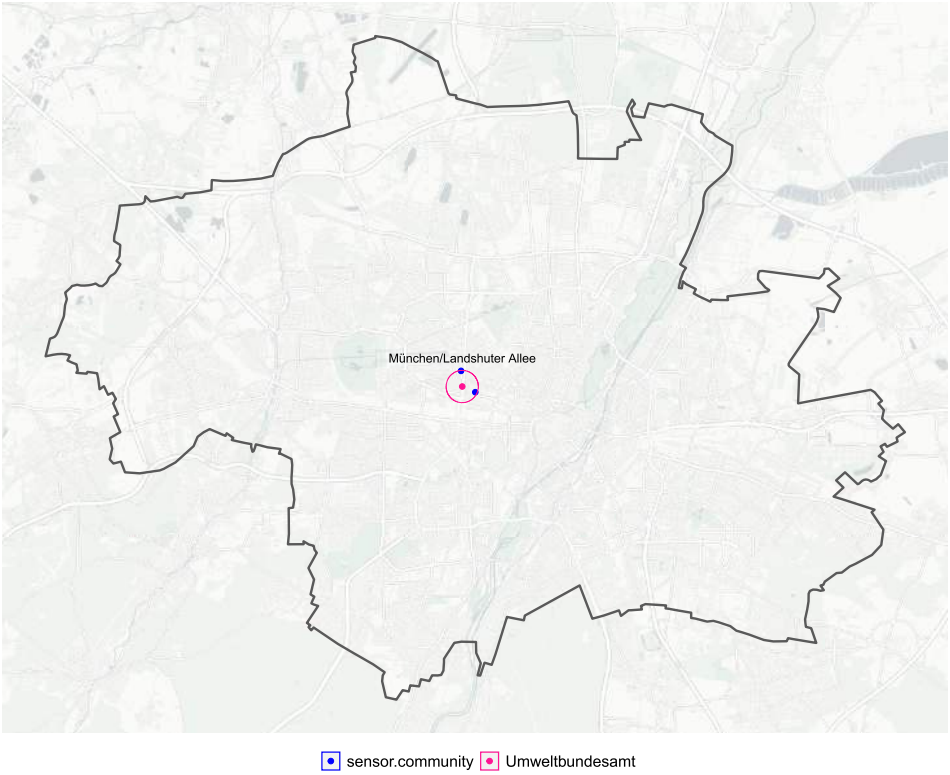


Figure 4.4: Private and official air quality measuring points finally selected for the comparison

Source: Open Sensor Web (https://www.opensensorweb.de)

data for the period January to February 2023 is exported in the temporal resolution of daily average values and merged in one data set. Implausibly high measured values (PM10 > 150) as well as measurement time series that cover less than 90 percent of the observed period are not considered (implausibly low values are retained for demonstration purposes as they do not hinder the representation in diagram form). Measuring stations that provide no or implausibly high PM10 values or that have incomplete time series are removed from the respective city data set and the remaining options for measurement data comparisons are examined. Finally, the time series of values are displayed in line charts so that the differences between official and unofficial measurement data can be determined visually.

Example of Munich

In Figures 4.2, 4.3 and 4.4, using the example of Munich, it becomes clear how the number of originally available AQS on the Sensor.Community platform is reduced by the chosen question and the methodological guidelines and finally how the comparison to an official measuring station is chosen. A high proportion of the sensors in the the Sensor.Community are not included because no data is available for the period selected or they should not be included after the carrying out of consistency checks. This means that no comparisons can be made for many official measurement locations, although measurement time series would be available. Perhaps increasing the radius around the official measuring stations would improve the situation, but at 500 meters, a fairly generous compromise has already been made with regard to comparability.

4.3 Results

In the charts below, the fine dust pollution in the selected cities in the selected period for the official measuring stations and the private AQS within a radius of 500m are shown.

The AQS in the area around the official measuring stations Berlin/Karl-Marx-Straße II, Berlin Neukölln, Berlin Silbersteinstraße, Berlin Wedding, Braunschweig-Verkehr, Bremen-Oslebshausen, Kiel-Bremerskamp, Mainz and Stuttgart Bad Cannstatt are very close to the official measurements in terms of the absolute level and trend of pollutant emissions.

The AQS around the official Berlin Schildhornstrasse measuring station are characterised by very high positive and negative deviations from the reference, which then balance out again on average. One AQS is effectively a total failure, with a similar picture for one sensor around the measuring station Leipzig/Lützener Straße and one sensor around the measuring station Nuremberg/Von-der-Tann-Straße.

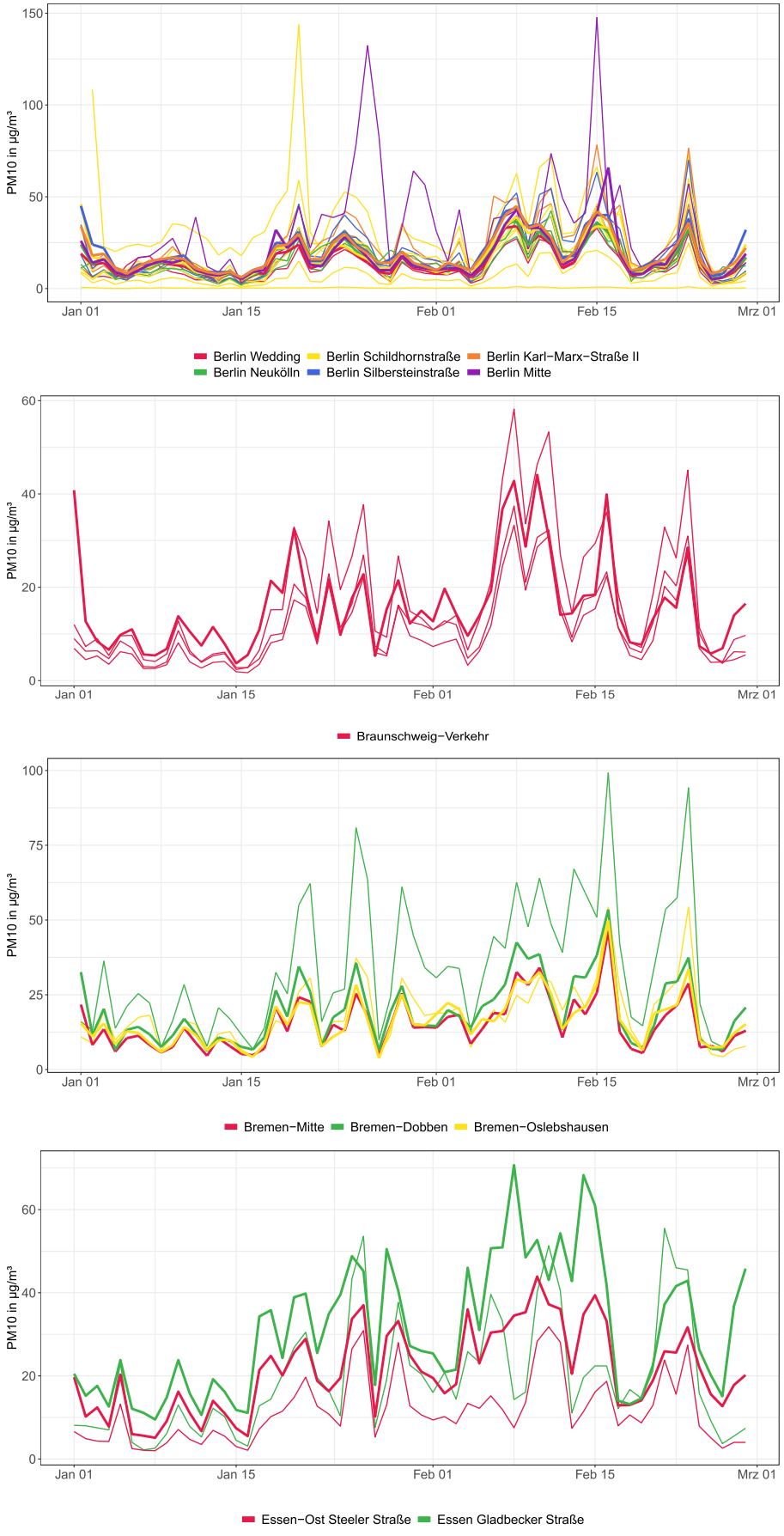
One AQS near each of the official measuring stations Berlin-Mitte, Bremen-Mitte and Bremen-Dobben shows significantly higher values and peaks than the official measurements; around the official measuring stations Essen-Ost/Steeler Straße, Essen/Gladbecker Straße, Mannheim/Friedrichsring, Munich/Landshuter Allee, Stuttgart/Am Neckartor and Stuttgart/Arnulf-Klett-Platz, the opposite picture emerges, with values and peaks tending to be lower.

Table 4.1: Deviations of private AQS from the average values

	Average PM10 pollution in µg/m³ in January and February 2023		Deviation of the private AQS measured values from the official measured values	
Name of the official measuring station	Official measuring station	Private AQS within 500m	Absolute	Percentage
Berlin Karl-Marx-Straße II	19.2	20.3	+1,2	+6,1
Berlin Mitte	17.6	33.2	+15,6	+88,8
Berlin Neukölln	16.1	16.3	+0,2	+1,1
Berlin Schildhornstraße	17.2	18.3	+1,1	+6,2
Berlin Silbersteinstraße	19.9	18.5	-1,4	-7,1
Berlin Wedding	14.8	12.0	-2,8	-18,9
Braunschweig-Verkehr	16.2	13.6	-2,6	-16,1
Bremen-Dobben	19.5	33.9	+14,3	+73,6
Bremen-Mitte	15.1	33.9	+18,7	+124,0
Bremen-Oslebshausen	16.2	18.2	+2,0	+12,5
Essen Gladbecker Straße	31.1	19.4	-11,7	-37,6
Essen-Ost Steeler Straße	21.2	11.4	-9,8	-46,3
Kiel-Bremerskamp	13.5	12.9	-0,5	-4,0
Leipzig Lützner Str.	16.5	15.2	-1,3	-8,0
Mainz-Parcusstraße	17.2	14.0	-3,2	-18,7
Mannheim Friedrichsring	18.9	12.3	-6,6	-34,9
München/Landsh. Allee	24.3	11.4	-12,9	-53,0
Stuttgart Am Neckartor	21.3	11.1	-10,2	-47,8
Stuttgart Arnulf-Klett-Platz	22.6	10.7	-11,9	-52,5
Stuttgart-Bad Cannstatt	16.5	13.7	-2,8	-16,9
Average	**18.7**	**16.7**	**-2,1**	**-11,1**

Figure 4.5: PM10 measured values from the sensor stations considered in the individual cities, part 1

Source: Open Sensor Web (https://www.opensensorweb.de)



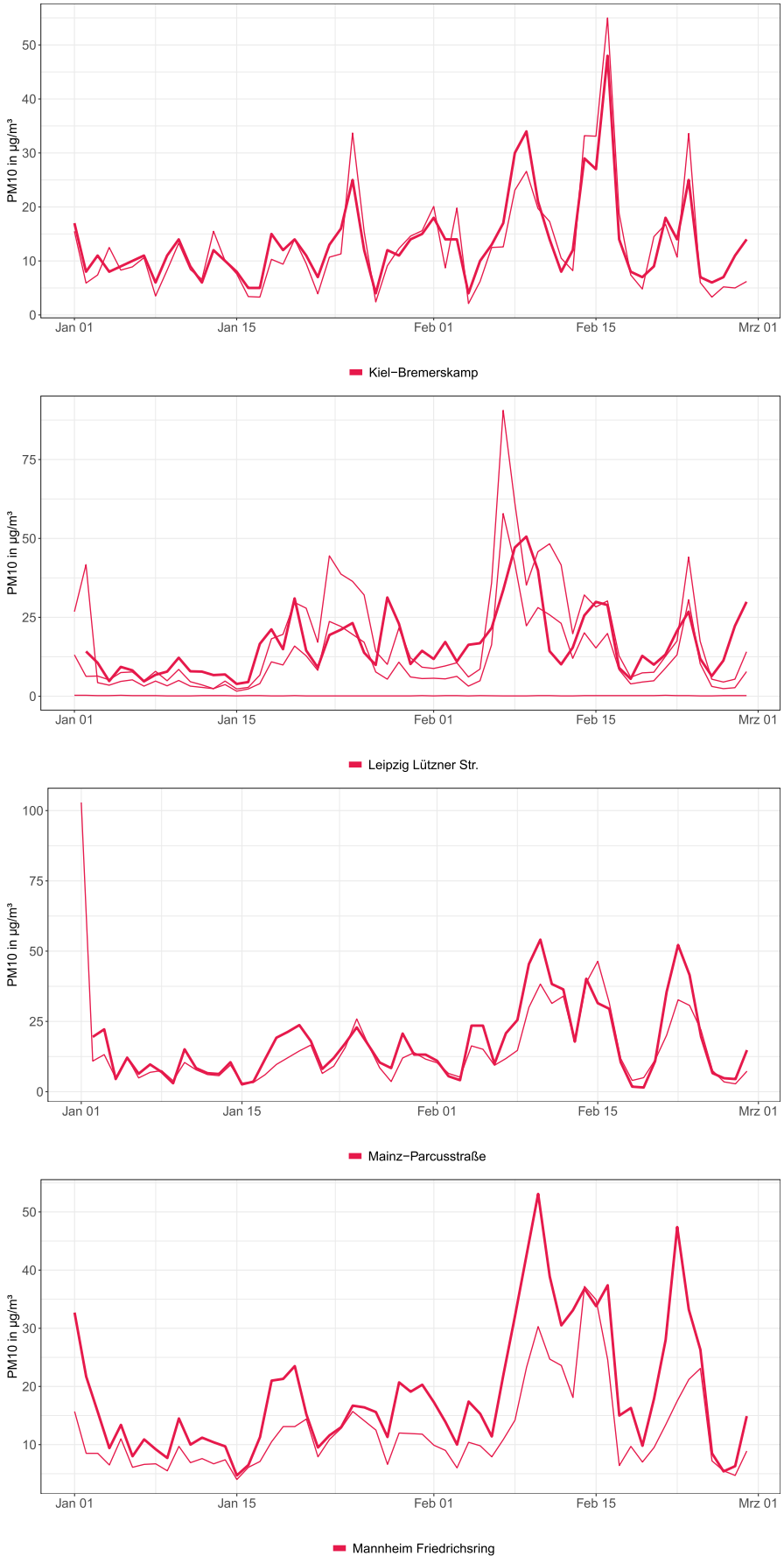


Figure 4.6: PM10 measured values from the sensor stations considered in the individual cities, part 2

Source: Open Sensor Web (https://www.opensensorweb.de)

Figure 4.7: PM10 measured values from the sensor stations considered in the individual cities, part 3

Source: Open Sensor Web (https://www.opensensorweb.de)

Table 4.1 lists the 20 official measuring stations in the vicinity of which there are private AQS with valid measurements (the three AQS that can be classified as effectively total failures based on their measured values are excluded).

Deviations and tendency

The results should be interpreted very carefully due to their strong aggregation. However, the values of the private AQS tend to be lower than those of the official measuring stations, with the exceptions mentioned above of course. Despite the requirements to be met when choosing private air

quality sensors for the comparative analysis, there are sometimes relatively large (absolute and percentage) deviations in the aggregated absolute measured values.

4.4 Conclusion

The global sensor network Sensor.Community that is operated by many contributors comprises between 12,000 and 13,000 daily active sensors in more than 70 countries worldwide. The number of registered measuring stations is estimated to be many times higher this and is a reflection of a key characteristic of the network, namely the greatly fluctuating availability of the individual sensors. This is not comparable with the sensors of the Federal Environment Agency, with the result that it is difficult to map consistent measurement time series with individual sensors. In Germany, one of the countries most densely populated with AQS, the participation of private individuals in the community is particularly high, with the result that a large proportion of the registered sensors can be found here. Only a fraction of these were usable for this analysis, also due to the specific question. Even in large cities such as Munich, Nuremberg and Dresden, there were practically no private sensors left for comparison with official measuring stations.

Uncertain data situation

The comparison of the measurements of the AQS of the citizen science project Sensor.Community with those of official measuring stations confirms the recommendation of the Federal Environment Agency to use them for supplementary monitoring and trend analyses. It is pleasing that the measured values of the AQS tended to be lower than those of the official stations. With this knowledge in the background, more extensive assessments could of course be carried out, without restriction to AQS that are comparable to official measuring stations due to their geographical location.

Supplementary monitoring and trend analyses

Even if the sensor density is much lower in this area, the approach chosen here could ultimately also be applied to the noise data that is also provided by the sensor network Sensor.Community.

Tobias Link is the executive secretary of the managing office for the KOSIS Association Urban Audit.
✉ urbanaudit@mannheim.de

5 Investigation of multiple environmental pollution based on the results of the Darmstadt Citizen Survey 2023

Dr. Jan Dohnke and Dr. Jan-Philipp Starcke

5.1 Introduction – Environmental justice as a new topic in statistics

There is an uneven distrubution of environmental polllution such as noise and air pollution in cities. As a result of climate change, other problems such as heat stress are also becoming increasingly important. Particularly in quarters where social problems are more common, not only are there more health issues caused by environmental problems, but there is also often a lack of environmental resources such as public green spaces to counterbalance these (see Krautzberger 2019[1], p.15). Health and social problems increasingly overlap in certain quarters, to the detriment of the local population (see Böhme et al. 2022[2], p.8ff.). But there are also interdependencies at individual level between social status on the one hand and increased environmental impact of noise, air pollutants and heat on the other (ibid., pp. 13f.).

Environmental justice

Building on the environmental justice approach, in recent years focus has been placed on the social and socio-spatial distribution of health-relevant environmental pollution. Various studies and monitoring projects have identified on a small-area level concentrations of various environmental pollution and social problems. In this way, these studies create a basis for reducing multiple health-relevant environmental pollutions in socially disadvantaged quarters and - regardless of social status or income – improving access to health-promoting resources (SenUVK 2019, SenUMVK 2022, Böhme et al. 2022[3]).

[1] Krautzberger (2019) in: [SenUVK 2019] Senate Department for the Environment, Mobility, Consumer and Climate Protection (2019): Basic report on environmental justice. Basics for socio-spatial environmental policy.

[2] Böhme et al. (2022): Environmental Justice Dialogue Forum – Common perspectives for federal, state and municipal authorities.

[3] [SENUVK 2022] Senate Department for the Environment, Mobility, Consumer and Climate Protection(2022): The city with environmental justice. Environmental Justice Atlas update 2021/22.

In the science city of Darmstadt, there are efforts to develop a monitoring system that can be used to observe the clustering of environmental pollution on a small-area level. This is happening against the background of the gathering pace of climate change, which requires appropriate climate adaptation measures. For example, in the Upper Rhine Rift the number of summer days and hot days[4] has increased noticeably in recent years (see Dohnke statistics on climate change and illustration, if applicable). Between June 2022 and August 2022, for example, 77 out of 92 days were summer days (83.7%), of which more than half were hot days (39 out of 77).

At municipal level, instruments such as the Berlin Environmental Justice Atlas (SenUVK 2019) provide a good starting point for municipal statistics to develop comparable indicator-based instruments. What all of these approaches have in common is that they take environmental pollution into account with the help of space-based indicators, such as external noise costs aggregated at quarter level or the provision of green and open spaces, for the purpose of city-wide comparability. However, the operationalisation of these indicators on a small-area level requires the existence of corresponding data bases at quarter level.

In contrast to this, an attempt is made below to use subjective assessments of environmental pollution, which were obtained in the Darmstadt Citizen Survey conducted in the summer of 2023, to identify multiple environmental pollution. Surveys are conducted regularly in many municipalities and could – if the questionnaire is adapted – be a potential source of data for determining environmental pollution.

The following questions should therefore be discussed below based on the data obtained:

- To what extent is multiple environmental pollution and overlapping of environmental pollution evident in Darmstadt? Is there a correlation with social problems?
- What importance do age and income have, in addition to spatial location, for the subjective perception of environmental pollution?
- Does the increased perception of being affected by environmental pollution result in motivation to act for more climate protection/climate adaptation?

5.2 The General Citizen Survey on the Quality of Life in Darmstadt 2023 and its use

The basis of this article is provided by the General Citizen Survey on the Quality of Life in Darmstadt 2023, which was conducted by the Statistics and Urban Research Department in the Office for Economics and Urban

[4] Summer days are days when the maximum daily temperature exceeds 25 degrees Celsius. On hot days, the maximum daily temperature is at least 30 degrees Celsius.

Development. In addition to many other topics[5], the questionnaire also contains questions about various environmental pollution factors (noise, heat, etc.) as well as attitudes and behaviour in relation to climate and the environment.

Sample

The Citizen Survey was conducted over a period of five weeks in the summer of 2023. The population of the survey was all residents between the ages of 18 and 84 who have their main residence in Darmstadt. A total of 10,242 people were randomly drawn from the register of registered residents and were asked to take part in the survey by letter sent by post. Participation was primarily online, a paper questionnaire could be requested on demand ('online first – paper on demand'). An individual access code[6] on the cover letter was used to ensure that each person written to could only take part in the survey once.

After deducting undeliverable first letters, the response rate was 25%; of the respondents, 2,289 participated online and 149 participated via paper questionnaires (2,438 people in total). However, due to non-responses to individual questions, the number of cases actually considered in the following assessments is sometimes lower. With regard to the socio-demographic characteristics of the respondents, the resulting sample has a high goodness of fit to the underlying population. Nevertheless, there are slight distortions in the response regarding individual characteristics. Where the target structure of the population is known from official statistics, the distortions in the sample were balanced out by weighting the survey data (here: by age group, gender, nationality and district). The assessments in this article refer to the weighted and subsequently plausibility-checked data.

Methodology

To answer the questions asked at the beginning, the scales were assigned values to determine subjectively perceived environmental pollution in order to be able to calculate average values and differentiate them by age, net equivalent income and district. In order to achieve uniform results, information on ordinal scales with four fields were transposed to values on an ordinal scale with five fields. In order to determine and classify multiple environmental pollution, an index value was formed from the average values of the individual types of environmental pollution.

In order to determine the correlation between the increased perception of being affected by environmental pollution and the resulting motivation to act, the responses to other questions were made comparable by averaging and then indexed for better correlation. Using this procedure, in addition to an index value for multiple environmental pollution, index values for 'concerns about the climate and the environment,' 'adjustment of the city's spending budget,' and 'climate protection-related behaviour' were created and correlated with each other.

[5] Among other things, the quality of life, urban development, living situation, transport mobility and the city's range of services.

[6] The access code was the same as the questionnaire number.

5.3 Perception of environmental pollution and resources

Perception of noise

All respondents to the Citizen Survey were asked to indicate the extent to which they perceive noise in their living environment. They could respond on a scale from 1 (no perception) to 5 (very strong perception). In addition to the question of the perception of 'noise in general', they were asked about different sources of noise (road traffic, rail traffic, air traffic, commerce/industry and passers-by/residents).

Overall, 23% of respondents indicated that they generally had a strong or very strong perception of noise. With regard to individual noise sources, only in the case of road traffic noise (27%) did more people indicate that they had a strong or very strong perception of this noise (see Fig. 5.1).

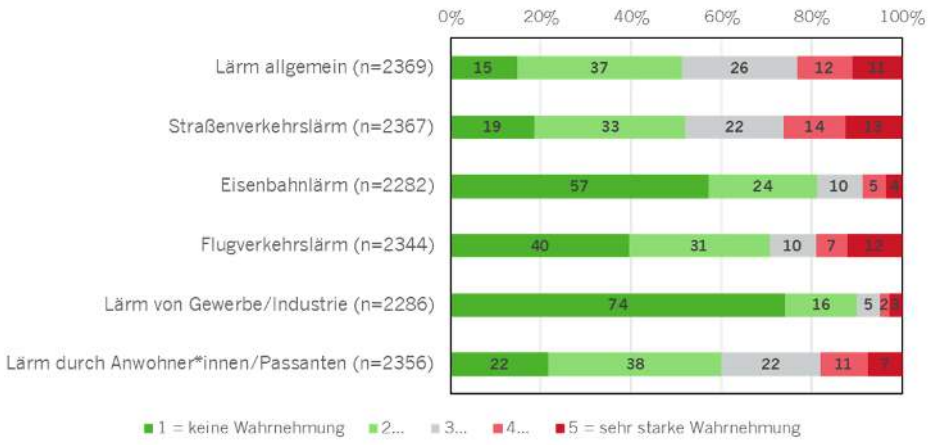


Figure 5.1: Perception of noise, differentiated by type of noise

Source: Darmstadt Citizen Survey 2023, own calculation

Differentiated by age and income, it can be seen that the perceived average noise pollution decreases slightly with increasing age. It can also be seen that as income increases, noise is perceived less strongly in the living environment or in other words: The wealthier or older someone is, the less noise there seems to be in the living environment (see Table 5.1).

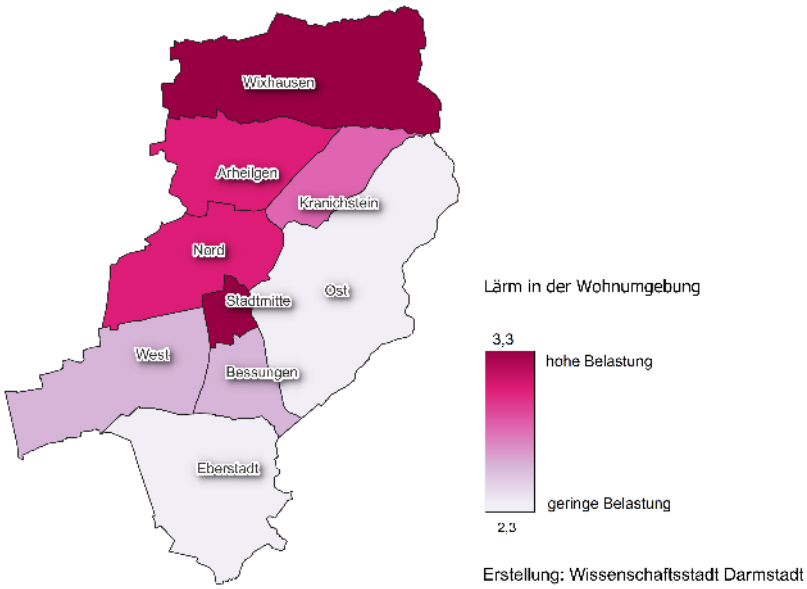
Differentiated by the nine districts of Darmstadt, a heterogeneous picture emerges (see Fig. 5.2): In the two northernmost districts of Arheilgen and in particular Wixhausen, the perceived noise pollution is comparatively high with values of 2.9 and 3.3 respectively. The same applies to the City Centre district and the North district, which is characterised by dense Gründerzeit quarters and industry. The other districts have comparatively low noise pollution. While the main reason in the northern districts is a departure path from Frankfurt Airport, in the City Centre and North the central location and structural density are the main reasons for noise pollution.

Table 5.1: Perception of noise in the living environment (average values), differentiated by age and income (Source: Darmstadt Citizen Survey 2023, own calculation)

Age (n=2,320)	Noise pollution (average value)	Net equivalent income (n=1,859)	Noise pollution (average value)
18-24 years	2.78	below 550 €	2.87
25-34 years	2.70	550 – 999 €	2.84
35-44 years	2.74	1000 – 1499 €	2.92
45-54 years	2.64	1500 – 1999 €	2.68
55-64 years	2.61	2000 – 2499 €	2.69
65-74 years	2.62	2500 – 2999 €	2.72
75-85 years	2.52	3000 – 3499 €	2.57
		3500 – 3999 €	2.54
		4000 € and more	2.36

Figure 5.2: Perception of noise, differentiated by district

Source: Darmstadt Citizen Survey 2023, own calculation



Perception of heat

The subjective perception of heat was determined by asking how strongly the respondents felt stressed by heat in their living environment when temperatures were persistently high in summer. 54% of respondents indicated severe or very severe stress, which corresponds to an average value of 3.56.

Heat stress

Similar to the perception of noise in the living environment, a gradient can also be seen in the case of stress by heat in the living environment when differentiated by age and income. Surprisingly, the perception of stress by heat is somewhat lower in the older age groups than in the younger age groups. One explanation for this could be that younger respondents tend to live in central locations where heat stress is higher due to the building density. What is less surprising, however, is that respondents with higher incomes perceive heat in their living environment to be less stressful. In Darmstadt, people with higher incomes live more often in leafy outskirts or hillside locations that are characterised by less soil sealing.

Table 5.2: Stress by heat in the living environment (average values), differentiated by age and income (source: Darmstadt Citizen Survey 2023, own calculation)

Age (n=2,346)	Heat stress (average value)	Net equivalent income (n=1,890)	Heat stress (average value)
18-24 years	3.64	below 550 €	3.91
25-34 years	3.74	550 – 999 €	3.58
35-44 years	3.54	1000 – 1499 €	3.67
45-54 years	3.38	1500 – 1999 €	3.66
55-64 years	3.53	2000 – 2499 €	3.64
65-74 years	3.50	2500 – 2999 €	3.52
75-85 years	3.39	3000 – 3499 €	3.49
		3500 – 3999 €	3.51
		4000 € and more	3.44

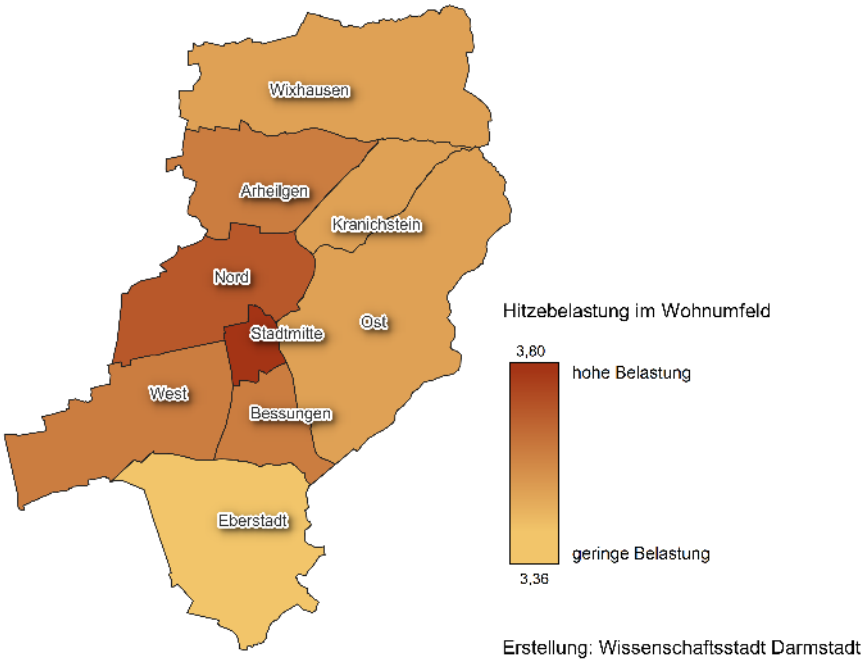


Figure 5.3: Stress by heat in the living environment, differentiated by district

Source: Darmstadt Citizen Survey 2023, own calculation

These assumptions are confirmed when the perceived heat stress is differentiated by district. The perceived heat stress is greatest in the high-density district City Centre district, followed by the North district, which is also characterised by dense Gründerzeit quarters. The perceived heat stress in the living environment is lowest in the outer districts, which have a much lower urban density and are characterised in some places by hillside locations (e.g. Eberstadt and East).

Perception of the cleanliness of the air

On a four-point scale, 30% of respondents rated the cleanliness of the air in their own living environment as rather poor or poor. This corresponds – transposed to the five-point scale used in the previous questions – to an average of 2.57. In contrast to the previous categories of noise and heat stress, the differentiation by age and income shows no apparent dir-

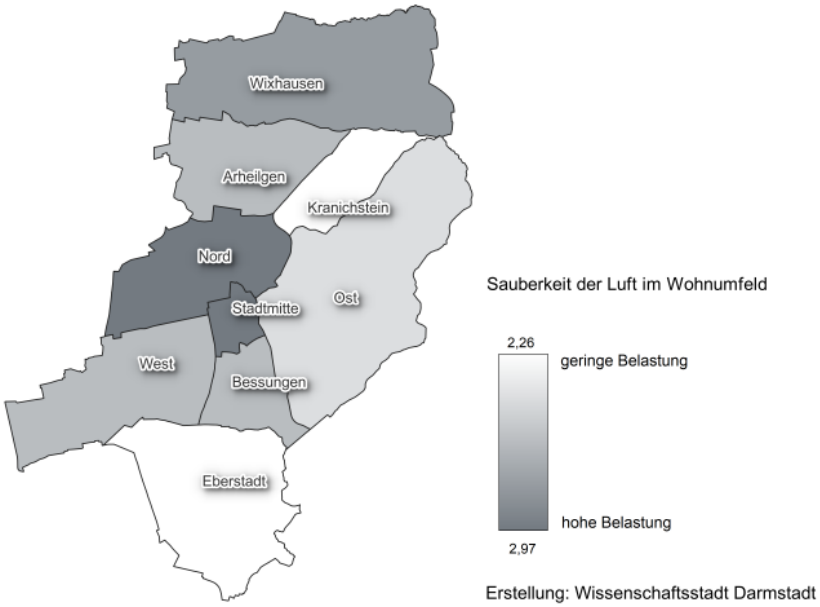
ect correlation between age or income on the one hand and the average perception of the cleanliness of the air in the living environment on the other.

Table 5.3: Perception of the cleanliness of the air in the living environment (average values), differentiated by age and income (source: Darmstadt Citizen Survey 2023, own calculation)

Age (n=2,250)	Cleanliness of the air (average value)	Net equivalent income (n=1,821)	Cleanliness of the air (average value)
18-24 years	2.58	below 550 €	2.49
25-34 years	2.53	550 – 999 €	2.40
35-44 years	2.61	1000 – 1499 €	2.62
45-54 years	2.52	1500 – 1999 €	2.64
55-64 years	2.57	2000 – 2499 €	2.61
65-74 years	2.67	2500 – 2999 €	2.60
75-85 years	2.64	3000 – 3499 €	2.56
		3500 – 3999 €	2.79
		4000 € and more	2.43

Figure 5.4: Perception of cleanliness of the air in the living environment, differentiated by district

Source: Darmstadt Citizen Survey 2023, own calculation



Environmental resource of green space

The picture produced by the differentiation by district is one that is partly expected. The perception of the cleanliness of the air is on average lowest in the central City Centre and North districts, and on average highest in the districts of Eberstadt, Kranichstein and Ost, which are on the outskirts or characterised by hillside locations. What is noticeable, however, is that the cleanliness of the air in the northern districts of Wixhausen and Arheilgen is rated comparatively poorly. The reason for this could be the location in the Rhine Plain, which, despite its peripheral location, results in a comparatively poor rating of air quality.

Perception of the offering of parks and green spaces in the living environment

Of the respondents, only 19% rated the offering of parks and green spaces

close to home as poor or rather poor. After adjusting the average value from the four-point scale used to a five-point scale, an average rating of 2.15 results. The differentiation by age produces a very homogeneous picture, differences between the individual age groups are marginal. The differentiation by income shows that the offering of parks and green spaces is rated better as income increases, which can certainly be seen as a result of the better offering of residential areas of higher-income population groups.

Table 5.4: Perception of the offering of parks and green spaces in the living environment (average values), differentiated by age and income (source: Darmstadt Citizen Survey 2023, own calculation)

Age (n=2,332)	Offering of parks and green spaces (average value)	Net equivalent income (n=1,874)	Offering of parks and green spaces (average value)
18-24 years	2.05	below 550 €	2.20
25-34 years	2.15	550 – 999 €	2.13
35-44 years	2.16	1000 – 1499 €	2.18
45-54 years	2.11	1500 – 1999 €	2.29
55-64 years	2.14	2000 – 2499 €	2.08
65-74 years	2.20	2500 – 2999 €	2.03
75-85 years	2.06	3000 – 3499 €	2.04
		3500 – 3999 €	2.03
		4000 € and more	1.94

The differentiation by district produces an in part surprising picture. The offering of parks and green spaces is rated as comparatively good in districts such as Bessungen or East, but also in central districts such as City Centre and North. In contrast, the rating in the two northern districts and the West district is comparatively poor. However, the last three districts are largely characterised by small-scale development with single and two-family houses, with a correspondingly high proportion of green spaces and, in some cases, short distances to the settlement border. The reason for the rather poor rating may be that the offering of public green spaces in the districts mentioned is rather limited. In the first-mentioned districts, however, the rating is comparatively good due to historical parks and, especially in central locations, a small proportion of private green spaces. However, an assessment of the environmental resource of green space would have to take into account both private and public or publicly accessible green spaces.

Multiple environmental pollution

If the results obtained are aggregated by adding the average values for the individual types of environmental pollution or environmental resource and then dividing them, it becomes apparent that income and the district in particular seem to play a role in the perception of environmental pollution and resources, the age of the respondents, on the other hand, less so (see Table 5.5).

The difference between the highest and lowest aggregated ratings between the different income groups and the districts is much more pronounced than between the individual age groups. In the income groups,

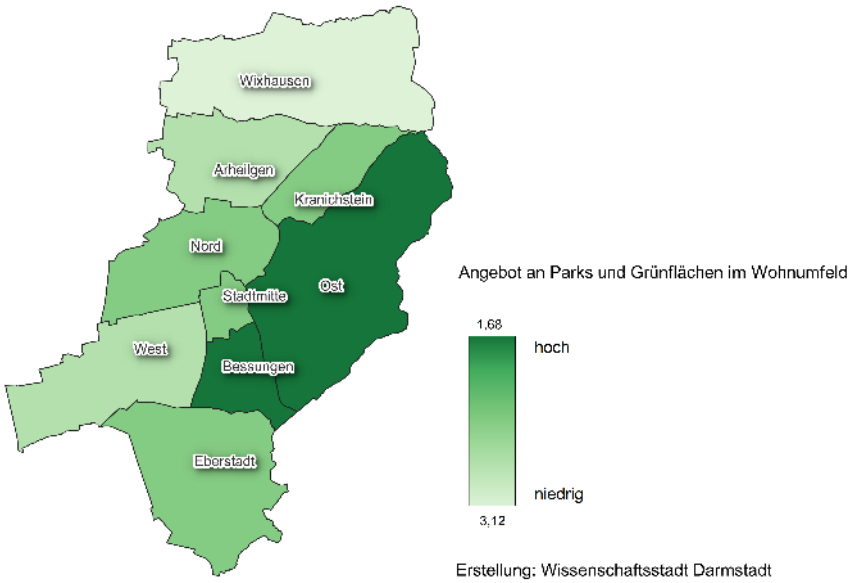


Figure 5.5: Perception of the offering of parks and green spaces in the living environment, differentiated by district

Source: Darmstadt Citizen Survey 2023, own calculation

there is also a slight decrease in multiple pollution as income increases. The differences between the districts also make it clear that the location in the city and the physical conditions play an important role.

Multiple environmental pollution and proportion of people entitled to SGB II benefits

However, a comparison of the results for multiple environmental pollution, which were obtained from the Darmstadt Citizen Survey, with the proportion of people entitled to SGB II benefits by reveals a different picture (see Fig. 5.6 and Table 5.5). In the comparatively wealthy districts of Bessungen and East, there is not only a low proportion of people entitled to SGB II benefits, but also comparatively low perceived multiple environmental pollution. In the Wixhausen district, where the perception of (aircraft) noise pollution and the perception of the offering of parks and green spaces is comparatively high or negative, there is the highest multiple environmental pollution, but a low proportion of people entitled to SGB II benefits. In contrast, the Kranichstein district, which is characterised by large residential areas, has a very high proportion of people entitled to SGB II benefits but a comparatively low multiple environmental pollution. This also partly applies to the Eberstadt district, which, in addition to the large Eberstadt-Süd housing estate, has one of the city's most upscale residential quarters on a hillside location, the so-called villa colony.

Perspectives on climate change and climate-protection-related behaviour

In addition, the questionnaire contains an item scale on attitudes towards changes in the climate and environment. For the assessments in this article, four items from the scale are used:

- 'Climate change will have an impact on my life.'
- 'It worries me when I think about the environmental conditions under which my children and grandchildren and subsequent generations are likely to live.'

Table 5.5: Multiple environmental pollution in the living environment, differentiated by age, income and district in Darmstadt (source: Darmstadt Citizen Survey 2023, own calculation)

Age	Assessment of multiple pollution	Net equivalent income	Assessment of multiple pollution	District	Assessment of multiple pollution
18-24 years	2.76	below 550 €	2.87	Stadtmitte	2.99
25-34 years	2.78	550 – 999 €	2.74	Nord	2.85
35-44 years	2.76	1000 – 1499 €	2.85	Ost	2.48
45-54 years	2.66	1500 – 1999 €	2.82	Bessungen	2.57
55-64 years	2.71	2000 – 2499 €	2.75	West	2.75
65-74 years	2.75	2500 – 2999 €	2.72	Arheilgen	2.82
75-85 years	2.65	3000 – 3499 €	2.67	Eberstadt	2.52
		3500 – 3999 €	2.72	Wixhausen	3.12
		4000 € and more	2.54	Kranichstein	2.60

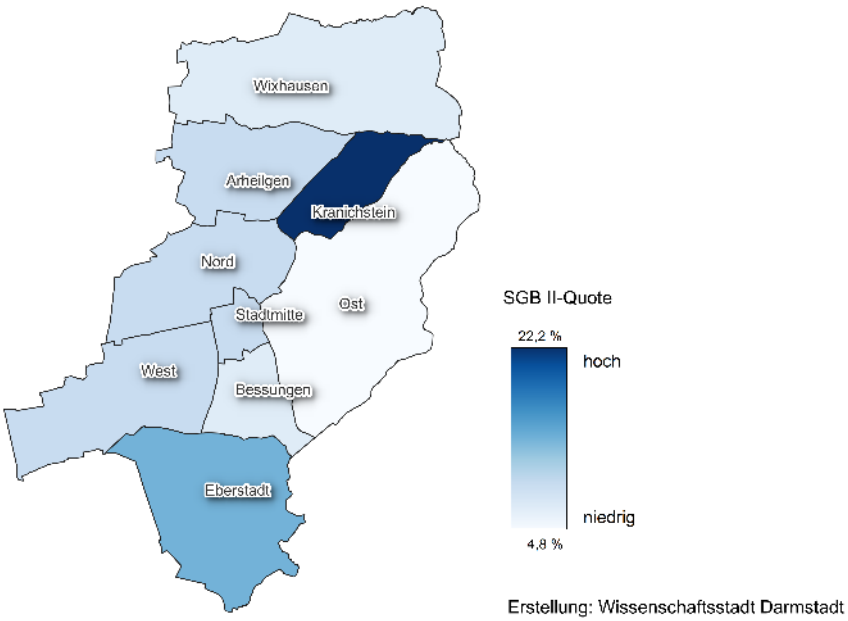


Figure 5.6: Proportion of people entitled to SGB II benefits, differentiated by district (date: 30.06.2023)

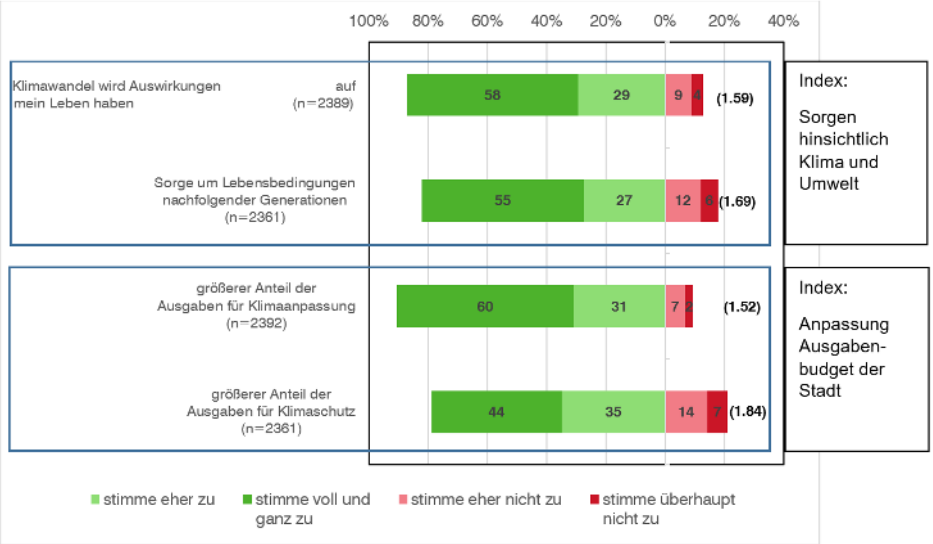
Source: Darmstadt Citizen Survey 2023, own calculation

- 'The city of Darmstadt should spend a larger proportion of its spending budget on climate adaptation measures (e.g. promotion of green and water areas in the city, unsealing areas).'
- 'The city of Darmstadt should spend a larger proportion of its spending budget on climate protection measures (e.g. solar power systems on public buildings, promoting e-cars).'

As shown in Figure 5.7, 87% at least tend to agree or agree entirely with the statement 'climate change will have an impact on my life'. At 82%, agreement was similarly high with the statement that they were worried about the living conditions of future generations. On the other hand, only a few respondents were not very concerned or not concerned at all about the effects of climatic changes.

Figure 5.7: Climate and environmental attitudes, (average values in brackets)

Source: Darmstadt Citizen Survey 2023, own calculation



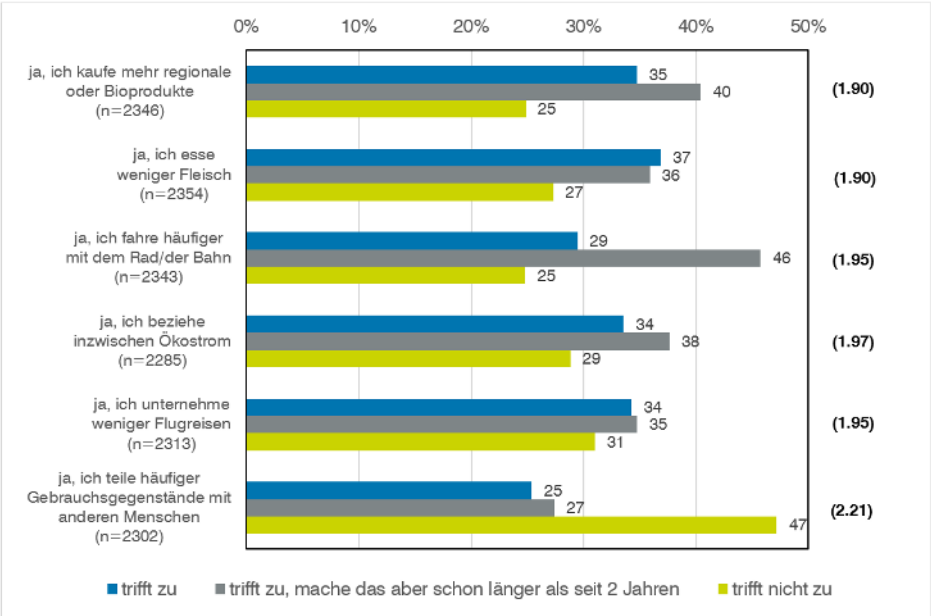
Necessity of climate measures

At 91%, the majority of respondents tend to agree or agree entirely with the statement that the city of Darmstadt should invest more money in climate adaptation measures. Resondents also tend to agree or agree entirely with more spending on climate protection measures, with 79% supporting this. For the correlative assessments, the first and last two scale items are each calculated into a separate mean index (see Figure 5.7):

- Concerns about the climate and environment (Cronbach's alpha consistency α = 0.81, Min = 1 / Max = 4, Mean = 1.63)
- Increasing the city budget for climate protection and climate adaptation measures (Cronbach's alpha consistency α = 0.72, Min = 1 / Max = 4, Mean = 1.68).

Figure 5.8: Climate-protection-related behaviour (average values in brackets)

Source: Darmstadt Citizen Survey 2023, own calculation



The questionnaire also contains an item scale on climate- and environmental-related behaviour (wording of question: 'Have you

specifically changed your behaviour in the last 2 years due to climate change?'; scale from 1-3: true, true, but have done for more than 2 years, not true; for the items in the scale see Figure 5.8). The largest percentage changes in behaviour over the last two years are that less meat is eaten (37% of respondents) and that more regional or organic products are bought (35% of respondents). For the other behaviours listed, around one third of respondents have also changed their behaviour in the last two years.

Climate-conscious behaviour

A slightly larger percentage have already adapted their own behaviour to climate change for more than two years. Looking across all items, between a quarter and a third of respondents stated that they had not made any changes in their behaviour. Only the sharing of everyday objects falls slightly short of the other behaviours, as only about half of respondents made any changes in this respect. The scale items are calculated into a mean index for the correlative assessments in this article: 'Climate and environmental behaviour' (Cronbach's alpha consistency α = 0.63, Min = 1 / Max = 3, Mean = 2.0).

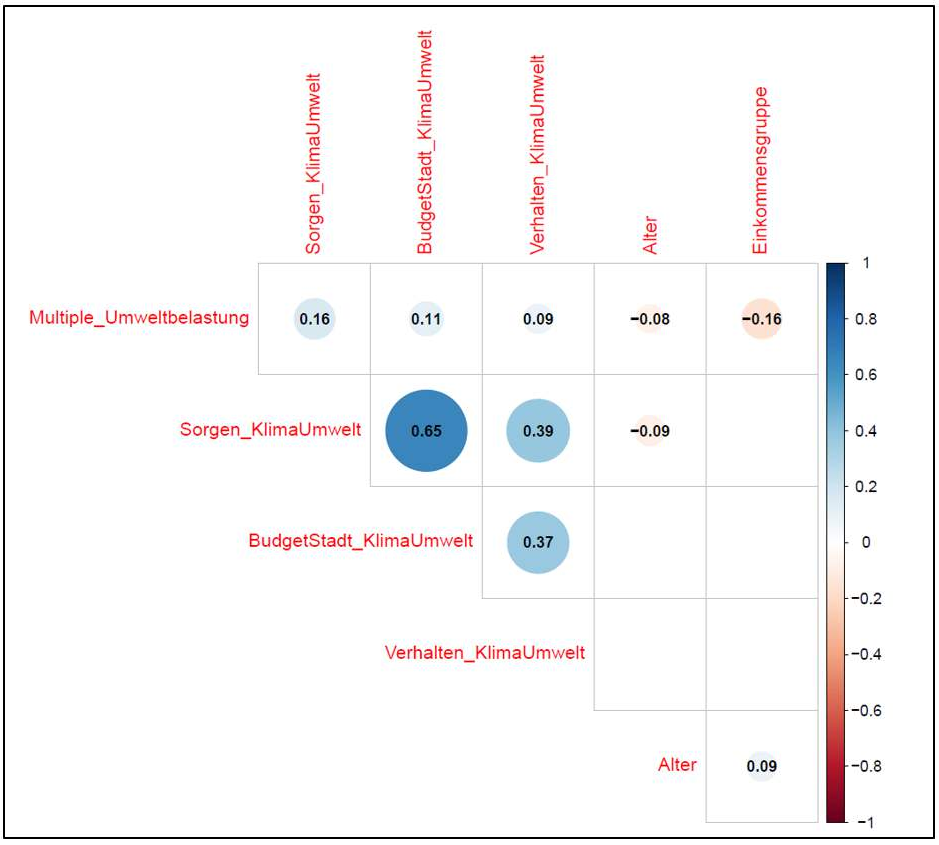


Figure 5.9: Correlations of multiple environmental pollution, climate and environmental attitudes, climate and environmental behaviour and socio-demographic characteristics (only significant coefficients, n = 1,598)

Source: Darmstadt Citizen Survey 2023, own calculation

Finally, the characteristics and constructs examined so far are considered in the context of correlations (Figure 5.9[7]). Multiple environmental pollu-

[7] To make the correlations easier to interpret, the scales 'Concerns about the climate and the environment', 'Increasing the city budget for climate protection and adaptation measures' and 'Climate and environmental behaviour' are recoded so that a higher value represents higher concerns, a greater desire to increase urban spending and greater climate-protection-related behaviour.

tion consists of the pollution factors heat in the living environment, noise in the living environment, cleanliness of the air in the living area and accessibility of parks and green spaces. There is a negative but weak correlation between environmental pollution and age (r = -0.08), i.e. the older the respondents are, the less affected they are by environmental pollution. The negative correlation between environmental pollution and income is somewhat stronger (r = -0.16). The higher the income, the less affected the respondent is by environmental pollution. The correlations correspond to their sign after the assessments in the previous part of this article.

In addition, there are positive but weak correlations between multiple environmental pollution and concerns about the climate and the environment (r = 0.16), the increase in the city budget for climate protection and climate adaptation measures (r = 0.11) and climate behaviour (r = 0.09).

Concerns about the climate and the environment have a negative but weak correlation with age (r = -0.09), i.e. the older the respondents are, the less concerned they are about changes in the climate and the environment. There is no significant correlation between income and the concerns. Neither the desire to increase urban spending on climate protection and climate adaptation nor climate-related behaviour have a significant correlation with age or income. Moderate correlations can be seen between climate-related behaviour and the concerns (r = 0.39) and the increase in the city budget (r = 0.37). Income and age have a weak positive correlation with the age and occupational structure (r = 0.09).

5.4 Discussion of the results

The first question in this article was to what extent is multiple environmental pollution evident in Darmstadt. For this purpose, three subjectively perceived environmental pollutions and one environmental resource were considered, differentiated by age, income group and district. Such multiple environmental pollution is indeed evident, both with regard to the available net equivalent income and at the level of the nine districts of Darmstadt. For example, respondents with a higher income assume, on average, slightly lower environmental pollution than lower income groups. As a first step, it can be concluded that a higher income in a living environment is reflected with lower environmental pollution. However, there is also the possibility that low income also has a negative impact on the perception of other impacts such as environmental pollution. Further analyses would be needed to examine this.

A differentiation of perceived multiple environmental pollution by district makes it clear that where the respondents live has a significant influence on environmental pollution. There does not always appear to be a correlation between income, district and perceived environmental pollution, as the comparison with the proportion of people entitled to SGB II benefits at district level makes clear. Most of Darmstadt's districts are also too heterogeneous, with the result that a comparable analysis at quarter level

would probably produce different results, since in this way the qualities of individual settlement typologies would become more important.

Two points can also be noted about the quality of the assessed indicators: although many respondents are able to assess the cleanliness of the air from their subjective point of view, it cannot be assumed that this assessment is consistent with air quality standards or air pollution limits. As a result, there can be significant differences between subjective assessments and official measurement results. The question about the quality of parks and green spaces also makes it clear that a subjective assessment of this environmental resource requires a more precise question that also takes into account private green spaces or the landscape surrounding settlements as recreational areas. The question about public green spaces does not do justice to the aspect of available environmental resources.

The second question in this article was which individual aspects, in addition to spatial location, are relevant for multiple environmental pollution. Using the environmental justice approach, two potentially vulnerable groups for multiple environmental pollution were taken into account: older people and the lower-income population. The assessments in this article have shown that a high income – in keeping with the assumptions – offers a certain degree of protection against being affected by environmental pollution. It is possible that financially better-off people can more easily choose to live in a location with less traffic and good infrastructure (e.g. with parks, etc.). It is also conceivable that as income increases, the opportunities to purchase protective technologies increase, e.g. noise and heat insulation.

Contrary to the assumptions, older respondents in the assessments were less affected by environmental pollution than younger respondents. Although older people are particularly vulnerable to environmental impacts such as heat (e.g. due to dehydration), statistically they are no more affected by harmful environmental impacts than young people. One possible explanation for this finding is where the respondents live. For example, the population statistics of the city of Darmstadt show that many young people live in the densely populated central areas of the city, which are characterised by heat and noise (including road traffic). The hillside locations on the outskirts of the city, on the other hand, are mainly inhabited by older people.

The third question in this article was whether the respondents' increased perception of being affected by environmental pollution resulted in motivation to act in respect of their own behaviour for more climate protection and climate adaptation. The assessments show that residents who perceive climate or environmental pollution in their living environment are more concerned about the effects of climate change and the development of future environmental conditions. As this article has shown, those who are more concerned are also more motivated to adapt their behaviour, for example by buying products from regional retailers. However, climate-related behaviour is statistically independent of an increased perception of being

affected by multiple environmental pollution. Income and age also have no significant correlation with behavioural changes due to climate change.

5.5 Conclusion and outlook

The findings on multiple pollution in the districts draw attention to a 'blind spot' in the assessments in this article. In the Citizen Survey, the respondents were assigned to the spatial aggregation level of the nine districts. However, an allocation on a smaller-area level - e.g. to the 37 statistical districts - is likely to provide a much more differentiated picture in which differences between specific types of housing area can be seen (e.g. single-family house area vs. high-rise development). For this, the survey results need to be able to be assigned on a small-area level and assessed representatively.

The assessment of individual questions used also shows that they must be worded precisely so that they can deliver meaningful results for the assessment of environmental pollution and resources. It must also be critically examined how reliable assessments of environmental pollution by surveyed citizens are, such as the cleanliness of the air. Here, too, questions may have to be adapted to the assessment options of the respondents, for example by not asking about the cleanliness of the air, but rather about the subjective exposure to air pollution.

Further multivariate considerations and controls are also required to determine the significance of individual aspects such as income and age for the assessment of environmental pollution. The first assessment approaches make this clear.

And finally, the extent to which the perception of environmental pollution asked in a Citizen Survey is able to generate valid statements about the actual pollution must be reflected on. This plays a particularly important role when the results of the survey are discussed against the background of the question of environmental justice or the socio-spatial distribution of health-relevant environmental pollution in the city. However, this requires adaptations and further analysis, as already mentioned.

Nevertheless, subjective assessments of environmental pollution obtained through surveys are not per se unsuitable for the identification of multiple environmental pollution on a small-area level. Because they meet the respondents where the issue of environmental pollution and environmental justice begins: with their individual perception, which is ultimately crucial for their own well-being. The question is therefore less whether survey data can be used for this purpose, but rather how it can be profitably combined with other municipal statistics data after prior qualification.

Dr. Jan Dohnke is the Head of the Statistics and Urban Research Department in the Office for Economics and Urban Development of the city of Darmstadt.
✉ statistik@darmstadt.de

Dr. Jan-Philipp Starcke is a member of the Statistics and Urban Research Department in the Office for Economics and Urban Development of the city of Darmstadt.
✉ statistik@darmstadt.de

6 Urban Audit – Quality of Life in German Cities: Development of the survey project and assessment of the change in method in 2021

Daniela Schüller

6.1 Introduction

What is the Survey on Quality of Life in German Cities?

Every three years since 2006, the Coordinated Survey on Quality of Life, a sub-working group of the Survey Working Group (VDSt AG Umfragen), has been conducting Citizen Surveys on the Quality of Life in German Cities. Cities organised in the VDSt (Association of German Municipal Statisticians) can take part in this survey voluntarily. On average, around 20 cities take the opportunity to collect standardised and comparable data in this way.

How did this VDSt working group come about?

The EU has been collecting subjective data to assess the quality of life in European cities in the so-called Perception Survey in the City Statistics Project (formerly: Urban Audit) since 2004. This data complements the objective structural data collected. 79 European cities are considered in this project, including seven major German cities (Berlin, Dortmund, Essen, Hamburg, Leipzig, Munich and Rostock).

Based on this survey, the VDSt organises a survey with other volunteer German cities. The opportunity to collect inter-municipal data that is comparable over time with relatively little cost and effort represents a tempting offer.

The EU welcomed the German involvement. Agreement was struck on the exchange and mutual use of the survey data as well as early information on the questionnaire for the next wave. Mannheim takes on the role of coordinating interface as the supervising body of the KOSIS Association Urban Audit.

Originally, a survey with identical content was conducted at the same time as the EU survey, which unfortunately became more and more difficult over the years. The VDSt working group developed its own questions and moved away from the survey phases that were held up due to delays in the process and changing questions from the EU in favour of continuous question items and regular data collection.

6.2 Developments in recent years

Why was an adjustment necessary?

Telephone interviews were the survey method of choice from the start because the EU had chosen this method and the survey design of the voluntary German survey was supposed to be very comparable. Landline area codes made it possible to contact the citizens of the relevant cities. However, over time the mobile phone became the only way to contact people by telephone, especially younger households. As a result, it was much more difficult to contact young households and the survey data for this target group had to be heavily weighted. Furthermore, one could no longer actually speak of a representative sample, as not all citizens of a city had the same probability of being included in the selection sample.

What further developments did the project take?

The EU project was originally designed to collect data on defined aspects of quality of life and satisfaction every three years. However, the EU deviated from this plan both in terms of time and content, with the result that the VDST working group had to decide whether to withdraw from the project or continue with a survey that was very comparable, which would result in a certain degree of flexibility in terms of time and less independence in terms of content.

In order to establish the views on the way forward, a survey was conducted among the cities that have participated in the project in the past. 26 cities participated in the survey with the following results:

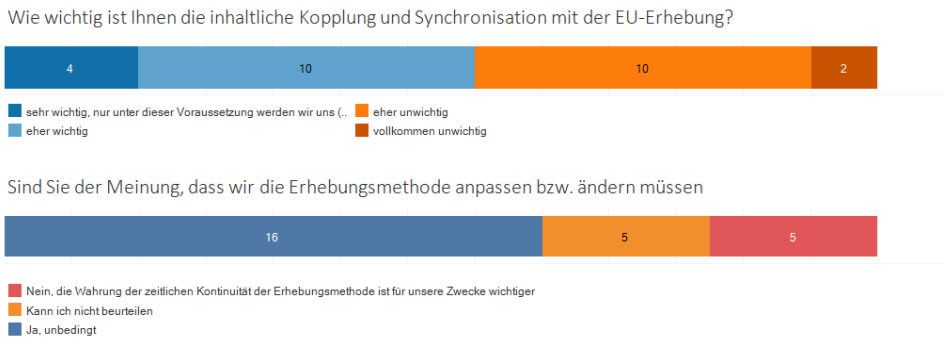


Figure 6.1: : Result of the survey of the working group members to establish their views on the way forward for the project, part 1

16 of the 26 cities stated that they felt a change in method was absolutely necessary, which equates to 62%. In addition, 65% of respondents said

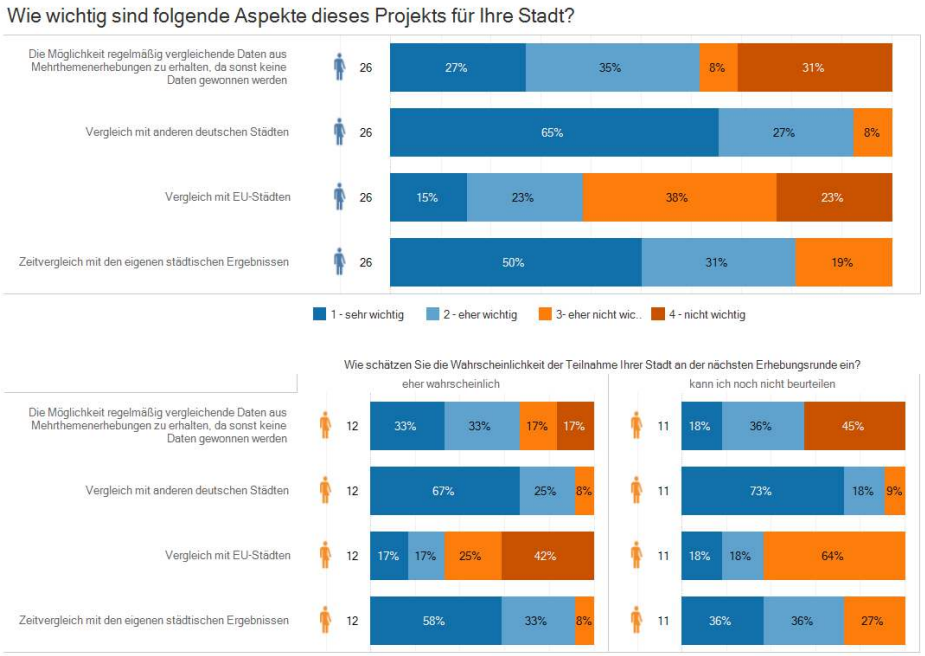


Figure 6.2: Result of the survey of the working group members to establish their views on the way forward for the project, part 2

they were more interested in comparing with German cities. 61% considered the comparison with EU cities to be (rather) unimportant.

For this reason, the VDST working group decided to withdraw from the EU's Perception Survey in 2020. This involved making an independent decision about the change in method and content of the questionnaire as well as setting the survey period for autumn 2021 in order to remain in a 3-year cycle.

Short note

It had become increasingly likely in recent years that the VDST working group was going to withdraw from the EU project, with the result that the currently interested group of cities is dominated by those who focus on comparisons within Germany and not the EU.

Despite this decision, cooperation with regard to data exchange continues, even though the comparability of the survey data is very limited.

Should the field phases and the questionnaire of the EU and the German survey align again in the future, the working group would be open to this and support greater comparability of the data and closer cooperation with the EU.

6.3 Change in method

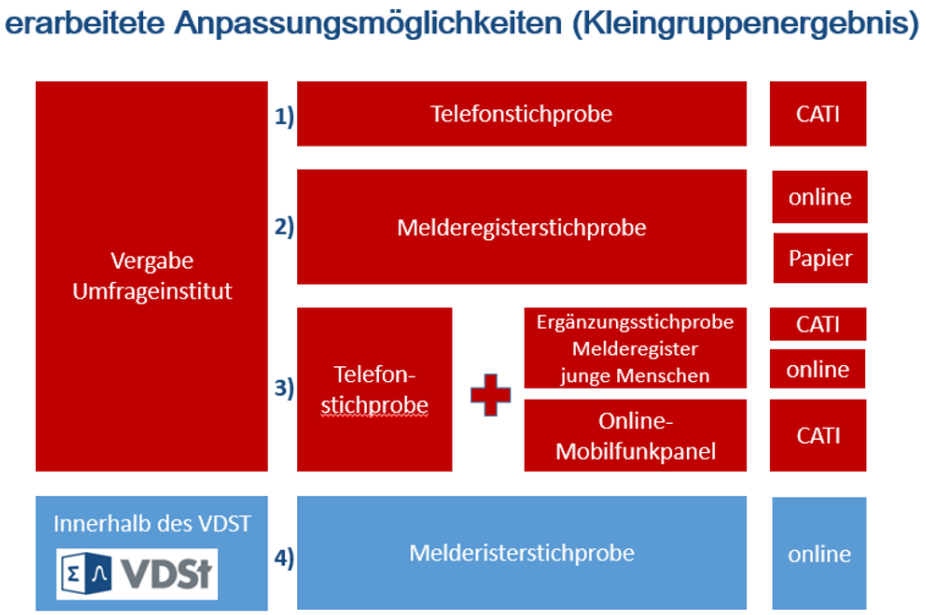
What adjustments were available?

After the change in method was decided, a group was formed from the Survey Working Group that developed various adjustment scenarios. The aim was to draw a representative sample with the same probability of selection and thus to better reach the younger age groups in particular.

A selection of four scenarios was presented to the Coordinated Survey on Quality of Life Working Group, discussed and put to a vote. The cities that had already agreed to participate in the autumn 2021 wave were eligible to vote.

The selection consisted of three scenarios, which also included the commissioning of a survey institute, and these were a telephone sample, a population register sample and a combined model. The fourth scenario was a survey conducted within the VDSt.

Figure 6.3: Adjustment options for the survey method



Option two was chosen unanimously for the following reasons:

Basically, the working group has influence over the survey design, meaning that it can be designed to meet the working group's quality requirements. This means that the current survey data is no longer distorted due to the survey method. In addition, all of the documents needed to contact the citizens could be provided in a city-specific design and with their own text. The cover letters were adapted individually by the cities based on blocks of text and signed by the respective mayor.

The 'costs' of change in method lie in the method break, which affects comparability with the previous year's results. In addition, the work required by the participating cities in the first wave with the new method was higher than in previous years. It is expected that this high level of work will reduce significantly in the following years. The expected higher costs of the new method have not materialised and are at a similar level.

How was the change in method made specifically, what decisions had to be taken?

After the VDSt Coordinated Survey on Quality of Life Working Group made the decision to change the method to Option 2, further decisions had to be made to fine-tune the following topics:

- Data protection-related decisions
- Specification of the survey method
- Number and timing of reminder letters
- Will a paper questionnaire be sent as well? If so, how often?
- Data protection criteria and consequences (tracking?), transfer of information about the survey data, …
- Sampling criteria
- Conversion of CATI questionnaires into paper questionnaires
- Creation of an online questionnaire based on the paper questionnaire
- Formulation of cover letter with data protection information
- Formulation of reminder letter

An important component was the conversion of the telephone questionnaire into a paper questionnaire. This was then converted into an online questionnaire. This conversion was not trivial and took by far the most time, as many method-related decisions had to be made, including the formulation of response categories, the handling of missing values, survey ergonomics and filter management.

The survey was not conducted on an 'online first' basis. In order to increase the response rate, an individual access code for the online survey and a paper questionnaire with an enclosed return envelope were sent with the first cover letter. A representative sample from the population register provided the basis for the survey. Three weeks after the start of the field phase, those who did not responded received a one-page reminder letter. The questionnaire was not sent again.

6.4 Assessment of the change in method

Was the adjustment of the survey method successful?

The subjective assessment of the adjustment by the participating cities is extremely positive, as a lessons learned workshop revealed. The costs for participating in the project were lower and the response rate was higher than expected. This means that all cities have more data than originally planned, meaning that a second reminder did not need to be sent.

Assessment of the change in method from a statistical perspective

Because in particular the high weights of the survey data have been criticised by members of the working group in recent years as this limited the quality of the data, an analysis of the distribution and amount of the weights was carried out. The distribution of the weights is viewed as an indicator of the representativeness of the overall population among the participants.

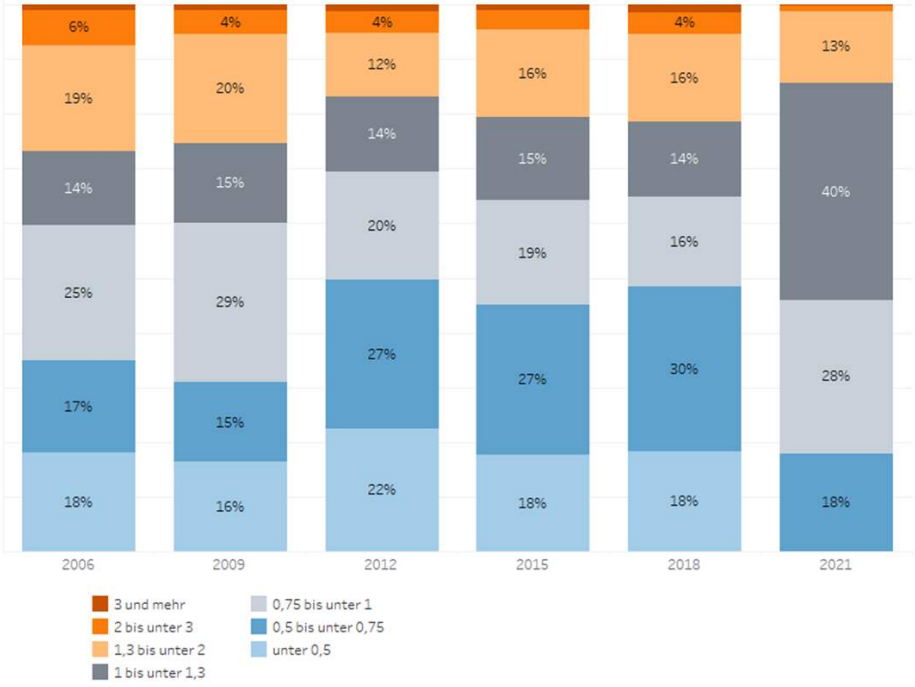
Since the group of participating cities is different in each survey, the weights of the cities of Saarbrücken, Konstanz, Koblenz, Freiburg and Braunschweig were included in the analysis because these cities have already taken part in several surveys.

In a first step, the weights were grouped in order to better represent the development of the extreme areas.

Figure 6.4: Response rates by city and method

Stadt	Anzahl Online	Anzahl Papier	Gesamt	Soll	Dif.	Stichprobe	Antwort-quote	Anteil Papier	Anteil Online
Aachen	674	409	**1.083**	800	283	3.200	34%	38%	62%
Braunschweig	493	807	**1.300**	800	500	3.200	41%	62%	38%
Dresden	273	601	**874**	500	374	2.000	44%	69%	31%
Freiburg	360	482	**842**	500	342	2.000	42%	57%	43%
Ingolstadt	374	393	**767**	500	267	2.000	38%	51%	49%
Kassel	264	432	**696**	500	196	2.000	35%	62%	38%
Koblenz	323	525	**848**	500	348	2.000	42%	62%	38%
Konstanz	334	489	**823**	500	323	2.000	41%	59%	41%
Mannheim	478	649	**1.127**	800	327	3.200	35%	58%	42%
Neuss	314	493	**807**	500	307	2.000	40%	61%	39%
Osnabrück	298	540	**838**	500	338	2.000	42%	64%	36%
Recklinghausen	532	738	**1.270**	800	470	3.200	40%	58%	42%
Saarbrücken	287	481	**768**	500	268	2.000	38%	63%	37%
Siegen	456	869	**1.325**	800	525	3.200	41%	66%	34%
Würzburg	207	713	**920**	500	420	2.000	46%	78%	23%
Mittelwert	**378**	**575**	**953**		**353**		**40%**	**60%**	**40%**
Summe	**5.667**	**8.621**	**14.288**	**9.000**	**5.288**	**36.000**			

Figure 6.5: Distribution of the grouped weights



A slightly different representation shows the grouped weight shares in a time comparison of the five selected cities. Here, too, it can be clearly seen that the shares of medium, moderate weights tend to decrease slightly over time, in favour of the weights in the extreme ranges.

The distribution of the 2021 survey differs significantly from the structure of previous surveys. If an observer had been not aware that there had been a change in method in 2021, this would have been made clear by the completely different distribution of weights. Weights in the extreme ranges (below 0.5; over 2) are hardly present in the 2021 survey compared to previous years.

In a next step, the mean values of the weights for the individual years, differentiated by age group, were examined.

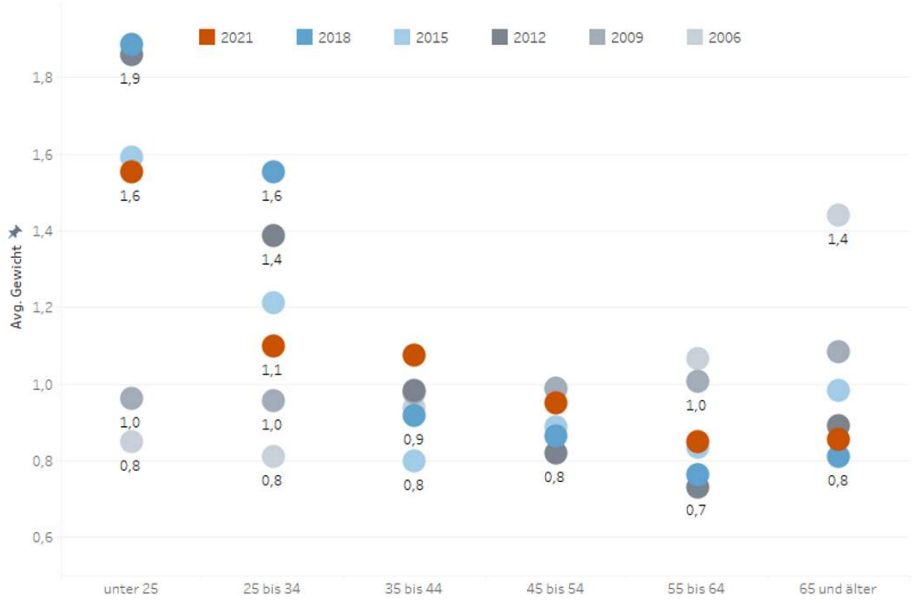


Figure 6.6: Average values of the weights by age group and year

With one exception (those aged 65 and older in 2006), the weights range from 0.8 to 1.1 for those aged 35 and older. No effect on the individual survey years can be seen.

For the 25 to 34 age group, there were higher average values of 1.6 and 1.4 in the years 2018 to 2012. Young respondents under the age of 25 had the highest average values in the survey years 2012 to 2018.

The chart shows in more detail the grouped weights in a time comparison of the five selected cities by age group.

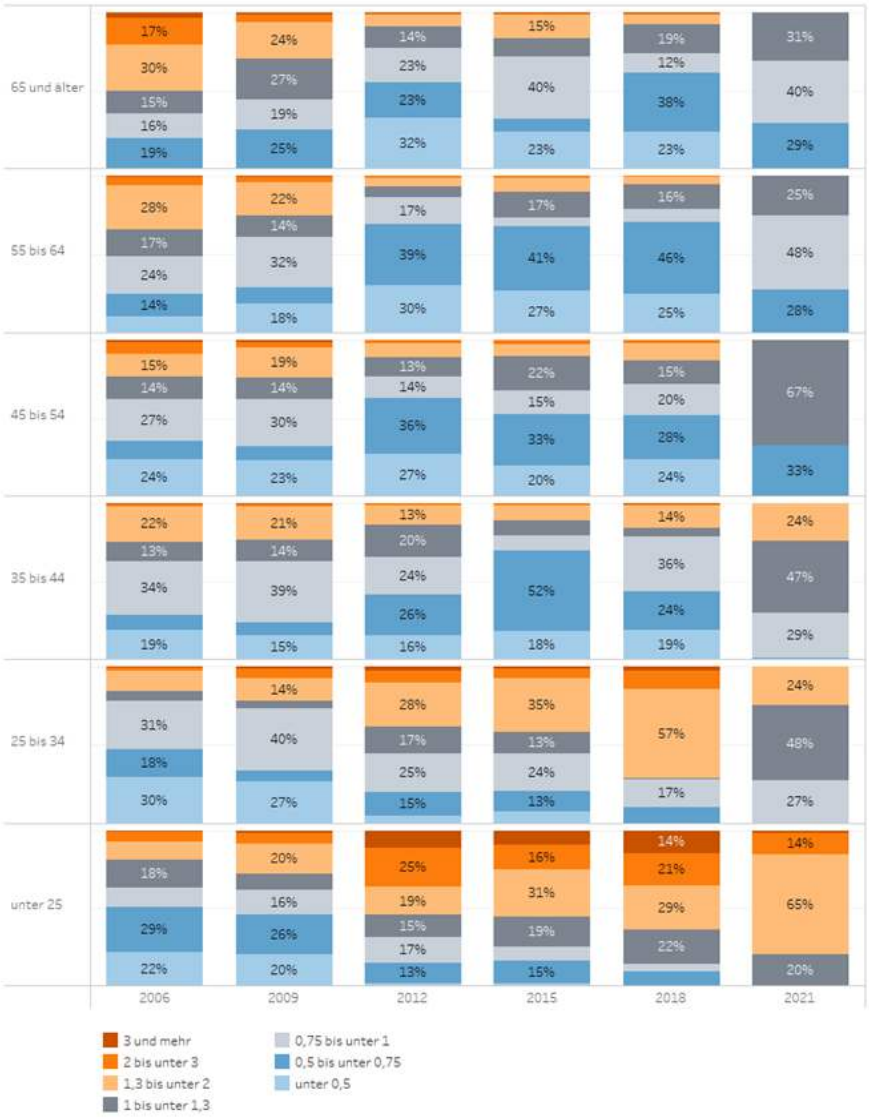
The partly continuous increase in extreme weights in the individual age groups for the years 2006 to 2018 can be clearly seen. The share of weights of 2 and more increases significantly in particular among those under 34 years of age. In 2021 weights of over 3 and under 0.75 hardly had to be assigned, although the younger age groups still need the highest weighting in the survey year.

What effects does this have on the data or what needs to be taken into account when interpreting the results?

The change in method limits comparability with previous surveys. Possible response errors such as interviewer effects, social desirability or approval tendencies are eliminated in favour of more honest, more considered answers. In addition, the respondent can decide when to answer the question themselves. However, other failure rates may arise due to self-selection processes.

Further differences lie in the sampling, the personal contact through a letter from the mayor, a changed structure of the participating cities and a shorter field phase.

Figure 6.7: Share of the weights by age



What questions arise from this for empirical science?

The questions can relate to measurement and mode effects that resulted from the change in method.

It would be interesting to look at what influence the method of participation (paper or online) had on the response rate in the individual cities and what effect the reminder letter had on the response rate. It would also be interesting to analyse which groups of people were more likely to participate online and whether the young people contacted preferred the option of online participation.

In addition, analyses of response behaviour could show which questions or items were not answered and whether there are differences with previous telephone surveys.

6.5 Conclusion

Due to the pandemic, the coordination meetings that usually take place as face-to-face meetings were not possible, as a result a switch to online formats took place. Although online meetings involve greater effort, they are easy to hold, therefore regular online meetings were held instead of fewer face-to-face meetings. They were explicitly designed as a participatory process with democratic decision-making. Ad hoc coordination discussions that were occasionally needed could also be held without any difficulty. It was also possible for several people from one city to take part in the meetings. A positive side effect that would otherwise not have occurred in this form due to the higher time and cost components of face-to-face meetings.

The high level of expertise and experience of the cities which are familiar with Citizen Surveys led to interesting discussions and the successful implementation of the change in method. The socio-demographic module developed in the VDSt Survey Working Group could also be used. The smaller and inexperienced cities reported that they benefited greatly from being able to discuss the design of surveys with the experts of the experienced cities.

Overall, a positive conclusion can be drawn regarding the change in method. The high weights required in previous surveys to counteract sample bias have been reduced. For the next wave, only the sampling is an area that still requires firming up and agreement.

What are the next steps for the project?

The next survey phase is planned for autumn 2024. A first informal meeting of interested cities to explore the needs in as large a group as possible and plan the next steps was held in September 2023.

Although the change in method was successful, that does not mean that everything went perfectly in 2021. Possible adjustments need to be discussed in order to continually develop the project and maintain its quality at a high level.

Five project meetings of 2 hours each are currently planned. These will be held as virtual as well as face-to-face meetings.

Daniela Schüller is the contact for the Coordinated Survey on Quality of Life of the sub-working group of the VDSt Survey Working Group of the same name.
✉ daniela.schueller@stadt.koblenz.de

A Contacts and responsibilities

KOSIS Association Urban Audit

In Germany, the KOSIS Association Urban Audit acts as the project partner for data collection to support the European urban comparison. In 2020, the City of Mannheim was elected as the managing office for another year. The project is supervised by the municipal statistical office of Mannheim. The managing office is responsible for business management, represents the association within its mandate, heads the steering group, carries out bookkeeping, and manages the funds of the association.

URBAN AUDIT

www.urbanaudit.de

STADT MANNHEIM

KOSIS-Gemeinschaft Urban Audit
c/o Stadt Mannheim
Sachgebiet Statistik und Stadtforschung
Postfach 101832
68018 Mannheim
Email: urbanaudit@mannheim.de

The director of the Municipal Statistics Office of the City of Mannheim, Dr Ellen Schneider, is responsible for the managing office.

Dr. Ellen Schneider
Phone: +49 (0) 621 / 293 7101
Email: urbanaudit@mannheim.de

Tobias Link is the executive secretary of the managing office who oversees and coordinates the project with the European Union in collaboration with the Federal Statistical Office.

Tobias Link
Phone: +49 (0) 621 / 293 7486
Email: urbanaudit@mannheim.de

Nassima Ouaarous is the contact person for the KOSIS Association Urban Audit in all matters relating to the collection of structural data.

Nassima Ouaarous
Phone: +49 (0) 621 / 293 7857
Email: urbanaudit@mannheim.de

The Federal Statistical Office is the project coordinator for the structural database and therefore the point of contact for Eurostat for all legal and financial matters. The contact person at DESTATIS is Gabriele Rutmann.

www.destatis.de

Statistisches Bundesamt
Regionalstatistik
B 11 – Programm der Bundesstatistik
Gabriele Rutmann
Gustav-Stresemann-Ring 11
65189 Wiesbaden
Phone: + 49 (0) 611/754614
Email: Regionalstatistik@destatis.de

Eurostat Directorate E, Sectoral and Regional Statistics, has overall responsibility for the project. The contact person is Teodora Brandmüller in Regional Statistics and Geographical Information.

epp.eurostat.ec.europa.eu

Eurostat
Unit E4 – Regional statistics and
geographical information
Teodora Brandmüller
5, rue Alphonse Weicker
L-2721 Luxembourg
Phone: +352 (0) 4301 / 1 (zentrale Telefonnummer)
Email: ESTAT-Urban-Audit@ec.europa.eu

The German survey, carried out parallel to the European survey on the quality of life from a citizen's perspective, is coordinated by the VDSt (Association of German Municipal Statistics) Survey Working Group (VDSt AG Umfragen).

Representative for the Coordinated Quality of Life Survey
Daniela Schüller
Stadt Koblenz, Kommunale Statistikstelle
Willi-Hörter-Platz 1
56068 Koblenz
Tel.: +49 (0) 261 129-1247
Email: daniela.schueller@stadt.koblenz.de

B Publications

Copies of all publications of the KOSIS Association Urban Audit may be requested at no charge from urbanaudit@mannheim.de. The PDF versions are available for download in the download section of the website www.urbanaudit.de – there you can also find many other national and international publications on the topic of Urban Audit.

Subjective Assessments of the Quality of Life in European Cities (2021): The survey on quality of life in cities, a successful project of EUROSTAT and German city statistics, is the focus of this brochure. It also presents extensive innovations in the (structural) data collection.

Quality of Life: Establishing New Data Sources (2019): This brochure takes up the challenge of new and alternative data sources and methods for measuring and monitoring urban quality of life. Exemplary model projects from the Urban Audit data collection or various cities are presented.

Quality of Life in the City and Suburban Areas (2017): The main focus of the Urban Audit brochure 2017 is the exploration of existing data for cities and their suburban areas and the testing of open geodata as an alternative data source. Overall, the brochure takes into account the growing importance of the urban dimension, not only at European level.

Regionalisierung des Mikrozensus für den europäischen Städtevergleich (2016) (Regionalisation of the micro-census for a comparison of European cities): This brochure documents the small estimation method which enables the utilisation of results from the regular micro-census survey and the registered statistics from the Federal Employment Agency for showing small, regionalised, socio-economic reference features.

Data – Indicators – Information (2015): The focus of this brochure is on the utilisation of comparative urban data. Let these national and international examples inspire you!

Comparison of Cities in the European Statistical System (2013): The compact brochure provides interesting information on the project background, organisation, and use of data for the German Urban Audit.

A Coruña Aachen Aalborg Aberdeen Acireale Adana Aix-en-Provence Ajaccio Alba Iulia Albacete Alcalá de Henares Alcobendas Alcorcón Algeciras Alicante Alkmaar Almada Almelo Almere Almería Alphen aan den Rijn Alytus Amadora Amersfoort Amstelveen Amsterdam Ancona Angoulême Ankara Annecy Antalya Antwerpen Apeldoorn Arad Argenteuil - Bezons Århus Arnhem Arrecife Aschaffenburg Ashford Asti Athina Aubagne Augsburg Aveiro Avellino Avilés Bacău Badajoz Badalona Baia Mare Balıkesir Bamberg Banská Bystrica Barakaldo Barcelona Bari Barking and Dagenham Bârlad Barletta Barnet Barnsley Barreiro Basel Basildon Basingstoke and Deane Bath and North East Somerset Bayreuth Bedford Belfast Benevento Benidorm Bergamo Bergen Bergen op Zoom Bergisch Gladbach Berlin Bern Besançon Bexley Białystok Biel Bielefeld Biella Bielsko-Biała Bilbao Birmingham Blackburn with Darwen Blackpool Blagoevgrad Bochum Bologna Bolton Bolzano Bonn Borås Bordeaux Botoşani Bottrop Bournemouth Bracknell Forest Bradford Braga Brăila Brandenburg an der Havel Braşov Bratislava Braunschweig Breda Bremen Bremerhaven Brent Brescia Brest Brighton and Hove Bristol Brno Bromley Brugge Bruxelles Bucureşti Budapest Burgas Burgos Burnley Bursa Bury Busto Arsizio Buzău Bydgoszcz Bytom CA Brie Francilienne CA de la Vallée de Montmorency CA de Seine Essonne CA de Sophia-Antipolis CA des deux Rives de la Seine CA des Lacs de l'Essonne CA du Plateau de Saclay CA du Val d'Orge CA du Val d'Yerres CA Europ' Essonne CA le Parisis CA les Portes de l'Essonne CA Marne et Chantereine CA Sénart - Val de Seine CA Val de France CA Val et Forêt Cáceres Cádiz Cagliari Calais Călăraşi Cambridge Camden Campobasso Cannock Chase Capelle aan den IJssel Cardiff Carlisle Carrara Cartagena Caserta Castelldefels Castellón de la Plana Catania Catanzaro CC de la Boucle de la Seine CC de l'Ouest de la Plaine de France CC des Coteaux de la Seine Celle Cerdanyola del Vallès Cergy-Pontoise České Budějovice Ceuta Charleroi Charleville-Mézières Chełm Chelmsford Cheltenham Chemnitz Cherbourg Chesterfield Chorzów City of London Ciudad Real Cluj-Napoca Coimbra Colchester Colmar Como Constanţa Córdoba Cork Cornellà de Llobregat Cosenza Coslada Cottbus Coventry Craiova Crawley Creil Cremona Croydon Częstochowa Dacorum Darlington Darmstadt Daugavpils Debrecen Delft Denizli Derby Derry Dessau-Roßlau Deventer Diyarbakır Dobrich Doncaster Dordrecht Dortmund Dos Hermanas Dresden Drobeta-Turnu Severin Dublin Dudley Duisburg Dundee City Dunkerque Düsseldorf Ealing East Staffordshire Eastbourne Ede Edinburgh Edirne Eindhoven Elbląg Elche Elda Ełk Enfield Enschede Erfurt Erlangen Erzurum Espoo Essen Esslingen am Neckar Evry Exeter Falkirk Fareham Faro Ferrara Ferrol Firenze Flensburg Focşani Foggia Forlì Fort-de-France Frankenthal (Pfalz) Frankfurt (Oder) Frankfurt am Main Freiburg im Breisgau Fréjus Friedrichshafen Fuengirola Fuenlabrada Fulda Funchal Fürth Galaţi Galway Gandia Gateshead Gaziantep Gdańsk Gdynia Gelsenkirchen Genève Genova Gent Gera Getafe Getxo Gießen Gijón Girona Giugliano in Campania Giurgiu Glasgow Gliwice Głogów Gloucester Gniezno Gondomar Görlitz Gorzów Wielkopolski Göteborg Göttingen Gouda Granada Granollers Gravesham Graz Great Yarmouth Greenwich Greifswald Groningen Grudziądz Guadalajara Guildford Guimarães Győr Haarlem Hackney Hagen Halle an der Saale Halton Hamburg Hamm Hammersmith and Fulham Hanau Hannover Haringey Harlow Harrow Hartlepool Haskovo Hastings Hatay Havering Havířov Heerlen Heidelberg Heilbronn Helmond Helsingborg Hengelo Hénin - Carvin Herne Hildesheim Hillingdon Hilversum Hoorn Hounslow Hradec Králové Huelva Hyndburn Iaşi Ingolstadt Innsbruck Inowrocław Ioannina Ipswich Irakleio Irun Iserlohn Islington İstanbul İzmir Jaén Jastrzębie-Zdrój Jelenia Góra Jelgava Jena Jerez de la Frontera Jihlava Jönköping Jyväskylä Kaiserslautern Kalamata Kalisz Karlovy Vary Karlsruhe Kars Karviná Kassel Kastamonu Katowice Katwijk Kaunas Kavala Kayseri Kecskemét Kempten (Allgäu) Kensington and Chelsea Kiel Kielce Kingston upon Thames Kingston-upon-Hull Kirklees Kladno Klagenfurt Klaipėda KÉbenhavn Koblenz Kocaeli Köln Konin Konstanz Konya Kortrijk Košice Koszalin Kraków Krefeld Kristiansand Kuopio La Rochelle La Spezia Lahti /Lahtis Lambeth Landshut Larisa Las Palmas Latina Lausanne Le Havre Lecce Lecco Leeds Leeuwarden Lefkosia Leganés Legnica Leicester Leiden Leidschendam-Voorburg Leipzig Lelystad Lemesos Lens - Liévin León Leszno Leuven Leverkusen Lewisham L'Hospitalet de Llobregat Liberec Liège LiepÕja Lille Limerick Lincoln Línea de la Concepción, La Linköping Linz Lisboa Lisburn Liverpool Livorno Ljubljana Lleida Łódź Logroño Łomża Lübeck Lubin Lublin Ludwigsburg Ludwigshafen am Rhein Lugano Lugo Lund Lüneburg Luton Luxembourg Luzern Maastricht Madrid Magdeburg Maidstone Mainz Majadahonda Málaga Malatya Malmö Manchester Manisa Mannheim Manresa Mansfield Mantes en Yvelines Marbella Marburg Maribor Marne la Vallée Marseille Martigues Massa Mataró Matera Matosinhos Meaux Medway Melilla Melun Merton Messina Middelburg Middlesbrough Milano Milton Keynes Miskolc Modena Moers Mollet del Vallès Mönchengladbach Mons Montpellier Monza Most Móstoles Mülheim a.d.Ruhr München Münster Murcia Namur Nancy Nantes Napoli Narva Neubrandenburg Neumünster Neuss Neu-Ulm Nevşehir Newcastle upon Tyne Newcastle-under-Lyme Newham Newport Nijmegen Nitra Norrköping North East Lincolnshire North Lanarkshire North Tyneside Northampton Norwich Nottingham Novara Nowy Sącz Nuneaton and Bedworth Nürnberg Nyíregyháza Oberhausen Odense Odivelas Offenbach am Main Offenburg Oldenburg Oldham Olomouc Olsztyn Oostende Opole Oradea Örebro Orléans Osijek Oslo Osnabrück Ostrava Ostrów Wielkopolski Ostrowiec Świętokrzyski Ourense Oviedo Oxford Pabianice Paderborn Padova Palencia Palermo Palma de Mallorca Pamplona/Iruña Panevėžys Pardubice Paredes Paris Parla Parma Passau Pátra Pavia Pazardzhik Pécs Pernik Perugia Pesaro Pescara Peterborough Pforzheim Piacenza Piatra Neamţ Piła Piotrków Trybunalski Pisa Piteşti Plauen Pleven Płock Ploieşti Plovdiv Plymouth Plzeň Ponferrada Ponta Delgada Pontevedra Poole Pordenone Porto Portsmouth Potenza Potsdam Póvoa de Varzim Poznań Pozuelo de Alarcón Praha Prat de Llobregat, El Prato Prešov Preston Przemyśl Puerto de Santa María, El Purmerend Radom Râmnicu Vâlcea Ravenna Reading Recklinghausen Redbridge Redditch Regensburg Reggio di Calabria Reggio nell'Emilia Reims Remscheid Reus Reutlingen Reykjavík Richmond upon Thames RŅga Rijeka Rimini Roanne Rochdale Roma Roman Roosendaal Rosenheim Rostock Rotherham Rotterdam Rozas de Madrid, Las Rubí Ruda Śląska Ruse Rybnik Rzeszów Saarbrücken Sabadell Saint Denis Saint-Brieuc Saint-Etienne Saint-Quentin en Yvelines Salamanca Salerno Salford Salzburg Salzgitter Samsun San Cristóbal de la Laguna San Fernando San Sebastián de los Reyes San Sebastián/Donostia Sandwell Sankt Augustin Sanlúcar de Barrameda Sanremo Sant Boi de Llobregat Sant Cugat del Vallès Santa Coloma de Gramenet Santa Cruz de Tenerife Santa Lucía de Tirajana Santander Santiago de Compostela Sassari Satu Mare Savona Schiedam Schweinfurt Schwerin Sefton Seixal Sénart en Essonne Setúbal Sevilla 's-Gravenhage Sheffield 's-Hertogenbosch Shumen Šiauliai Sibiu Siedlce Siegen Siirt Sindelfingen Sintra Siracusa Sittard-Geleen Slatina Slavonski Brod Sliven Slough Słupsk Sofia Solihull Solingen Sosnowiec South Tyneside Southampton Southend-on-Sea Southwark Speyer Spijkenisse Split St Albans St. Gallen St.Helens Stalowa Wola Stara Zagora Stargard Szczeciński Stavanger Stevenage Stockholm Stockport Stockton-on-Tees Stoke-on-trent Stralsund Stuttgart Suceava Sunderland Sutton Suwałki Swansea Świdnica Swindon Szczecin Szeged Székesfehérvár Szombathely Talavera de la Reina Tallinn Tameside Tampere / Tammerfors Tamworth Taranto Târgovişte Târgu Jiu Târgu Mureş Tarnów Tarragona Tartu Tczew Telde Telford and Wrekin Terni Terrassa Thanet Thessaloniki Thurrock Tilburg Timişoara Toledo Tomaszów Mazowiecki Torbay Torino Torrejón de Ardoz Torremolinos Torrevieja Toruń Tower Hamlets Trabzon Trafford Trenčín Trento Treviso Trier Trieste Trnava Tromsø Trondheim Tübingen Tulcea Tunbridge Wells Turku Tychy Udine Ulm Umeå Uppsala Ústí nad Labem Utrecht Valence Valencia Valladolid Valletta Valongo Van Vantaa Varese Varna Västerås Veliko Tarnovo Velsen Venezia Venlo Verona Versailles Viana do Castelo Viareggio Vicenza Vidin Vigevano Vigo Vila Franca de Xira Vila Nova de Gaia Viladecans Vilanova i la Geltrú Villingen-Schwenningen Vilnius Viseu Vitoria/Gasteiz Vlaardingen Volos Vratsa Wakefield Wałbrzych Walsall Waltham Forest Wandsworth Warrington Warszawa Warwick Waterford Waveney Weimar Westminster Wetzlar Wien Wiesbaden Wigan Wilhelmshaven Winterthur Wirral Witten Włocławek Woking Wolfsburg Wolverhampton Worcester Worthing Wrexham Wrocław Wuppertal Würzburg Wycombe Yambol York Zaanstad Zabrze Zagreb Zamora Zamość Zaragoza Zgierz Zielona Góra Žilina Zlín Zonguldak Żory Zürich Zwickau Zwolle A Coruña Aachen Aalborg Aberdeen Acireale Adana Aix-en-Provence Ajaccio Alba Iulia Albacete Alcalá de Henares Alcobendas Alcorcón Algeciras Alicante Alkmaar Almada Almelo Almere Almería Alphen aan den Rijn Alytus Amadora Amersfoort Amstelveen Amsterdam Ancona Angoulême Ankara Annecy Antalya Antwerpen Apeldoorn Arad Argenteuil - Bezons Århus Arnhem Arrecife Aschaffenburg Ashford Asti Athina Aubagne Augsburg Aveiro Avellino Avilés Bacău Badajoz Badalona Baia Mare Balıkesir Bamberg Banská Bystrica Barakaldo Barcelona Bari Barking and Dagenham Bârlad Barletta Barnet Barnsley Barreiro Basel Basildon Basingstoke and Deane Bath and North East Somerset Bayreuth Bedford Belfast Benevento Benidorm Bergamo Bergen Bergen op Zoom Bergisch Gladbach Berlin Bern Besançon Bexley Białystok Biel Bielefeld Biella Bielsko-Biała Bilbao Birmingham Blackburn with Darwen Blackpool Blagoevgrad Bochum Bologna Bolton Bolzano Bonn Borås Bordeaux Botoşani Bottrop Bournemouth Bracknell Forest Bradford Braga Brăila Brandenburg an der Havel Braşov Bratislava Braunschweig Breda Bremen Bremerhaven Brent Brescia Brest Brighton