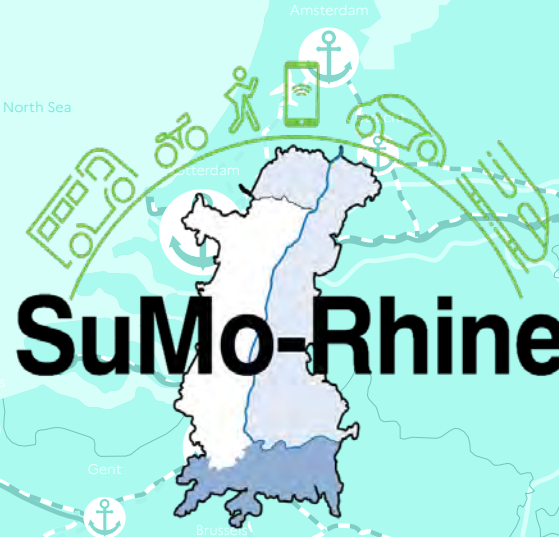

Interreg Programme

Sustainable Mobility in the Upper Rhine Region

July 2018 - December 2021

FINAL RESEARCH REPORT

WP2.8 & Transversal Contributions between WPs

PROOF OF CONCEPT

ATLAS *SuMo*
SuMo STRASBOURG 2030 SCENARIOS

Asso. Prof. Dr. Andreea Grigorovschi (dir.)
UR7309 AMUP – ENSA/INSA Strasbourg and University of Strasbourg
Chair of Innovative Metropolitan Mobility (Coord. WP2.8)

December 2021

amup Architecture, Morphologie / Morphogenèse Urbaine et Projet
ÉCOLE NATIONALE SUPÉRIEURE D'ARCHITECTURE STRASBOURG
PARTENAIRES CAUP TONGJI UNIVERSITY ARTELIA
MOBILITÉS MÉTROPOLITAINES INNOVANTES
Strasbourg, école d'architecture

Scientific Director : Andreea Grigorovschi, Asso. Prof. Dr.

ENSAS Research Team:
Marie Fruiquière, research fellow.
Jeremy Hawkins, assist. professor.
Mete Kutlu, research fellow.
Othmane Hanini, research intern.
Yuanduo Sun, research intern.

Graphic design and layout: Marie Fruiquière
Cover : Mete Kutlu, Marie Fruiquière, 2021

SuMo-Rhine

Programme Interreg

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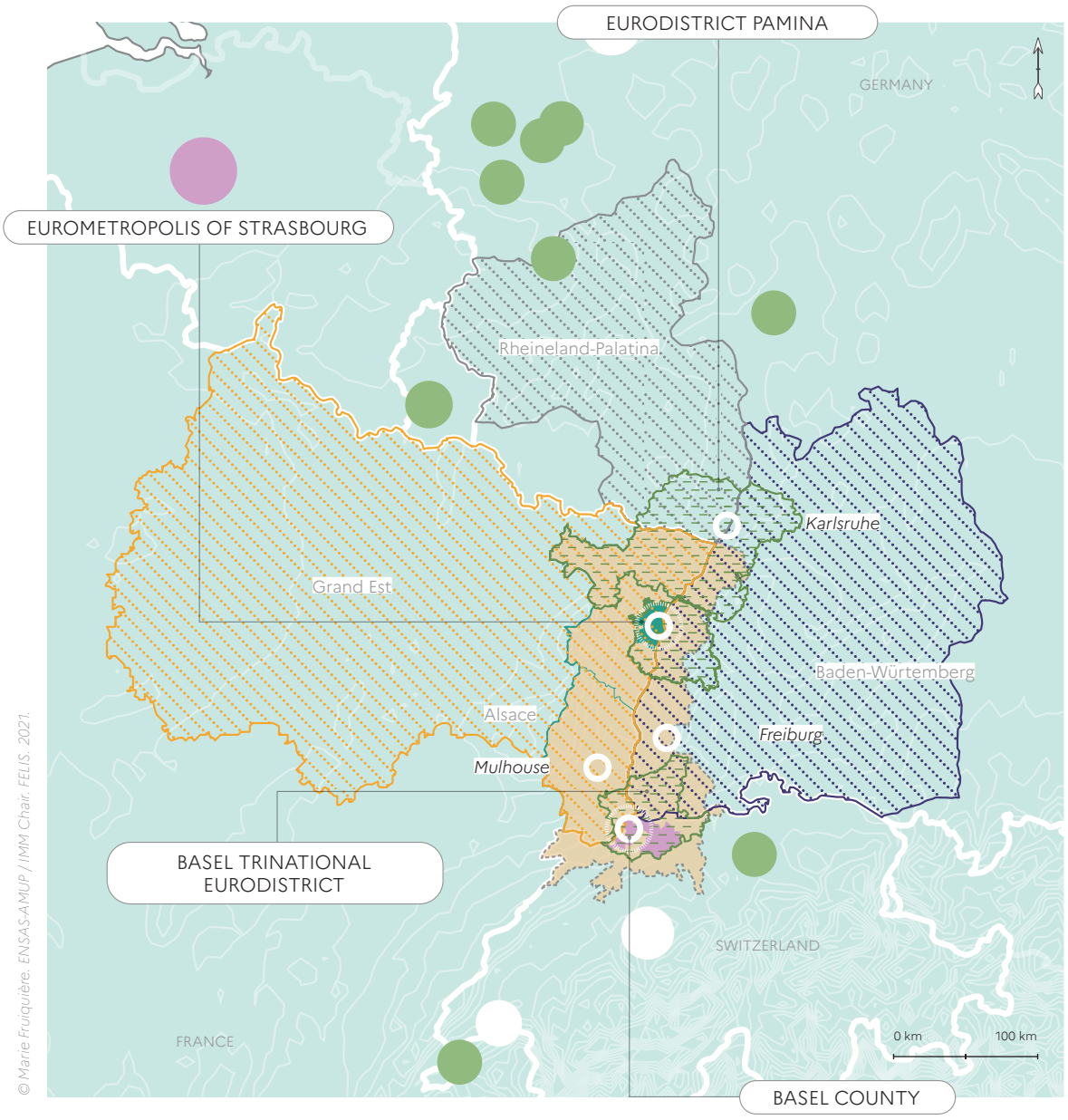
List of acronyms

ACRONYM	FRENCH
ADEUS (fr)	Agence de Développement et d'Urbanisme de l'Agglomération Strasbourgeoise
UR AMUP (fr)	Unité de Recherche - Architecture Morphologie / Morphogénèse Urbaine et Projet
BHNS (fr) **/ BRT** (en/de)	Bus à Haut Niveau de Service
CNRS (fr)	Centre Nationale de la Recherche Scientifique
CTS (fr)	Compagnie des transports strasbourgeois
CUS (fr)	Communauté Urbaine de Strasbourg
DD (fr)	Dévéloppement Durable
DREAL (fr)	Direction Régionale de l'Environnement, de l'Aménagement et du Logement
REEM (fr) **/ EEMN** (en)	Réseau Express EuroMétropolitain
EMS (fr)	Eurométropole de Strasbourg
ENR (fr)	Energies Renouvelables
ENSAS (fr)	Ecole Nationale Supérieure d'Architecture de Strasbourg
FELIS (de)	Chaire de Télédétection et systèmes d'information sur le paysage - Université de Fribourg
GCO (fr)	Grand Contournement Ouest de Strasbourg
HCM (en)	Manuel de capacité des autoroutes
IMM (en)	Chaire des Mobilités Métropolitaines Innovantes
INSA (fr)	Institut National des Sciences Appliquées
KIT – DFIU (de)	Institut de technologie de Karlsruhe - Institut Franco-Allemand de Recherche sur l'Environnement
KIT – ECON (de)	Institut de technologie de Karlsruhe - Institut d'économie
LEED-ND (en)	Certification 'Leadership en matière de conception énergétique et environnementale pour l'aménagement des quartiers'
LETCV (fr)	Loi de transition énergétique pour la croissance verte
LIVE (fr)	Laboratoire Image Ville Environnement
LOM (fr)	Loi d'Orientation des Mobilités
OCDE (fr) / **OECD** (en/de)	Organisation de coopération et de développement économiques
P+R (fr/en/de)	Parking-relais
PADD (fr)	Plan d'Aménagement et de Développement Durable
PAMA (fr)	Plan d'Action des Mobilités Actives
PLUi (fr)	Plan Local d'Urbanisme intercommunal
PREPA (fr)	Plan national de Réduction des Emissions de Polluants Atmosphériques
RER (fr)	Réseau Express Régional
SCOTERS (fr)	Schéma de Cohérence Territoriale de la Région de Strasbourg
SIG (fr) **/ GIS** (en/de)	Système d'Information Géographique
SNBC (fr)	Stratégie Nationale Bas Carbone
TAD (fr)	Transport à la demande
TOD (en)	(Développement orienté vers le transport en commun)
TSPO (fr)	Transport en Site Propre Ouest strasbourgeois
UHA (fr)	Université de Haute Alsace
Unistra (fr)	Université de Strasbourg
VAE (fr)	Vélo à Assistance Electrique
VLIO (fr)	Voie de Liaison Intercommunale Ouest strasbourgeois
WP (en) / **AP** (de)	Lot de travail / tâche
ZFE (fr) **/ LEZ** (en)	Zone à Faibles Emissions

ENGLISH	GERMAN
Development & Urbanism Agency of Greater Strasbourg	Agentur für Städtebau und Stadtplanung des Ballungsraums Straßburg
AMUP Research Unit	Forschungseinheit AMUP
Bus Rapid Transit	Bus Rapid Transit
French National Centre for Scientific Research	Nationales Zentrum für wissenschaftliche Forschung
Strasbourg Transport Company	Straßburger Transportgesellschaft
Urban Community of Strasbourg	Gemeindeverband Straßburg
Sustainable Development	Nachhaltige Entwicklung
Regional Directorate for Environment, Planning and Housing	Regionaldirektion für Umwelt, Raumordnung und Wohnungsangelegenheiten
Express EuroMetropolitan Network	Eurometropolitan Express-Netzwerk (EEN)
Eurometropolis of Strasbourg	Eurometropole Straßburg
Renewable energies	Erneuerbare Energien
Strasbourg National School of Architecture	Nationale Hochschule für Architektur Straßburg
Chair of Remote Sensing and Landscape Information Systems – University of Freiburg	Professur für Fernerkundung und Landschaftsinformationssysteme - Albert-Ludwigs-Universität Freiburg
Great Western Bypass	Große Westumgehung/Westumfahrung von Straßburg
Highway Capacity Manual	Handbuch der Autobahnkapazität
Innovative Metropolitan Mobility Chair	Lehrstuhl für Innovative Mobilität in Ballungsräumen
National Institute of Applied Sciences	Nationales Institut für angewandte Wissenschaften
Karlsruhe Institute of Technology - French-German Institute for Environmental Research	Karlsruher Institut für Technologie - Deutsch-Französisches Institut für Umweltforschung
Karlsruhe Institute of Technology - Institute of Economics	Karlsruher Institut für Technologie - Institut für Volkswirtschaftslehre
Leadership in Energy and Environmental Design for Neighborhood Development certification	Zertifizierung ‚Führend in energie- und umweltgerechter Planung für Stadtviertelentwicklung'
Energy transition law for green growth	Gesetz zur Energiewende für grünes Wachstum
Image, City, Environment Research Unit	Labor Bild, Stadt, Umwelt
Mobility Orientation Law	Gesetz zur Orientierung der Mobilität
Organisation for Economic Co-operation and Development	Organisation für wirtschaftliche Zusammenarbeit und Entwicklung
Park & Ride	Park + Ride
Sustainable Development Plan (French planning doc)	Plan für nachhaltige Raumordnung und Entwicklung
Active Mobility Action Plan	Maßnahmenplanung für aktive Mobilität
Intercommunal Local Urbanism Plan	Interkommunaler Flächennutzungsplan
French National Plan for the Reduction of Air Pollutant Emissions	Französischer Plan zur Reduzierung der Luftverschmutzungsemissionen
Regional Express Railway Network	Regionales Expressbahnnetz (S-Bahn-artig)
Territorial Coherence Plan for the Strasbourg region	Territoriales Kohärenzschema der Region Straßburg
Geographic Information System	Geoinformationssystem
French National Low Carbon Strategy	Nationale Niedrigemissionsstrategie Frankreichs
Transport on demand	ÖPNV-Sonderformen (bedarfsorientierter Transport)
Transit-Oriented Development	Transitorientierte Entwicklung
Transportation in exclusive right-of-way west (Strasbourg)	Transport auf eigener West-Strecke, Straßburg
University of Haute Alsace	Universität des Oberelsass
Strasbourg University	Universität Straßburg
Electric Bicycle	Elektrofahrrad
West Strasbourg Intercommunal Link Road	Interkommunale Verbindungsstraße West-Straßburg
Work package	Arbeitspaket
Low emission zone	Umweltzone / Niedrigemissionszone



STATEMENT

High environmental impact of the transport sector in the Upper Rhine region (in FR approx. 31%, in CH approx. 32%, in DE approx. 20% of national CO2 emissions). The modal share of **cross-border journeys** is largely **dominated by the car** due to a **lack of green mobility alternatives.**

STAKES

High demand for **sustainable and reliable transport concepts for cross-border mobility** in border regions. **How can we promote the sustainability of cross-border mobility ?**

GOALS

Development of a **system of indicators to evaluate the quality and the sustainability of the mobility systems** in the Upper Rhine region. Identification, feasibility study and operationalisation of relevant indicators. Formulation of strategies taking into account **applicability for municipalities and stakeholders.**

INTRODUCTION

General presentation of the SuMo Rhine research programme

The transport sector is essential for the cohesion, competitiveness, and quality of life of the Upper Rhine Region. However, the sector is costly and causes high emissions of pollutants. In particular, road transport also contributes to the emission of gases that are harmful to public health. Today, passenger and freight transport accounts for about 32% of national greenhouse gas emissions in Switzerland, about 31% in France and 20% in Germany. However, sustainable mobility concepts should not stop at national borders. It appears that common and multinational transport concepts could create considerable synergies to reduce the environmental impact of cross-border transport.

Against this background, the «SuMo Rhine - Promotion of sustainable mobility in the Upper Rhine region» project was launched on 1 July 2018. It aims to help the municipalities of this territory to set up and develop sustainable cross-border transport systems by proposing a new «decision support system». This tool, consisting of composite indicators for the evaluation of sustainable mobility, is intended to be the cornerstone of the recovery of mobility in border regions. The aim is to make these sustainable mobility indicators available both to local actors and to the general public, in order to identify more precisely the potential for improving transport services with low environmental impact and for increasing the market share of alternative modes of transport. Modern multimodal transport concepts with a high proportion of non-motorised routes or electric mobility are considered here as fundamental elements of sustainable mobility. In addition to the positive effects on the environment, they are also understood in terms of the considerable secondary effects they can have on the economy and the health of the population. The aim of the SuMo Rhine research project is therefore to act as an observatory for mobility systems in the Upper Rhine region, but also to identify instruments that could make this area a model for the development of mobility in other European border regions[1].

Coordinated by KIT-DFIU, the research was carried out by a multidisciplinary consortium of economists, sociologists, geographers, urbanist-architects, and computer developers. The studies are divided into 4 modules (see figure p.10).

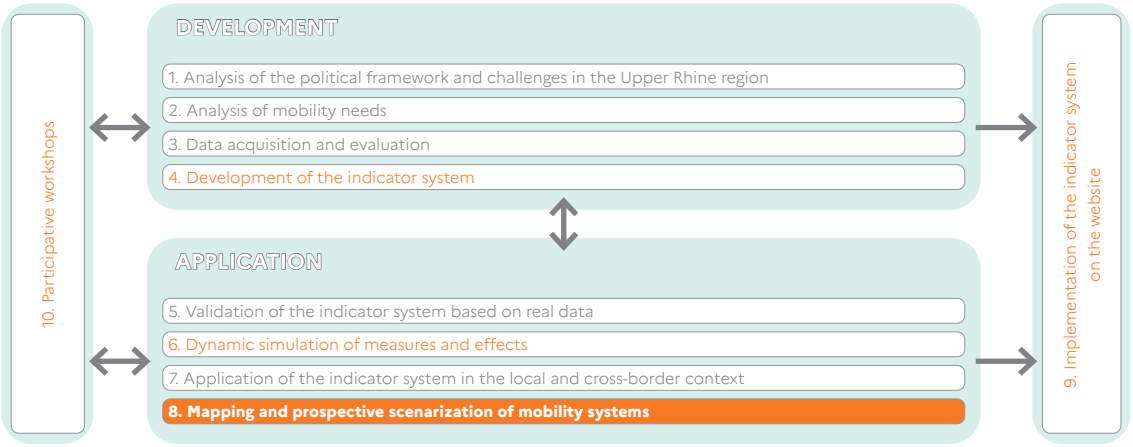
The first module, «Development», concerns the creation of an information base on the Upper Rhine region. This includes a study of cross-border mobility conditions (policy objectives, local influencing factors, etc.) (WP2.1. - Sc. Coord. KIT-ECON), the results of a cross-border survey on commuters' mobility needs (WP2.2. - Sc. Coord. Uni-Landau) and a compilation of existing data on transport flows and infrastructure for the construction of the indicator system (WP2.3. & 2.4. - Sc. Coord. FELIS).

The module «Areas of application» refers to both the examination of planned or completed mobility projects and the use of the evaluation tool. The Indicator System was tested in the field with the City of Lorräch (WP2.5. - Sc. Coord. FELIS). This task is in line with the objectives of WP2.7. (Sc. Coord. Unistra-LIVE / CNRS) in the analysis of already-implemented projects such as the effects of the extension of the tramway line 3 from Basel to Saint-Louis. In addition, specific simulations have been carried out at a local level for the prospective application of this evaluation tool in order to predict the possible impacts of mobility policies (WP2.6. - Coord. Unistra-LIVE / CNRS - UHA). This task is closely linked to WP2.8. which is coordinated by our research team at ENSAS-AMUP / IMM Chair. This report describes in detail the studies carried out in the framework of the latter task to test the applicability of the Indicator System, the visualisation of its results and its potential as a decision support tool.

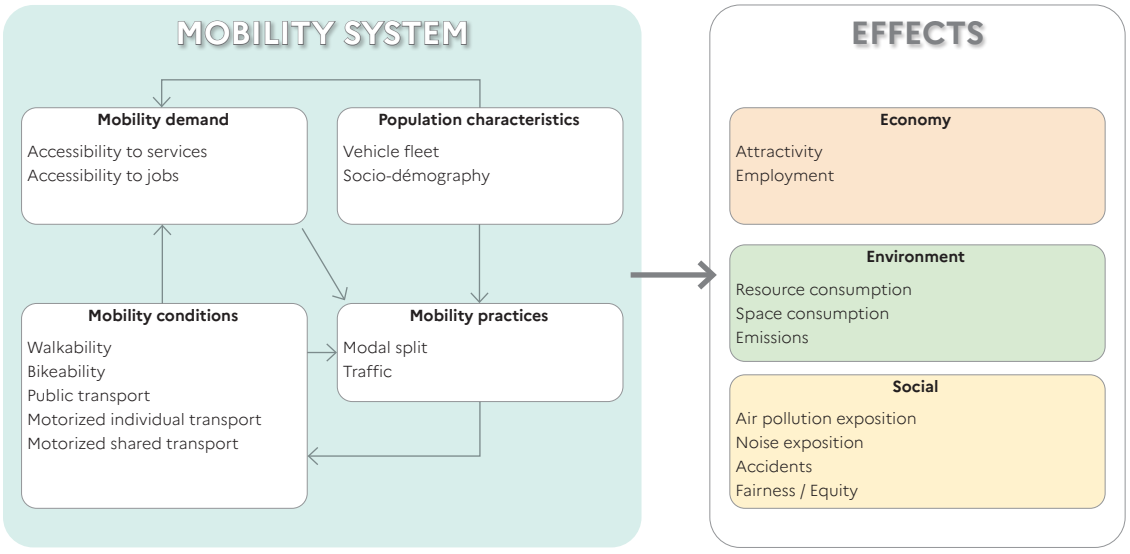
In parallel, the «Participatory Workshops and Symposia» module created collaborative and transnational interfaces between project activities, project partners and stakeholders with an interest in the project.

Finally, the module «Implementation of the Indicator System on the website» has the task of implementing the evaluation tool developed on the online website.

1 https://sumo-rhine.com/fr/



The multidisciplinary approach in the SuMo Rhine project - *Coordination and contributions of the ENSAS-AMUP / IMM Chair in the different work packages (WP)*



The SuMo Rhine project seeks to make sustainable mobility **measurable, visible and comparable** at the municipal level in the Upper Rhine Region. The indicators developped by the research team assess the conditions of a:
_**Mobility system** (mobility offer, transport demand, mobility pattern) ;
As well as its *Effects* on:
_**Environment** (resource consumption, CO^2 emissions, land consumption) ;
_**Social** (pollution, traffic accidents) ;
_E**conomy** (accessibility to transport, congestion, intermodality).

The SuMo Rhine Indicator System - *A composite of key factors and effects*

Objective, posture et general problematic

WP2.8. Cartography and prospective scenarisation of mobility systems

Action Coordinator: ENSAS-AMUP / IMM Chair

Academic Partners: FELIS, Unistra-LIVE / CNRS, KIT-DFIU, Universität Koblenz-Landau
Associated Partners: ZAEU, City and Eurometropolis of Strasbourg, ADEUS, Eurodistrict Strasbourg-Ortenau, INSA Strasbourg, Grand Est Region, SCOTERS

While the objectives of the SuMo Rhine research programme focus on the indicator approach to mobility, our work (carried out in particular within WP2.8) has focused more specifically on the places and territories of Upper Rhine mobility from a more qualitative and situated understanding. The latter resonates with and complements the more quantitative, statistical, and data-driven approaches developed by other research teams in the consortium, particularly in the development and application of the SuMo Indicator System.
Linked to the disciplinary field of urban architecture, our positioning and our analytical tools are thus based on the human and social sciences, favouring an approach that considers space both in terms of its physical and formal aspects, but also in terms of its impalpable and difficult-to-measure dimensions linked to perceptions, mental representations, and individual and collective imaginations (Lussault, 2003; Secchi, 2008) that fill them with meaning and help to shape the quality of places and territories. In this sense, mobility, as a distribution system (of people and goods), is the support of the spatial framework of architectural objects, but it is also an urban material, a landscape, a practice, and a cultural representation in its own right - and therefore a project material intrinsically linked to other systems, materials, actions, and ideas that shape our territories.
Thus, the central hypothesis of our work is that mobility, beyond the questions of efficiency, competitiveness, and accessibility of territories, also represents a problem of spatial, landscape and ecological design and finally a major stake in the present and future habitability of our environment.

By mobilising the tools for reading and designing the architectural, urban and landscape project, we are interested in the meaning that sustainable mobility takes (and could take in the future) in the Upper Rhine territory, in complementarity and on the basis of data, evaluations and modelling developed by and with our fellow researchers of the consortium. By meaning, we mean on the one hand the value that we as societies (but also nations and communities) give to the different aspects of mobility that we experience today, a value that is reflected in the spatial choices and infrastructural facilities of specific places and territories. But also, meaning as possible and desirable future aims and directions to achieve «sustainable mobility», conditioned by future societal choices and intrinsically linked to transformations of the spatial and ecological conditions and qualities of our cities and territories.
As professionals of spatial design, we propose to reflect within the SuMo Rhine consortium on mobility as spatiality - as architecture, landscape and atmosphere stemming from various rationalities (Vigano, Fabian, Secchi, 2016), but also as a lever for ecological and environmental transition of our living spaces. For this reason, in our contribution we have sought to take into account the relationships between mobility, its practices and its places, the architecture of the city and its territories, other major infrastructural frameworks (hydrography, natural corridors, etc.), densities and built forms, etc., in a systemic and complex understanding of our living environments.
We have thus begun to explore, on different spatial and temporal scales, the link between public policy visions and the choice of transport systems, the possibilities of including infrastructures in the territory and their effects in terms of the organisation of urban spaces, landscape ecosystems and cross-border balances, by trying to examine the levers of action to support the ecological and energy transition of the territories in the light of mobility. The challenge of this work was to contribute to the construction of the Indicator System and to experiment with its potential by testing its operation and its limits.
In this quest for the meaning of sustainable mobility in the Upper Rhine region, three families of questions have guided our work:

Can the SuMo Indicator System integrate the qualitative aspects of mobility spaces?
How to define spatial quality? How can the quality of a space be transcribed into numerical data? Can we make sense out of figures alone? How can we understand and interpret the differences in the quantitative evaluation of Rhine cities? How can the qualitative dimension be introduced into the territorial analysis of mobility? How can we ensure that the SuMo Indicator System becomes a tool for producing knowledge and a decision-making tool rather than an evaluation tool that encourages competition between territories?

What kind of knowledge can the SuMo Indicator System produce?
What are the relevant scales and units of calculation and representation to «make the indicators speak» in relation to the current territories? What graphic and cartographic representations should be used to inject a more spatial and qualitative understanding of mobility into indicators calculated on the basis of quantitative and georeferenced data?

How can sustainable mobility be achieved in an Upper Rhine city?
What society and vision of the future for what

mobility? How can we characterise the new mobility policies and the positions of local politicians in terms of territorial and urban planning? What is the role of an evaluation tool such as the Indicator System in the framework of a prospective project that seeks to explore the levers of sustainable mobility and ecological transition?

While the first family contains the basic questions that guided our contributions in the phase of defining the Indicator System, its variables and its possible uses through the online platform (Axis 3), it is the other two categories of questions that formed the basis of the work that we carried out and piloted within WP2.8 (Axes 1 and 2). After the construction of the SuMo Indicator System, this work concerned the development of two applications of the latter: one aimed at investigating and producing knowledge on the existing state of mobility in this territory through a collection of maps that we proposed to call the SuMo Atlas (Axis 1); the other with a more prospective aim, of modelling and evaluating sustainable mobility scenarios centred on the Strasbourg metropolis (Axis 2)

In these reflections, various hypotheses have guided our work:
The first refers to the importance of the quality of mobility spaces, which is for us a given. In this sense, we put forward the idea that, despite its quantitative character, the SuMo Indicator System and the web tool that will result from it could - and should - integrate qualitative aspects (even if only partially) from its definition phase.
Secondly, with regard to its potential, we hypothesise that the Indicator System could be not only a measurement tool but also a tool for generating more situated and contextual knowledge.
Finally, while sustainability is a shared value when thinking about the future of our urban environments and systems, sustainable mobility does not refer to single, generally valid solutions. It is an intellectual construct subject to debate. The hypothesis we make is that the exploratory scenario tool opens up a critical space for thinking about these issues and that the use of the Indicator System in such a foresight approach could not only feed into this debate, but also inform decision-making.

Structure of the report

The report is organised in such a way as to give an account of the three lines of investigation which have structured our work. They combine the notion of sustainable mobility with the search for spatial quality and levers for the ecological, social and energy transition of inhabited territories:

AXE 1 :
SuMo Atlas | Multi-scale mapping and visual analytics for the analysis of current mobility systems and urban environments in the Upper Rhine (WP2.8)

AXE 2 :
SuMo Scenarios | | Infrastructures and their relationship to the city, sustainable mobility policies and transition levers in the territorial scenarios for Strasbourg 2030 (WP2.8)

AXE 3 :
For a more qualitative reading of mobility territories | Contribution to the methodology for building systems for reading, representing, and assessing the value of mobility systems and their impacts (WP2.4 & WP2.6)

Method

From our contributions to the definition of the Indicator System (WP2.4), to the proposals for the construction of the *SuMo digital webtool* (WP2.5), through the development of two applications of the system of indicators (the *SuMo Atlas* and the *SuMo Exploratory Scenarios*) that we piloted within WP2.8, it is the articulation between mobility and urbanism that has been at the heart of our concerns. From a methodological point of view, the tools and means implemented by the ENSAS-AMUP / IMM Chair research team try to answer in a transversal way to the three proposed axes.

State of the art. The research work is based first of all on a corpus of references, both theoretical and visual, which has supported the reflections on the production and visualisation of new forms of knowledge about a territory (both abstract / digital and contextual / qualitative, and their articulations).
This repertory concerns first of all a state of the art on the notion of spatial quality and its articulation with a quantitative evaluation system (Axis 3).
This point was also addressed by the search for graphic references concerning the representation and visualisation of quantified and georeferenced results from indicators. Serving as a reference bank, these sources of inspiration showed us the multiplicity of possible modes of representation but also the limits in the confrontation of quantitative and qualitative data (Axes 1 and 3).
These questions led us to also look for references relating to techniques and modes of knowledge sharing via online platforms and tools (SuMo webtool), focusing on interactive platforms that allow us to imagine the reading of the territory through indicators and through its morphological, landscape, sensory/sensitive realities, etc. (Axis 3).

Development. On a practical level, the Upper Rhine has been the field of support for all the research and experimentation on the various applications of the SuMo Indicator System. Moreover, due to its proximity, the Eurometropolis of Strasbourg was a central case study in our contribution.
First of all, it consists of a cartographic approach to the existing mobility systems in this territory, in the light of the first results of the indicators (Axis 1). This work is presented in the form of a transcalar atlas and is based on close

collaboration with the FELIS research team, whose first attempts to operationalise and calculate the Indicator System served as a basis for the development of a method for mapping these results and the first SuMo maps constructed on different terrains and scales, and according to several indicators.
As part of our contribution to the definition of the Indicator System (WP2.4), echoing the theoretical references on the integration of spatial quality by indicators, our team used the analysis of Strasbourg's urban fabrics to try to identify new indicators and parameters relating in particular to the sensory perception of mobility spaces (Axis 3).
The Eurometropolis of Strasbourg was also the laboratory for exploring the possibilities of the Indicator System as a prospective tool (Axis 2). Based on an analysis of the context and issues related to mobility and the metropolitan project (studies of planning documents, political discourses, and expert opinions), we proposed two exploratory scenarios of urban mobility. These visions have been parameterized in GIS data for their evaluation by the Indicator System. This task was one of the main missions of a research intern (supported by the ZAEU) whose activity benefited from a shared supervision between the research teams of ENSAS-AMUP / IMM Chair in a first phase (support in the elaboration of the scenarios), and Unistra-LIVE / CNRS (cartographic evaluation of the scenarios by the indicator system).

Frameworks for shared reflection. Finally, our research team benefited throughout the project from external and multidisciplinary expertise.
Bilateral or trilateral meetings (face-to-face or by video) with our colleagues from the other consortium teams have punctuated and enriched our progress throughout the research. As mentioned above, this concerned in particular the development of the Indicator System (WP2.4) and the associated web platform (WP2.5), with the FELIS team, but also the work carried out in cooperation with Unistra-LIVE / CNRS for the prospective application of the Indicator System through the evaluation of scenarios (WP2.6 & 2.8).
More broadly, the *Annual Retreat Meeting* and the monthly meetings have been opportunities for sharing and co-construction with the whole consortium, especially during internal workshops (such as the one organised by our team in 2020).
Finally, we were able to organise a participatory workshop in March 2021 which allowed for exchanges with local mobility stakeholders in the Strasbourg context. This event focused on the two applications developed in the framework of WP2.8 and gathered representatives from the mobility department of the Eurometropolis of Strasbourg, the ADEUS, the Eurodistrict Strasbourg-Ortenau and the Grand Est Region.

Overall, the tools and methods used by our research team at ENSAS have made it possible to set up a demonstration of possibilities and contribute to the formulation of multiple forms of feedback on the very construction of the SuMo Indicator System, by pointing out its stakes and limits in a theoretical as well as operational way.

AXIS 1

SUMO ATLAS

MULTI-SCALE MAPPING AND VISUAL ANALYTICS FOR THE ANALYSIS OF CURRENT MOBILITY SYSTEMS AND URBAN ENVIRONMENTS IN THE UPPER RHINE

To explore the potential of the SuMo Indicator System in terms of generating knowledge about the existing state of mobility in the Upper Rhine, we proposed the development of a multi-scale atlas based on the results of the SuMo Indicator data processing.

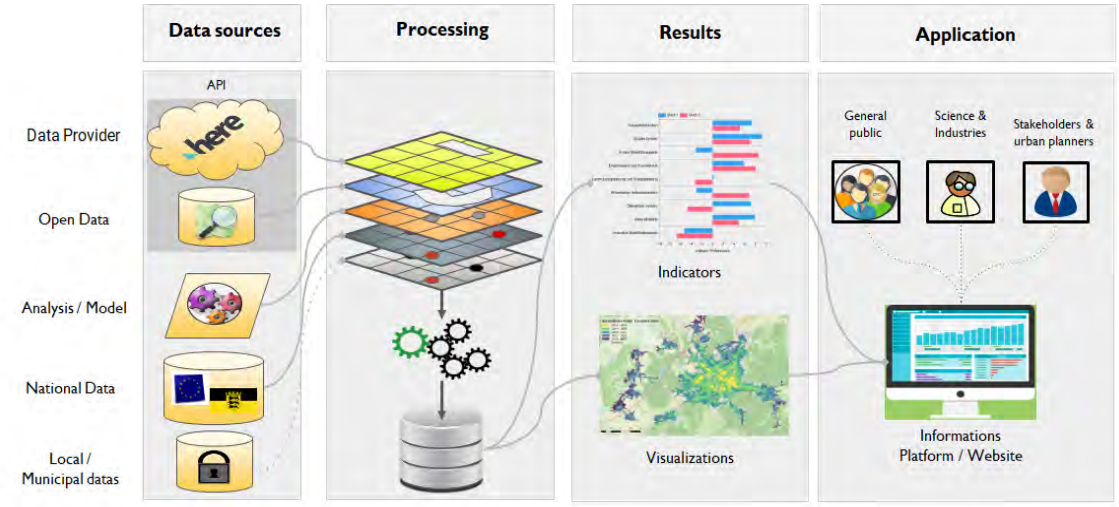
The SuMo Atlas is envisaged as a collection of transcalar and multi-criteria cartographic and visual representations of mobility, which could become a basis for investigation and a framework for reflection common to the whole cross-border region. From the scale of the Upper Rhine to the heart of the municipalities, its objective is to propose different levels of analysis and to produce contextual knowledge through various modes of calculation and representation.
Within the framework of WP2.8, the atlas has been elaborated at the methodological and conceptual levels, but also in a practical way, through «pilot» maps which constitute a demonstration of its feasibility for its future development (proof of concept).

This work was carried out in collaboration with the FELIS research team, which is responsible for the development of the Indicator System, data collection and processing.

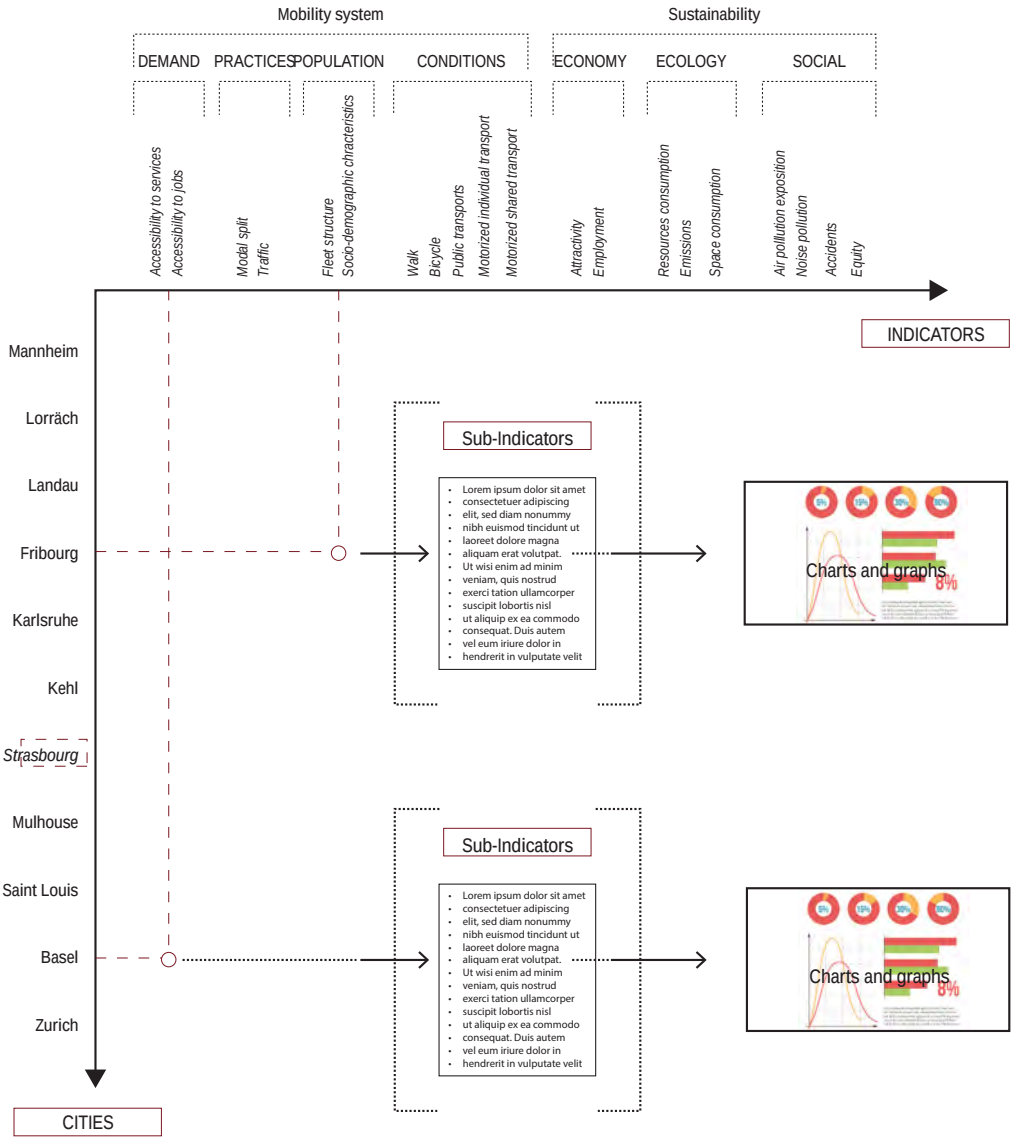
Methodological development of cartographic representations

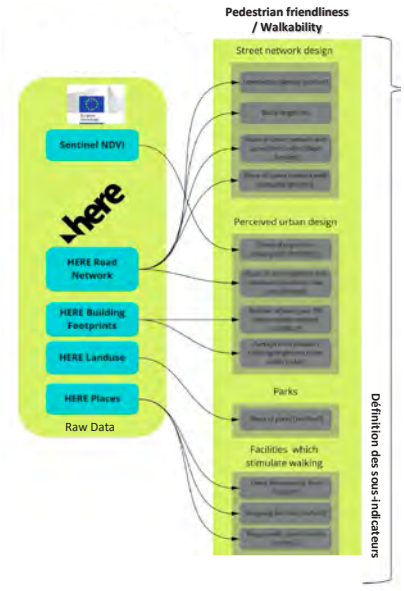
In order to place this work in the context of the research, we recall the development process and the basic functioning of the Indicator System, presented below in 4 stages: the collection of data from various sources that contributed to the definition of the indicators and, above all, the raw data that serve as a basis for the evaluation (*Data sources*); followed by the processing of these data according to the calculation formulas for each indicator (*Processing*); to obtain a diagnosis of the mobility systems in the form of numerical values translated into analytical visuals (graphs) and spatialised through maps (*Results*); these results will then have to be fed into the online interactive platform that will allow them to be disseminated to the various stakeholders and the general public (*Application*).
As a reminder, each indicator is calculated on the basis of sub-indicators, which are themselves calculated from raw data (see diagram on page 16).

Focusing on the *Results stage,* our work consisted in thinking, in conjunction with the FELIS team, about how to carry out a spatial diagnosis of the mobility systems and to build the first maps and analytical visuals that will feed the SuMo Atlas.



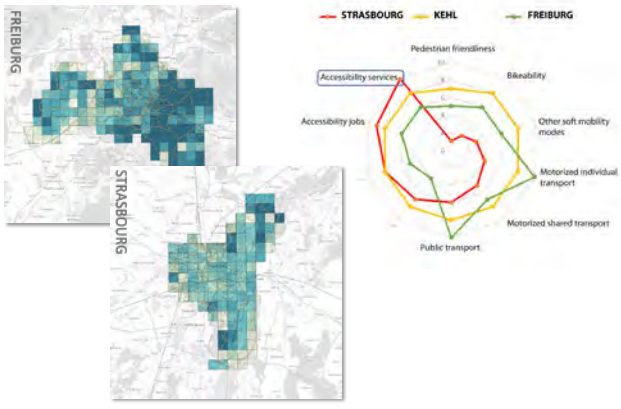
Process and application of the Indicator System - *Cartographic visualisations, tools for territorial diagnosis and mediation of results with local actors and the general public.*





Graphical and mapped visualization of the results of the indicator system

Mirror cities through quantitative data and their geolocation

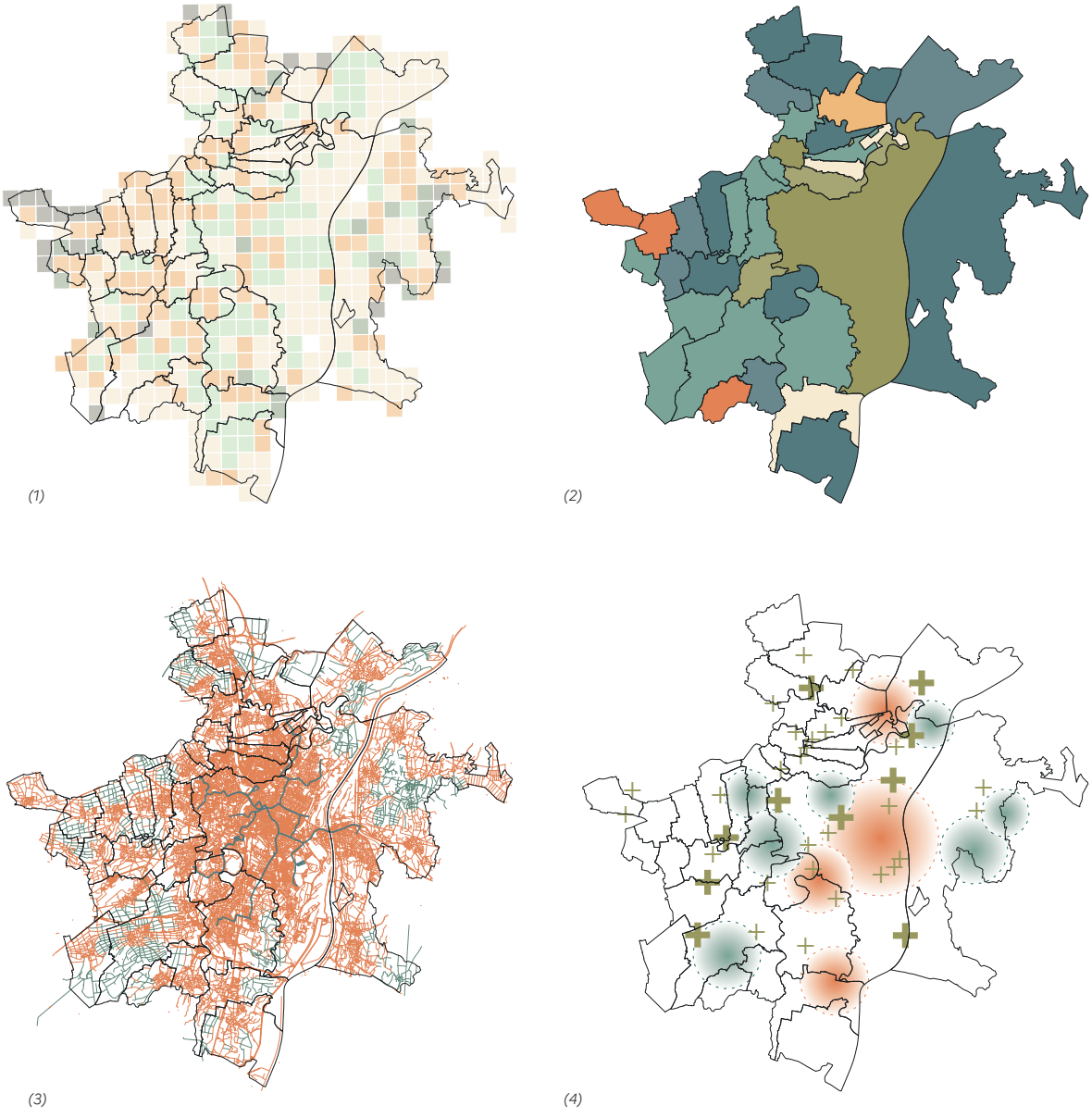


To propose a double reading of the results of the Indicator System by cities and by indicators *- From raw data to graphic and mapped visualisations*

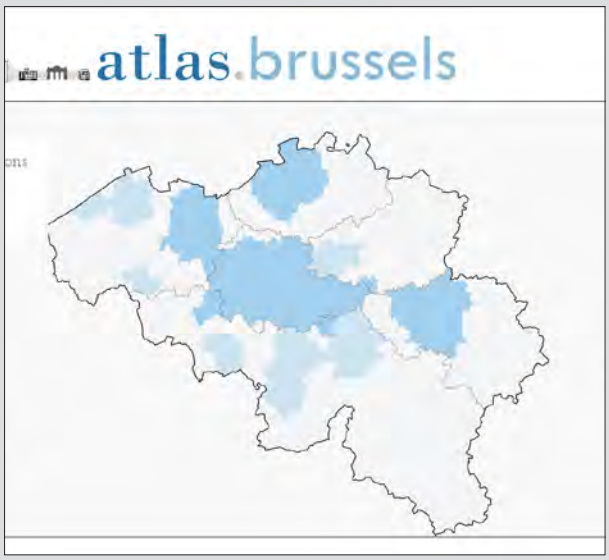
COLLECTING (CARTO)GRAPHIC REFERENCES

Commonly, the graphic language for communicating quantitative results is based on tables, graphs and, where appropriate, the geolocation of these data. Within the framework of the SuMo Rhine project and for the construction of the Atlas, the ENSAS research team first carried out a preparatory work of collection and analysis of graphic and cartographic references centred on the spatialized representation of quantitative data. This non-exhaustive state of the art (see extracts pp. 18-21) highlighted different types of possible spatial representation for quantitative data (see figure below), such as:

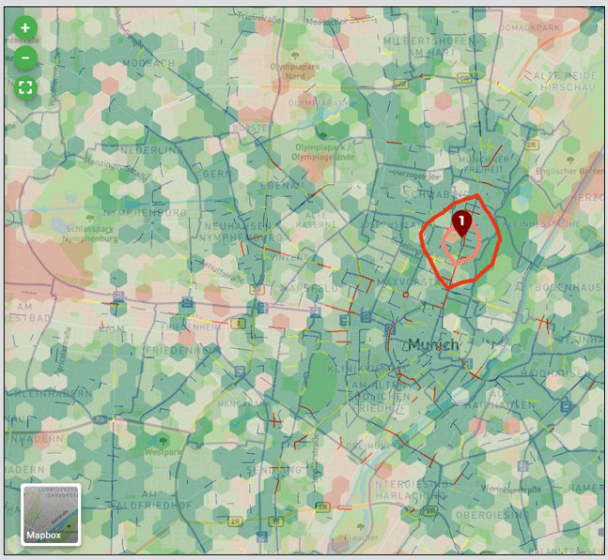
- A **grid (1)**, either rectangular or hexagonal, as a reference unit of measurement in the calculation of data. In this case, it is often averages within a closed unit;
- A **delimited administrative/geographical area (2)**, of a city or a district for example and on which an average is made on the same principle as the grid;
- A line (3) or section of a way that thickens or changes colour to represent a route and/or a certain intensity of the result represented;
- A punctuating shape (4) such as a point or a circle whose diameter is more or less large depending on the intensity or importance.



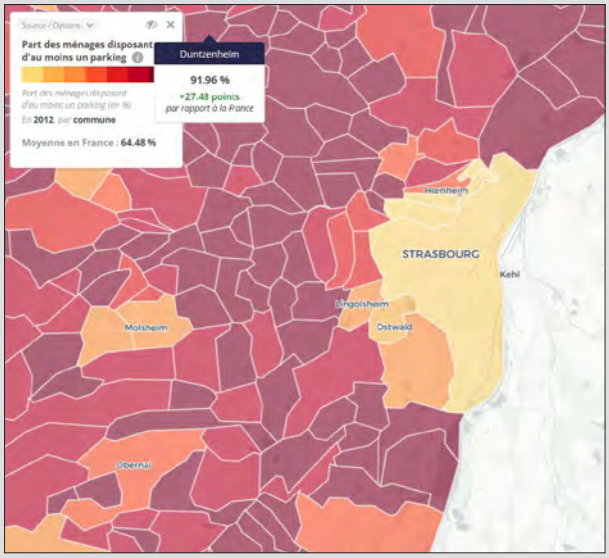
The different types of data representations on a territory *- The grid and the geographical area selected for the calculation and visualization of data in the SuMo Rhine project*



Atlas Brussels. *Olivier Finance, Arnaud Adam.*
https://atlas.brussels/explore.html

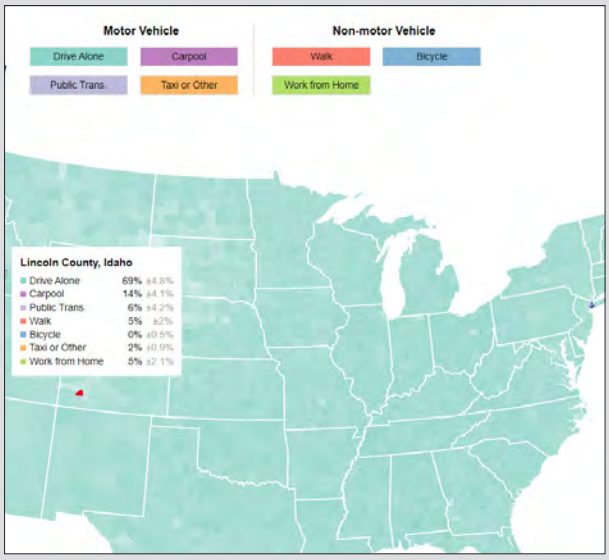


GOAT, Geo Open Accessibility. *2020.*
https://www.open-accessibility.org/

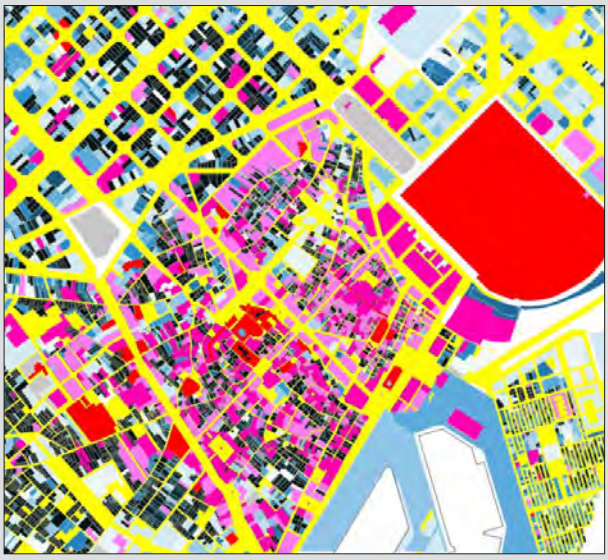


Data France. *Part des ménagements disposant d'au moins un parking. 2021.*
http://map.datafrance.info/population

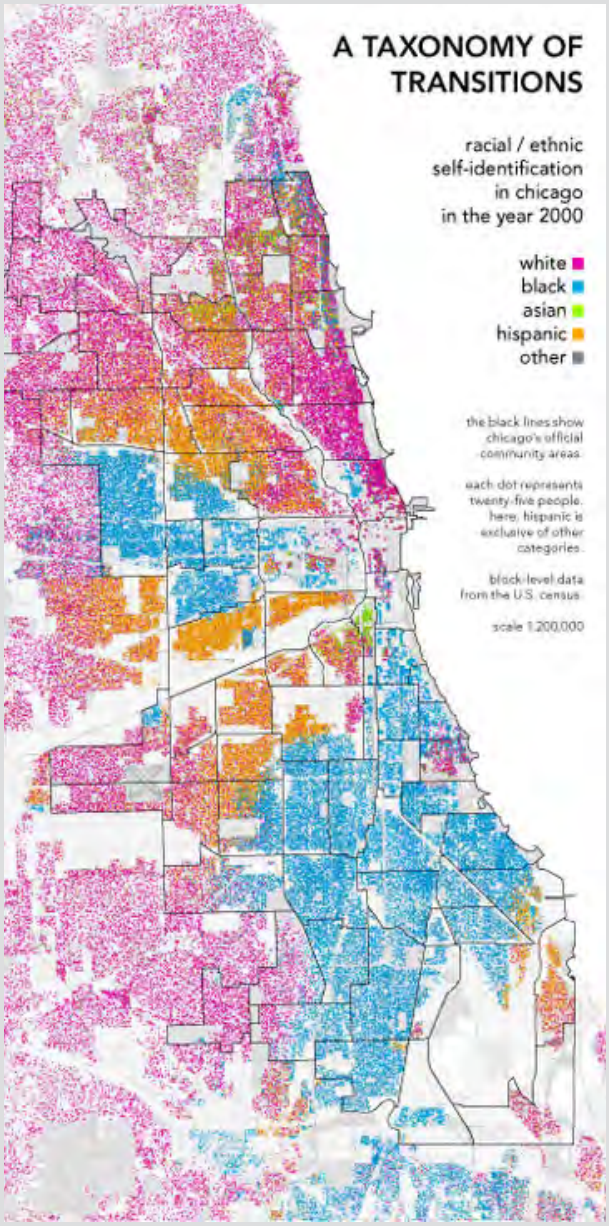
L'Institut Paris Région. *Gisement solaires des toitures franciliennes. 2018.*
https://cartoviz.institutparisregion.fr/?id_appli=psidf&x=650815.5887385339&y=6868202.558447169&zoom=12



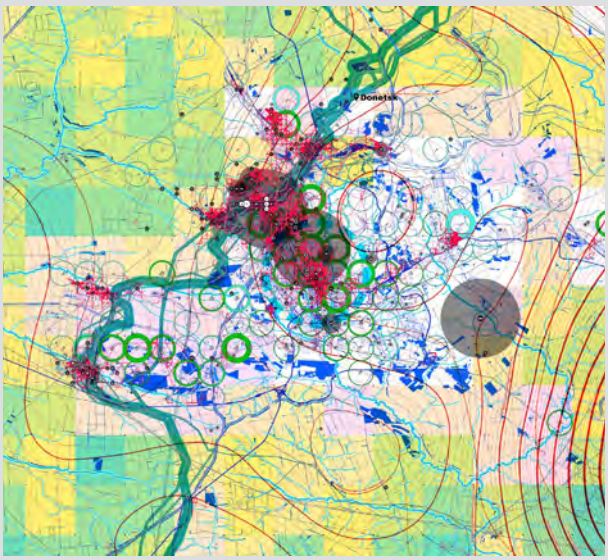
How American Get to Work. *Nathan Yau. 2013.*
https://flowingdata.com/2015/01/20/how-americans-get-to-work/



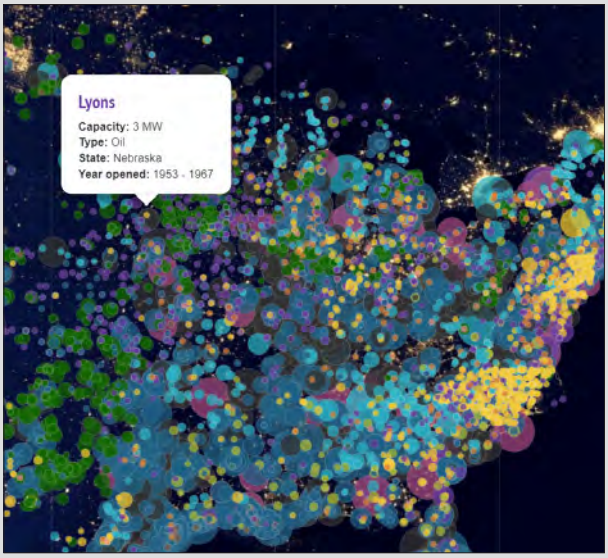
Traces Barcelona. *300000 km/s. 2018.*
http://bigtimebcn.300000kms.net/



A taxonomy of transitions. *Bill Rankin. 2009.*
http://www.radicalcartography.net/index.html?chicagodots

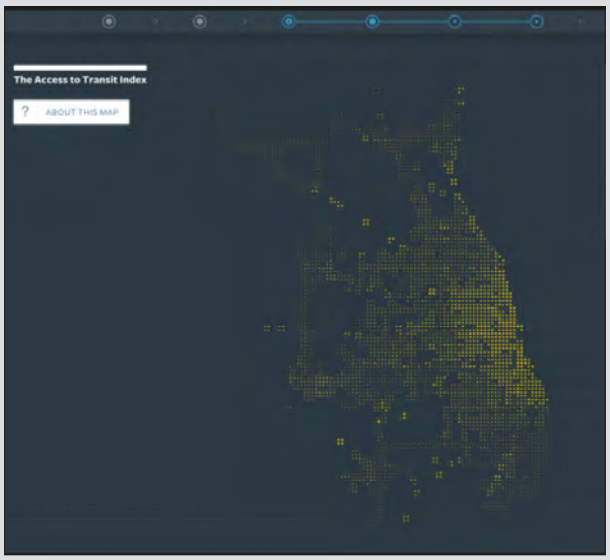


Data War. *300000 Km/s. 2016.*
https://300000kms.net/case_study/data-war/

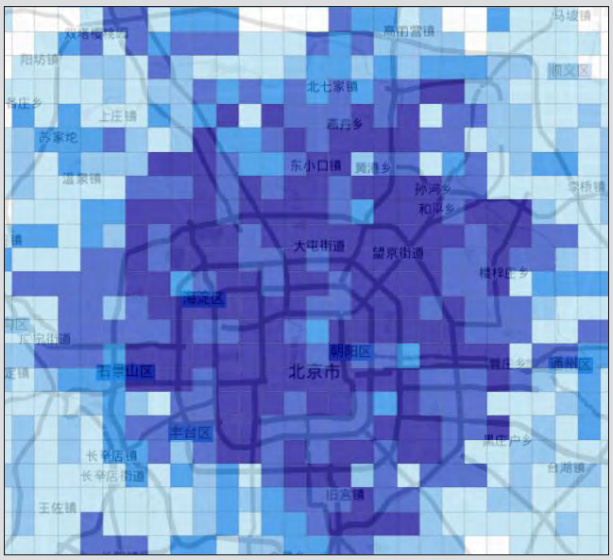


US electricity sources. *Simon Evans, Rosamund Pearce. 2017.*
https://www.carbonbrief.org/mapped-how-the-us-generates-electricity

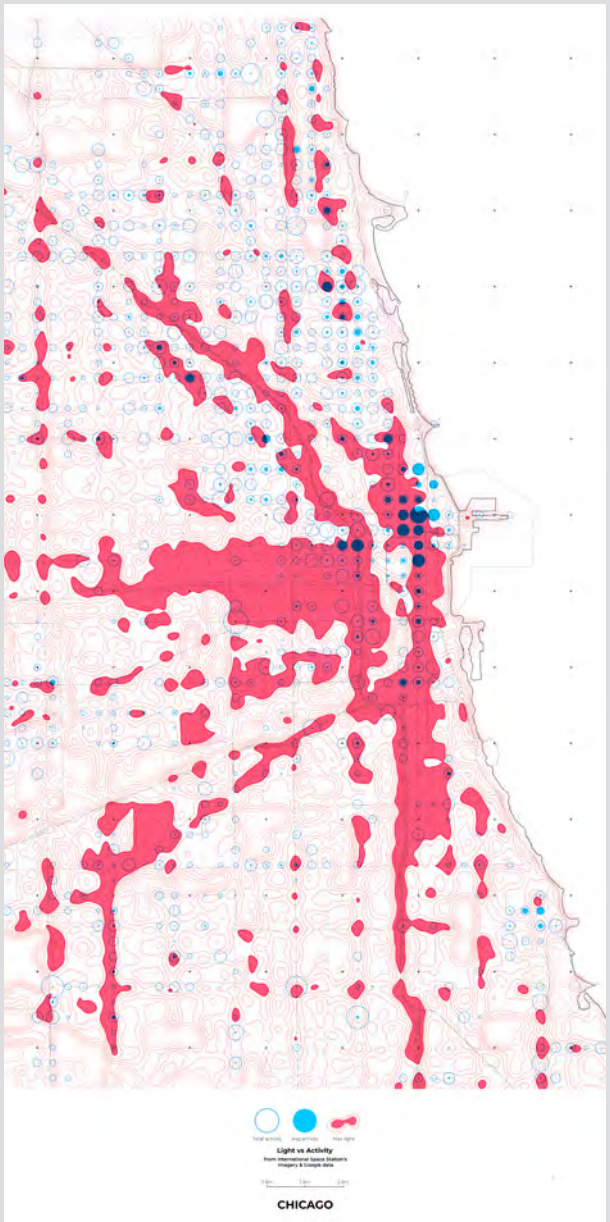
Bike mobility in London. *Eden Au. 2019.*
https://edenau.github.io/maps/density-evening/



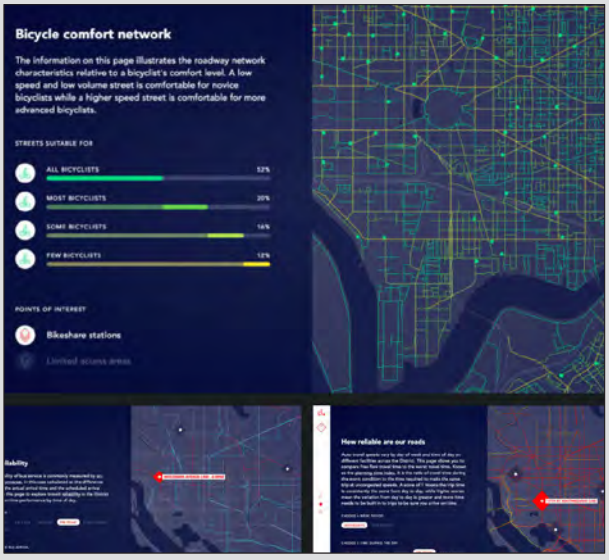
Chicago Mobility. *Chicago Metropolitan Agency for Planning. Thomas Clever. 2014.*
https://www.cmap.illinois.gov/mobility/explore#/



Binning on map - Beijing. *Apache ECharts.*
https://echarts.apache.org/examples/zh/editor.html?c=map-bin

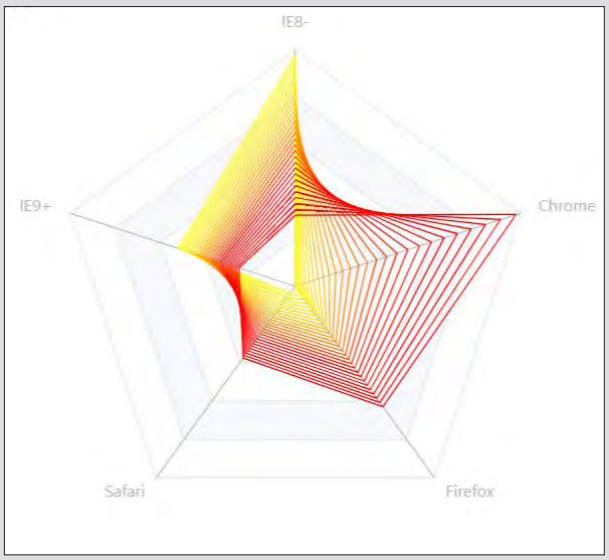


Nightscapes. *300000 Km/s. 2019.*
https://300000kms.net/case_study/nightscapes/

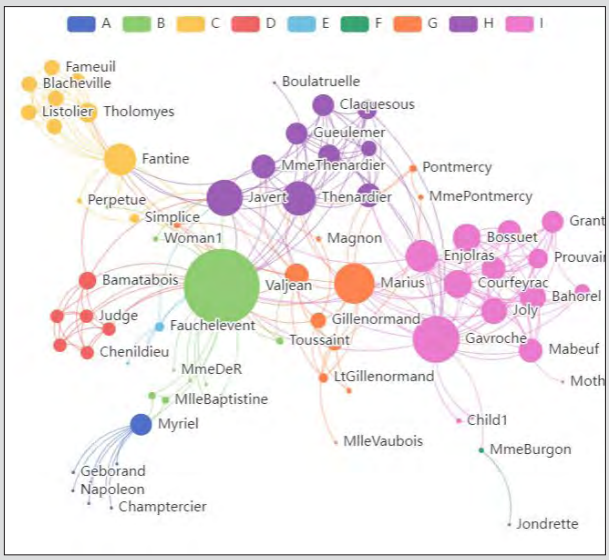


District mobility. *Columbia District Department of Transport. Thomas Clever.*
https://www.cleverfranke.com/work/district-mobility

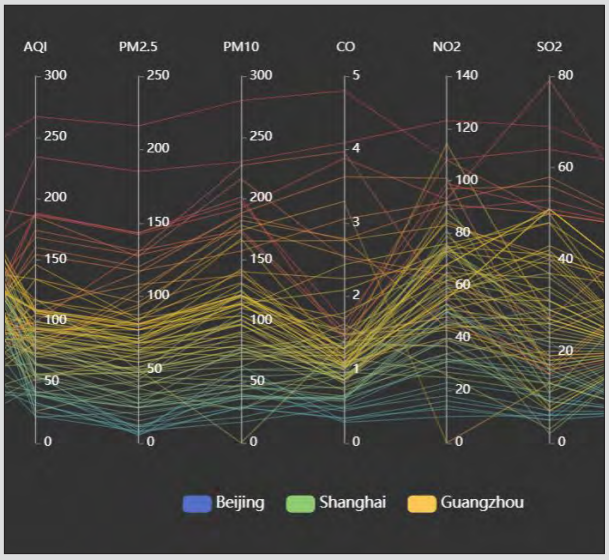
Airlines on globe. *Apache ECharts.*
https://echarts.apache.org/examples/zh/editor.html?c=lines3d-airline-on-globe&gl=1



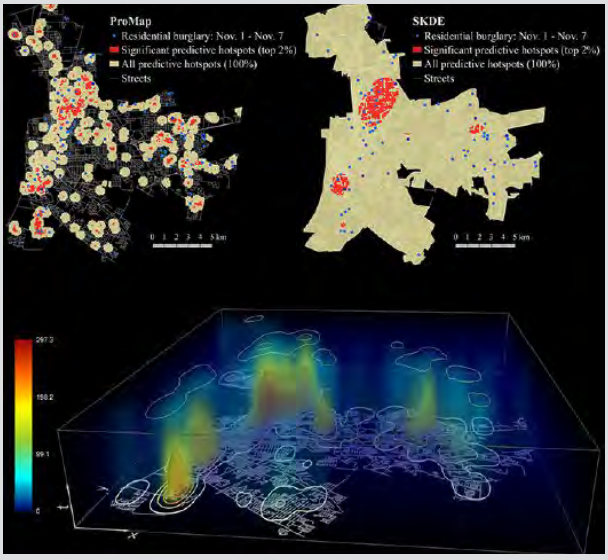
Browser accounted for changes. *Apache ECharts.*
https://echarts.apache.org/examples/zh/editor.html?c=radar2



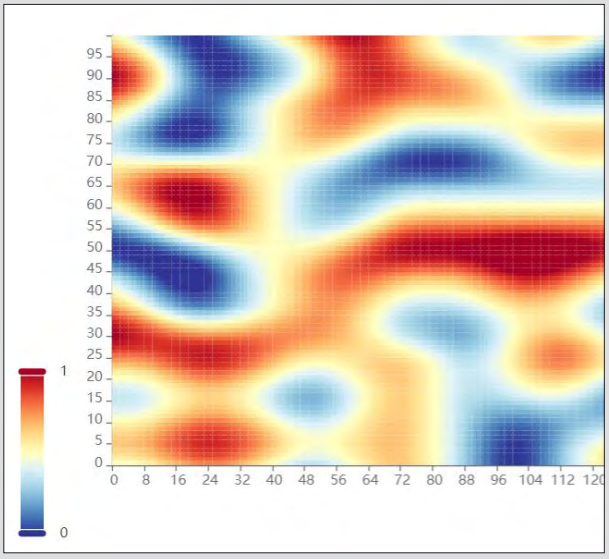
Relationship diagram. *Apache ECharts.*
https://echarts.apache.org/examples/zh/editor.html?c=graph-label-overlap



AQI distribution. *Apache ECharts.*
https://echarts.apache.org/examples/zh/editor.html?c=parallel-aqi



A Spatio-Temporal Kernel Density Estimation Framework for Predictive Crime Hotspot Mapping and Evaluation. *Yujie Hu, Fahui Wang, Cecile Guin, Haojie Zhu. Mai 2020.*
https://www.researchgate.net/publication/341816231_A_Spatio-Temporal_Kernel_Density_Estimation_Framework_for_Predictive_Crime_Hotspot_Mapping_and_Evaluation



Heat map. *Apache ECharts*
https://echarts.apache.org/examples/zh/editor.html?c=heatmap-large

Bike mobility in London. *Eden Au. 2019.*
https://edenau.github.io/maps/density-evening/

UNITS OF CALCULATION AND REPRESENTATION ACCORDING TO SUMO (SUB)INDICATORS

For the SuMo Atlas, given the data available, the comparative aims central to our research (linked in particular to the complexity of the Upper Rhine cross-border territory) and the processing capacities, we will retain the first two types of data representation - the grid and the administrative area, linked to calculation methods that can be envisaged within the framework of the project.

The geo-localised values are based on the evaluations made by the FELIS team via the SuMo Indicator System (developed in collaboration with Unistra-LIVE / CNRS). Each level of representation involves different sampling methods, revealing different ranges of detail, for spatialization with varying degrees of accuracy.

Three levels of calculation and representation have been developed:

- **Aggregate value on the municipality:** this first level allows the average value of a (sub) indicator to be visualised on the whole city. The data represented is spatialised on the administrative boundaries of the city in question.
- **Values distributed on a 1km-by-1km grid**: Each municipality is divided into a 1km² grid. The calculations associated with the indicators are specific to each cell.
- **Values distributed according to a 100m-by-100m grid**: Like the previous mode of representation, this finer grid allows a more precise reading of the organisation of urban mobility.

The maps are also complemented by analytical graphs that visually translate the quantitative values.

SCALES AND PERIMETERS

The Atlas thus includes 3 levels of reading, namely:

- **Overview map / Upper Rhine scale:** 2D maps that provide an overall perspective of the current mobility conditions of the «test» cities according to the selected indicators. These maps are complemented by analytical graphs that visually translate the quantitative values.
- **Inter-city/municipal scale comparative mapping**: 2D maps allowing a comparative perspective of the mobility conditions of several «test» cities according to different indicators.
- **Multi-indicator mapping - focus on cross-border territories / multiple sampling methods**: mapping allowing a cross-analysis according to several indicators, several sampling methods, and several comparable investigation perimeters (municipal, community, cross-border scales). In the context of the «pilot» maps which are the subject of this report, we will be particularly interested in the Strasbourg-Kehl territory.

The following maps present the first results of the calculations of a selection of sub-indicators according to the stage of elaboration of the system of indicators in its June 2021 version (the end of our mission within the project). These first sub-indicators, defined through the successive meetings of the consortium's multidisciplinary working groups and participatory workshops, concern not only aspects related to the organisation and functioning of mobility in the territory (traffic, presence of infrastructures, frequencies, etc.) but also aspects related to the urban environment in which it evolves and which in turn conditions it (such as functional diversity understood as a factor encouraging walking, or the presence of parks or the share of streets with low traffic, both sub-indicators taken into account for the calculation of the «walkability» indicator).
These «pilot» maps should allow a cross-reading by city and by (sub)indicators (see figure p.16). They serve as a test to understand the type of knowledge that this approach can produce (some hypotheses: capacity to highlight the strengths and weaknesses of existing mobility systems, the possible territorial imbalances that they would cause, the lack of articulation linked to the presence of borders, etc.) as well as its possible limits (by looking more closely at the possible undesirable effects produced by the initial choices).
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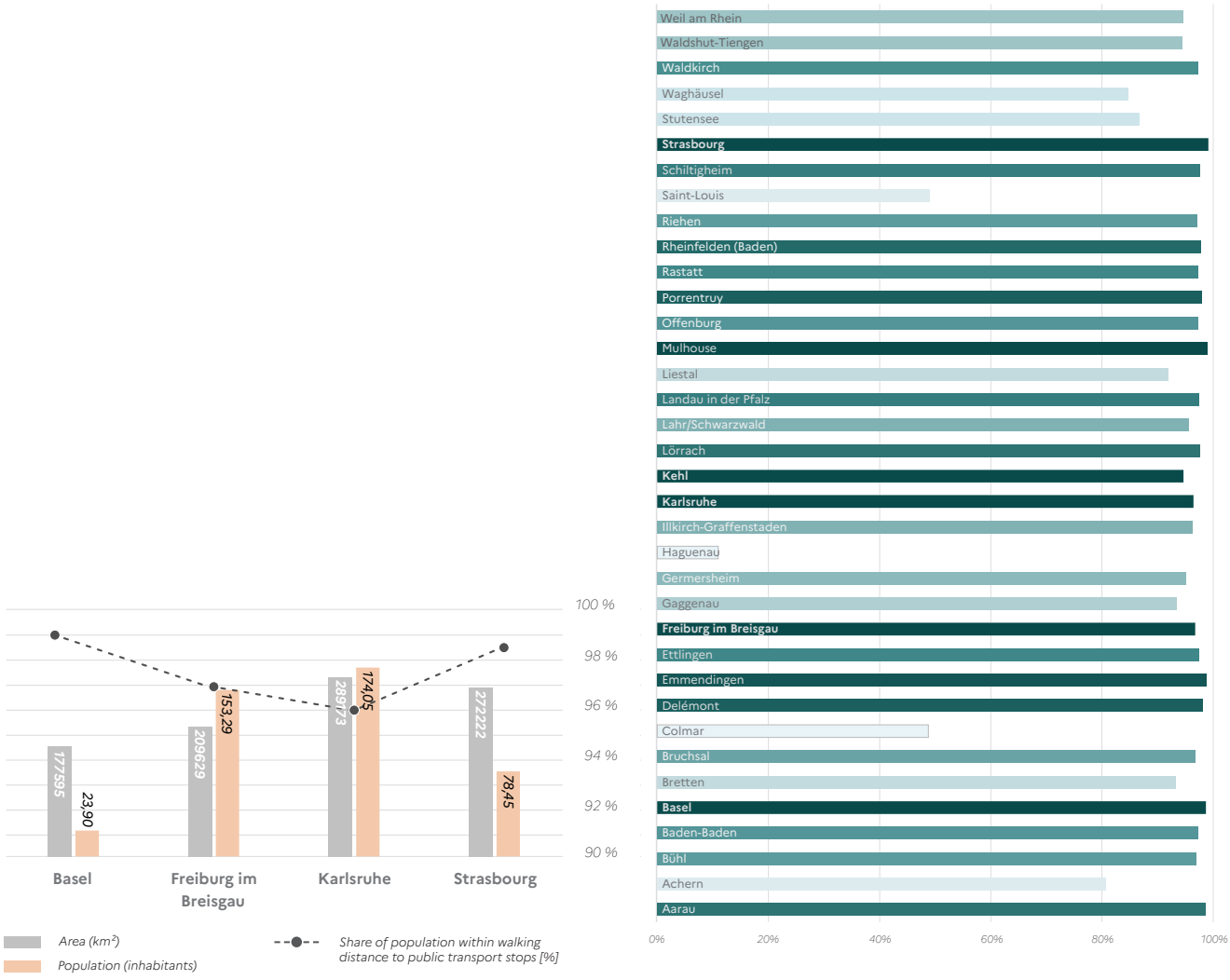
SuMo Atlas – "Pilot" Cartographies

First maps and visualisations of the results of the Indicator System

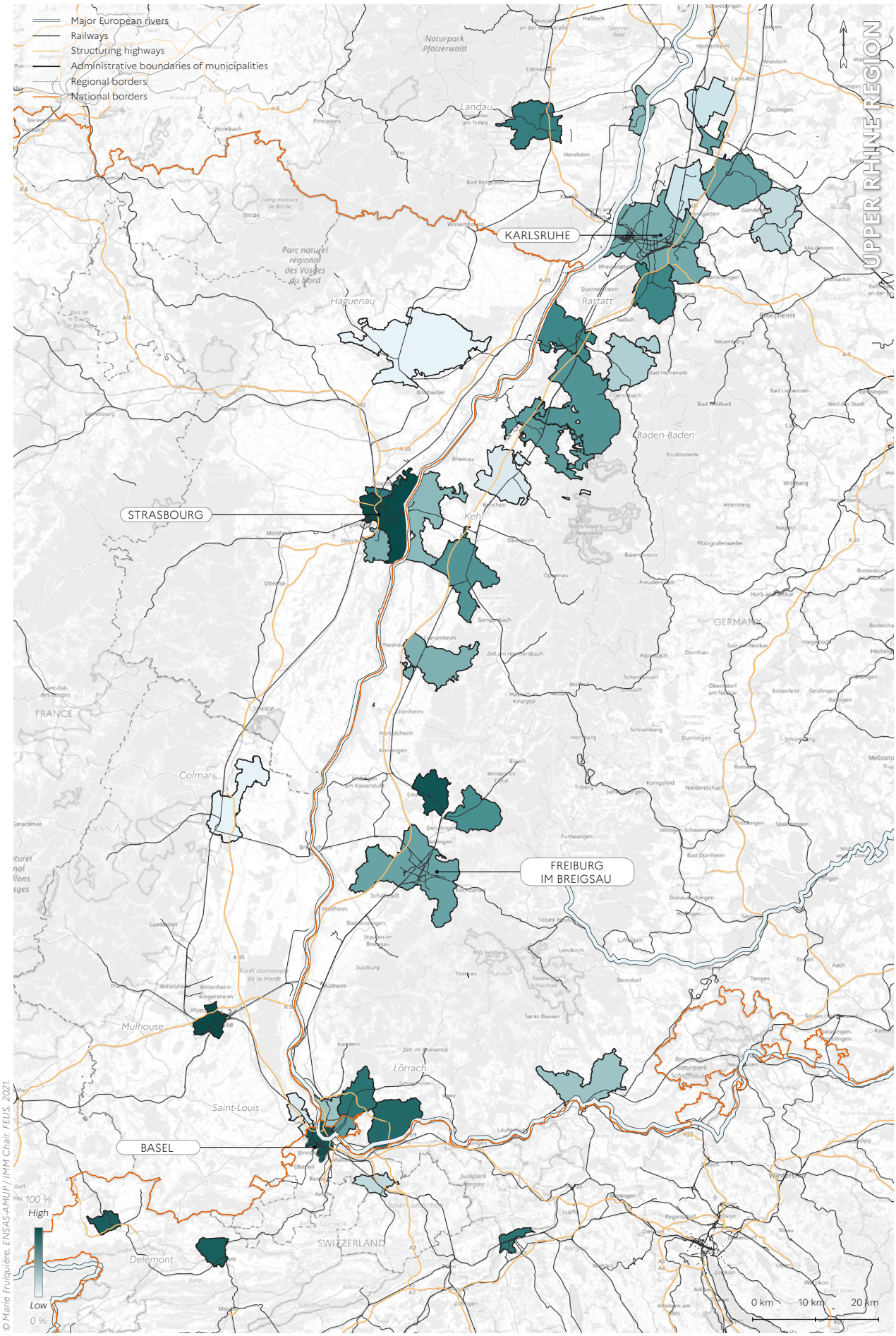
CARTOGRAPHIC OVERVIEW OF THE UPPER RHINE REGION
AGGREGATED DATA AT MUNICIPALITY LEVEL

On the Upper Rhine scale, the mapping offers a broad perspective of the current mobility conditions of the «test» cities via the selected (sub)indicators, opening up the possibility of a first comparative reading.

The list of «test» cities was established by the SuMo research team in order to obtain a panel of cities representative of the Upper Rhine territory: localities with more than 20,000 inhabitants, in each of the three countries (Germany, France, Switzerland), of different sizes and located close to the national borders. These cities were also the target of interviews with local actors in charge of mobility in these territories (WP2.1.).



Public transport coverage *- Share of population with walking distance to public transport stops [%]*
(Number of inhabitants in proximity to public transport stops / Total number of inhabitants) x 100



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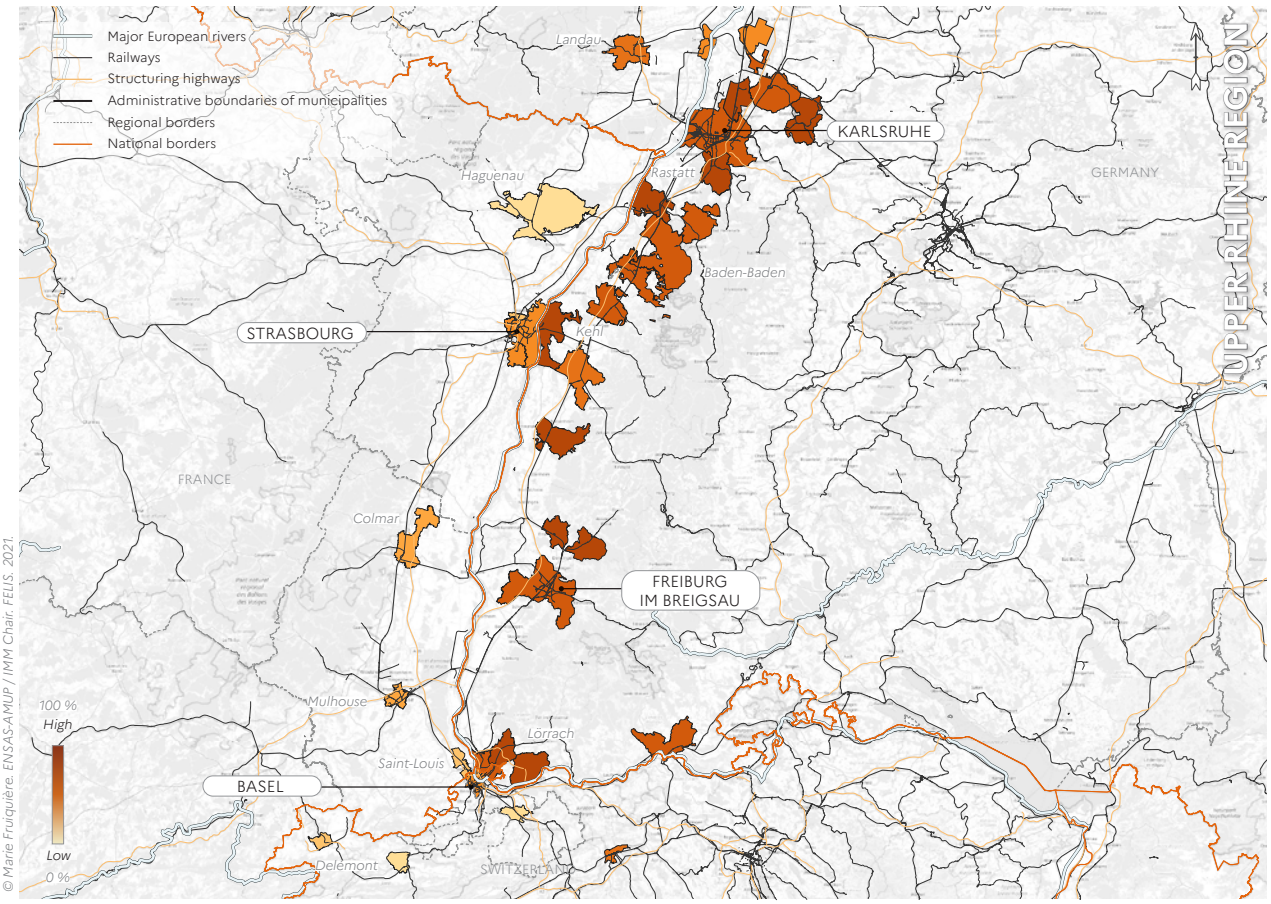
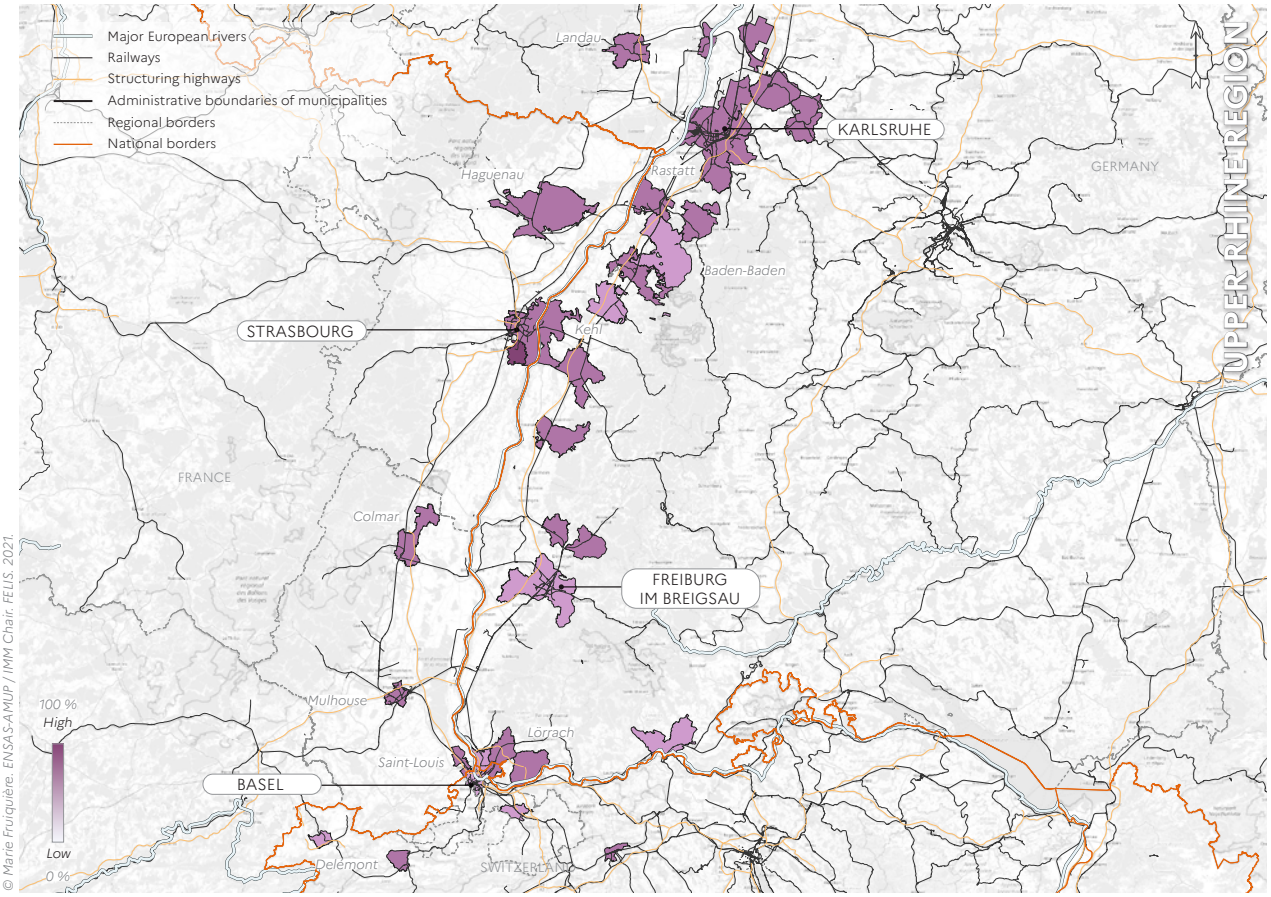


Speed limits - *Share of street with speed limit under 30km/h [%]*

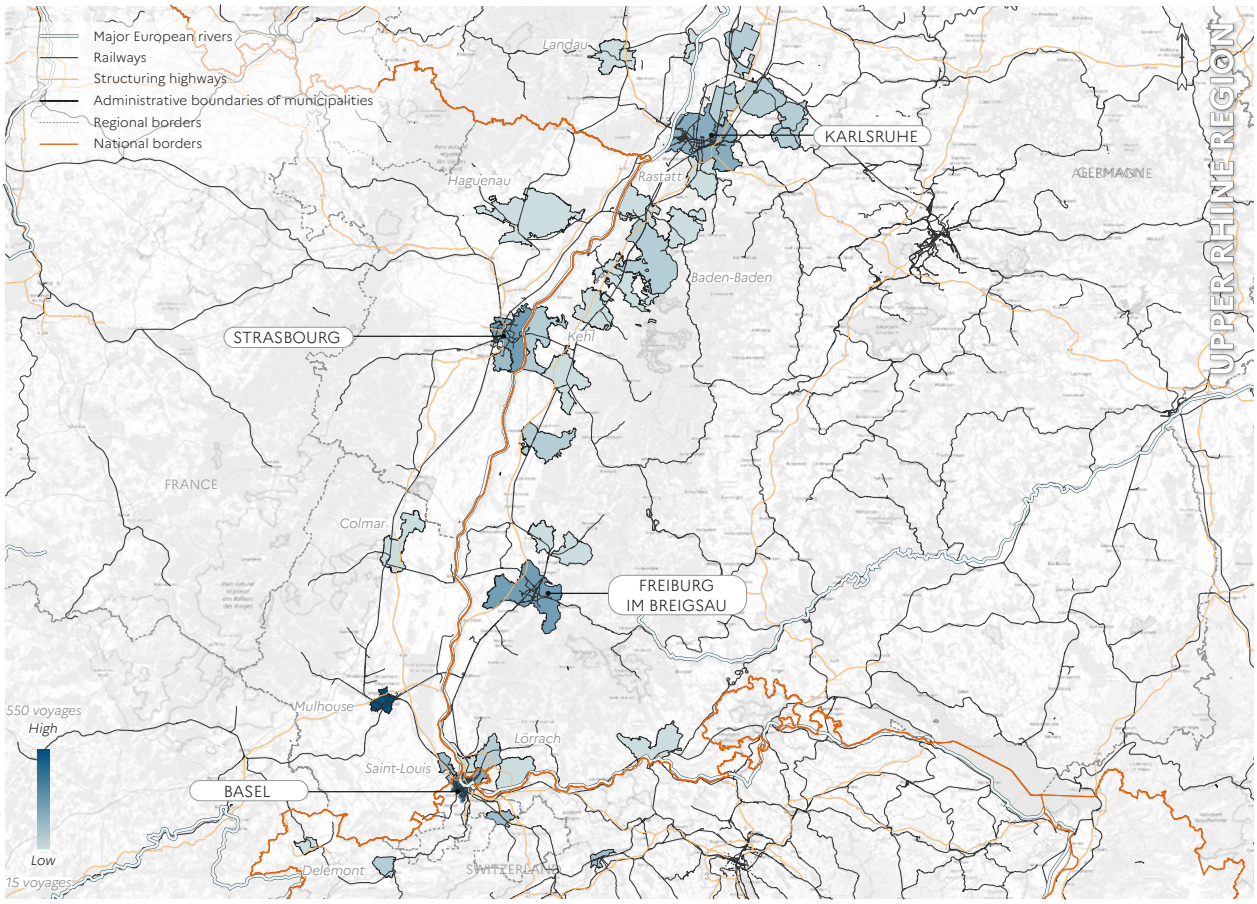
(Distance of streets limited to 30km/h or lower / Total street distance) x 100



Road traffic intensity - *Share of streets with low traffic volume [%]*

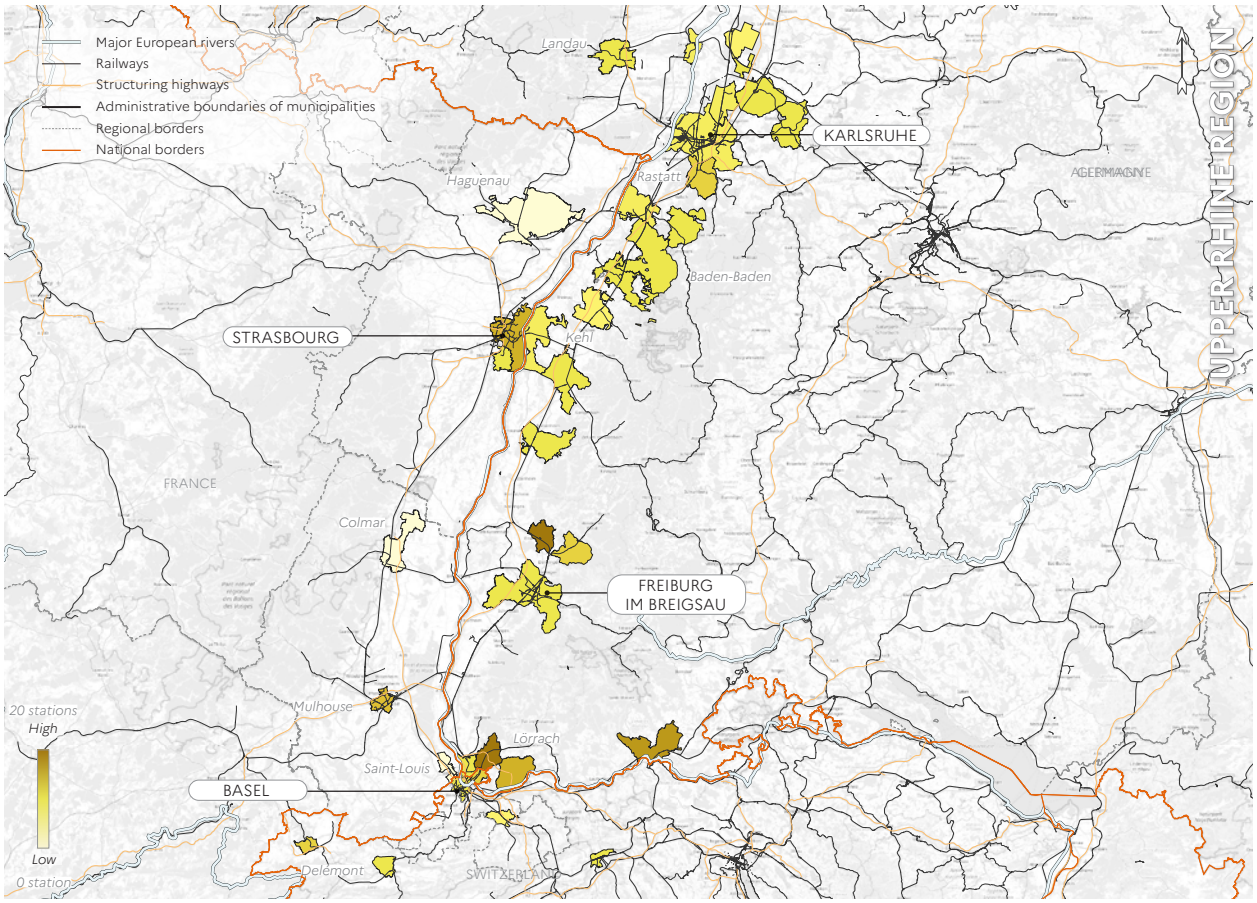
(Distance of streets with low traffic volume / Total street distance) x 100

0 km 25 km 50 km



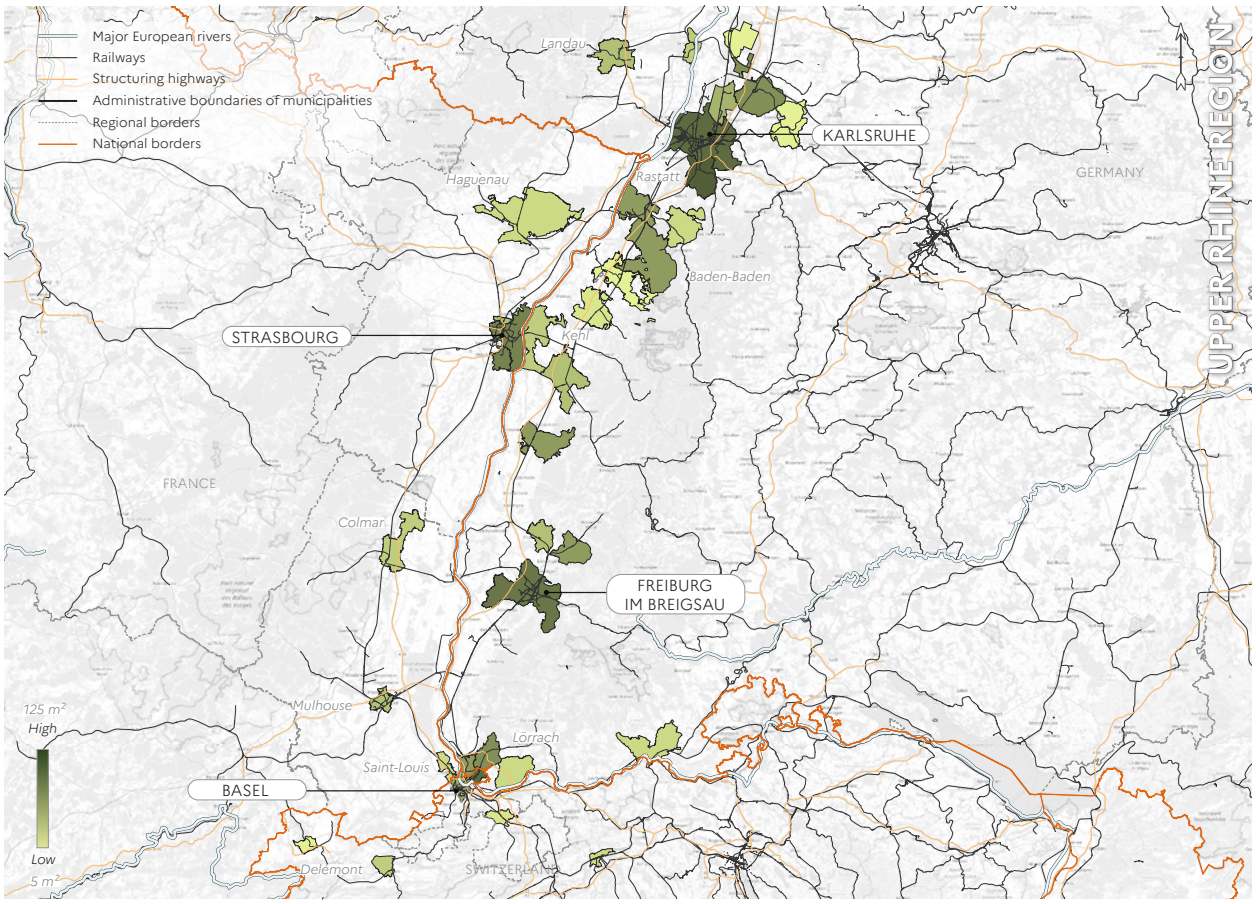
Public transport service frequency - *Number of trips per day per station [number/station]*

Average trips per station per day / Number of stations



Extent of the public transport network *- Public transport stops density [number of stations / km²]*

Number of stations / Surface

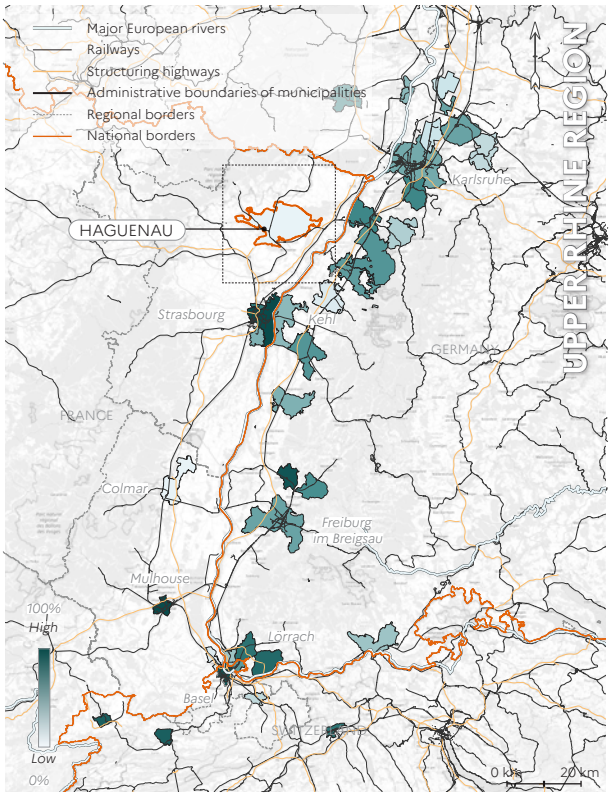


Park area per inhabitant - *Surface area of parks in walking distance per capita [m² / capita]*

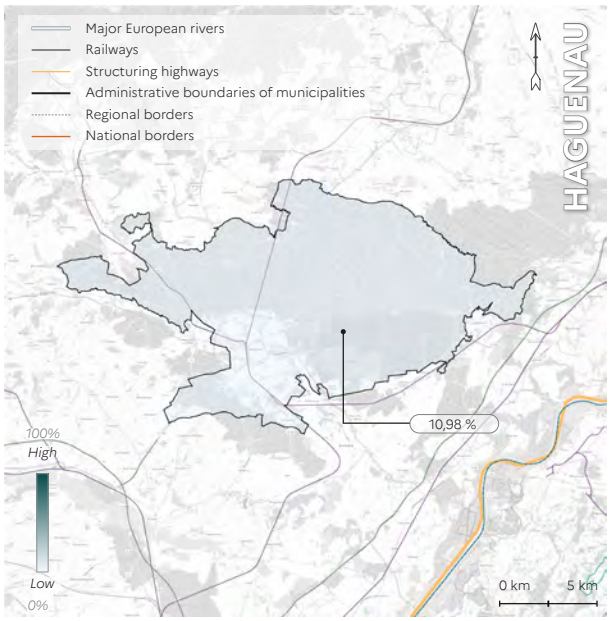
Surface area covered with vegetation / Number of inhabitants

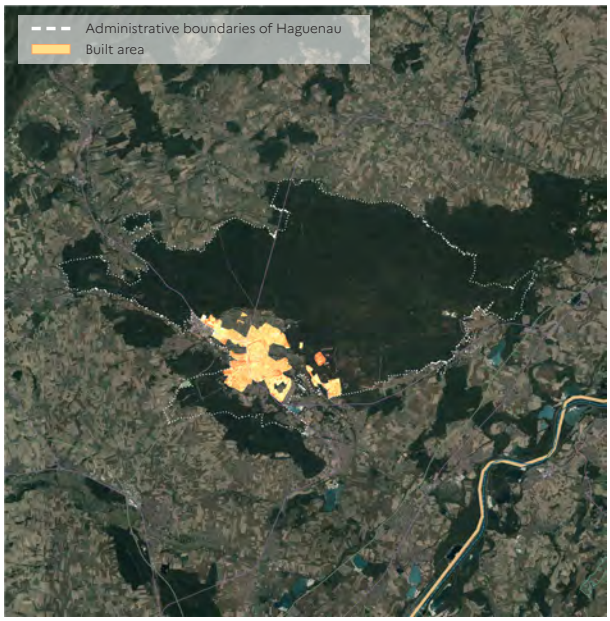
These initial cartographic experiments enabled us to visualise and locate very quickly the municipalities where the values obtained were very low and to question the causes of these results. This led us to make the very first confrontations with the territorial realities in question, which enabled us to identify certain biases in the methods of calculating the indicators and to make feedback to improve the precision of the measurements taken.

For example, among the parameters mapped, we were able to observe the share of the population located near a public transport stop (walking distance, see maps and graphs p.24-25). These first mapped results show that for the most densely populated cities such as Basel or Strasbourg the accessibility is higher, while in cities such as Colmar or Haguenau the results seem lower.
These values can be explained by the unit of territory that is taken into account in the calculations, defined here on the basis of the administrative boundaries of the cities. In the case of Haguenau, this explains the very low value resulting from the fact that the municipal territory is largely covered by forests (see figure opposite). On this basis, one of the pieces of feedback on the calculation methods was to consider not the entire municipal perimeter, but the urban area (built-up continuities).



Public transport coverage *- Share of population with walking distance to public transport stops [%]*
(Number of inhabitants in proximity to public transport stops / Total number of inhabitants) x 100

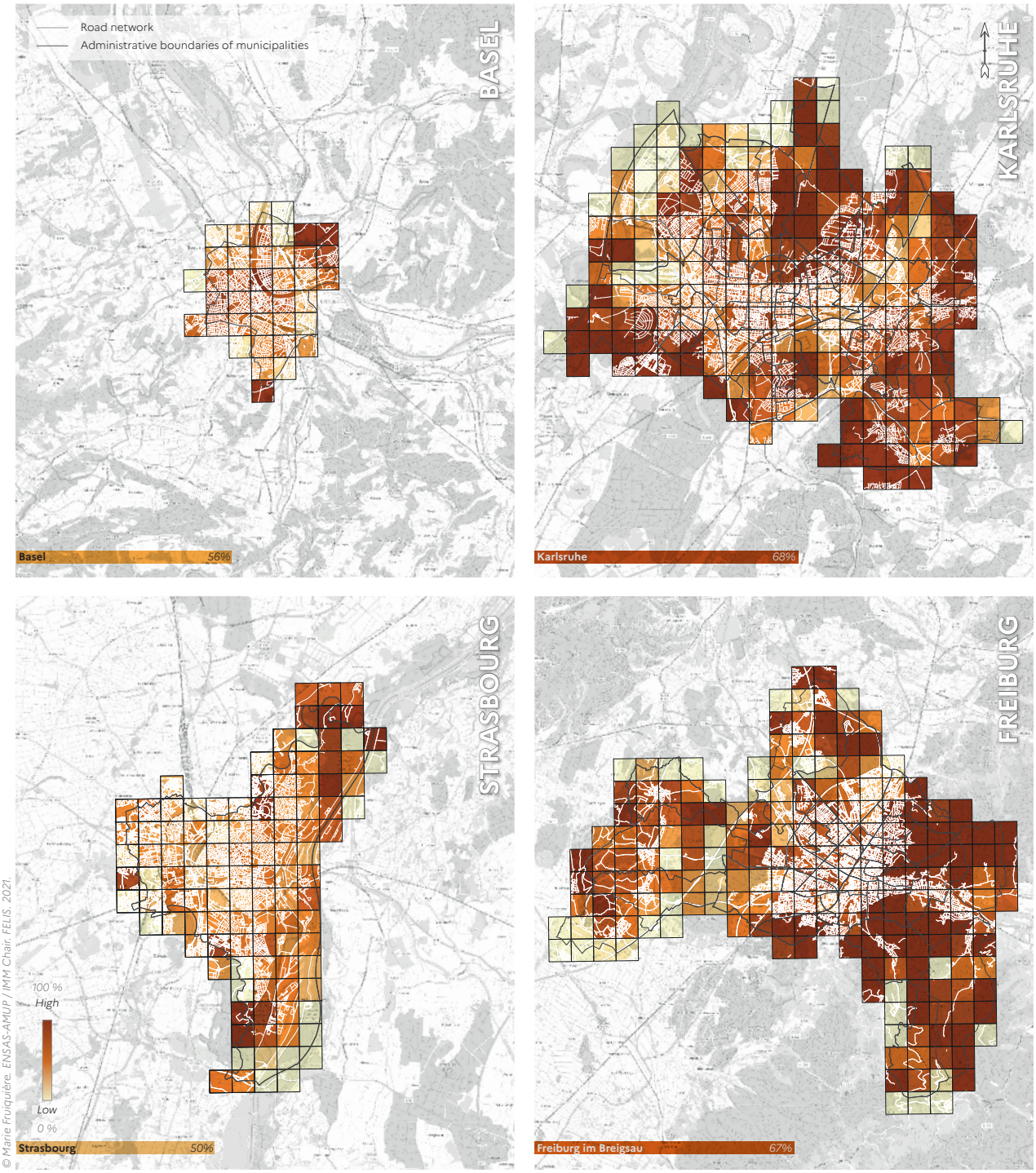




Evaluated territories - *Built zones and buffer to take into account in the calculation of (sub)indicators*

COMPARATIVE MAPPING BETWEEN AND WITHIN «TEST» CITIES
1 KM X 1 KM GRID

The multidimensional evaluation matrix of the SuMo Indicator System is intended to help municipalities measure the influence of planning strategies on their territory and to compare them with other Upper Rhine cities. This detailed mapping of mobility systems within municipal boundaries could serve as a basis for discussing the links between policy frameworks and the various factors influencing mobility (such as the urban environment), and for measuring their effects.
In contrast to the first maps at the regional level, the results are visualised here in more detail by spatialising them in a 1km-by-1km grid. The maps overlay the results of the Indicator System (numerical

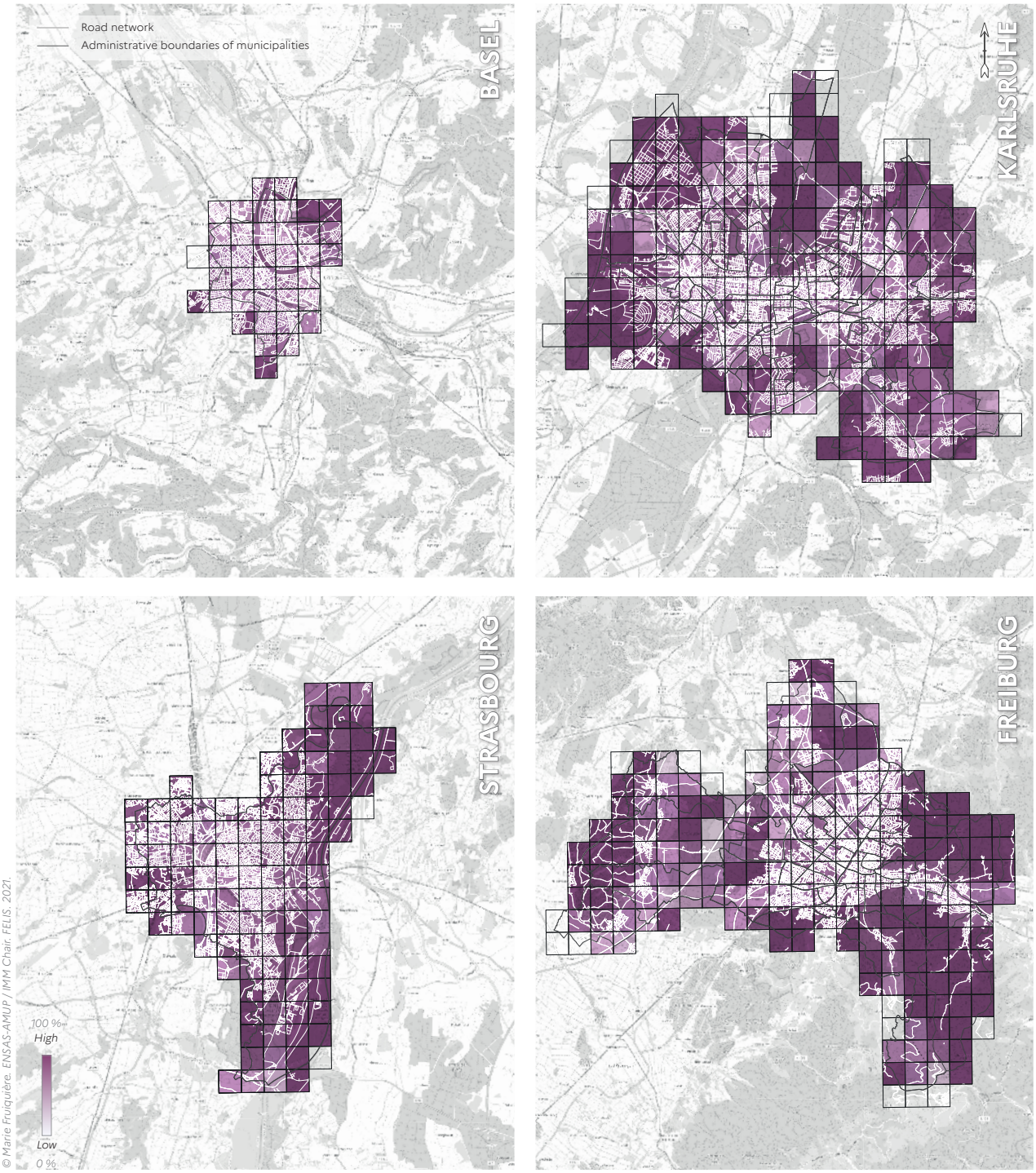


Speed limits *- Share of street with speed limit under 30km/h [%]*
(Distance of streets limited to 30km/h or lower / Total street distance) x 100

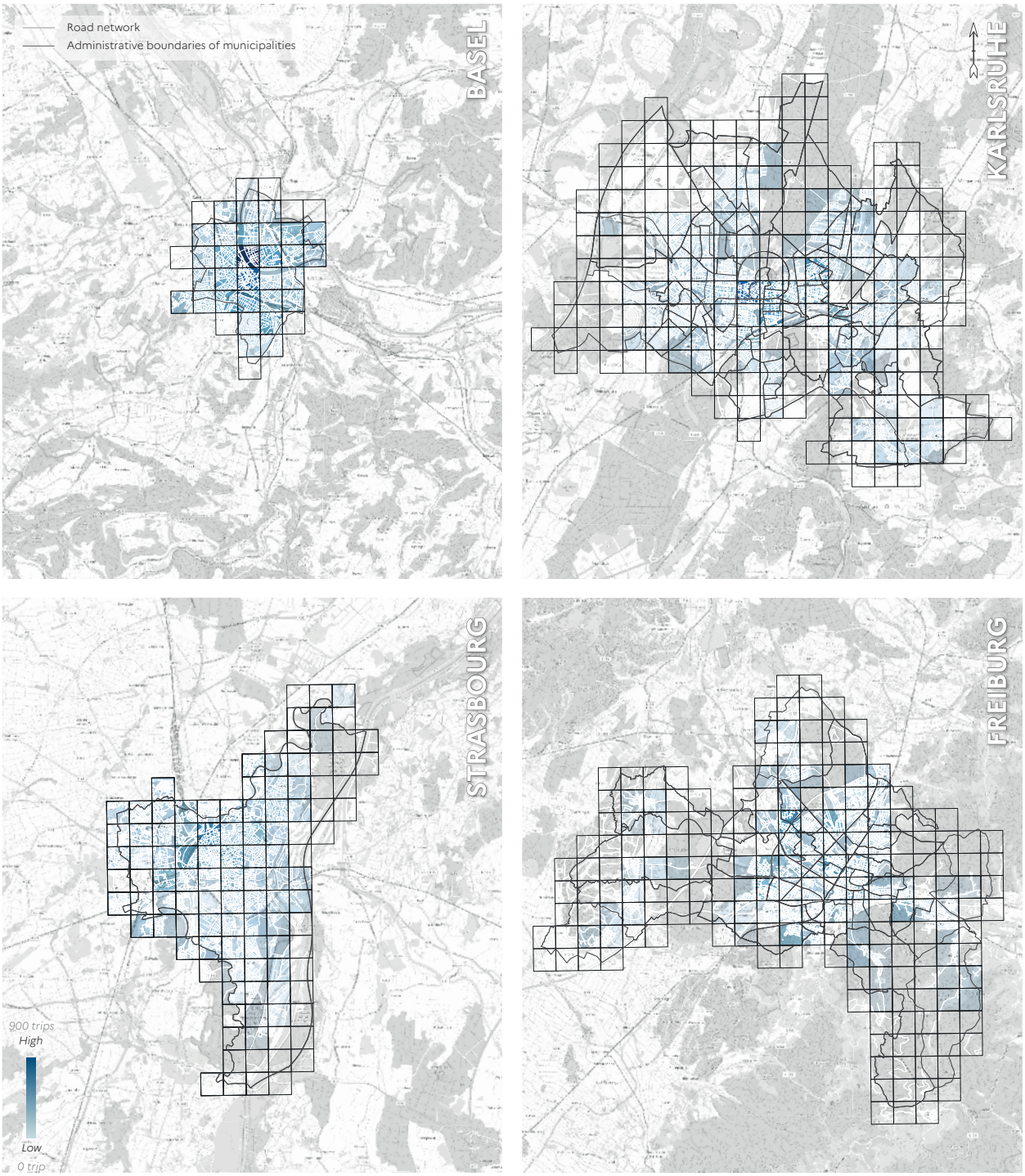
5 km

data) and the major spatial characteristics of each city in its territory (contextual data). This mosaic serves to show the organisation of mobility conditions within cities but also to compare their distribution between cities.

To illustrate this comparative approach, four cities have been represented in this way: Basel, Strasbourg, Karlsruhe, and Freiburg im Breigsau. By means of the sub-indicators relating to speed limits (see Fig. p.30), it is interesting to see, for example, that the share of streets limited to 30km/h or less is highest in the city centre in Basel, whereas in Strasbourg the highest values are found in the peripheral residential areas (such as Robertsau and Stockfeld).

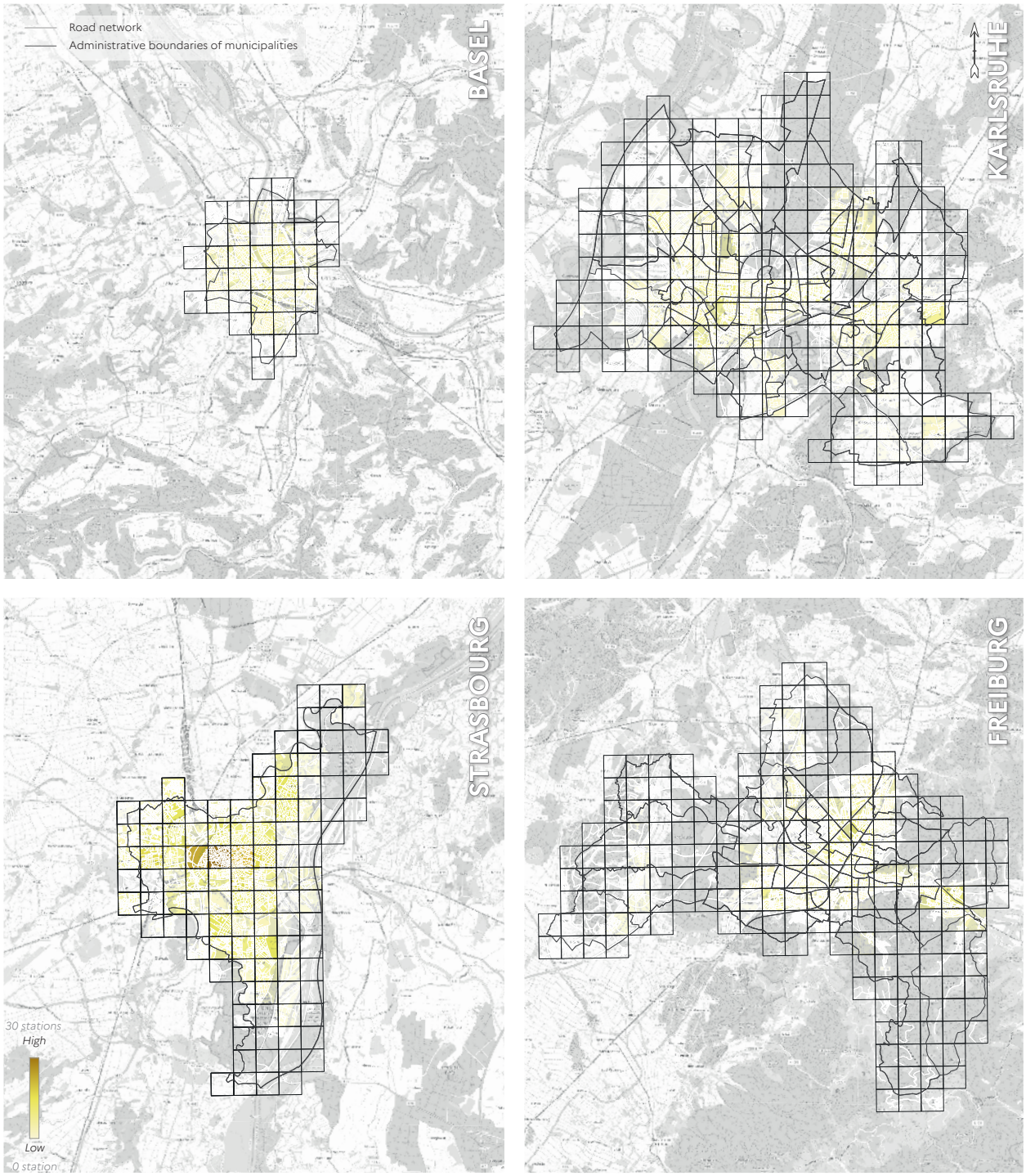


Road traffic intensity *- Share of streets with low traffic volume [%]*
(Distance of streets with low traffic volume / Total street distance) x 100



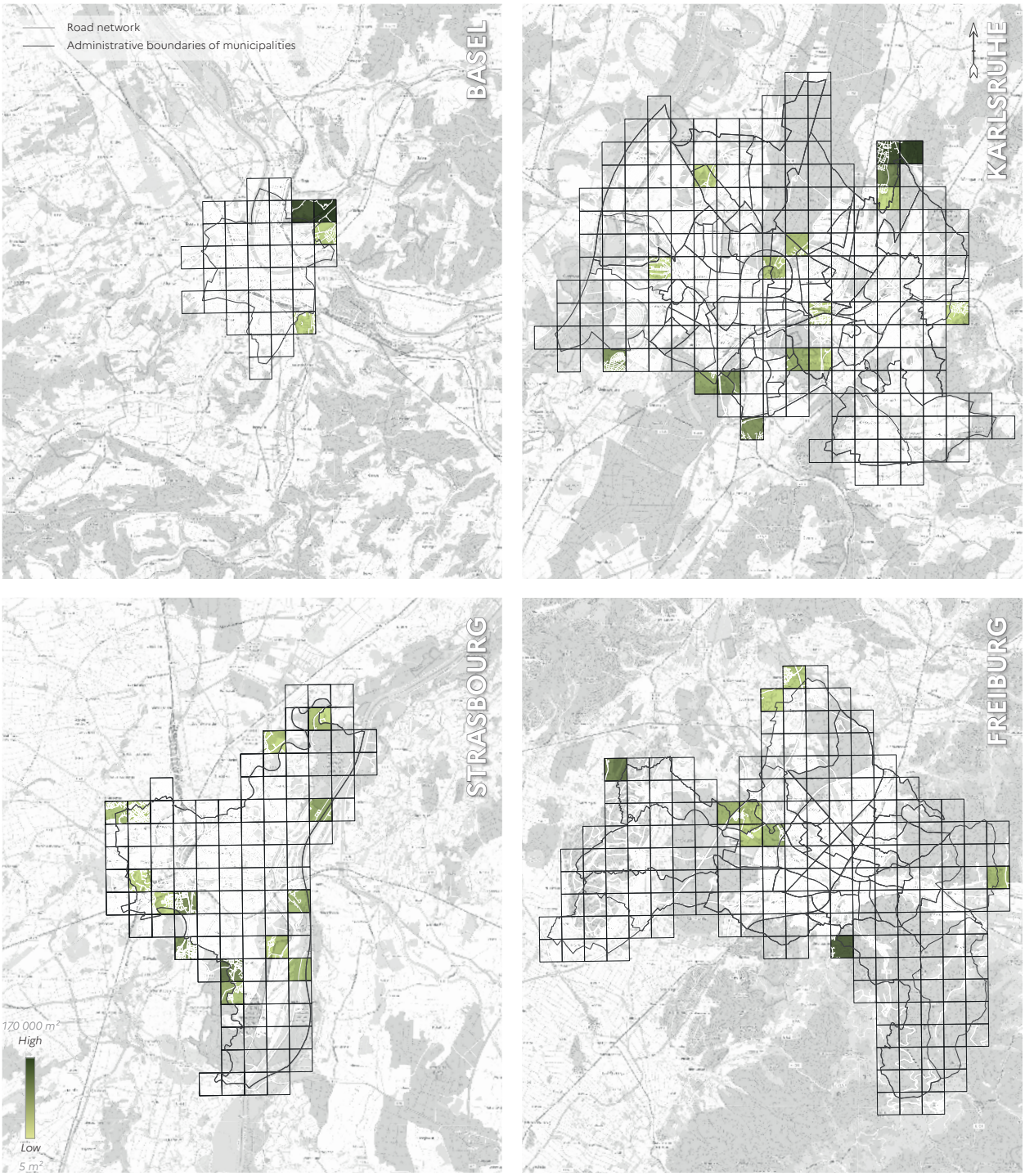
Public transport service frequency - *Number of trips per day per station [number/station]*

Average trips per station per day / Number of stations



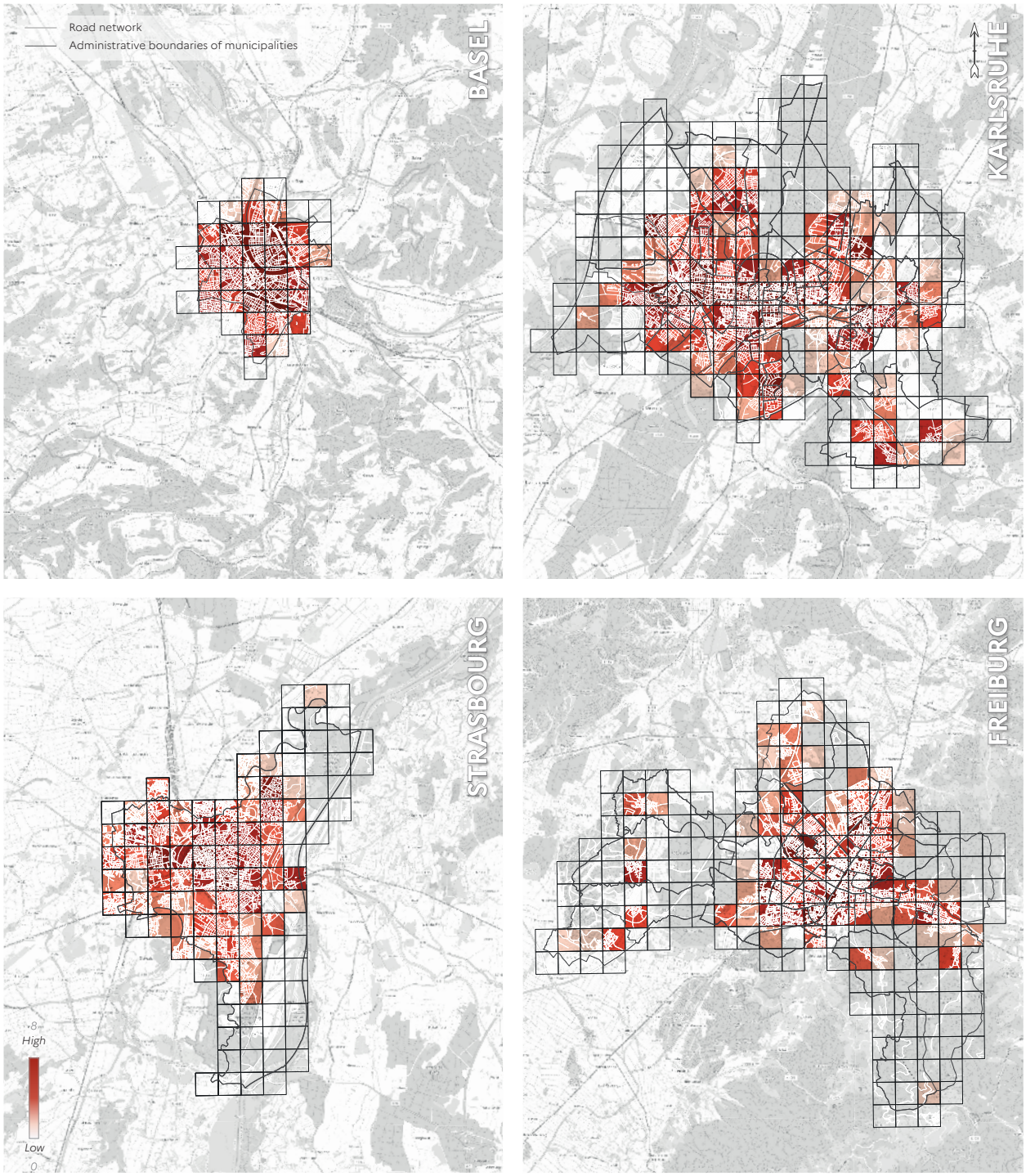
Extent of the public transport network - *Public transport stops density [number of stations / km²]*

Number of stations / Surface



Park area per inhabitant - *Surface area of parks in walking distance per capita [m² / capita]*

Surface area covered with vegetation / Number of inhabitants



Functional diversity - *Average density of services per grid cell*

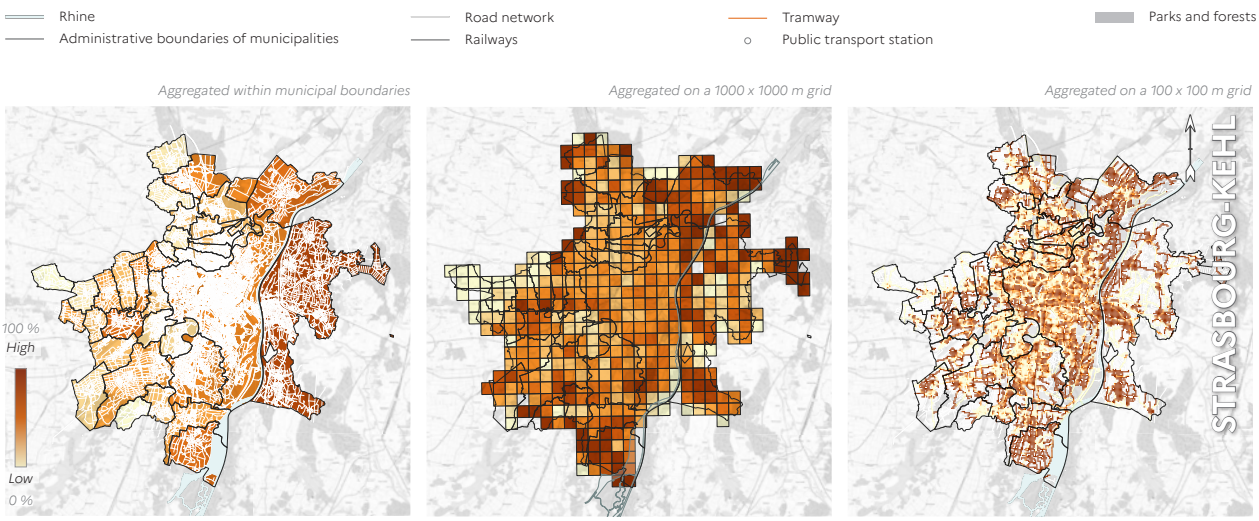
ε Number of inhabitants per cell (∀ Presence of facilities in the cell > 0)

DETAILED MAPPING OF A CROSS-BORDER TERRITORY
FOCUS ON THE STRASBOURG-KEHL METROPOLIS
MULTIPLE SAMPLING METHODS

Within the framework of this work, the cross-border metropolis of Strasbourg-Kehl was chosen as an experimental territory to enable the SuMo research team to test multiple indicators, several sampling methods and mapping strategies.
This focus thus proposes a more in-depth reading of a cross-border situation through a multi-indicator cartography aggregated in several ways: according to the administrative perimeters of the municipalities that make up this territory, according to the 1km x 1km grid and through a finer breakdown of 100m x 100m that allows for a more precise reading.

As an example, if we look more closely at the case of the sub-indicator below, which shows a graded distribution of territories subject to a reduced vehicular speed limit, the first map shows the results aggregated by municipality. In the Eurometopolis of Strasbourg, it is the westernmost municipalities where the share of streets limited to less than 30km/h appears to be the lowest (this distribution goes hand in hand with a less developed public transport network - see indicators opposite). Overall, it is the city of Kehl that stands out with a high level of streets limited to 30 km/h or less. The second map already allows us to qualify this distribution through the 1km x 1km grid, which no longer takes account of administrative limits, but which is interesting, for example, because of the average values obtained in the centre of Strasbourg. It is the third, even finer, distribution that makes it possible to explain this, allowing a more spatial understanding of the results. It brings out precisely the spaces occupied by the high-speed road infrastructures of the metropolis (very low values according to this indicator), such as the A35 and A351 motorways, which juxtapose the historic centre, where very high values finally appear (as they are practically inaccessible by car). These highly contrasting values juxtapose each other, which explains the average values on the previous map. As this is a sub-indicator of walkability, one could begin to associate places with low values with breaks and problematic spaces for walking. Conversely, the spaces in dark red (high values of the share of streets reduced to less than 30km/h), would be more suitable for walking. These results must be put into perspective in relation to other sub-indicators of walkability, such as the presence of pavements (a factor of comfort and safety), functional diversity or the accessibility of parks (considered as key factors to favour walking).

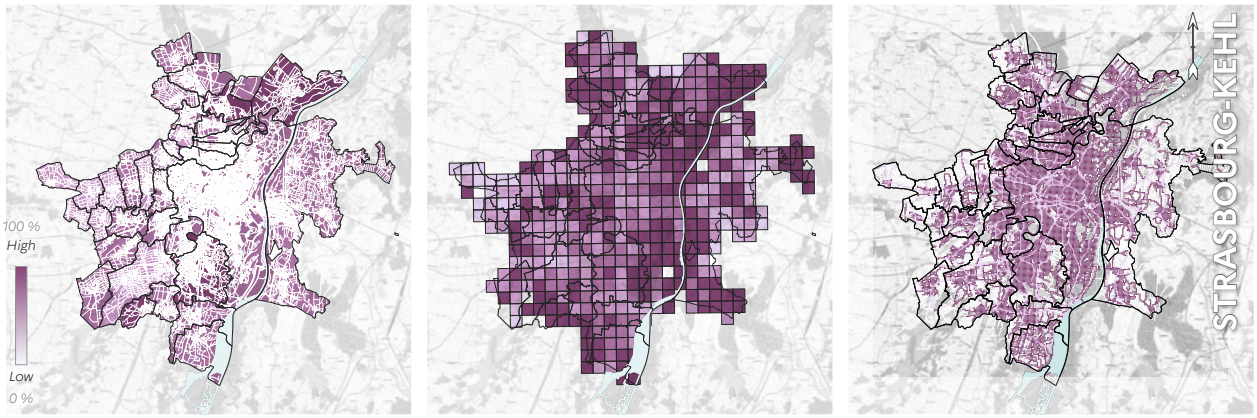
This scale of investigation also allowed us to raise the question of the bias introduced by the data used. In this respect, the last maps in this series (accessibility of parks - 1km x 1km & 100m x 100m) are interesting because of the few cells that stand out on the whole territory (degrees of green), despite the presence of parks or forests near inhabited areas (black and white hatching). It should be noted that the results of the Indicator System (in green) were calculated on the basis of HERE data, while the extent and location of vegetated areas correspond to open source geolocalised data from the Eurometropolis of Strasbourg and Open Street Map (for Kehl).



Speed limits *- Share of street with speed limit under 30km/h [%]* (Distance of streets limited to 30km/h or lower / Total street distance) x 100

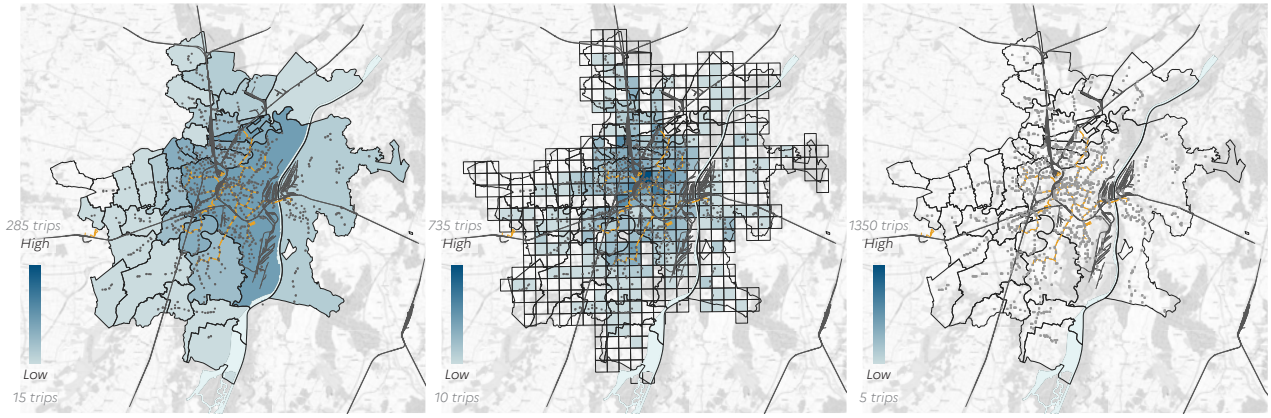
Rhine
Administrative boundaries of municipalities
Road network
Railways
Tramway
Public transport station
Parks and forests

Aggregated within municipal boundaries | *Aggregated on a 1000 x 1000 m grid* | *Aggregated on a 100 x 100 m grid*



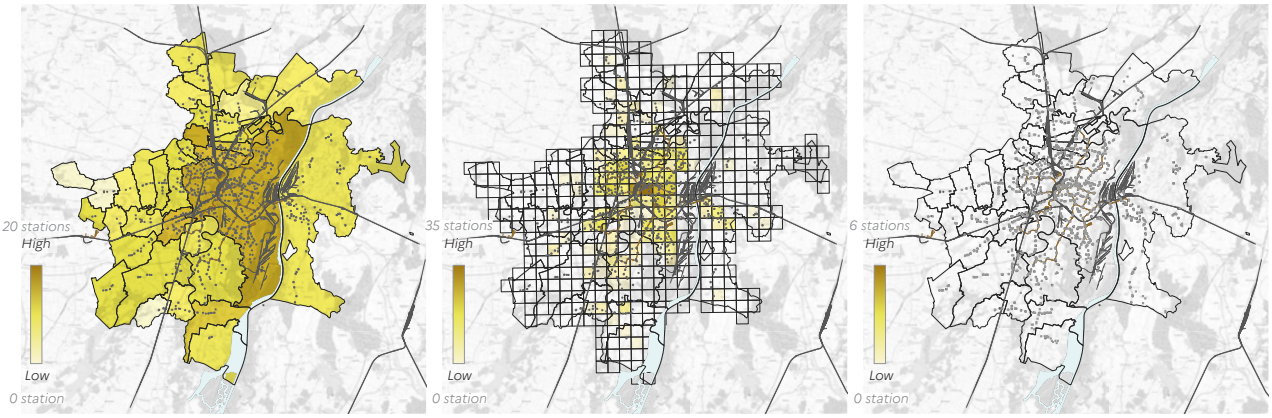
Road traffic intensity *- Share of streets with low traffic volume [%]*

(Distance of streets with low traffic volume / Total street distance) x 100



Public transport service freq. - *Num. of trips per day per station [num./station]*

Average trips per station per day / Number of stations



Extent of the public transport network *- Public transport stops density [num. of stations / km²]*

Number of stations / Surface

Park area per inhab. - *Surface area of parks in walking distance [m² / capita]*

Surface area covered with veget. / Num. of inhab.

5 km

AXIS 2

SUMO SCENARIOS
INFRASTRUCTURES AND THEIR RELATIONSHIP TO THE CITY, SUSTAINABLE MOBILITY POLICIES AND TRANSITION LEVERS IN TERRITORIAL SCENARIOS FOR STRASBOURG 2030

The SuMo Rhine research programme aims to build a new «decision support system» to identify the potential for improving low environmental impact transport services and increasing the market share of alternative transport modes. While the Indicator System developed within the SuMo project is primarily designed as a diagnostic tool through the evaluation of existing mobility systems and urban situations, it also aims at improving future mobility. In this sense, the research team has also planned to explore its potential prospective aim.

In order to open up this field of reflection, we have worked, in collaboration with the LIVE-UNISTRA/CNRS team, on the development of exploratory mobility scenarios for the Strasbourg metropolis which serve as a basis for testing the possible applications of SuMo Indicators in a prospective approach.

Designed on the basis of an analysis of the urban and mobility dynamics at work, but also of the debates and visions held by the local political stakeholders, these scenarios have a double interest/role.
On the one hand, they allow us to reflect on the meaning that «sustainable mobility» could take on in this territory and to think about the future of the metropolis by considering different choices and their coherence in terms of mobility planning policies, changes in behaviour by 2030, and their effects in terms of the organisation of urban spaces at different scales. They do not aim at operational applicability but are intended as a support for reflection on the habitability of our territories and our collective capacity to support a decarbonised urban transition in order to respond to climate emergencies.
On the other hand, through modelling and simulations of various kinds, they aim to experiment with the Indicator System as a tool to assist prospective decision-making by testing its capacity to evaluate and compare - between themselves and with what already exists - various orientations in terms of future mobility, city, and society, through a quantitative approach.

More broadly, the objective is to understand how the SuMo Indicator System could contribute to the evaluation of local political visions in terms of sustainable mobility and facilitate the dialogue between the different actors concerned.

Scenario development framework and methodological approach

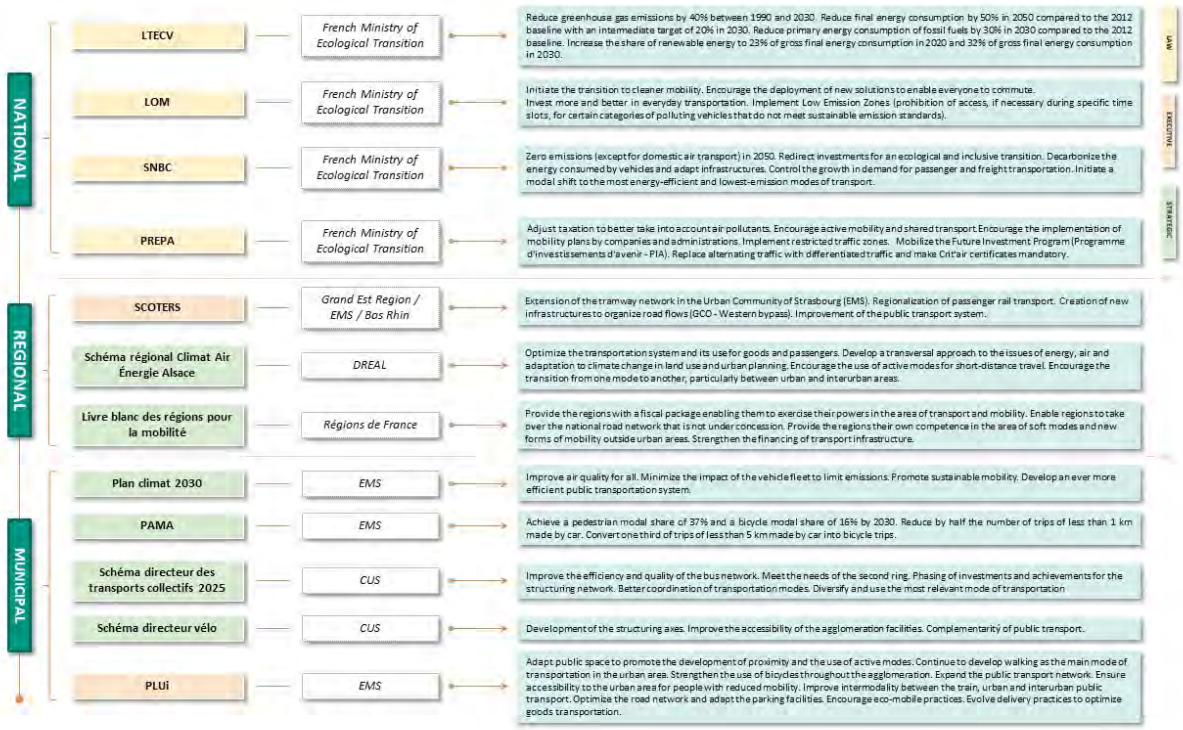
APPROACHES TO SCENARISATION

From a methodological point of view, the scenarios were the subject of a double construction, narrative and spatial. The **narrative scenario** work was based, among other things, on an analysis of the speeches of the candidates in the 2020 municipal elections. More experimental methods were also tested on this occasion, such as collaborative poetic writing, collective wanderings and in situ note-taking workshops for sensitive seizures of mobility spaces (see Annexes).
The **narration** of divergent future situations was articulated with a **spatialization** through maps and 2D diagrams, as well as detailed views (in 3D or in section) on territories at stake.
The narrative and the spatialization are concomitant, even if they can evolve at different speeds, which allows them to feed each other, feeding the scenario design process through this internal feedback mechanism.

SCALES, TEMPORALITIES, FOCUS

Apart from the conceptual exploration of city and mobility choices, the scenarios are designed as a basis for experimenting and testing the viability of the indicator system in the context of a prospective exercise. This means that their development must also take into account the functioning and constraints (particularly technical) linked to the parameterisation of the indicators.

In terms of territory of exploration (and in particular of scale), following the change of municipal administrations following the local elections, and following exchanges with the partners of the consortium which enabled us to take into account the technical constraints relating to the various models, we moved the focus of the scenarios. Initially planned for the urban territory of the A35 motorway in the process of being downgraded (an area at stake for the former municipal team, which was carrying out prospective reflections there; see Annexes), **the scenarios were finally extended to the whole of the Strasbourg Eurometropolis (EMS)** in order to allow the entire metropolitan mobility system to be taken into account. However, although the

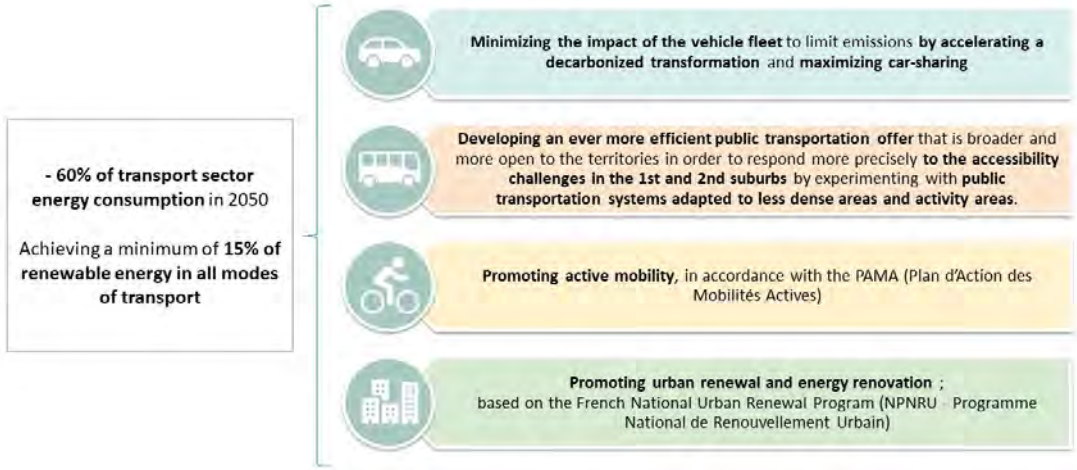


Modal split of the inhabitants of the Eurometropolis of Strasbourg

	2009		2019		Evolution		2030	
	Number of trips	*Modal share*	*Number of trips*	*Modal share*	*Evolution of the number of trips*	*Evolution of the modal share (in points)*	*Number of trips (trends)*	*Modal share (goals)*
Walk	532 204	33%	680 041	37%	+ 22%	+ 4	778 637	37%
Bike	125 584	8%	201 325	11%	+ 38%	+ 3	336 708	16%
IUPT	18 084	1%	13 065	1%	- 38%	0	32 566	1%
UPT	181 955	11%	261 167	14%	+ 30%	+3	325 186	16%
PDC	570 609	35%	557 804	30%	- 2%	- 5	526 106	25%
PPC	167 495	10%	135 108	7%	- 24%	- 3	105 221	5%
Total	1 595 932	100%	1 848 509	100%	+ 14%	/	2 104 424	100

Source : ADEUS, Enquête Mobilité 2019 – Résultats essentiels, Plan Climat 2030

IUPT Intercity public transport
UPT Urban public transport
PDC Personal driver's car
PPC Personal passenger car



Challenges and objectives of the 2030 Climate Plan

metropolitan catchment area extends beyond the territory of the EMS (to Haguenau, Sélestat, Molsheim, Kehl and even Offenburg), the technical capacities for modelling, simulating, and calculating indicators, as well as the availability of basic data, obliged us to remain within the administrative boundaries of the metropolis. This made it possible to use the Open-Source data made available by the Eurometropolis of Strasbourg.

In order to respect these technical capacities, the scenarios were also built for a fixed time horizon. During the study, it emerged that a certain number of strategic orientation documents share a common time horizon set at 2030: this is the case of the PAMA, the PLUi, the Climate Plan (in its immediate horizon) as well as the Grenelle des Mobilités (projects envisaged in the short and medium term). We have therefore chosen this time horizon of 2030 for the scenarios. The results can thus be compared in the form of a before and after, rather than in the form of a gradual evolution in stages over time.

Finally, apart from the scales of reflection - temporal and spatial - the issues considered and the project levers were also conditioned by the capacities of the Indicator System. The scenarios must therefore be sufficiently contrasted in their basic choices so that the results of the evaluations by the indicators present conclusive differences, without going to extremes that would make the comparison sterile. They must also detail the evolution of modal distributions, the levels of service of the imagined mobility systems, but also the transformation of the related urban fabrics and, more broadly, of land use through the basic categories considered in the parameterisation of the indicators.

STATE OF PLAY: MOBILITY ISSUES IN THE EUROMETROPOLIS OF STRASBOURG

Prior to the development of the scenarios, the ENSAS research team first carried out a cross-sectional analysis of the mobility system in the Rhine metropolis of Strasbourg as a basis for the prospective approach. This study was based on a corpus of documents covering various fields of knowledge:

- **the vision of political actors** (2020 municipal elections) and **the prospective reflections under debate:** Grenelle des mobilités
- **the framework of mobility policies at different scales and local strategic and urban planning documents** on mobility and urban planning: PLUi, Plan Climat 2030, PAMA, Schéma directeur transports collectifs, etc.
- **the dynamics at work** (in terms of mobility practices) and **societal expectations:** ADEUS studies and surveys between 2009 and 2019, Strasbourg Eurometropole Development Council reports, CTS activity reports, etc.

Strasbourg is one of the French cities where the car share has decreased the most in recent years. The trends identified by the ADEUS surveys between 2009 and 2019 (Household Travel Survey - Mobility Survey) show a strong increase in the modal share of active modes (+22% for walking and +38% for cycling). However, the modal share of the private car has only decreased by 2%, allowing it to remain the second most used mode of transport, not far behind walking (respectively 30% and 37% of modal shares). In terms of pollutant emissions (mainly linked to the transport sector), these results are in line with the findings of the Grand Est Climate-Air-Energy Regional Observatory, which show that despite the decreases recorded since 2000, the trend in the territory has been one of stagnation over the last few years (a 23% drop in GHGs between 1990 and 2018, but only a 10% drop since 2012 (Climate Plan 2030 - Strategy for the City of Strasbourg, 2020). As shown by the 2019 mobility survey (ADEUS), 63% of trips are still made by car in the EMS, while 19% of trips of 1 to 3 km, the area of relevance for pedestrians and cyclists, are still made by car. On the other hand, journeys of more than 10 km are difficult to compete with other modes of transport. Despite the work undertaken to extend the public transport network (extension of the tramway lines, creation of the BRT lines, introduction of the TAD), inter-urban services (in the first and second suburbs), where the car is still predominant, remain a major challenge.

In order to counterbalance these trends, the Eurometropolis of Strasbourg has developed several tools in the form of regulations and strategic orientation documents (Climate Plan 2030, PAMA, Bicycle Master Plan, PLUi...) identifying action levers and quantified objectives related to the transition of mobility. They are consistent with regional documents (SCOTERS, Regional Climate-Air-Energy Plan, White Paper of the regions for mobility), which also fit into a national regulatory framework (LOM law, LTECV, etc.) or even a European one (Paris Declaration) to achieve «climate neutrality» by 2050. At the local level, we particularly note the 2030 Climate Plan, which sets cross-cutting objectives in terms of mobility and more specifically for each mode of transport. Generally speaking, it envisages a 60% reduction in transport-related emissions and a 15% increase in the share of renewable energy in this sector. With regard to the vehicle fleet, the objective is to accelerate the decarbonised transformation and to encourage car-sharing (limiting the modal share of the car to 25%). One of the alternatives proposed concerns public transport, the modal share of which must increase to 17%. Within the Climate Plan itself, the issues concerning active mobility refer more specifically to the PAMA (Plan d'Action des Mobilités Actives). Voted on in March 2019, it includes 20 action points to move towards a 40% pedestrian and 16% bicycle modal share. They focus on the deployment of electrically assisted bicycles (VAE) and the construction of a major cycling and pedestrian network. Finally, the last aspect taken into account by the Climate Plan concerns the built and landscape fabric for which the objectives are to encourage urban renewal and strengthen ecological continuity. In a more qualitative and operational way, the PLUi of the Eurometropolis of Strasbourg also highlights in its PADD its objectives in terms of attractiveness (innovative

and intermodal mobility, connection to the Upper Rhine basin), proximity (accessibility of services on foot or by bicycle through secure spaces and the networking of pleasant public spaces) and sustainability (soft and green mobility for the improvement of air quality and the urban environment). These orientations are projected on well identified action sites in connection with the poles of metropolitan interest (Strasbourg-Entzheim International Airport; reinforcement of the port functions; development of transport infrastructures in exclusive right-of-way such as the tramway, TSPO, VLIO; requalification of the A35; extension of the TER offer; new parking policy...) (PADD PLUi 2016).
Launched in 2018, the Grenelle des Mobilités is a testimony to the cooperative enthusiasm between regional and local players to redesign the mobility system in its multiple scales from the Strasbourg territory. Its major structuring projects are being deployed in the same way as the Climate Plan for the various modes of transport. In terms of rolling stock, the flagship project focuses on the downgrading of the A35 motorway crossing the city, following the construction and commissioning of the GCO (Grand Contournement Ouest de Strasbourg). In addition, the Low Emission Zone (LEZ) is to be deployed from 1 January 2022 (Climate Plan 2030 - Strasbourg City Strategy, 2020). These are all disincentives to encourage modal shift. The development of public transport services in the first and second suburbs requires the creation of new infrastructures such as the Regional Express Railway Network, new bus links throughout the metropolitan area and the development of transport on demand. Finally, on active mobility, the Grenelle des Mobilités includes projects for a bicycle express network (VéloStras) and the extension of priority zones for pedestrians in line with the Pedestrian Plan 2021 - 2030 (Climate Plan 2030 - Strasbourg City Strategy, 2020).

To understand these figures and objectives, it is interesting to recall that, since the 1990s, with the tramway in particular, we have witnessed in Strasbourg a coordination of urban planning and transport, with mobility becoming one of the major levers of the project for the construction of the Strasbourg conurbation and its internationalisation through the reinforcement of its attractiveness (inter-municipal territory ; with a gradual awareness on the part of local elected officials of the need to regulate urban development and to think together about urban growth and transport services), as well as a tool for urban renewal aimed at improving the quality of life (through the redevelopment of public spaces) which will set a precedent. More recently, the cross-border tramway line linking the centre of Strasbourg to the city of Kehl (opened in 2017), also introduces a TOD (Transit Oriented Development) logic, with the development of new residential districts organised around the stations (Deux-Rives axis). Today, the Grenelle des Mobilités seems to be taking up this development-renewal logic by changing the scale: from a conurbation made up of tramways to a regional metropolis with the development of an RER. But if the agglomeration project (started at the end of 1989) linked to that of the tramway combined spatial planning and mobility with the objectives of economic development that were central at the time, the metropolitan construction is now confronted with the climate emergency and the imperatives of transition. If the local urban culture has always been marked by an ecological sensitivity and a certain landscape identity which have been used to the benefit of the Strasbourg urban project, the environmental crisis is now bringing them to the forefront. The future of Strasbourg and its mobility must be formulated between two rationalities that seem to be opposed: the logic of development and the search for sobriety.

STATE OF PLAY: THE LOCAL POLITICAL DEBATE (2020 MUNICIPAL ELECTIONS)

These concerns were also felt during the election campaign for the 2020 municipal elections. Without going into the details of the debates, it is interesting to note that they revealed quite clear and contrasting positions on the vision for the urban future of Strasbourg and its mobility. On the one hand, the ambition of the right-wing to position Strasbourg as a major European cross-border metropolis like Geneva, Frankfurt, or Milan, which seeks to pursue its development - and in particular its economic development - and wishes to strengthen the efficiency of its intra- and inter-metropolitan mobility system, relying in particular on technological innovations and the knowledge and know-how of the smart city and smart grids. Fully embracing urban growth, this vision envisages densification around public transport and network nodes «in order to minimise individual transport and facilitate the life of inhabitants». Its response to the climate crisis includes less polluting transport, the creation of a «green lung» behind the station and the planting of 50,000 trees/year, as well as new industrial synergies.
On the other side of the political spectrum, the classic left wishes to maintain the status quo and in particular to keep the Strasbourg metropolis on a human scale, «balanced in its territories», while sharing certain points of view with the right, such as the importance of large productive and mobility infrastructures like the port and the airport, or the continued development of the city's housing stock. Ecological sensitivity is reflected in the energy savings to be achieved through the renovation of the building stock, the creation of an urban park around the A35 motorway, which is in the process of being downgraded, and the development of the organic sector.
A third path is outlined in the ecologists' programme, which imagines Strasbourg as a «resilient, balanced, hospitable and Rhine-like metropolis» based on the model of the social and solidarity economy, using cities such as Berlin for its citizen initiatives, Copenhagen for its environmental commitments, or Rennes or Brussels for food autonomy as references. As for mobility, apart from the importance of public transport (on which there is a consensus), the Greens put forward proposals to strengthen active mobility (create 15km of cycle paths per year; double the share of bicycle travel, & protected pedestrian routes), aiming for the creation of a Green Zone and the end of diesel by 2025. On the other hand, they insist on the nuisances created by transport, especially if it is concentrated in certain areas. On the environmental side, without going to the extremes

expressed by other radical left-wing lists that imagined transforming the whole city into a large park, the Greens defend, among other things, a massive greening of the city so that each inhabitant can have a green space within 5 minutes of his or her home.
A detailed analysis of the proposals of these three lists as well as the paths they may have inspired for the scenarios are available in the appendix of the report.

WHAT SUSTAINABLE MOBILITY FOR STRASBOURG 2030? CONTRASTING EXPLORATORY SCENARIOS

Inspired by these different tensions and contrasting visions from the 2020 municipal election campaign, from the smartest and most high-tech to the most sober, the two proposed scenarios explore the dynamics of change and envisage two possible Strasbourg futures that consider the mobility transition in two different ways, without going to the most extreme positions.

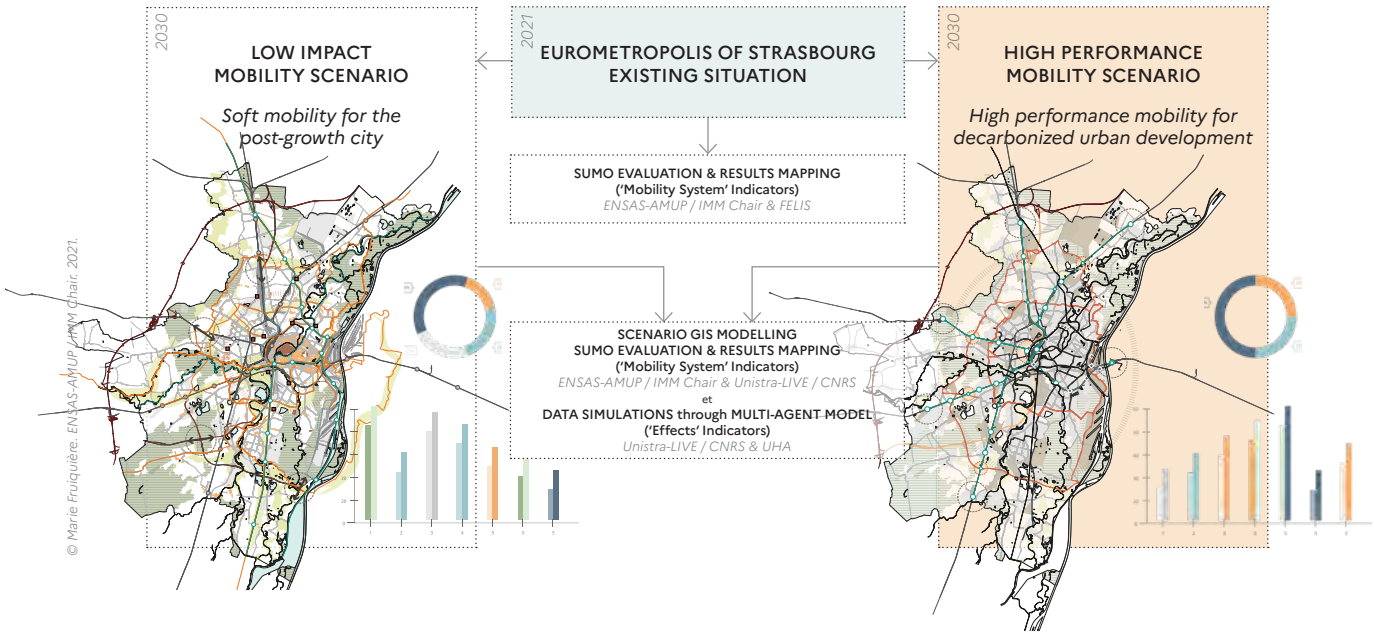
The first - *Low impact mobility scenario* - is oriented towards active and soft mobility, based on a low impact strategy that relies on a major change in mobility behaviour, favouring above all walking and cycling, and more broadly on more sober lifestyles, production, and consumption patterns. It situates the future in a post-growth city, marked by a return to the local, with proximities that are being redesigned, particularly on the scale of a fine mesh of cycle mobility to be built, and around a new territorial landscape structure, with the creation of a system of metropolitan parks and a river mobility network. It breaks with the urban development logic of the last few years by limiting land consumption (favouring the unsealing and renaturalisation of soils), and by renewing the way the metropolis functions in order to reduce the carbon footprint of human activities and the ecological footprint of people, through new territorial metabolisms, in search of a balance between resources, network availability, social expectations and the environment.

The second - *High performance mobility scenario* - seeks to respond to environmental imperatives by focusing on the reduction of energy-consuming travel and greenhouse gases through an increase in the supply of public transport and a policy of supporting technological innovations. It is in line with the logic of metropolitan development and urban renewal, through an enlarged, more densified, and optimised public transport network, with urban densification planned around the stations of these key routes. It thus adopts an environmental approach that is embodied in the ideas of density and compactness, and presupposes major investments in the infrastructural and technological development of collective and individual mobility.

The two scenarios thus meet the objectives defined by the 2030 Climate Plan and should make it possible to obtain contrasting results when evaluated by the Indicator System, particularly with regard to the impact indicators.

FRAMEWORKS FOR CO-CONSTRUCTION AND DISCUSSION OF SUMO SCENARIOS

Although, methodologically, the elaboration of the scenarios was initially envisaged through a participative approach with «open» workshops for the general public in order to take into account the different interests, points of view and desires of the inhabitants and transport users of the Strasbourg metropolis, measures linked to the Covid-19 pandemic led us to reorient our working method



The development of contrasted scenarios in the Strasbourg Eurometropolis *- A comparative approach through cartographic evaluation of scenarios and data simulation by the multi-agent model*

by starting from the proposals of the candidates for the municipal elections in Strasbourg in 2020 (see Annex).

Two collective workshops contributed to the work of elaborating the prospective scenarios: one conducted with the academic partners of the SuMo Rhine consortium in February 2020, the second, held in March 2021 in the form of a webinar bringing together both the researchers who are members of the consortium and the local partners of the Strasbourg metropolis.
While the first allowed the research team to measure the potential of the SuMo Indicator System for decision making, it also allowed for an awareness of the technical difficulties, of the issues related to the consideration of spatio-temporal scales, but also of the biases that the unavoidable initial choices introduce.
The second allowed for the review, with the help of the feedback provided by the local actors, of the representation and calculation modalities carried out on the basis of indicators/sub-indicators to evaluate the mobility systems and the existing urban environments, but also to confirm the interest of the scenarisation, evaluation and simulation approach for the debate of the mobility policies and their impacts on the urban futures

In fine, these participatory workshops, as well as the regular working meetings with our partners from Unistra-LIVE / CNRS, were places of co-construction and debate which progressively guided choices relating to the scenarios, both in terms of methodology and the technical dimension with a view to their evaluation by the SuMo Indicators, and in terms of their content.

Annual Retreat Meeting workshop

See Annexe

In February 2020, during the annual «retreat» meeting of the SuMo Rhine research programme, ENSAS proposed a workshop to the partners in order to feed reflections on scenario building. The team first recalled the objectives of this task, the challenges of narrative scenarios and related issues (spatialization, qualitative data, etc.). In this workshop, participants were invited to design mobility scenarios through a practical activity. By engaging the partners in forward thinking about modal choice, the discussions revealed initial concerns about forward-looking uses of the Indicator System for scenario evaluation.

After being divided into interdisciplinary groups, each team received various working documents: context data on the project site - the A35 motorway in Strasbourg awaiting downgrading -, a list of indicators composing the SuMo system (2020 version), schematic backgrounds, information on trends in the nearby urban environment - references of the envisaged projects, etc. Based on a selection of different mobility options (bicycle lane, bicycle highway, car lane, tramway line, BRT lane, pedestrian lane), the participants were invited to imagine the most desirable mobility scenario in their eyes according to different urban environments, more or less dense. Within the same team, the partners brainstormed about possible changes in their scenarios and, in case of significant transformation, tried to anticipate (individually) the evolution of the values of the indicators.

All the partners finally exchanged views collectively on the urban proposals and the modes of transport envisaged, the methodology adopted for the construction of the scenarios, but also on the weighting and the units of measurement of the indicators. During this exchange, the participants first of all pointed out the conditions of the exercise, in particular the subjectivity of the evaluation of the scenarios linked to the absence of a reference value for the existing situation in relation to which the evolution in the values of the indicators would have to be assessed. Some groups focused on trends in the evolution of data rather than assigning an absolute value. The participants pointed out the risks of a possible ranking of the results between the different cities or scenarios evaluated.
From a technical point of view, the FELIS team pointed out the difficulties in implementing modified data for scenario evaluation in a system built on real-time data (Google transport data, Open Street Map data, HERE, etc). The challenge lies in the availability of data for future scenario projections. Several assumptions were made on how to fill in the missing values (data simulation, modelling, theoretical assumption, trends...).
On the other hand, some participants noted the difficulty of classifying values that will change over time, after 10, 20 or 30 years. This remark raises questions about the timing of the evaluation, but also about the scales: how can the impact of mobility transformations be evaluated on a larger scale? Where to stop in terms of space and time?

Members agreed that the objective of the scenarios and the corresponding task (WP2.8.) is not necessarily to provide a perfect and complete solution but to show the potential of the indicator system in decision making. The aim is to show a method and the issues at stake in the use of the Indicator System in the assessment of foresight visions.

Summary of the Inter-Stakeholder Workshop:

"Scenarios for a Qualitative Transformation of mobility infrastructures on the basis of Sustainable Mobility Indicators"

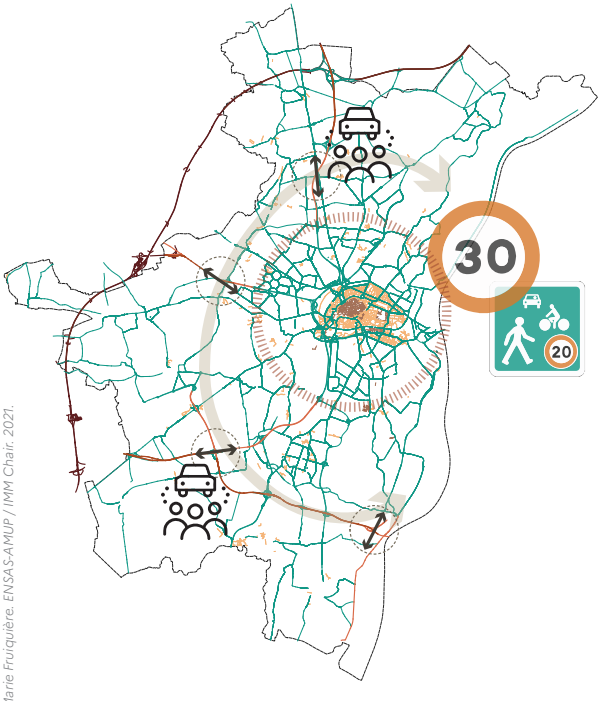
See Annexe

On 29 March 2021 the SuMo-Rhine project conducted a participatory online workshop with the theme «Strasbourg Rhine Metropolis: what sustainable mobility? The workshop was organised by the AMUP / IMM Chair research team of ENSAS with the participation of Unistra-LIVE / CNRS.

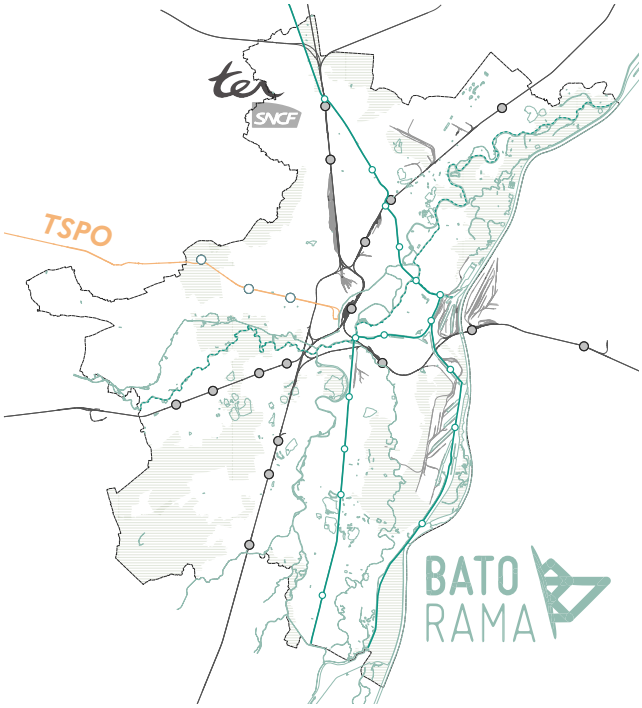
As an introduction, the contents and expectations of the session were presented as well as the SuMo Rhine project, its objectives and organisation, with a focus on the Indicator System and its two applications discussed during the workshop. The workshop was structured in two parts, according to two working axes. The first part focused on the mapping and multi-scale assessment of existing mobility conditions, while the second, more prospective part, discussed exploratory mobility scenarios and their modelling.
In the first work stream, entitled «The SuMo Atlas: Mapping existing mobility conditions on the basis of the first results of the indicator system», the participants had the opportunity to see the very first visualisations of the assessments for the Rhine cities (multi-scale maps and graphs) according to the SuMo Indicators and sub-indicators calculated only one week before the workshop took place. We were also able to show the work needed to calibrate the calculation of the indicators. The presentation was followed by a discussion that allowed the participants and the SuMo Rhine team to exchange on the advantages and challenges of the indicator calculation and the mapping approach.
After a short break, the second part of the workshop showed the development and modelling of exploratory mobility scenarios for the Strasbourg Eurometropolis. The LIVE laboratory (Unistra / CNRS) presented the multi-agent model which can reproduce the movements of people on a territory. It should make it possible to analyse mobility and development scenarios in order to simulate their effects on the mobility practices of inhabitants, and then determine their respective impacts according to sustainability indicators. Subsequently, the ENSAS team presented two exploratory scenarios for the Rhine Metropolis of Strasbourg. As a basis for testing the Indicator System as a tool for decision-making and evaluation of local policy with regard to the sustainability of mobility, the two exploratory and contrasting scenarios for the year 2030 were presented.
In conclusion, the links between the scenarios, the Indicator System and the multi-agent model were explained, as well as the type of results expected. The scenarios are thus subject to a double evaluation: on the one hand, through the GIS configuration and the calculation of indicators directly qualifying the imagined mobility systems (walkability, public transport, etc.); and on the other hand, through the multi-agent model developed by Unistra-LIVE / CNRS, which allows the calculation of changes in the behaviour of individuals as well as sustainability indicators (pollution, emissions, etc.). In this way, the two exploratory scenarios can be compared with each other, but also with the existing mobility system.

The discussion that followed the presentation of the scenarios highlighted the fact that the Indicator System can add new perspectives for the development of future mobility.

The Exploratory Scenarios



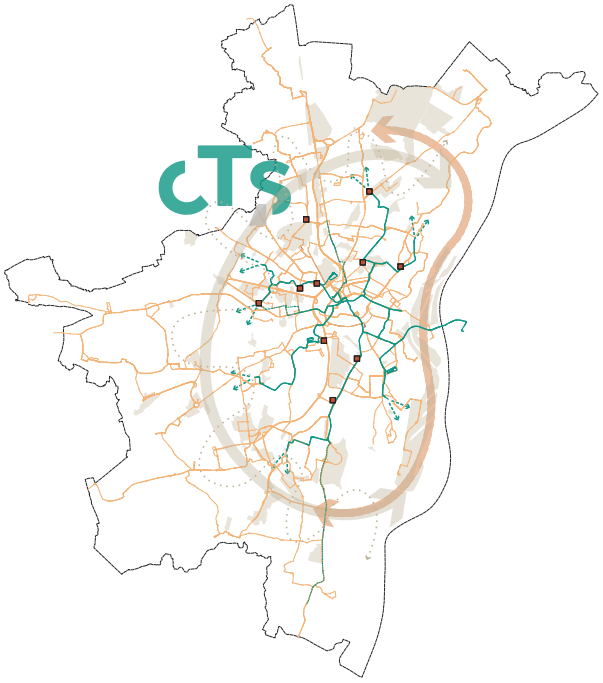
Discourage car entry by deploying a « Calm City » Plan and promoting car sharing



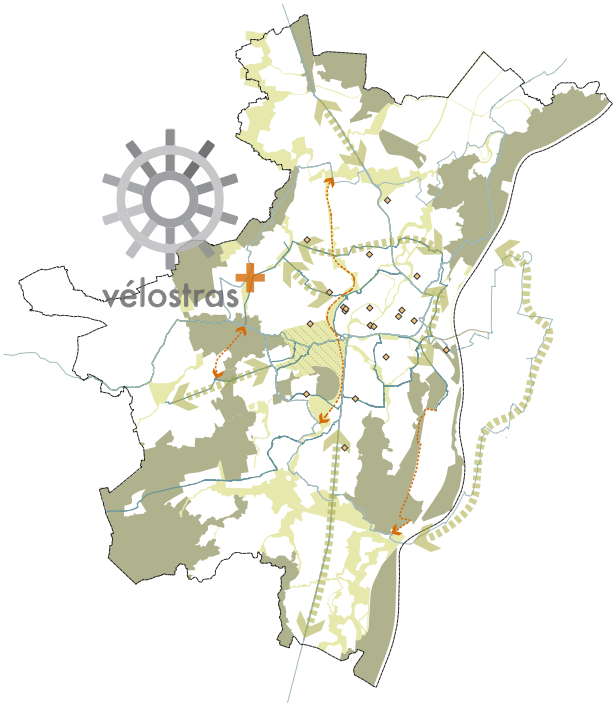
Provide interurban service via the existing TER rail network, a river shuttle and transport on demand in perirurban areas

LOW IMPACT MOBILITY SCENARIO

Soft mobility for the post-growth city



Extend the existing bus and tramway matrix for urban transportation services



Deploy a dedicated bicycle express network based on the VéloStras plan and reinforce ecological continuities

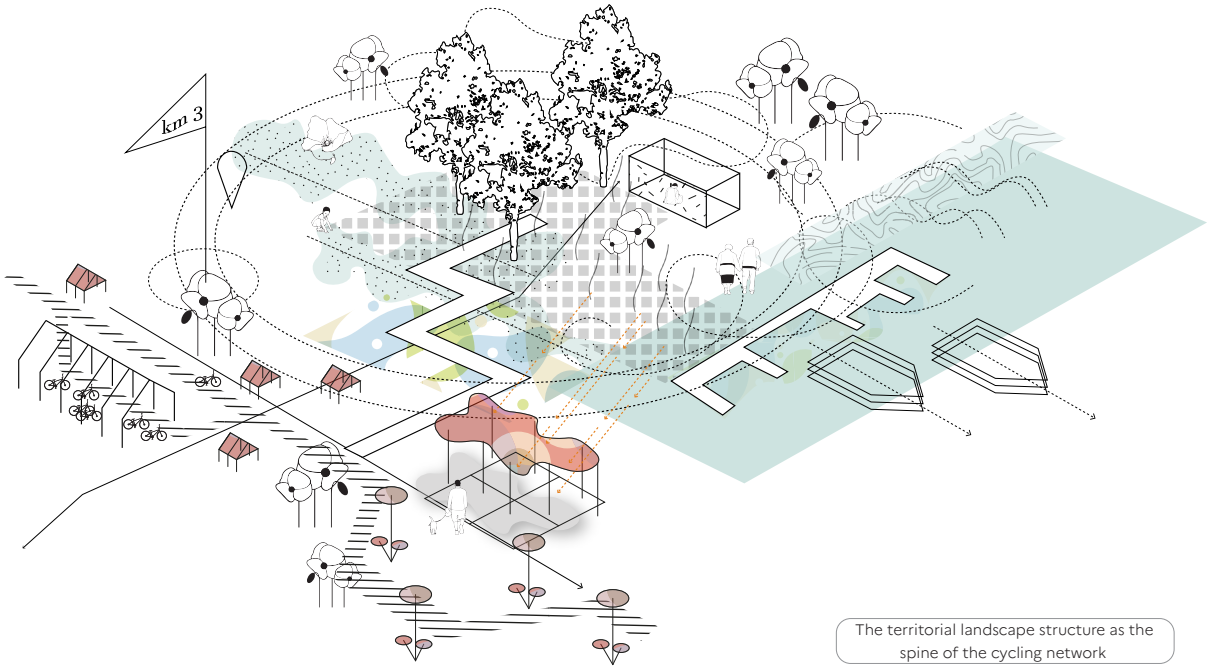
*Improve the **quality of urban space** by rethinking*
mobility networks** in coherence with **living infrastructures

LOW IMPACT MOBILITY SCENARIO

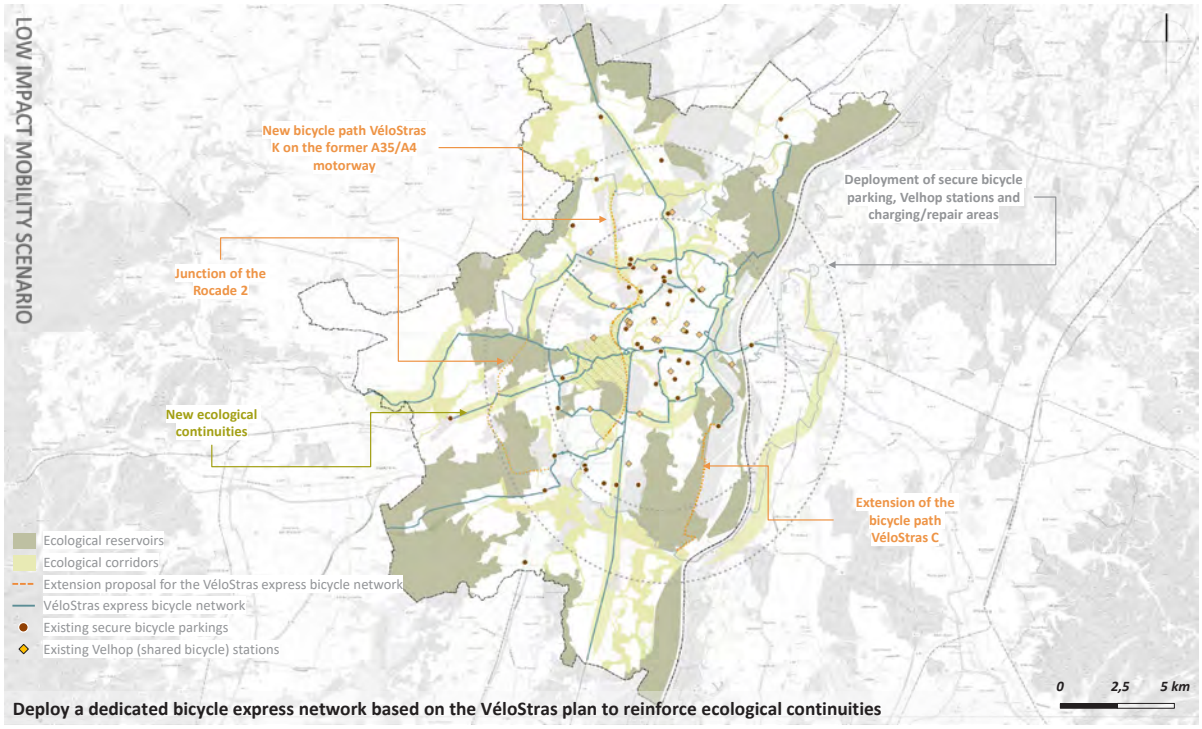
The first scenario is oriented towards active and soft mobility, and is based on a change in behaviour, values, and lifestyles, favouring a return to the local context and mobilising a relatively low level of investment. It can be implemented in a crisis situation or supported by a strong political will and is inspired by a vision of the metropolis that leaves aside the logic of growth, in favour of a territorial anchorage with new, more sober metabolisms, yet to be invented. It envisages a mobility system that relies on the resources of its territory, i.e. a hydrographic network, topographical conditions and a landscape network (to be strengthened) that become supports for affirming and diversifying active and soft mobility - particularly walking and cycling, but also a new network of river mobility. Based on the observation that the technical and technological responses deployed in recent years are not sufficient to respond to the climate emergency, this scenario is based on the hypothesis that only a massive and consequent change in our modes of consumption, travel, and production (following the example, for example, of the «slow living» philosophy or bioregionalist thinking) could truly initiate and support the ecological transition.

More concretely, this first low impact scenario is characterised in particular by the reinforcement of the VéloStras cycle express network as the backbone for ecological continuity. The objective is to reaffirm the place of pedestrians and cyclists by rethinking and enhancing the associated public spaces. By 2030, the Eurometropolis of Strasbourg aims to be 100% cyclable and to deploy a 100% pedestrian master network representing 3,200 additional cycle trips per day and 2,500 walking trips per day. It is accompanied by increased deployment of electric bicycles (+ 25,000 users by 2025 in the 2030 Climate Plan), which have an average range of 9 km per trip. To achieve this, a hierarchy must be established between a high service level cycle network and a much finer grid. The VéloStras network is then completed by new structuring routes such as an alternative route for the ring road 2, the extension of the C line or the creation of the K line taking advantage of the future downgrading of the A35. At the same time, these cycling facilities allow for the experimentation of new types of facilities such as the unmarked central lane to make cycling safer, with an average speed of 20 km/h, while avoiding conflicts between cyclists and other users (motorists and pedestrians) and lateral obstacles as much as possible.
In addition to the cycle lanes, this network is completed by equipped rest areas (services, weather forecasting, benches, etc.) to shelter from the rain, refill your tires or quench your thirst at a water fountain. New Velhop bike sharing stations and secure bicycle parking facilities are being deployed throughout the region. Finally, the green network plays a key, even indispensable role, since the vegetation, in addition to providing pleasure, shelters cyclists from the wind and protects them from the sun. On infrastructures such as the A35, it is a question of triggering a real demineralisation of the soil, which will also contribute to the construction of new cool islands and the reduction of existing heat islands (80% of the population located less than 300m from a cool island by 2030).
The «blue network» also becomes a support for soft mobility with a proposal for a collective river network to better serve the eastern part of the Eurometropolis. In addition to generating low environmental externalities, this alternative mode is deployed on the existing hydrographic environment and therefore does not require any major investment other than the creation of the station infrastructure. The level of service offered is similar to that of a waterborne shuttle bus. The stations of this new river network are in principle located at the intersections with other transport networks (individual and collective) and particularly with the increased VéloStras network, to create intermodality. This also applies to urban services at intersections with existing public transport networks, supplemented by a transport-on-demand offer in the first and second ring roads.
To support all of these measures, a «Calm Metropolis» plan is proposed to discourage the entry of cars into urban areas by reprioritisation of the road network according to speed limits. The city centre is extended to include the Gare, Neustadt, Etoile and Esplanade districts, while the island ellipse is turned entirely into a pedestrian area. It also includes incentives to maximise carpooling and carsharing by creating dedicated lanes on major infrastructures and increasing the number of Citiz stations and carsharing spaces.
Finally, this scenario responds to the need for accessible nature and quality of life put forward in the dual context of the health and ecological crises. It creates a new landscape grid: a structuring system of metropolitan parks (natural and river spaces), relayed by a finer natural mesh that irrigates and ensures the continuity of biodiversity right into the neighbourhoods. It accommodates soft and active mobility and becomes the support of new proximities.

The green and blue matrix, support for alternative mobility in Strasbourg Eurometropolis



The territorial landscape structure as the spine of the cycling network

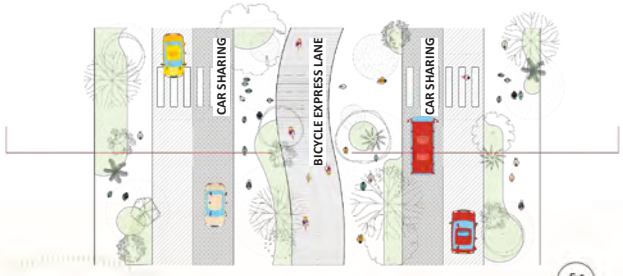


Deploy a dedicated bicycle express network based on the VéloStras plan to reinforce ecological continuities

LOW IMPACT MOBILITY SCENARIO

A35 motorway transformation

The A35 is no longer a structural fracture in the landscape, it becomes a planted and porous urban boulevard.



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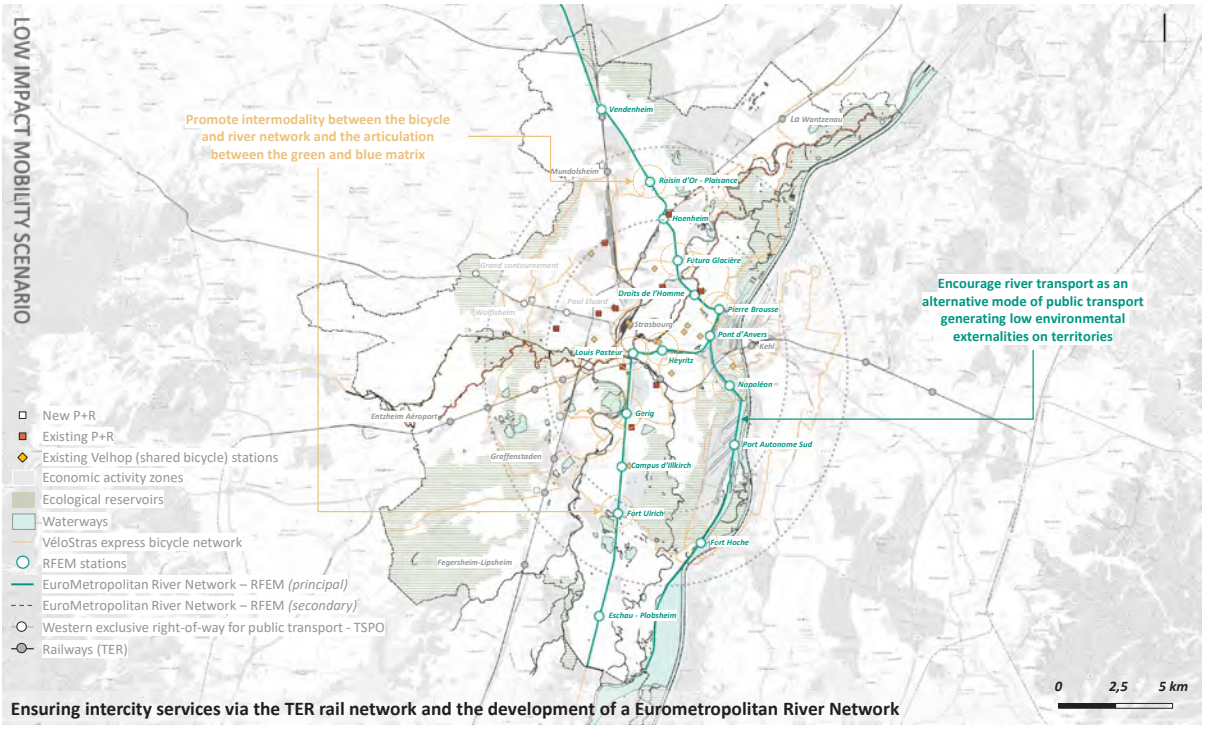
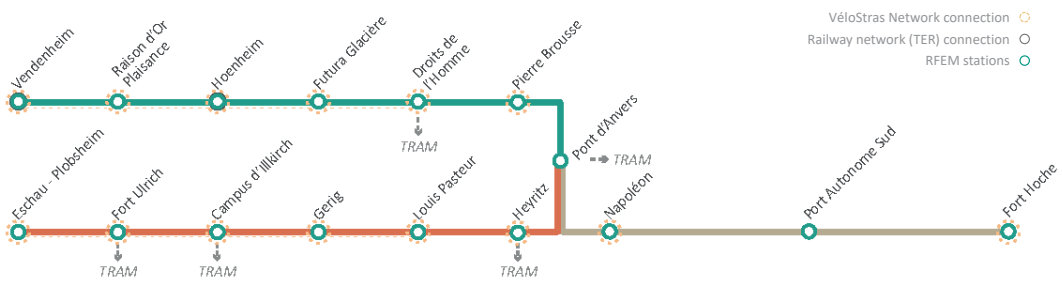


Ensuring intercity services via the TER rail network and the development of a Eurometropolitan River Network

LOW IMPACT MOBILITY SCENARIO

Level of service - Eurometropolitan River Network (RFEM)

Type	Boat-bus / River shuttle		**Length of the network**	51,14 km
Amplitude	**Start**	8h00	**End**	21h30
Vehicle frequency	**Peak hours**	Every 15 minutes	**Off-peak hours**	Every 45 minutes
Vehicle speed	**Minimum**	10 km/h (5,5 knots)	**Maximum**	25 km/h (13,5 knots)
Vehicle capacity	**Seats**	30	**Standing**	65 (including 20 bikes)



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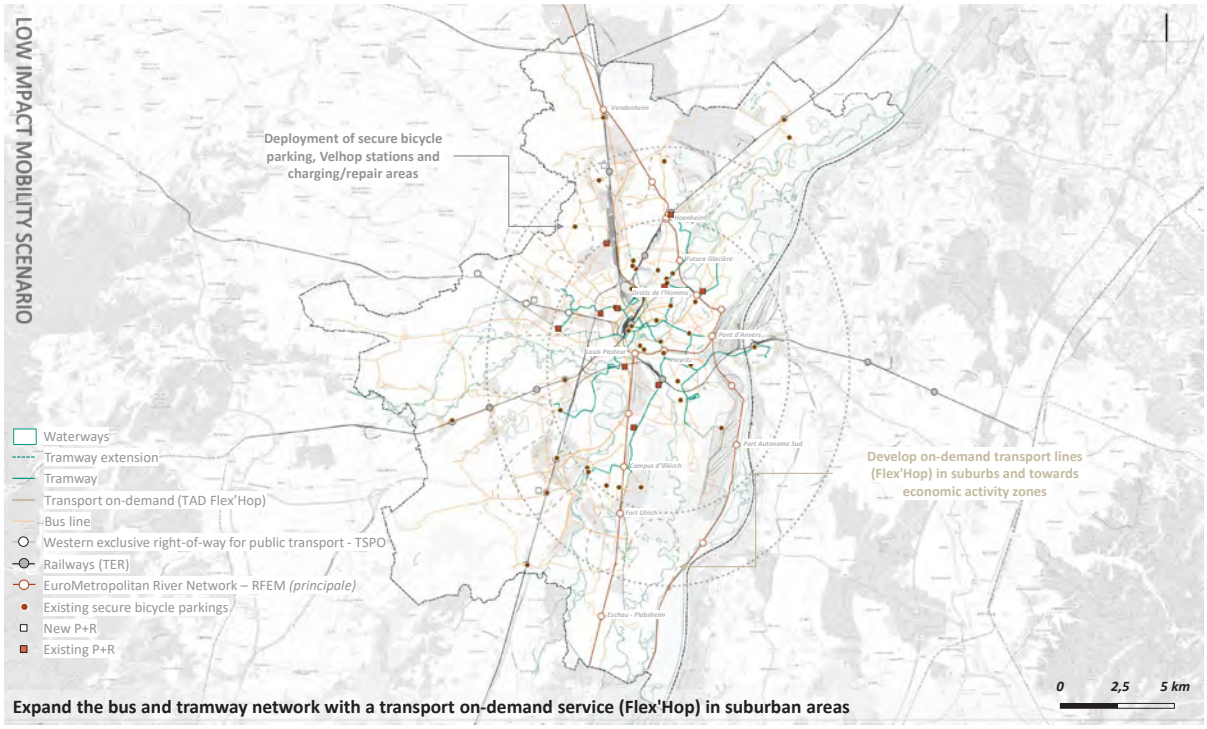
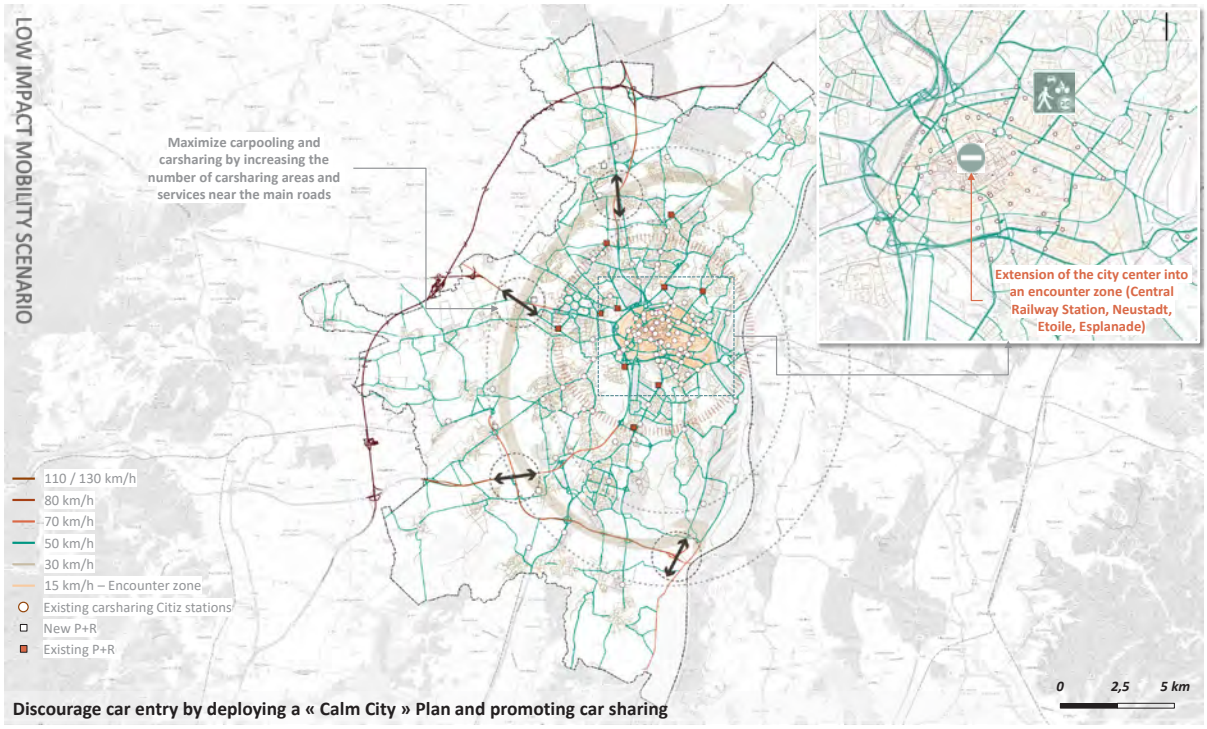
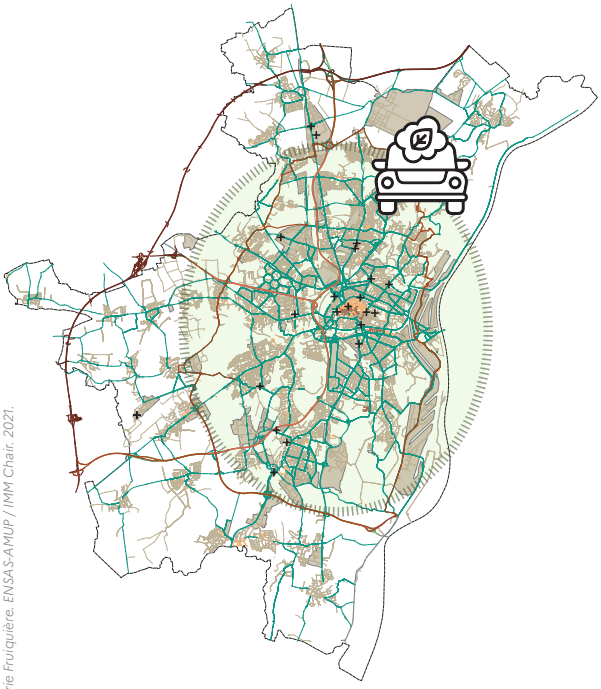


Expand the bus and tramway network with a transport on-demand service (Flex'Hop) in suburban areas



Discourage car entry by deploying a « Calm City » Plan and promoting car sharing



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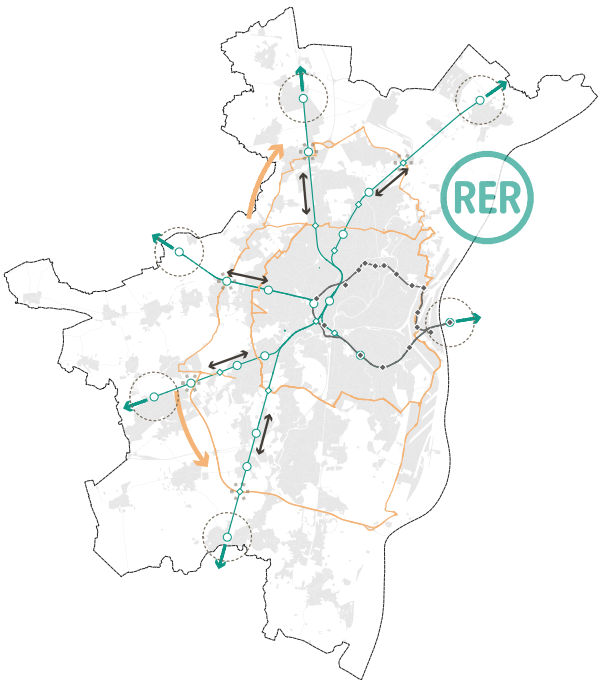
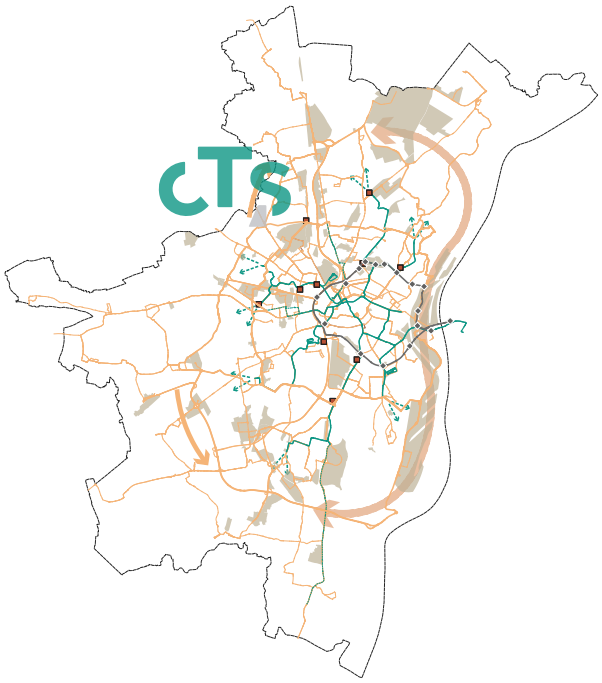
Accompany the decarbonized transition by the deployment of low-emission zones, as well as hydrogen and electric charging stations



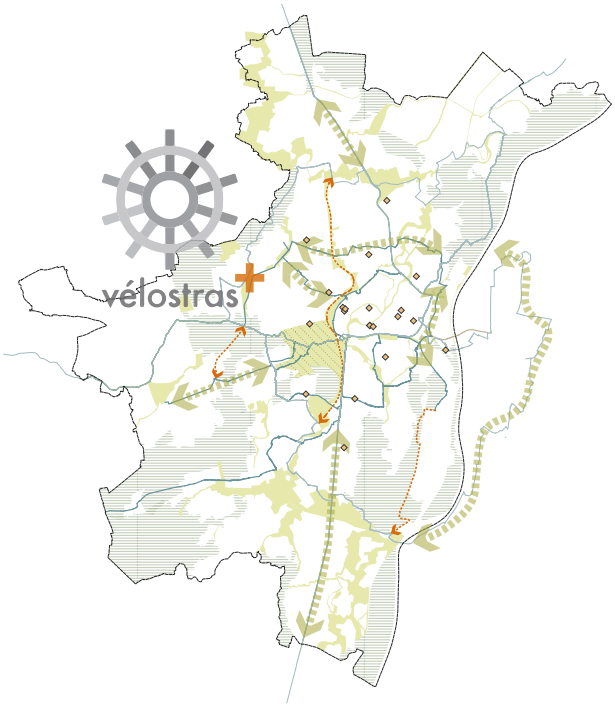
Develop an Eurometropolitan Express Rail Network (EEN) and BRT bypasses on the outskirts as vectors of urban renewal

HIGH PERFORMANCE MOBILITY SCENARIO

High performance mobility for a decarbonized urban development



Create a dense and extensive urban public transport matrix (tramway and bus) and implement a tram-train



Deploy a dedicated express bicycle network based on the VéloStras plan to form a fine territorial matrix

Densify and reorganize the urban fabric *around a* ***rapid transit*** *network*

HIGH PERFORMANCE MOBILITY SCENARIO

The second scenario follows more of a logic of optimisation and innovation, envisaging in particular the reinforcement of public transport and its articulation with active mobility, in a search for efficiency in mobility. In contrast to the previous scenario, it maintains a certain continuity with the reasoned development dynamics of recent years. It seizes the opportunities to create new densities and centralities linked by high-performance mobility systems without abandoning the Strasbourg tradition of active mobility linking the bicycle scale with the territorial scale.

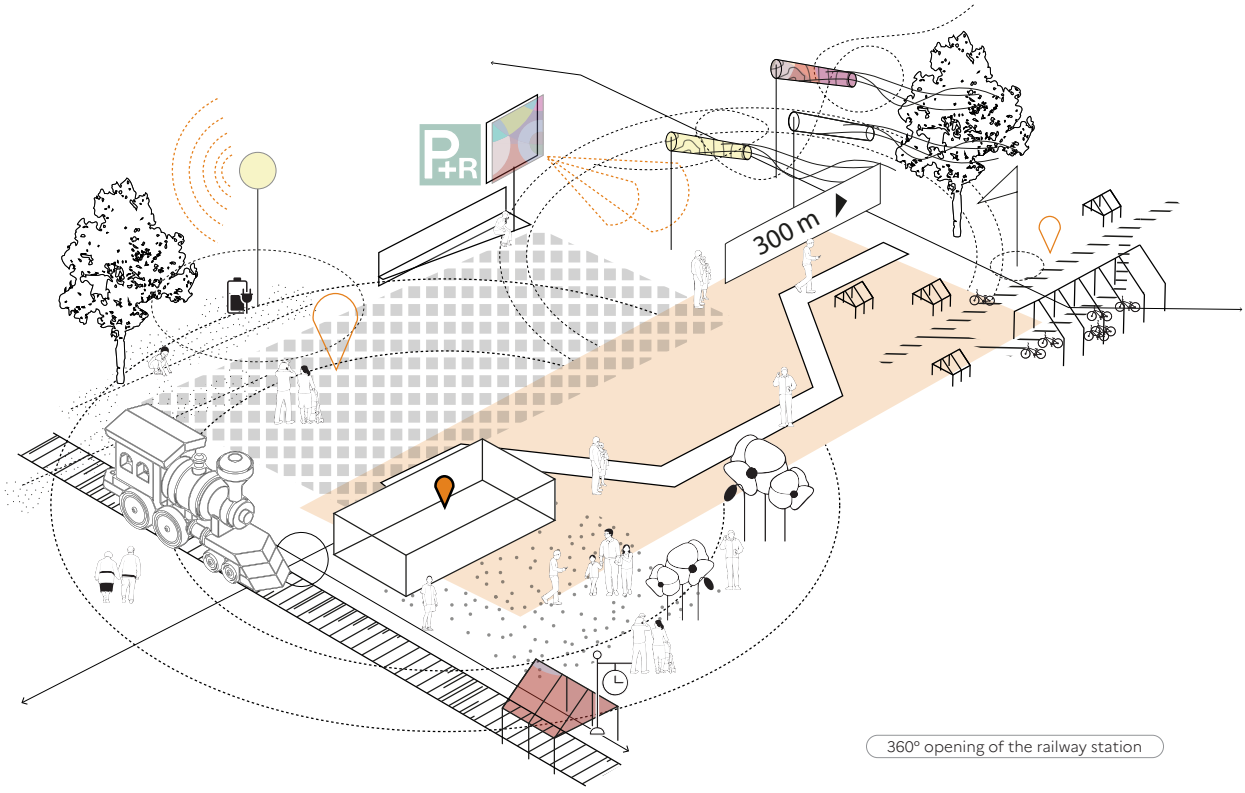
In order to meet the challenges of serving the first and second ring roads of the Eurometropolis, this scenario focuses on a competitive proposal with a high level of service around a Eurometropolitan rail express network. Intercity public transport is therefore reorganised around this new star network in the Eurometropolis around 3 diametrical lines of the REEM (Regional Express Railway Network), on the existing rail infrastructures but also through a new section on the exclusive right-of-way transportation route to the west (TSPO). These connections allow for the creation of new stops in the area and multimodal interfaces on the outskirts that simultaneously accompany renewal, but also urban development through densification around the stations. The aim is to combat urban congestion and optimise the urban fabric by offering new points of access to the network with opportunities for housing, employment, and commerce. This REEM is characterised by a level of service that is close to that of an RER and the Basel S-Bahn to ensure better service and increase the number of links between Strasbourg and the peripheral municipalities.
In addition to these branches of the rail network, two BRT lines are being created in the first and second ring roads, notably on the new intercommunal link route and its extension. The aim here is to improve intermodality between rail and rolling interurban public transport. This network is based on the existing public transport stations and on the territory's business areas.
A third tram-train ring around the Strasbourg city centre will finally link Strasbourg and Kehl. Between light and heavy rail, this new line relies on both the infrastructure of the French national rail network (especially in the south) and the tramway network. The line creates new connections with the REEM rail network and relieves congestion at the central station by installing the tram-train route on the downgraded A35. This also allows the station to be turned around and opened up to the west, thus encouraging the renewal of this district. The A35 is no longer a fracture that divides the landscape of the metropolis from north to south: it becomes a porous urban boulevard that can be crossed like a seam to facilitate flows between the east and west of the city.

In parallel, the scenario considers the mutation of the individual vehicle fleet, notably with the deployment of the LEZ throughout the Eurometropolis. To facilitate its implementation, a hundred or so electric recharging stations will be set up throughout the territory, particularly near major road and rail routes such as the connection between the Great Western Bypass and the REEM C/TSPO line. A similar dynamic is proposed for hydrogen stations to facilitate the use of clean vehicles.
In the city centre mainly, new measures will also limit parking, such as new housing projects where the number of parking spaces is capped per household. In this case, the scenario calls for the conversion of one in three squares to green public space.

Finally, the cycle network plays a complementary role to public transport, through the implementation of the Velostras network and the extensions proposed today.

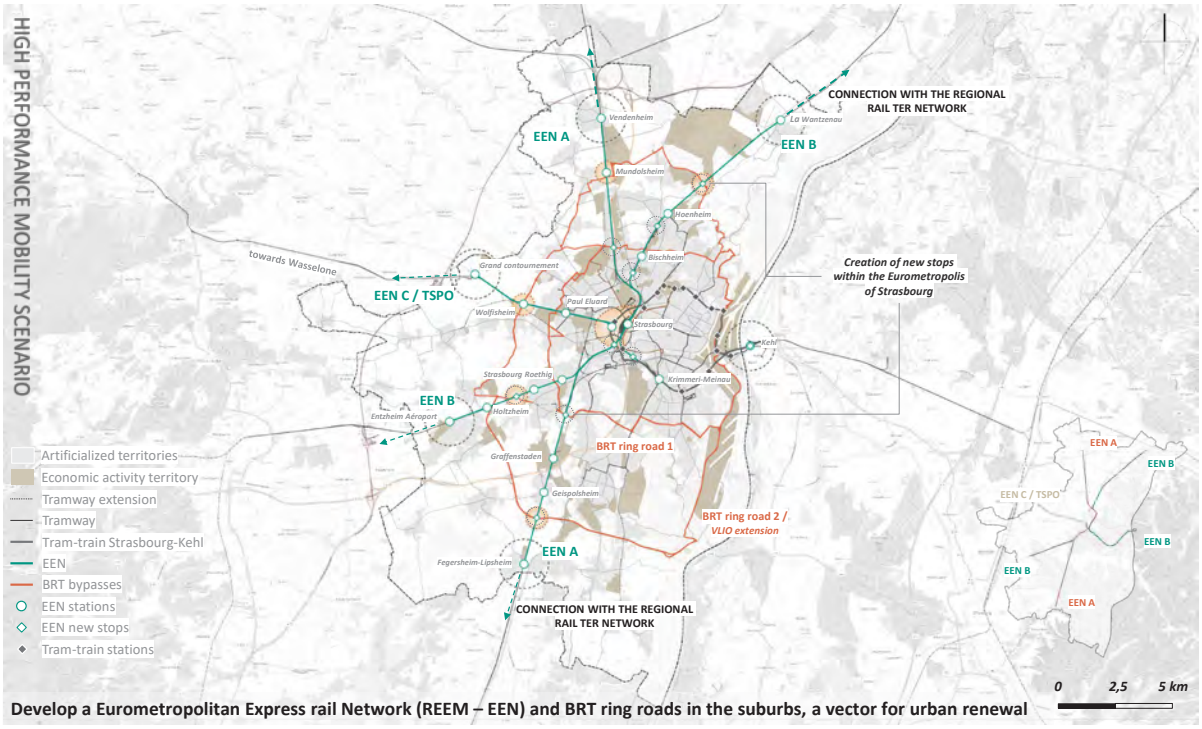
The objective here is to reorganise and optimise the urban fabric around a public transport network, complemented by active mobility, in order to meet the environmental, social, and economic challenges of a territory that is pursuing its rational development. This scenario is inspired by certain visions that defend the performative and efficiency dimension of mobility and responds to the transition of mobilities through rather high-tech developments and quality large-scale mobility. It adopts the model of the short-distance metropolis, which is based on densification and the strengthening of centralities around the nodes of the network.

Transport Oriented Development
for urban renewal in the Strasbourg Eurometropolis



360° opening of the railway station

HIGH PERFORMANCE MOBILITY SCENARIO



Develop a Eurometropolitan Express rail Network (REEM – EEN) and BRT ring roads in the suburbs, a vector for urban renewal

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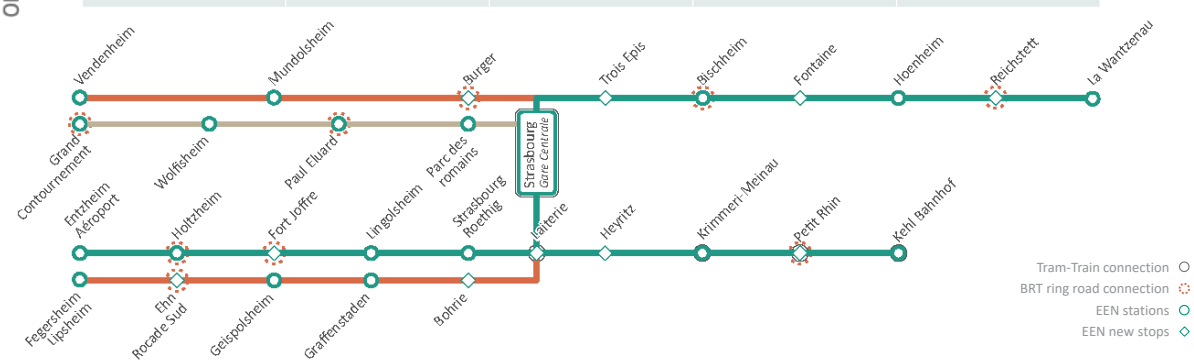
HIGH PERFORMANCE MOBILITY SCENARIO

Level of service – Eurometropolitan Express rail Network (REEM – EEN)

Type	RER – Railway		**Length of the network**	156,05 km
Amplitude	**Start**	4h30	**End**	22h30
Vehicle frequency	**Peak hours**	Every 7 minutes	**Off-peak hours**	Every 15 minutes
Vehicle speed	**Minimum**	80 km/h	**Maximum**	160 km/h
Vehicle capacity	**Seats**	120	**Standing**	80 (including 30 bikes)



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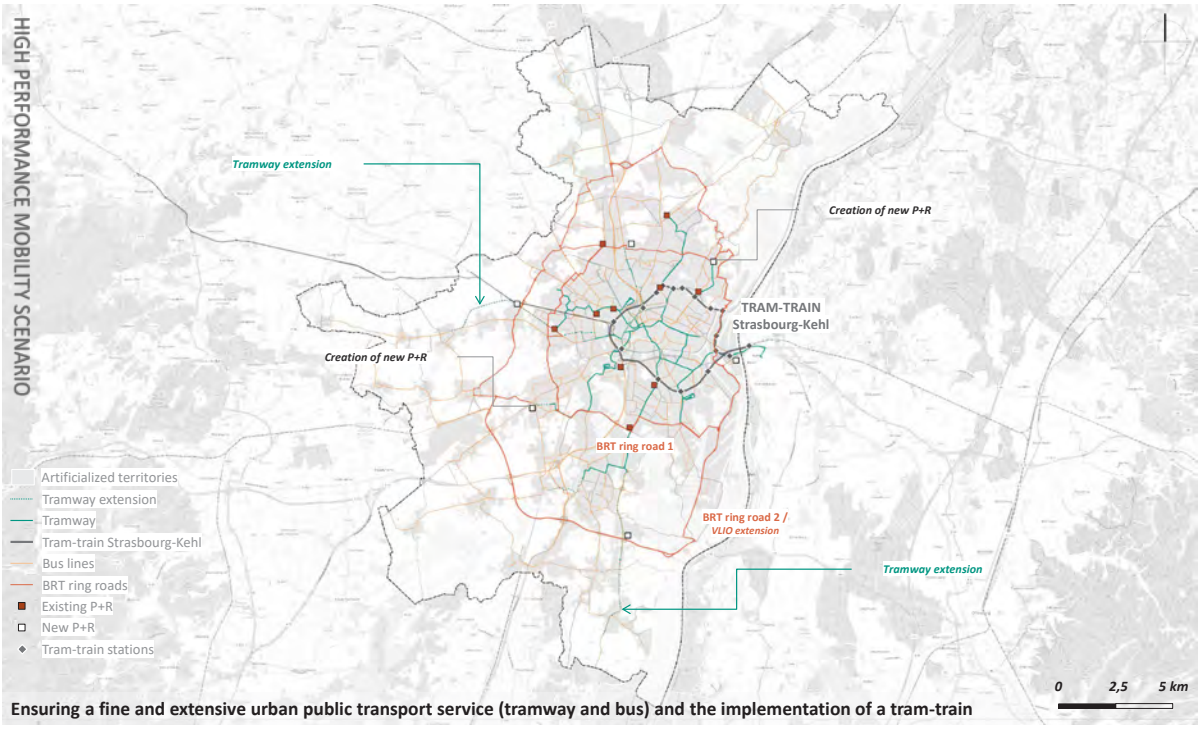
HIGH PERFORMANCE MOBILITY SCENARIO



Ensuring a fine and extensive urban public transport service (tramway and bus) and the implementation of a tram-train

HIGH PERFORMANCE MOBILITY SCENARIO

Level of service – BRT ring roads

Type	Bus-Rapid Transit		**Length of the network**	183,66 km
Amplitude	**Start**	5h00	**End**	22h00
Vehicle frequency	**Peak hours**	Every 7 minutes	**Off-peak hours**	Every 20 minutes
Vehicle speed	**Minimum**	20 km/h	**Maximum**	90 km/h
Vehicle capacity	**Seats**	60	**Standing**	30

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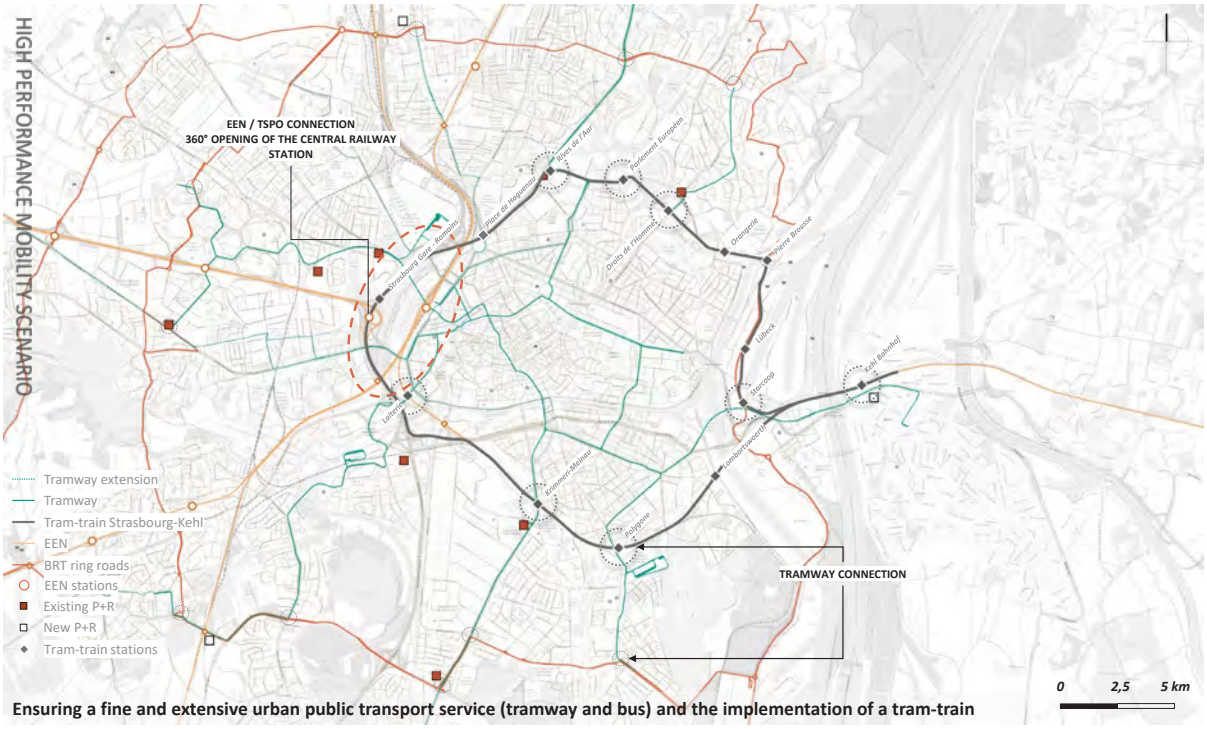
HIGH PERFORMANCE MOBILITY SCENARIO

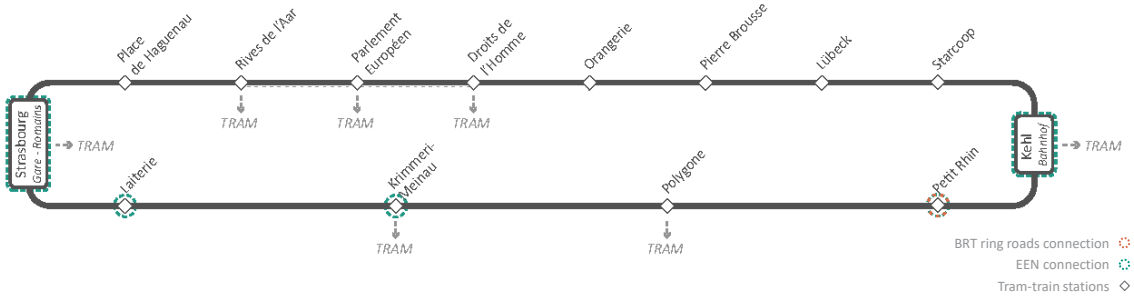


Ensuring a fine and extensive urban public transport service (tramway and bus) and the implementation of a tram-train

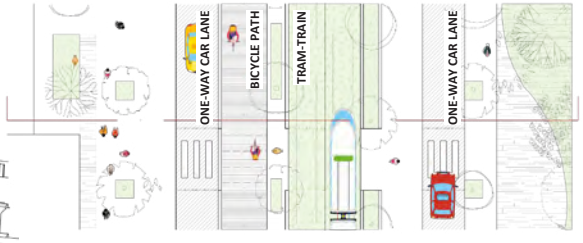
HIGH PERFORMANCE MOBILITY SCENARIO

Level of service – Tram-Train Strasbourg-Kehl

Type	Tram-train / Light and heavy railway		**Length of the network**	20,29 km
Amplitude	**Start**	6h00	**End**	23h00
Vehicle frequency	**Peak hours**	Every 7 minutes	**Off-peak hours**	Every 20 minutes
Vehicle speed	**Minimum**	30 km/h	**Maximum**	100 km/h
Vehicle capacity	**Seats**	100	**Standing**	150 (including 40 bikes)

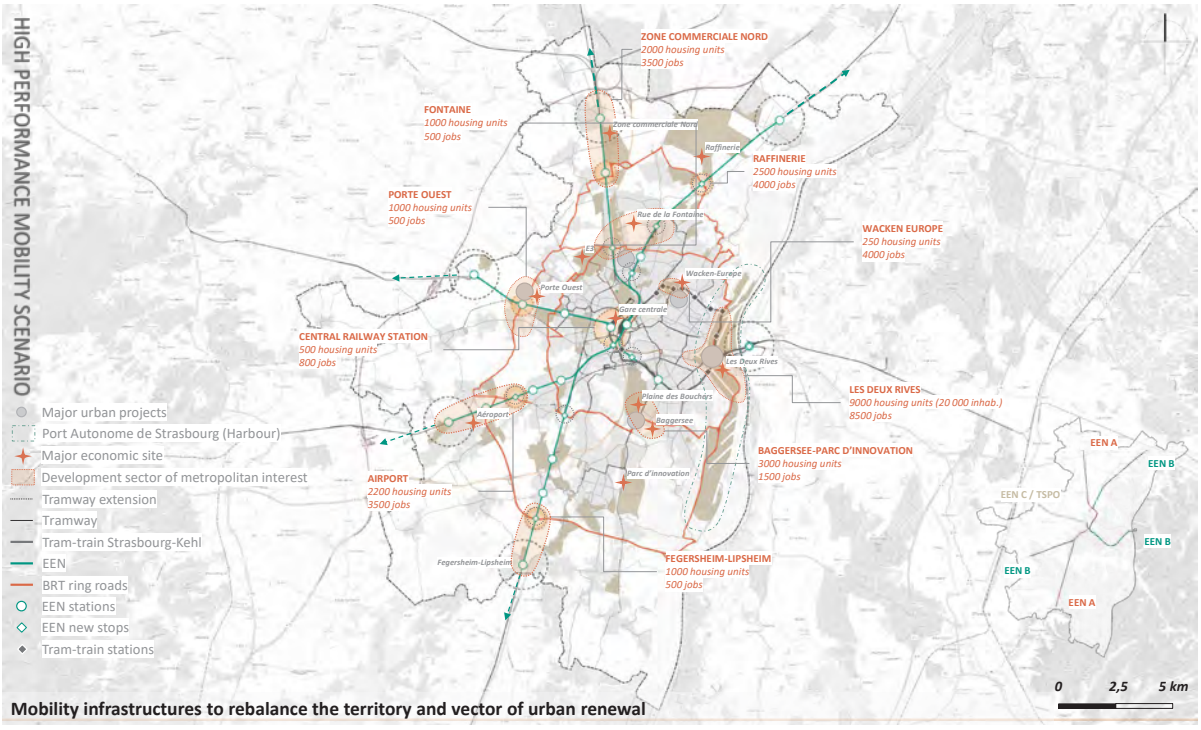


A35 motorway transformation



The tram-train route is on the A35 so as not to saturate Strasbourg Railway station, permitting the urban renewal of the rear station.

HIGH PERFORMANCE MOBILITY SCENARIO



Mobility infrastructures to rebalance the territory and vector of urban renewal

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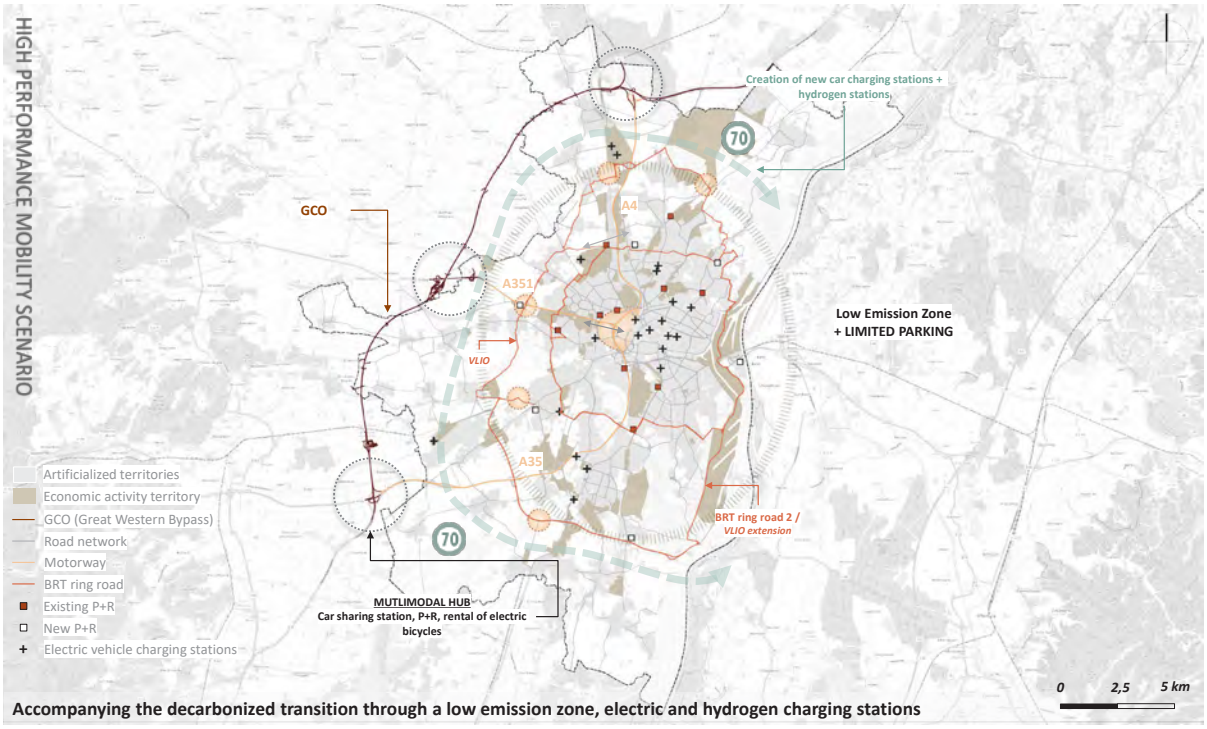
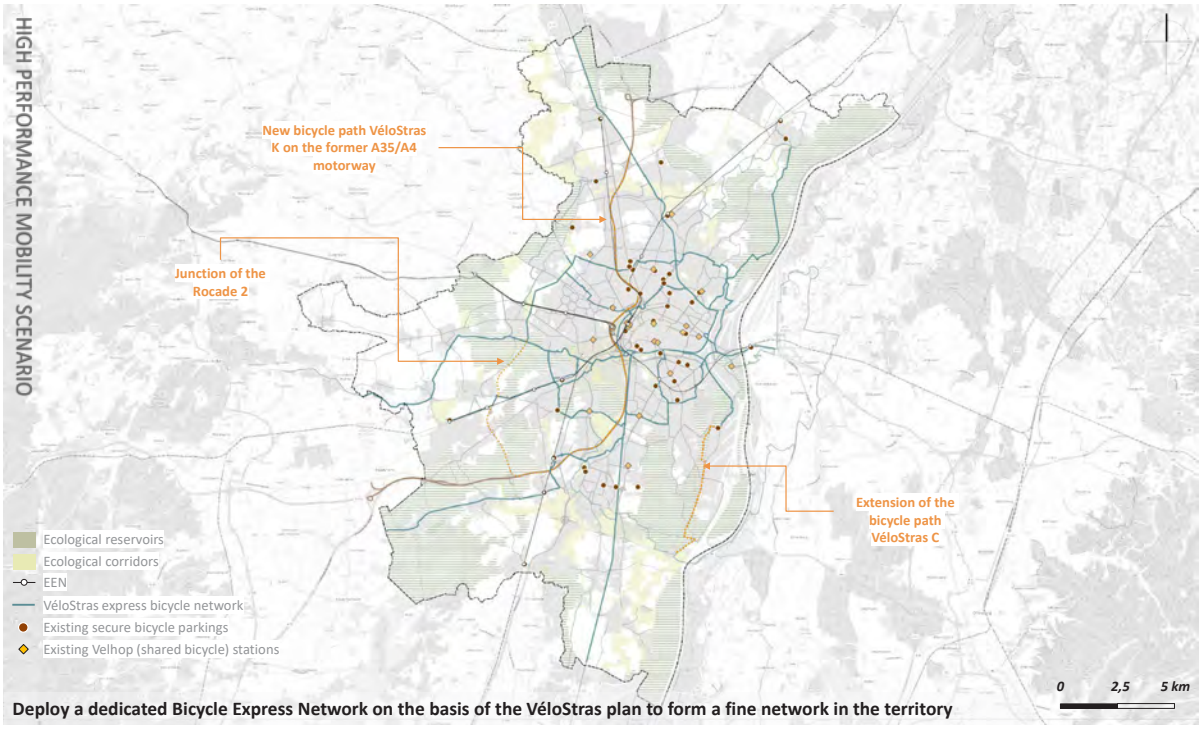


Accompanying the decarbonized transition through a low emission zone, electric and hydrogen charging stations



Deploy a dedicated Bicycle Express Network on the basis of the VéloStras plan to form a fine network in the territory

Evaluation of the prospective scenarios by the SuMo Indicator System (in connection with WP 2.6)

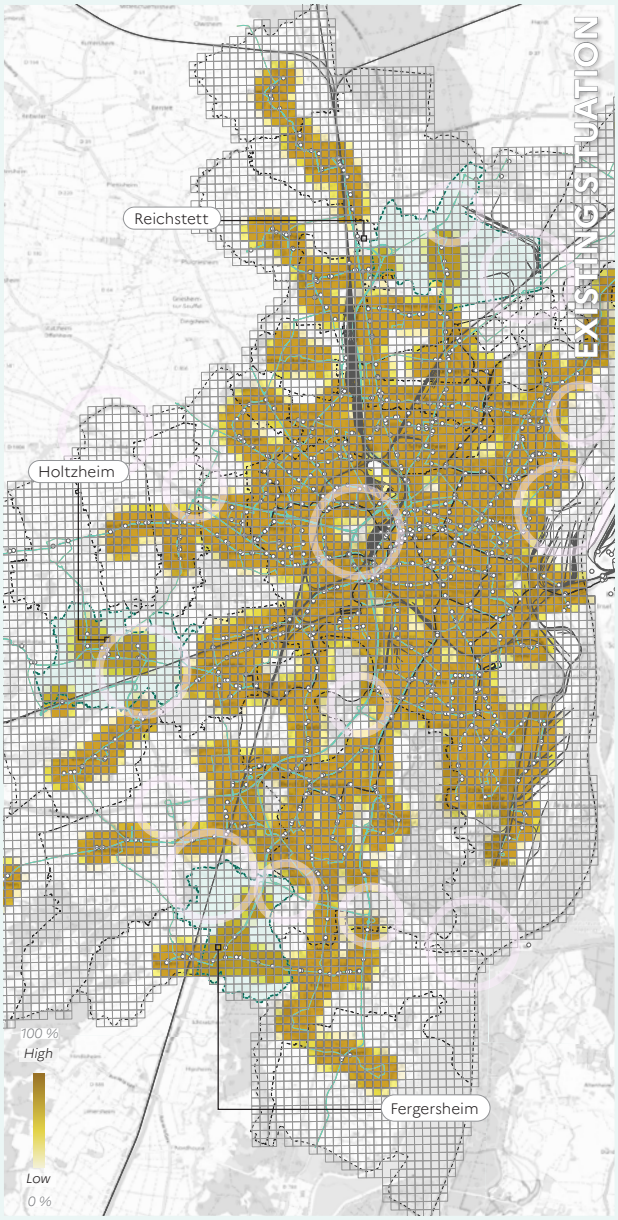
In order to test the Indicator System as a decision-making tool, the scenarios were designed to be evaluated in two ways: firstly, through the GIS configuration and the calculation of indicators directly qualifying the imagined mobility systems (walkability, public transport accessibility, etc.); and secondly, through the multi-agent model developed by Unistra-LIVE / CNRS, which allows for the simulation of changes in the behaviour of individuals in order to calculate sustainability indicators (pollution, emissions, etc.). They therefore had to be capable of integrating both technically and in their content the data taken into account in the calculation of the indicators.

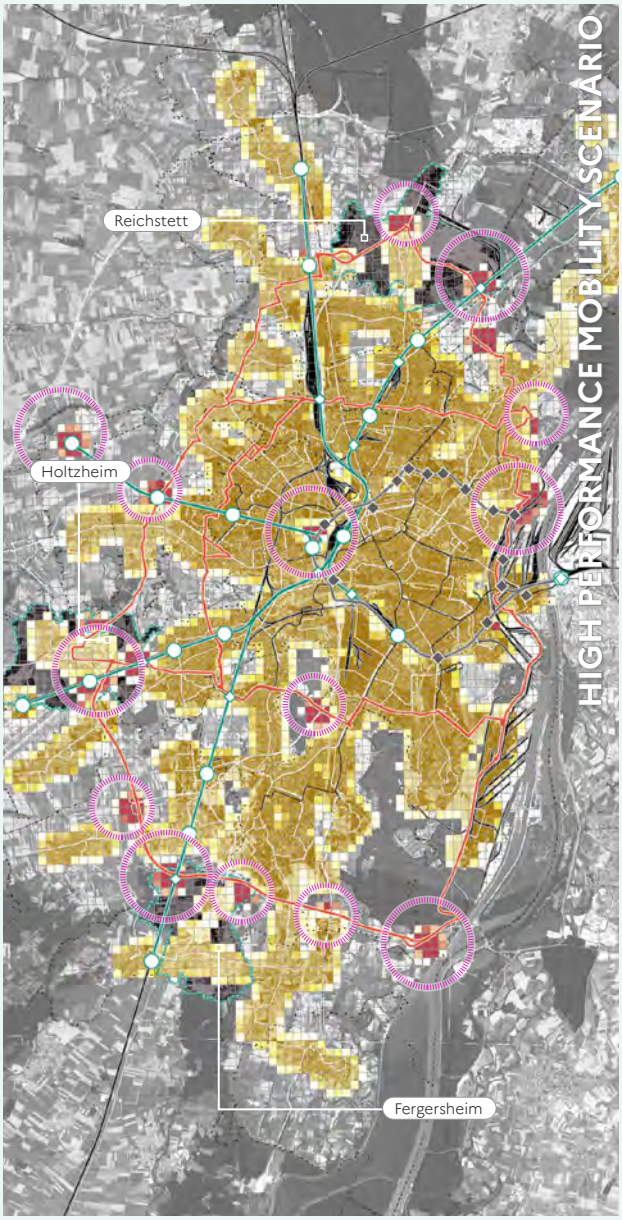
In parallel with the spatial design work, the scenarios were subject to rigorous digital parameterisation in GIS format, carried out in collaboration with Unistra-LIVE / CNRS. This work was carried out simultaneously with the construction of the indicators and the multi-agent model. The evaluation of the scenarios by the Indicator System was conditioned by the progress of the work in these related work packages, progressively orienting the elements to be taken into account and their levels of detail in the modelling of the scenarios.
Thus, the first cartographic evaluations, which were carried out in collaboration with Unistra-LIVE / CNRS, were carried out on the High-Performance Mobility Scenario, which was observed through the indicator relating to *public transport accessibility* (share of the territory accessible within 400m of a public transport station). The GIS parameterisation was built on the basis of the Open Access data of the Eurometropolis of Strasbourg (public transport line, location of stations...) modified according to the characteristics of the selected scenario in terms of spatiality and level of service (definition of the routes of the new public transport networks, location of the multimodal hubs, frequencies...). This parameterisation was used as a basis for calculating this indicator in an aggregated way on a 200m x 200m grid from the new realities simulated by the scenario. This allowed us to map the results in the same way as we did for the «pilot» maps of the Sumo Atlas (see Axis 1). The two maps opposite show the accessibility of public transport assessed from the existing situation on one side (left) and the scenario on the other (right). The mapped evaluation of the scenario, compared to that of the existing situation, thus makes it possible to better grasp the impact of the mobility policies imagined: it confirms, for example, the potential for improvement that this scenario represents in terms of accessibility/network coverage for public transport on the territories of certain communes in the second ring (Reichstett, Holtzheim, Fegersheim, etc.), but it also reveals the limits of the proposed scenario, with isolated stations such as the connection with the Great Western Bypass at the West Gate or the connection to the south of the Autonomous Port of Strasbourg. In the long term, these initial assessments should serve as a basis for simulations carried out by Unistra-LIVE / CNRS and UHA and feed the input data of the multi-agent model to determine the impacts in terms of sustainability (indicator 'Effects') such as the environmental footprint of travel.

This work has highlighted, in terms of spatial design, the limits of a simplification imposed by technical constraints linked to the availability of data and evaluation models (such as the predetermined and limited perimeter of reflection and design), as well as the difficulties linked to the level of detail imposed by the parameterisation, which calls for an absolute mastery of the functioning of the mobility systems imagined, making the future rather fixed. At the same time, while remaining vigilant about the margins of error and the dangers of this type of simplification in quantifying reality, this prospective approach can shed light and provide a new vision by prioritising reflexivity on current projects. Experience does not yet allow us to draw any transversal conclusions on possible correspondences between mobility indicators and the morphological and landscape characteristics of mobility areas, but this remains an interesting avenue for future research.

Administrative boundaries of municipalities
Railways
Tramway line
Bus line
Public transport station

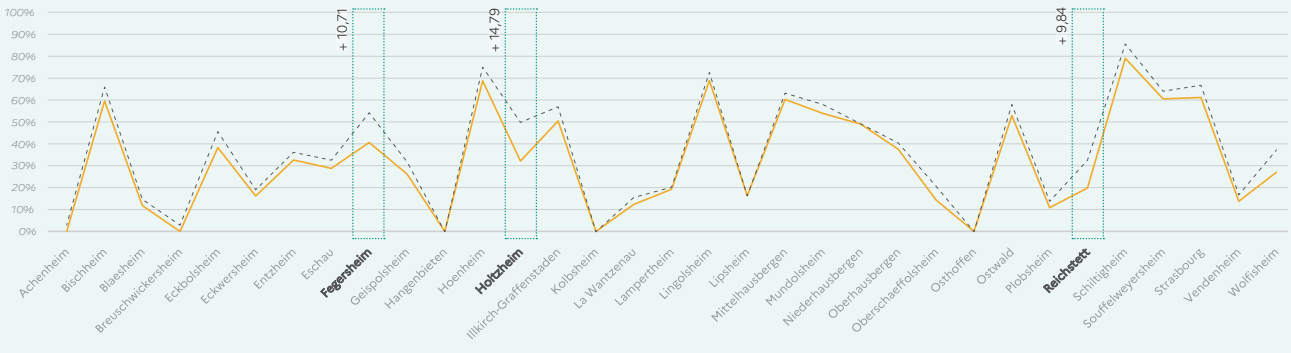
Administrative boundaries of municipalities
Railways
Express Eurométropolitan Network (EEN)
Tram-train by-pass
BRT ring road
Tramway line / Tramway line extension
Bus line





Existing situation
Scenario evaluation

0 2 km



Public transport accessibility - *Share of land accessible by public transport [%]*
(Area accessible within 400m of a public transit station / Total area) x 100

AXIS 3

FOR A MORE QUALITATIVE READING OF MOBILITY TERRITORIES

CONTRIBUTION TO THE METHODOLOGY FOR THE CONSTRUCTION OF SYSTEMS FOR READING, REPRESENTING AND ASSESSING THE VALUE OF MOBILITY SYSTEMS AND THEIR IMPACTS

In parallel to the cartographic and prospective work carried out within WP2.8, the ENSAS-AMUP / IMM Chair research team has contributed to other related tasks which have fed the fundamental reflections on the relationships between mobility, practices, and territories in a quest for sustainability. In particular, they have enabled new elements to be brought into the definition phase of the Indicator System, its readings and representations, but also its possible uses on the basis of a more qualitative understanding of the territories of mobility. The issues at stake include the contrasts between an objective/quantitative approach to mobility systems and a more sensitive/qualitative one. Our research on these relationships was carried out through two other tasks of the project:

- **Contribution to the construction of the Indicator System** (WP.2.4.) ;
- **Participation in the definition of the digital webtool for exploiting the results of the Indicator System** (WP.2.9.).

WP2.4. / If the Indicator System appears as a digital tool, our view as architects and urban planners questions the integration of the qualitative dimension in this tool. Our contribution to the definition of this system thus takes up the first questions raised concerning the definition of spatial quality and its transcription into digital data. It is on the basis of these concerns that our reflection has focused on the possibility of taking into account this spatial and qualitative understanding of mobility through indicators calculated on the basis of quantitative and georeferenced values. In order to better understand the issues at stake in this quantity/quality duality, we first of all carried out a state of the art on the notion of spatial quality as well as the possible interrelationships and limits of an approach to space exclusively through indicators. In a more practical way, this theoretical view was completed by a case study on the urban fabric of Strasbourg to try to objectify the qualitative criteria. *In fine,* we submitted a proposal of indicators echoing the perception of space to FELIS, the team responsible for this WP. Our contribution questions more broadly the role of the Indicator System not as a tool for evaluation and ranking between territories but rather as a tool for knowledge production.

WP2.9. . / The cartographic work carried out for the SuMo Atlas (see Axis 1) in the representation of the Indicator System results revealed the potential and interest of the method, but also the limits of an exclusively digital and georeferenced approach to the territory. Taking part in the definition of the digital tool for exploiting the indicators thus opened new doors to more spatial and qualitative graphic and cartographic representations of mobility. Aligning with the questions raised in the work for WP2.4, the contribution of ENSAS in the development of the web platform dedicated to the sharing of the results of the Indicator System proposes to introduce the qualitative dimension in the territorial analysis of mobility. In this sense, a reference base was constituted to explore the diversity of sensitive elements that could complete the results of the Indicator System. It has allowed to build a methodology of visual communication according to different types of inserts - more or less abstract and on a larger or smaller scale - while exploring the potential of an interactive tool to offer a more comprehensive reading of mobility spaces.

Contribution to the development of quantitative and qualitative indicators

REMINDER OF THE OBJECTIVES OF THE ACTION

WP.2.4. Development of the Indicator System

Action Coordinator: FELIS

«The evaluation matrix facilitates the identification of fields of action. This matrix is intended for municipalities and allows a comparison of the results of policy strategies with other urban areas. The design of the indicator system is based on the evaluation of in-depth studies on the social, technical, and economic factors influencing sustainable mobility in Europe [...]. This action aims to show the interrelations between the policy framework and the factors influencing mobility through indicators and to make their effects measurable. The indicator system will be developed taking into account the transferability of existing indicator sets for the evaluation of urban mobility systems. [...] Also in the framework of this action, a set of indicators [...] will be compiled to assess mobility in different policy areas (e.g., urban planning, social policy, education policy). [...] The indicators will each be assigned to the three impact axes of sustainability (economic, environmental, social). The social dimension will also include, among other things, the participation of users in planning processes. The ecological dimension will cover the health effects of mobility. [This multidimensional assessment matrix [...] will allow municipalities to compare the chosen strategies and progress with the results of other regions[1]».

HOW TO DEFINE SPATIAL QUALITY IN A DIGITAL SYSTEM? ISSUES AND METHOD

If the Indicator System appears as a digital measurement tool, our view as architects and urban planners questions the integration of the qualitative dimension in this tool. More precisely, this leads us to question the definition of spatial quality and its transcription into digital data. In order to better understand the stakes of this quantity/quality duality, we first of all carried out a state of the art on the notion of spatial quality and the few experiences of similar projects that have attempted to approach it through indicators. In a more practical way, we wanted to experiment with the possibilities of objectifying qualitative aspects based on analyses of the urban fabric of Strasbourg. We thus formulated a proposal for indicators related to the perception of space which we submitted to the FELIS team, coordinator of this task.

STATE OF THE ART ON THE NOTION OF SPATIAL QUALITY AND ITS POSSIBLE INDICATORS

As early as the Renaissance, architects, landscape architects and urban planners mobilised the notion of «quality» to apply it to the city. However, the concept of urban quality mainly developed with hygienist thinking, the functionalist city and the Athens Charter. In the 1960s, it was then «determined by urban and architectural models declined in essentially physical and material planning principles, in the name of a 'healthy', 'beautiful', and 'modern' city» (Bailly, 2019). But in addition to its spatial components, quality is also, and above all, associated with the experiential, perceptive, identity, sensory and affective «human» dimensions of places, giving quality, in addition to its physical dimension, an intangible dimension that is difficult to apprehend, what is known in the field of architecture as the genius loci (spirit of place) (Norberg-Sculz, 2017; Rossi, 2006). This assessment of perceived quality is enriched by environmental psychology (Bonnes, 2019) which looks at environmental satisfaction (architectural and urbanistic characteristics (density, socio-economic characterisation, green spaces, aesthetics, etc.); relational and social characteristics (types of sociability, socio-economic categories of inhabitants, etc.); functional characteristics (services, commercial, cultural and leisure facilities, etc.); attachment (Neighbourhood Attachment Scale: Bonnes M. (1997)). Urban quality is thus based on «a series of elements which are often immaterial. For example, the charm of a city, its atmosphere, its local colour, are neither quantifiable nor identifiable in established protocols» (Paquot, 2019). Emeline Bailly therefore defines urban and landscape quality in a constructive duality, consisting of urban reality but also the experience of informal spatiality (2019). According to this new definition, «urban quality is at the interface of a form (composition and urban aesthetics) and its appreciation.»

However, «in the field of planning, quality is often reduced to 'quality' approaches, centred on processes and/or urban indicators, essentially quantitative or formal (comfort, environmental performance, etc.)» (Bailly and Marchand, 2019), which sets quality against quantity. Urban quality is increasingly associated with technical quality and innovation through quantifiable data in a process of compliance with standards and labels (e.g., HQE, BBC) (Renauld-Giard, 2019). In competition with the ambitions of development actors, «quality is becoming a criterion for qualifying and even comparing territories» (Manola and Duret, 2019). In order not to reduce «the intangible components of territories to a sum of measurable elements», Alain Maugard (2019) stresses that it is important not to measure only the technical and technological progress made in terms of mobility and the ergonomics of urban development.
So how can these subjective elements be integrated into a system of indicators that aims to be objective?

1 Definition of the action / work-package in the descriptive annex of 31 May 2018 (extracts)..

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The use of the concept of urban quality intensified from the beginning of the 2000s thanks to the rise of the sustainable development objectives. However, the appearance of multifactorial indicators in the methods of evaluating and objectifying sustainable development dates back to 1987, when the World Commission on Environment and Development (Brundtland Commission) called for the integration of social and ecological aspects (in addition to the economic dimension) in Agenda 21 (adopted in Rio de Janeiro at the United Nations Conference on Environment and Development) (Babey and Clivaz, 2005). Since then, there has been a real enthusiasm for this type of quantified and classified assessment at the global, national, regional, and local levels: «Some even speak of a veritable 'indicator industry'» (Fromm et al 2000). As a reminder, an indicator can be defined as the translation of a concept or a phenomenon into the form of a signal or an (objectifiable) number (Boutaud, 2010) and whose ambitions are to «simplify information to make it understandable and usable by a target audience, sometimes made up of non-experts (general public, decision-makers) [and] to describe a situation at a given time and place and then, by replication, to allow comparisons in time and/or space» (Hak et.al, 2007; Bossel, 1999).

Jégou et al (2012) note the multiplication of this type of tool and method over the last few decades in all fields and in particular for evaluating sustainable development approaches: «These abundant tools challenge the geographer, the planner and the GIS engineer: in fact, they rely on databases bringing together various sources of geographical information enabling the understanding and planning of territories but also, in their more societal dimensions, the appropriation and implementation of sustainability».

From the 1970s onwards, several experiments to assess the quality of life and the urban environment began in France. The Organisation for Economic Co-operation and Development (OECD) proposed a set of 25 indicators (covering three areas: housing, services and employment, the ambient environment, and nuisances) to describe the quality of the human urban environment (Hatchuel and Poquet, 1992). In the 1980s-1990s, certain rankings were also produced by press organisations on the environment or living environment, and the urban quality indicators which initially focused on the built, functional, social, and human environment gradually included nature (Bonnes, 2019).

As for the work that focuses more specifically on mobility spaces and systems, despite the diversity of approaches and indicators envisaged, most authors agree on trying to formulate both quantitative and qualitative indicators. In 1971, Fruin attempted to characterise the level of service of pedestrian spaces (especially pavements) by quantifying pedestrian facilities according to several parameters such as human anatomy, field of vision, comfort distance between individuals according to their relationships, physical effort related to travel and the psychological perception of space. His research echoes the Highway Capacity Manual (HCM), a book published by the Transportation Research Board (USA) and devoted to the concepts and procedures for evaluating the capacity and quality of road facilities of various kinds (motorways, expressways, arterial roads, roundabouts, intersections, rural roads...) as well as the effects of public transport, pedestrians, and bicycles on the performance of these facilities. First published in 1950, C. Jostin Khisty returned in 1994 to the third edition of the HCM, which had become an international reference, where he noted the absence of a methodology for comprehensively assessing and measuring the walkability of a place and in particular the consideration of environmental factors (in the sense of built environment/ landscape) in the perception of a space. In 1995 and 1996, Sarkar and Dixon integrated new qualitative dimensions into their work to characterise subjective variables such as safety, security, comfort, convenience, continuity, coherence of the system and attractiveness, while Kihsty (1995) and Snaches (2001) had the common objective of relating qualitative elements to pedestrians' perceptions. For cyclists, the key factors considered until the 1980s were mainly speed, freedom of manoeuvre, interruption of traffic, comfort, convenience, and safety (Epperson, 1994). In the 1990s, new criteria were used to better define bicycle spaces, such as traffic intensity, path width, speed limit, road condition and location of the bicycle facility (Turner et al., 1997). The risk criteria will be highlighted in particular in the studies by Hunter et al (1995) and Wang and Nihan (2004).

Most of the research is based on a specific mode of transport and on case studies to test the indicators that seem to be the most relevant according to different approaches (health, safety, population concentration...). The researchers from the Department of Art and Architecture, Science and Research Branch, Islamic Azad University in Tehran, assume that human presence is a key factor influencing behaviour and the perception of space and the city. They propose a case study on the city of Kashan in Iran which, crossed with a theoretical approach, highlights several criteria used to evaluate spatial quality (Azam Sadat Razavizadeh et al., 2015). These indicators are presented in four families: spatial devices favouring exchanges and daily encounters, the type of activities (conditions of attractiveness and possible social life in neighbourhood centres), environmental perception (encouragement to rest, to walk, to collective experience) and finally environmental factors (noise, climatic conditions, humidity, lights). In 2018, Garau and Pavan similarly propose a set of indicators and sub-indicators («Indicator of Smart Urban Quality») capable of assessing the quality of urban life in relation to the concept of smart-sustainable city, especially in medium-density neighbourhoods, and their application to the city of Cagliari in Sardinia (Italy). The authors mention key factors such as public transport services, environment, housing conditions, digital infrastructure, governance but also services and jobs. In a similar way, Monteiro and Campos present in 2012 a new set of indicators to assess the attractiveness of multimodal stations for pedestrian and cyclist mobility based on a case study of Rio de Janeiro.

Among the criteria that are retained as determinants of non-motorised mobility, the authors consider the continuity of the paths, the attractiveness and convenience of the routes, the distance to be travelled, the slope of the path, the state of the pavements, the straightness of the route and any other factor that facilitates walking.
Despite the diversity of approaches, walkability appears to be a key criterion in the studies. Genre-Grandpierre and Foltête (2003) are interested in the potential factors, both quantitative and qualitative, of geographical contexts on the practice of walking in addition to socio-economic determinants (individual characteristics, age, sex, motorisation, etc.). They highlight certain parameters of urban morphology influencing pedestrian movements such as land use, building density, building form (length, complexity), or the presence of green spaces. On the same theme, Rebecchi et al. define in 2019 a new framework for assessing the walkability of a city by paying attention to indicators affecting health in Milan. Zuniga-Teran et al. identify the gaps and strengths of the *Leadership in Energy and Environmental Design for Neighbourhood Development* (LEED-ND) certification system created by the U.S. Green Building Council in 2009. They propose potential improvements to this certification system that reflect what is known about improving walkability more comprehensively through analysis of neighbourhood design (Zuniga-Teran et al., 2016).
In the same way that the above-mentioned authors have attempted to define indicators of the spatial quality of mobility spaces through case studies, the ENSAS research team has attempted, for the SuMo Rhine project, to extract qualitative indicators on the basis of a spatial reading of the Strasbourg territory (see Box p.74-75).

LIMITATIONS AND POTENTIAL OF AN INDICATOR-BASED APPROACH TO MOBILITY

The feedback from this type of experience suggests limitations in the reading of mobility spaces by indicators.
Babey and Clivaz return in 2005 to the limits of existing systems: "Moreover, most existing systems have so far largely ignored qualitative indicators. [...] Nevertheless, it seems difficult to capture certain dimensions of [Sustainable Development] without taking qualitative aspects into account". In connection with the definition given of spatial quality, the contributions in the book by Emeline Bailly and Dorothée Marchand (2019) are similarly unfavourable to this objectivization of urban quality, which is inseparable from the experiential, perceptive, identity, sensory and affective dimensions of places. Théa Manola and Hervé Duret (2019) denounce the drying up of reality in favour of a definition of quality based on a finite number of quantifiable themes, at the risk of losing what makes sense in a territory in a given society.

The contributions attempting to combine the quantitative and qualitative dimensions come up against the methodological limits of an indicator-based approach, both in terms of the scales taken into account and the availability of data.
In most of the case studies, the indicators relating to sensitive and qualitative aspects required in-depth investigations on the ground apprehended on a human scale (survey, photographic report, interviews, etc.) as raw material for the evaluation by indicators: "The evaluation of the quality of urban spaces consists of documenting the current conditions and then applying methodologies aimed at achieving the objectives of urban and environmental quality of the city. To do this, a methodological process must be initiated that begins with a site analysis, during which critical aspects are highlighted" (Garau and Pavan, 2018).
In the context of the SuMo Rhine project, whose issues are spatialised over the entire Upper Rhine region, it is interesting to question the validity, reproducibility and resources needed to develop such an approach over such a large tri-national territory.

Conversely, the generic and large-scale approach (intended to be applicable to any urban environment) of Hatchuel and Poquet (1992) also has its limits in the sense that its sectorisation (dissociation of 84 indicators categorised into families separating the spatial factors - "Urban landscape" for the aesthetics and attractiveness of the city, "Ambient environment and nuisance" for the quality of the natural environment, "Services and public facilities", etc. - from the indicators relating to transport - approached from a service level perspective) does not allow the dialogue between the multiple indicators retained to be grasped. - The scale of the indicators relating to transport - approached from a service level perspective - does not allow the dialogue between the multiple indicators to be understood. In this proposal, the scale taken into account requires a certain simplification of reality by the indicators, whereas the evaluation of the quality of urban life is a multidisciplinary concept that includes environmental, social, and urbanistic characteristics, as well as a subjective assessment (Garau and Pavan, 2018). Moreover, limitations in access to data (e.g., the existence and availability of data on a territory) imply choices in the definition of indicators and raise fundamental questions about the indicator approach that is initially intended to be objective.
At both the macro and micro levels, Hatchuel and Poquet (1992) note that "this classic opposition between objective and subjective indicators is not sufficient to account for all the nuances of reality. [...] We can certainly try to objectify subjectivities, but we must be aware that subjective assessments can very well be modified in the light of objective data, or even subjective assessments by other people". The scales addressed imply different methodological approaches (more or less quantitative) which influence the indicators selected (urban area/ administrative boundaries, choice of boundaries, etc.) and therefore the accessibility of the data used.

As an example, Genre-Grandpierre and Foltête (2003) point out the lack of resources on how to assess the walkability potential of a place due to the ubiquity of the automobile. The studies on Kashan (Azam Sadat Razavizadeh et al., 2015) open up questions on indicators capable of taking into account human presence (in motion) in a system that relies mainly on socio-demographic criteria, spatial

characteristics of the urban environment and mobility systems and their environmental impacts. Jégou et al (2012) show the complexities involved in constructing a system of indicators in terms of evaluation scales depending on the quality of the data (source, temporality, scope). They also highlight the biases to which these indicator systems may be subject: "Indeed, based on a phenomenon and/or raw data presented in the form of quantitative or qualitative descriptors of the phenomenon (temperature, CO2 flow, cost, etc.), an indicator is constructed, resulting from a more or less biased and conscious choice of available data. The choice of raw data constitutes a major difficulty in defining the indicator, as the desired data are not necessarily available. These limitations therefore raise fundamental questions about the indicator approach, which presents itself as objective.

In the same way that there is no single definition of spatial quality, "there is no standardised approach to measuring sustainability and defining a set of [Sustainable Development] indicators" (Babey and Clivaz, 2005). In this sense, Meadows already expressed in 1998 that "All indicators are at least partially subjective", the choice of an indicator being conditioned by a personal approach of the important values or not to be taken into account (Babey and Clivaz, 2005). Hatchuel and Poquet (1992) also note "that few indicators - if any of those selected - are common to the various proposals made". Boutaud (2010) also highlights the thresholds implied by an indicator-based approach and the judgement that it amounts to making about a situation: "good, bad, developed, sustainable, etc." which can lead to abuses in the use of indicators as a comparative tool, particularly through the political appropriation of indicators.

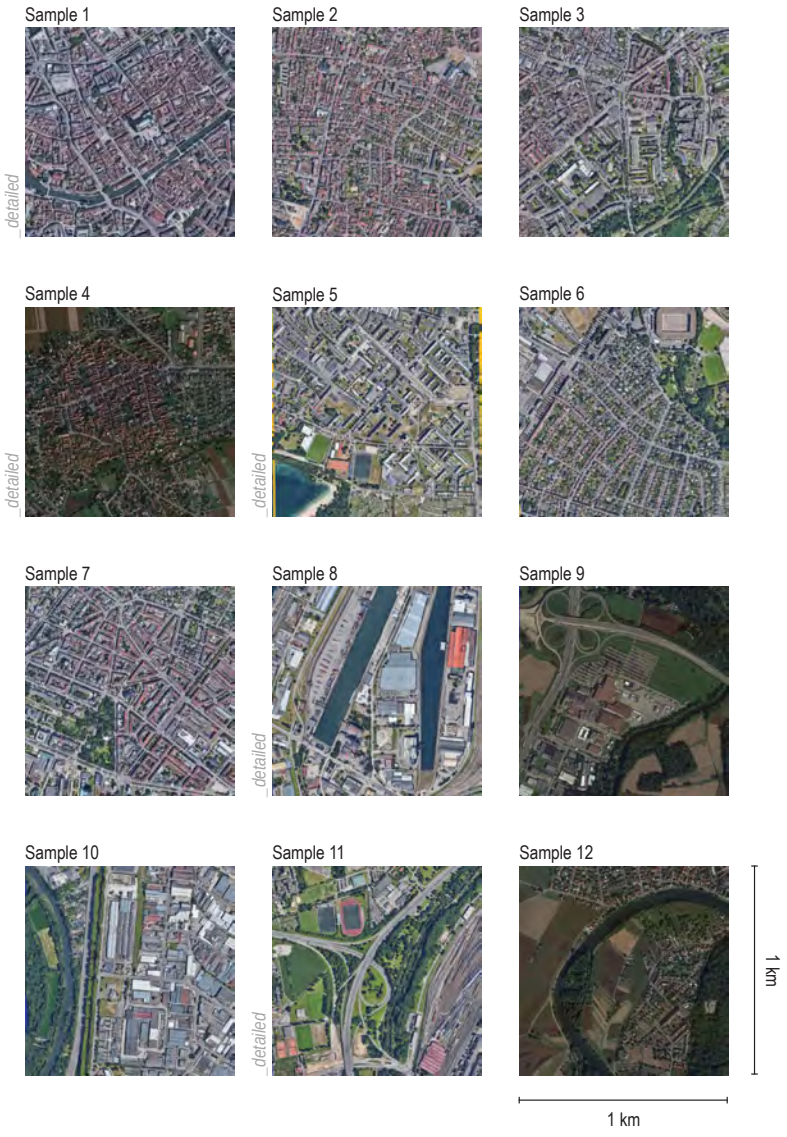
These precedents and the critical feedback that may have been given warn us of the need to be able to relativise the objectivity and valid generality often attributed to the results of indicator systems. If, as the above-mentioned studies show, the quality of a place cannot be entirely assessed by indicators, it is nevertheless always possible to observe and make the effort to integrate, from the stage of defining indicators, a certain number of aspects that contribute to increasing spatial quality defined as "the product of the equation between urban forms, feelings and socio-cognitive relationships" (Bailly and Marchand, 2019).

The extracts presented in the following insert show how we have approached this work within our project, as well as the different categories of indicators formulated to understand the quality of mobility spaces.

Identification of possible SuMo Indicators of spatial quality through the analysis of urban samples

See Annexe

Although experiential and socio-demographic aspects cannot be integrated into the Indicator System developed in the framework of the SuMo Rhine programme, we have tried to extract the key elements of urban space that have an impact on its perception and, consequently, on its quality. On the basis of the state of the art and from an analysis of 12 samples of Strasbourg's urban fabric (1 km x 1 km) aimed at characterising them in terms of spatial quality, we extracted three categories of indicators which detail: the quality of mobility infrastructures, the quality of the built environment and the quality of the natural and landscape environment.



Suggested / Selected indicators and sub-indicators

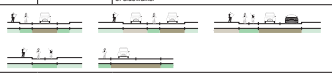
The selected indicators are divided into 3 categories:

The quality of the mobility infrastructure:
Types of mobility infrastructure, density of junctions, public transport stops, soft mobility infrastructure (urban factors underpinning walkability, «walkscore», presence of pavements and cycle paths, speed bumps, car speed limits) ...

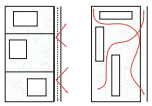
The quality of the built environment:
Morphology and urban design (furniture, paving, street hierarchy, urban lighting, maintenance, etc.), density and typology of the built fabric (porosity of blocks, rhythms, scales, etc.), diversity of land use (destination and equipment of ground floors: leisure, shops, social destinations, homes, industry, etc.)...

The quality of the landscape and natural environment:
Type of green spaces (presence of agricultural spaces, recreational environment...), tree alignments, perception of the natural space (maintenance...), relationship to the hydrographic network...

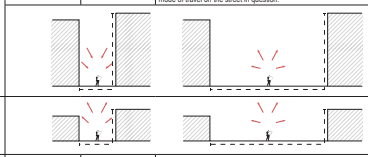
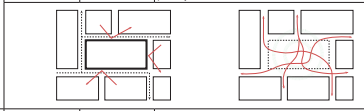
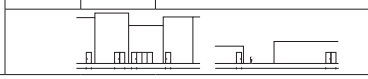
Quality of the mobility infrastructure

	Sub-Indicator	Unit	Definition
3	Car infrastructure	Average width of roads within the sample (m)	The width of the lanes dedicated to motor vehicles shows the importance given to cars. The wider the lanes, the more we can assume that cars occupy an important place in the urban space, potentially to the detriment of soft mobility infrastructures. It should be compared with the width of the lanes dedicated to cyclists and with the width of the sidewalks, as well as the mobility related noise.
			
4	Sealed surface area by carpark	% of the sample	The importance of the space occupied by parking lots is often linked to the predominance of the car in the urban fabric. It should be compared with the share of sealed surfaces for roads, as well as pedestrian and bicycle zones.
			
5	Speed bumps	Number / km²	The presence of speed reducers is often associated with areas mainly used by pedestrians. They make it possible to partly ensure the safety of the latter and limit the influx of automobile traffic.
6	Speed limit	Average speed limit of the sample	The average speed limit is largely associated with accessibility and pedestrian crowds. The lower the limitation, the more space will be used and organized for pedestrians, conversely, the higher the limitation, the less infrastructure dedicated to pedestrians and soft mobility.
7	Mobility related noise	Average dB on the sample	Linked to speed limits and the number of road lanes, noise is an indicator of the quality of a space's sensory experience. Noise pollution linked to traffic has a negative impact on the quality of a space.
10	Pedestrian infrastructure	Average width of sidewalks within the sample (m)	The width of sidewalks shows the importance given to pedestrians. The wider the sidewalks, the more we can assume that pedestrians occupy an important place in the urban space. It should be compared with the width of the lanes dedicated to cars and bicycles.
11	Urban lighting	Number of street lights % of area covered by urban lighting of the sample	Urban lighting is an important element in the security feeling associated with a place at night, especially for soft mobility. A well-lit urban space will provide a feeling of security for users, as long as a dark space, with little or no lighting, will be inhospitable and associated with insecurity.
13	Share of bicycle zones	% of the sample	The importance of the space dedicated to bicycle is often linked to the predominance of pedestrians and soft mobility networks in the urban fabric. It should be compared with the share of sealed surfaces for roads, as well as pedestrian zones.
14	Cycling infrastructure	Average width of bikelanes within the sample (m)	The width of bike lanes shows the importance given to cyclists. The wider the lane is, the more we can assume that bicycles occupy an important place in the urban space. It should be compared with the width of the lanes dedicated to cars and and the width of sidewalks.
			

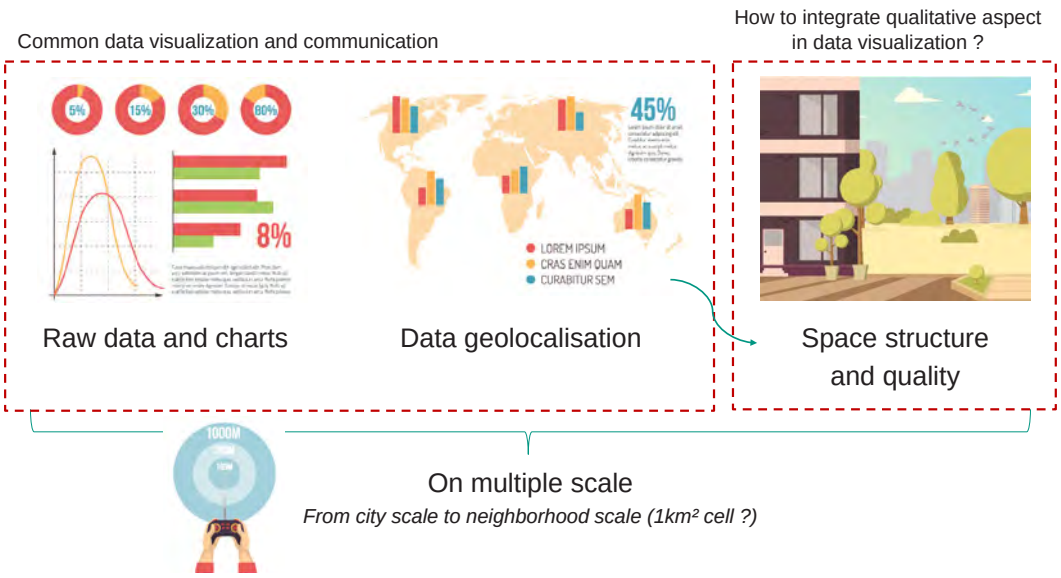
Quality of the natural landscaped environment

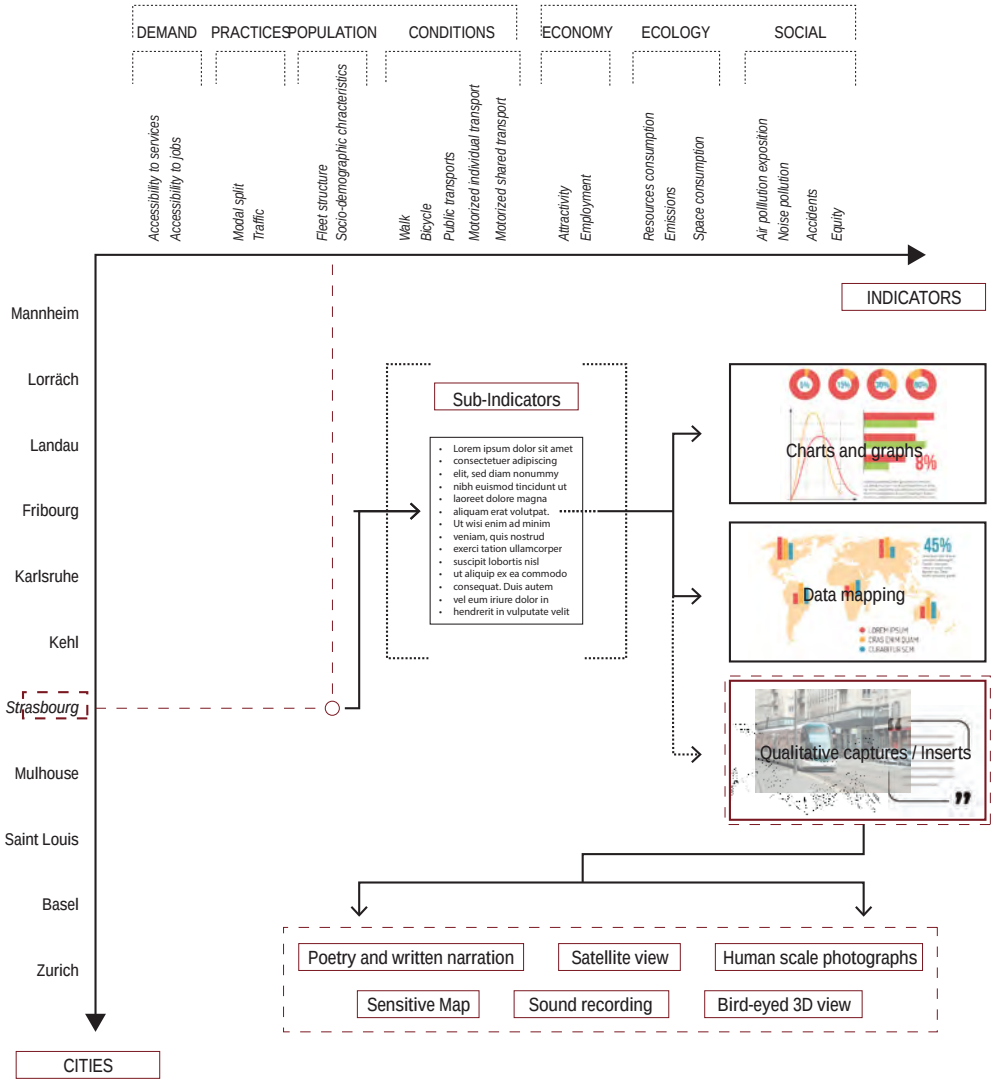
	Sub-Indicator	Unit	Definition
24	Type of green spaces	% of private green space of the sample % of public green space of the sample	In addition to the overall plant space of a sample, it is important to know whether it is practicable or not. A private planted space, although visually present, will appear as a limit to public space, unlike a public park that can be crossed.
			
25	Trees alignment	Trees alignment linear	The alignments of trees contribute to a better perception of urban space by reducing the mineral aspect of a city but also by providing freshness.
26	(Access / Distance to water ?)		

Quality of the built environment

	Sub-Indicator	Unit	Definition
15	Built density	% of built up area of the sample	Built density can be an indicator of the quality of an urban space. The perception of distances in a dense built space will certainly be shorter than the distances perceived in a sparse space thanks to the rhythm imposed by buildings. On the other hand, the density cannot be observed alone. It must be mirrored by other factors such as functional diversity : a densely built space in a periphery with an industrial vocation will appear to be of lower quality than a densely built space in a dynamic city center.
16	Human scale perception	Average ratio between building height and street width	The perception of a space also goes through the 3D dimension. The ratio between the width of the street and the height of the building gives an indication of the apparent narrowness or opening of a space. Regardless of the quality of the building, a narrow street surrounded by large buildings will be perceived more oppressively than a narrow street surrounded by buildings of low heights. This ratio should also be compared with the proportion of spaces allocated to each mode of travel on the street in question.
			
17	Functional diversity	% of facilities related ground floor of buildings within the sample	Functional diversity may be an indicator of the vitality of a neighborhood. The visible continuity between the commercial ground floors as an extension of the street space dynamically punctuate the urban space. Conversely, a residential street, although quiet, may be perceived as monotonous. The dynamism and vitality of a space simultaneously provides a feeling of security.
			
18	Block porosity	Fences linear % of inaccessible spaces to pedestrians of the sample	The porosity of an island or a plot is associated with the fluidity of the trajectories of an individual. The more porous the block, the more free a pedestrian will be. This porosity or impermeability is observed thanks to the limits set up which likewise influences the quality of the course. Although a border, a plant barrier will be more pleasant to the passer-by than a mineral barrier such as a wall.
			
19	Street pavement	% of paved streets within the sample	The nature of the soil in the urban space is often characteristic of the type of users and main modes of transport on a street. Cobbled streets are particularly associated with old urban centers whose streets have sometimes been entirely pedestrianized or where the car presence is reduced. In addition to these correlations with the different users, a paved street appears more aesthetic to the pedestrian than an asphalt street, associated with road network. These observations can also be linked to the heritage dimension of a neighborhood.
20	Architectural assets	Number of historical sites of the sample % of historical and heritage protection area of the sample	The presence of a protected site in a district generally involves a radius of heritage protection around the latter. Car traffic is often reduced in these areas to the benefit of soft mobility and particularly of pedestrians, thanks to the tourist scope of these sites. In addition to the not negligible aesthetic characteristics of these sites, they form attractions that bring dynamism to a neighborhood and help ensure a feeling of security. The streets around these sites are generally paved.
21	Rythms	Number of doors	The rhythms of the façades and the number of doors speak volumes about the type of user and the main modes of transport in a district. The car undeniably makes it possible to cover greater distances and therefore allows the distance from entry points such as in industrial zones. Conversely, the frequency of entrances suggests that the pedestrian can easily walk through the neighborhood thanks to the reduction in distances.
			

Proposed parameters to (partially) integrate the sensitive dimension in the Indicator System *- Sub-indicators related to the perception of space*





A third grid of interpretation of the territory to reveal the results of the Indicator System - *Graphs, geolocation of data and qualitative inserts*

The web platform: an opportunity for an «enhanced» visualisation of the results of the Indicator System

REMINDER OF THE OBJECTIVES OF THE ACTION

WP.2.9. Implementation of the Indicator System

Action Coordinator : FELIS / KIT-DFIU

«The Indicator System will be implemented on the project website [...]. The technical aspects of the integration of the IT platform on the website will be addressed in this action. The data used and their interaction with the indicators and mobility concepts will be described on the website. Municipalities that wish to evaluate specific mobility concepts will be given personalised access. The calculation platform will be managed as required in MS Excel or Java.[1]»

FROM THE GEOLOCATION OF THE QUANTITATIVE RESULTS OF THE INDICATOR SYSTEM TO A MORE GLOBAL UNDERSTANDING OF MOBILITY SPACES

For all the territories studied in the Upper Rhine, the FELIS research team is coordinating the creation of an online platform presenting the results of the measurements carried out through the Indicator System, which is aimed at mobility stakeholders, municipalities, and the general public (more commonly known as the «webtool» by the consortium partners).
The platform has been named «KINaMo (Kommunales Informationssystem für Nachhaltige Mobilität - Communal Information System for Sustainable Mobility)» and is accessible in its beta version from the following link: https://kinamo-3ec0e.firebaseapp.com/home.

Our contribution helped to establish the choice of a navigation for reading the results on this platform according to two entries: the indicators and/or sub-indicators, and the cities studied.
Furthermore, in addition to the graphs and values calculated at the scale of the municipalities considered, a visualisation in the form of geo-localised mapped data from the Sumo Atlas (see Axis 1) was proposed. This is to allow a flexible navigation and use of the results giving the user the possibility to start with:

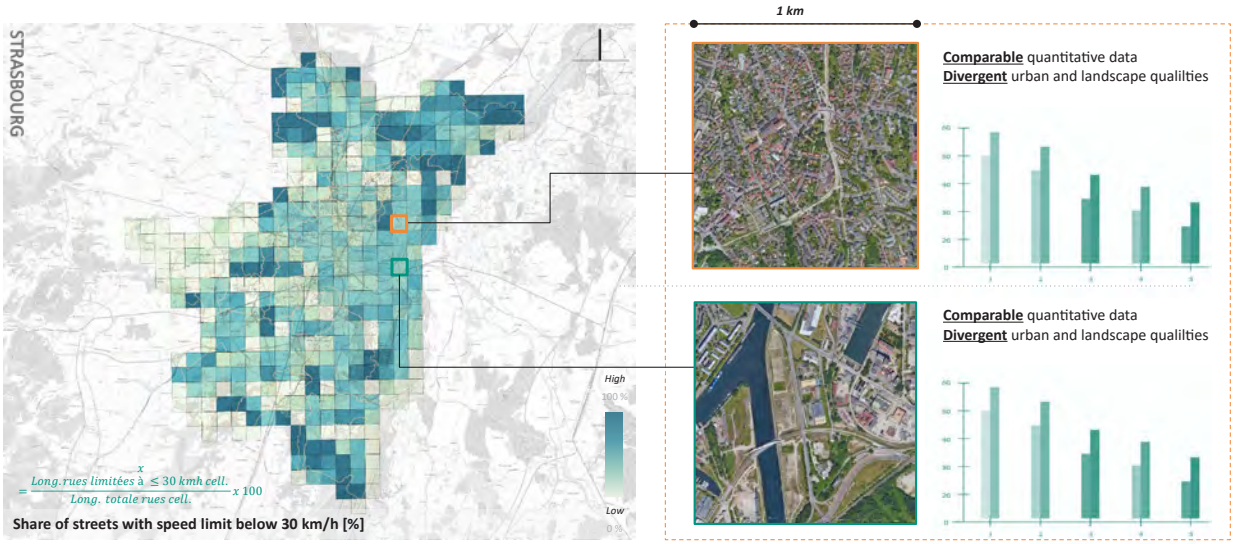
- **Choose a (sub)indicator** to have a comparative view of the different cities studied through the corresponding graphs and maps

or

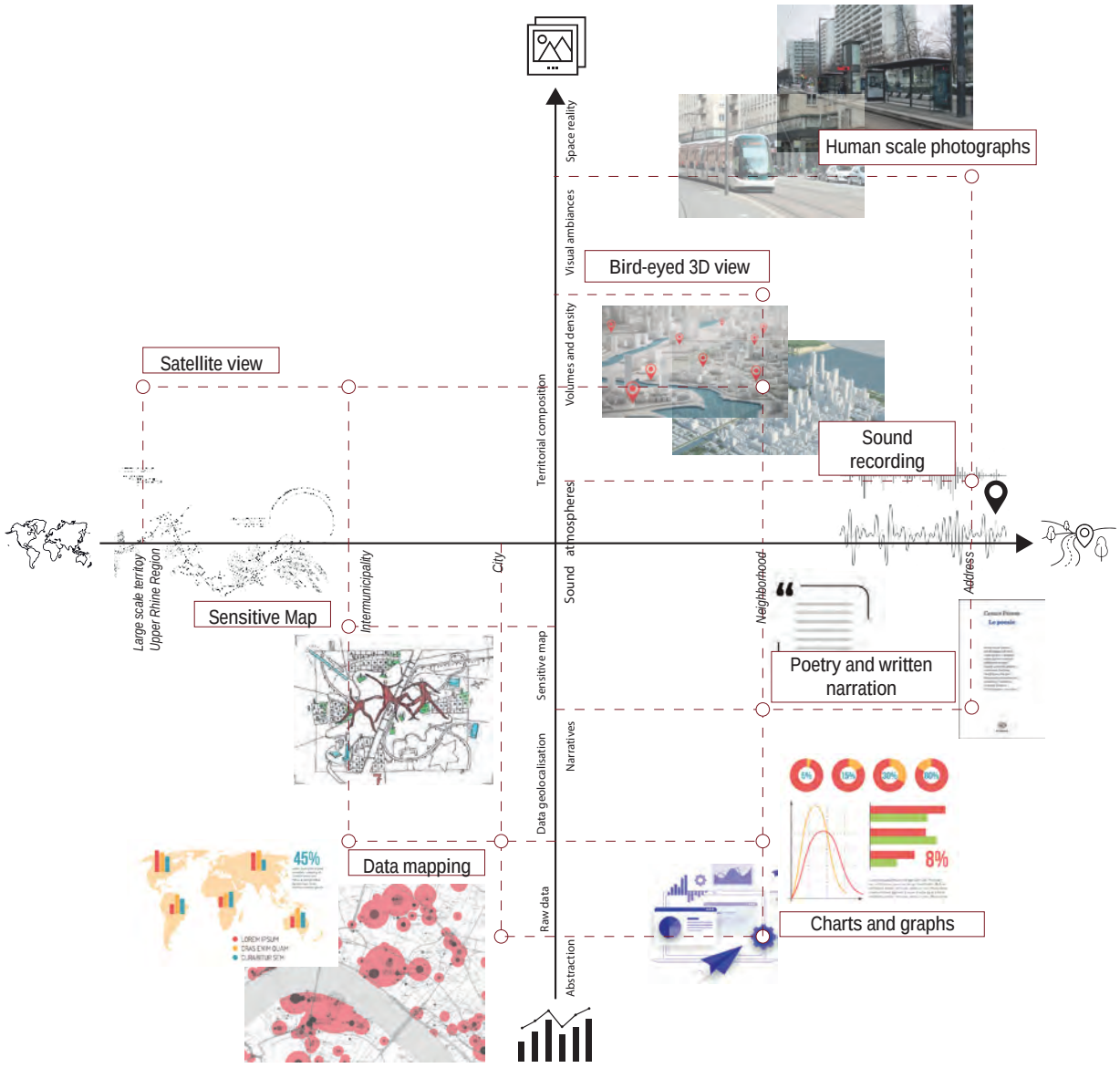
- **Choose a city**, for a more in-depth exploration of its mobility system, with the possibility of selecting the indicators (and the scale of detail) that you wish to visualise on the map background.

From this base, we also reflected on how this platform could integrate other levels of knowledge, more qualitative, to make the reading and the possibilities of analysis and interpretation of the results of the Indicator System more complex. For, despite the geolocation of the data, SuMo maps do not make it possible to capture characteristics, such as the morphological and landscape characteristics of a territory. It therefore becomes difficult to establish complete diagnoses on the basis of figures alone if one does not know the urban forms, the atmosphere, the quality, and the organisation of a space. From this point of view, the challenge of the visualisations made available on the web platform lies in the possibility of associating

1 Definition of the action / work-package in the descriptive annex of 31 May 2018 (extracts).



Disparities and convergences between quantitative data and territorial realities *- How to integrate the qualitative dimension of space in the visualisation of digital results?*



Capturing space and its qualities in different forms *- From scale to scale, a more or less abstract and sensitive reading of the territory*

geolocalised quantitative information with other types of representations of the mobility territories concerned, such as satellite images, for example. As illustrated in the figure below, this association can help to identify disparities and contrasts between samples of territory with similar numerical results, but with different types of urban fabric. Or, conversely, areas which are similar in their morphology, but which differ in their evaluations according to the indicators.
For example, highlighting a section or portion of a lane where traffic is slowing down will not provide insight into the potential causes of the slowdown, which may be related to restrictions or elements of a physical context (e.g., traffic lights/signs, lane reduction, poor quality pavement, reduced leafleting, etc.). Similarly, in a grid, a cell with less cycle traffic than another cell with a similar network cannot explain the cause of these disparities without looking at the space itself. In this case, the disparities could be explained by the abundance of pedestrian flows, obstacles on the route, the landscape setting and atmosphere, the lack of quality in the facilities provided for cyclists, such as the absence of trees along a route making it impractical in hot weather, etc.
Our initial comparisons between the results of the system of indicators and the field thus show that, for an equal value, the mobility environment, its spatial realities, can be completely different. This is particularly the case for the sub-indicator relating to car speed limits, for which we see similar results for two cells, one occupied by a suburban fabric (Robertsau, Strasbourg) and the other by a predominantly harbour fabric undergoing change, including a few residential pockets (the "Ile aux épis" district in Strasbourg) (see figure p. 77).

Given these initial observations, we looked for ways to integrate these different registers (formal and qualitative) into the visualisation of the results of the Indicator System. In this sense, we conducted a study in two stages:

- **Construction of a reference database of web platforms** based on thematic and cartographic analyses;
- **Methodological definition of visual communication and interactive SuMo mapping**, based on the case of the Strasbourg Eurometropolis.

This work was carried out in collaboration with the FELIS team during bilateral meetings.

METHODOLOGICAL APPROACH TO ONLINE VISUAL COMMUNICATION FOR A HYBRIDIZATION OF KNOWLEDGE AROUND MOBILITY SPACES

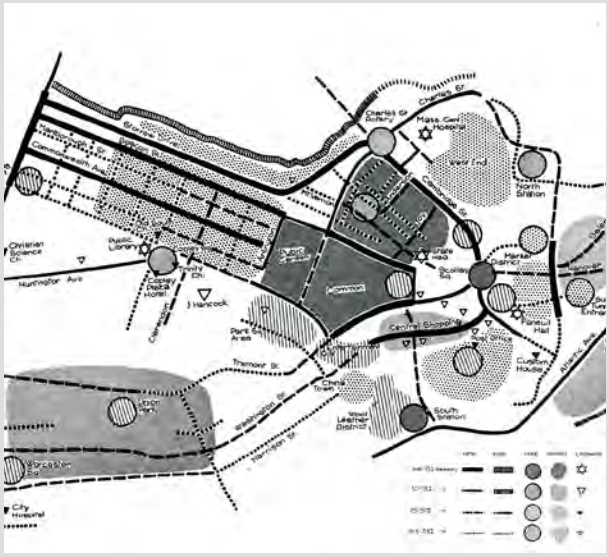
In an experimental approach, Strasbourg was chosen as a «pilot» city to explore the possibilities and challenges of a representation combining quantitative and qualitative data. These graphic and conceptual choices, alternative to the conventional representation of data, should bring a new dimension to the understanding of the results.

Different means and degrees of representation - from the most abstract to the most concrete (see diagram opposite) - and various aspects of the qualitative dimension of space are thus considered:

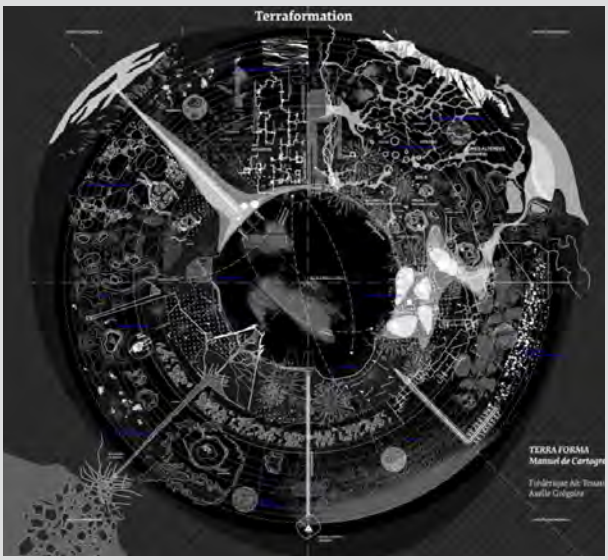
- **Written poetry and narration**: stories and writings revealing the qualities and atmosphere of a place and a neighbourhood (e.g., a resident's story, a cyclist's log);
- **Sound recording**: recording of sound ambiences and noises at a given address (e.g., public transport stop, proximity of road/rail infrastructure, pedestrian street) orienting the reading of a site by hearing;
- **Sense map**: : superimposition of a sense map / subjective mental map representing, by means of redefined graphic codes, the infrastructures (multi-modal hubs in 3D) and main grids (red grid - main transport and mobility lines -, as well as the blue and green grids in the background) aiming at a certain schematisation of the space for an intuitive approach in the form of collages, distortions or diagrams;
- **Satellite view**: overlay of an aerial view of the city and/or a district (e.g., Google Earth);
- **3D animations**: short dynamic videos of a 3D model of space and/or transport (e.g., tramway line, multimodal point) giving an overview of experienced spatialities;
- **Human scale photographs**: Photographs of a specific address or location (e.g., train station, intermodal points, pedestrian street) providing information about urban and landscape landmarks on a given site.

Presented in the form of capsules or qualitative inserts added to the numerical data collection of the Indicator System, these additional levels of reading would offer the user the possibility of an extensive, less abstract, and more qualitative understanding of the territories and mobility systems studied. The integration of this register of knowledge would also empower the user, who would thus be able to go beyond the feeling of truth introduced by the figures or the temptation of rankings and adopt the necessary critical distance in order to interpret and make the most of the measured results.

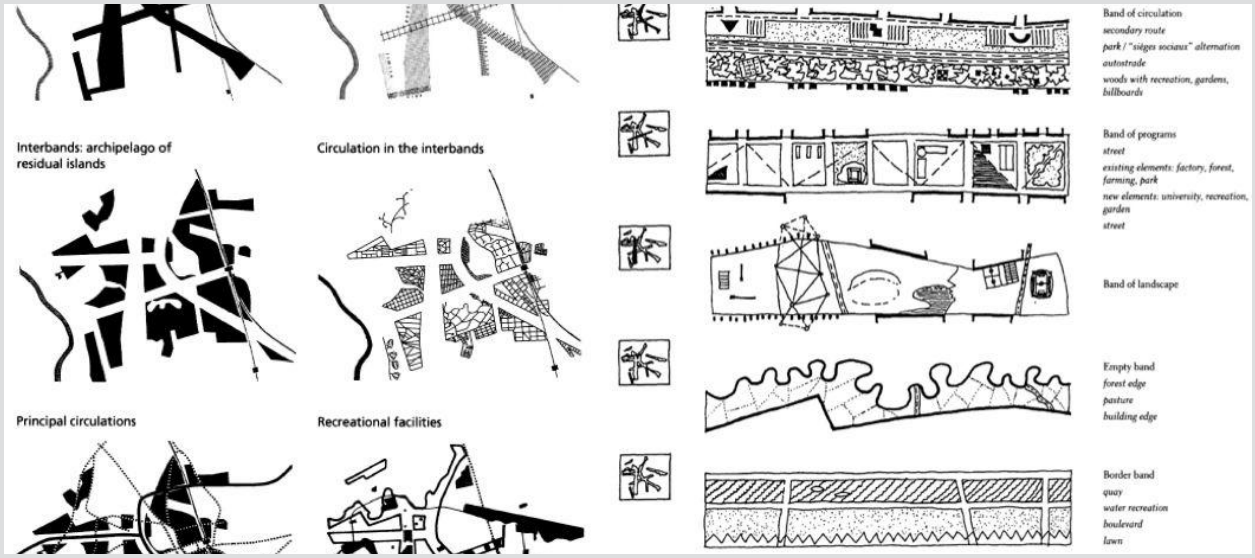
From the geolocation of data to photography, the different types of representation and knowledge have been graded according to the scales involved and their degree of abstraction (see graph on p.78).
The first axis identifies and organises the different types of representation possible, from the most abstract to the most realistic: from graphs, diagrams, and histograms to an aerial view of a neighbourhood or a photograph of a place taken on a human scale.
The second axis organises the visuals according to spatial scales, from the broadest (territorial) to the most targeted (of a place such as a street, a square or a crossroads, or an architecture, such as that of a station)



The Image of a City. *Kevin Lynch. MIT Press. 15/06/1960.*



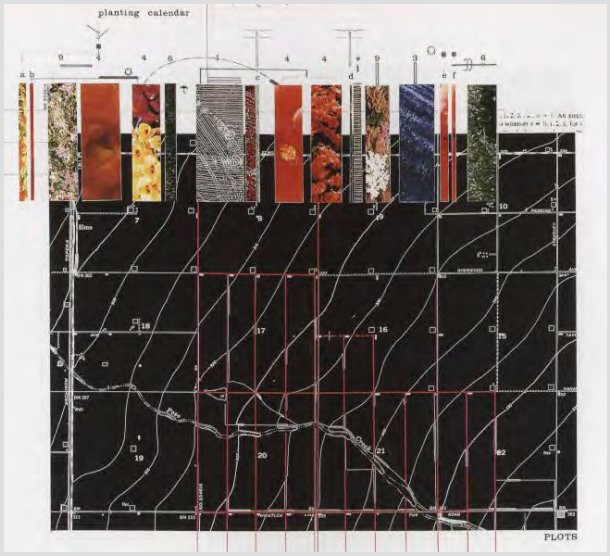
Terra Forma, Manuel de cartographies potentielles. *Frédérique Aït-Touati, Alexandra Arènes et Axelle Grégoire. Edition B42-110. Avril 2019.*



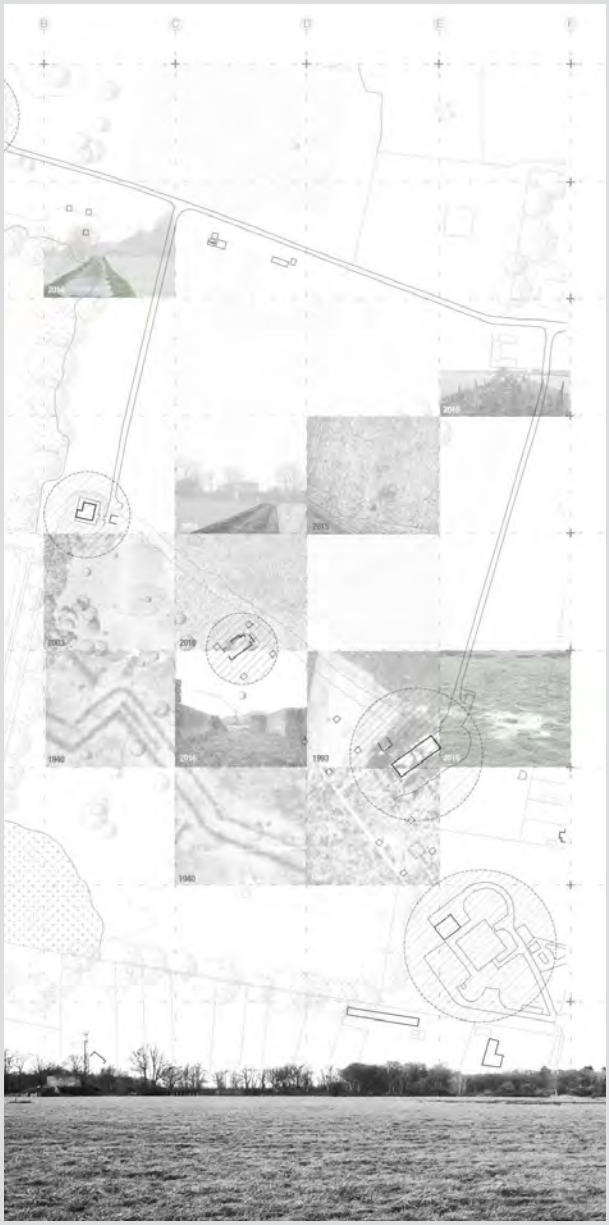
Ville Nouvelle Melun Senart. *OMA. 1987.*
https://www.oma.com/projects/ville-nouvelle-melun-senart

New Babylon. *Constant Nieuwenhuys.*
ttps://www.museoreinasofia.es/coleccion/obra/new-babylonsevilla-triana-groep-nueva-babiloniasevilla-grupo-triana

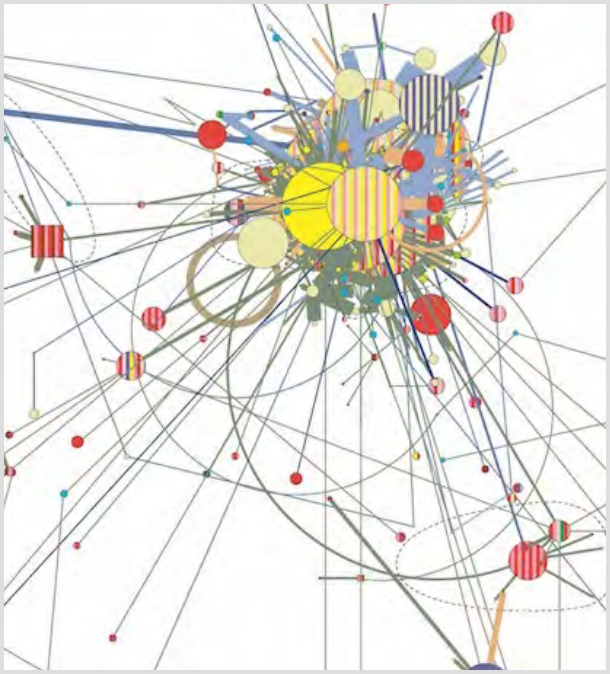
Programmatic Explosion of Cultural Clusters. *Mads Christiansen.*



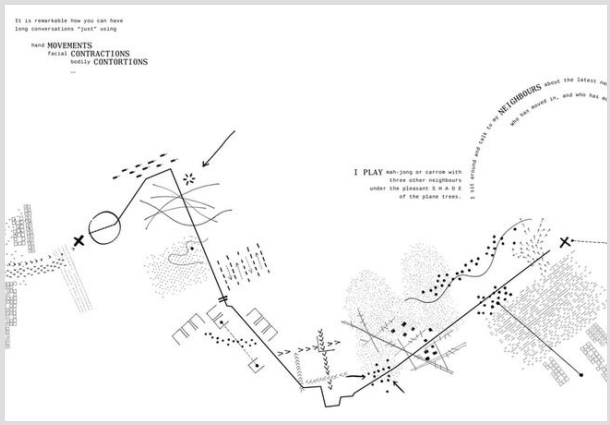
Taking Measures Across The American Landscape. *James Corner, James M. Corner, Alex S. MacLean. Yale University Press. 01/01/1996.*



Visible certainty. *Chris T. Cornelius.*



A sample of individuals residing Paris. *Scalab. / André Ourednik, « Mapping the diachronic reality of the inhabited space on 2D. », EspacesTemps, 2012*
https://www.espacestemps.net/articles/mapping-the-diachronic-reality-of-the-inhabited-space-on-2d/



Mindwalks, 8 graphic narratives in Shanghai. *Sensual City Books. 01/06/2016.*

These two axes and the different categories of materials they present help to think about how the website could be organised to allow an «augmented» presentation of the results of the Indicator System, through the superimposition, juxtaposition or overlay of more realistic, sensitive, and qualitative visualisations of the quantitative evaluations of the indicators.

THE INTERACTIVE MAP AS A POSSIBLE ANSWER

Eventually, the website could be navigated using an interactive and augmented cartography that would zoom in and out from scale to scale, from the Rhine territory to the address.
At least three scales of reference between which the user can navigate by zooming in/out are identified:

- **The Upper Rhine scale**: would be the scale of the project's default cartography; it assumes a planimetric background through a schematic map or satellite photo of the region, on which the results of the different selected indicators could be superimposed (covering the surface of the concerned municipalities, see SuMo Atlas - overview of the Upper Rhine Region, Axis 1).
- **The urban/metropolitan scale**: This scale can be reached by zooming in on the map of the Upper Rhine on the chosen city or by clicking on it. It allows an oblique view of the territory concerned through a schematic 3D map background (see fig. p. 90) on which the evaluation grids of the indicators that the user chooses to display are superimposed.
- **The scale of the grid cell / sample (1km x 1km):** This scale can be reached either by clicking on the desired cell, or by zooming in on the territory of interest from the previous urban scale. It displays the satellite image of the sample, juxtaposed with the results of all the SuMo Indicators on this cell (1km x 1km), as well as geo-localised points of interest superimposed on the satellite view which would open up a whole set of «qualitative capsules» documenting the spatial situations accommodating mobility (sensitive/mental maps of the city, sound/video recordings of a route, 3D models - of the neighbourhood, of a multi-modal point, etc.). - human-scale photographs - of an intersection, a station, a cycle track at a specific location, etc.). Geolocated points could be colour coded according to the type of materials available.

By clicking on an indicator of choice, the user can superimpose on the satellite image the 100m x 100m evaluation grid of this indicator.
While the visualisation of quantitative data remains an essential aspect of the platform, at the scale of the sample, it can be enriched by the qualitative elements proposed in different formats (see Annexes):

- a **dynamic cloud**: if the user chooses, they can display all the qualitative materials associated with the cell distributed around an invisible sphere superimposed on the de-opacified cartographic background. The cloud could be manipulated by the mouse in order to be turned over to discover all the elements that make it up, which would thus come to the fore in preview mode.
- **pop-up windows**: if the cloud mode is not activated, the qualitative capsules can be activated by clicking on the geolocated points of interest.

Zooming out from the last two reference scales would take the user to the previous scale.

Thus, from the most static to the most dynamic, the interaction is first built between the scales and the level of abstraction described above. The objective of this interactive platform is to propose a more playful and didactic approach to mobility systems in their multiple dimensions, both sensitive and objective. The following insert presents a simplified proposal to concretise these ideas on the basis of the platform built by the FELIS team.

Architecture of a comprehensive SuMo web platform

Proposition ENSAS/IMM, 2020

Title

Explore Cities in the Upper Rhine Region

Sub-title

Follow the transition towards sustainable mobility

Suggestion Top down

Global goals from Paris agreement for transport have to be broken down into local measures
Multiple factors contribute to sustainable mobility → Indicator System
Identify areas of action and monitor progress and compare your city

And bottom-up

This site gives you detailed information about sustainable mobility in your city
Helps users make choices about their mobility habits
Supports decision makers to make decisions about the future

First layer general public - directly visible
Second layer specialist - accessible by further actions - go to methods page, click on icons,

Overview

First View

- Welcome Claim (Header)
- Title
  - SUstainable MObility in the Upper Rhine Region
  - Explore the mobility system in your city
  - Learn more about the SuMo Project
- Visualization
  - Show a city or the region
- City Gallery

City Ranking

- Title
  - SuMo City Index
- Subtitle
  - Compare cities using the 18 SuMo Indicators
- Explanation
  - The SuMo City Index shows areas of action in sustainable mobility, and how neighboring cities perform compared to the regional average.

City View

Overview

- Title
  - Analyse/Exploring sustainable mobility in...

City Overview

- Sustainable Mobility in CITYNAME at a glance
- CITYNAME on the way towards sustainable mobility

Strength / Area of Action

Indicator view

- City indicators in detail
  - Key factors / sub-indicators

Data mapping does not provide information about real space and urban context and quality.

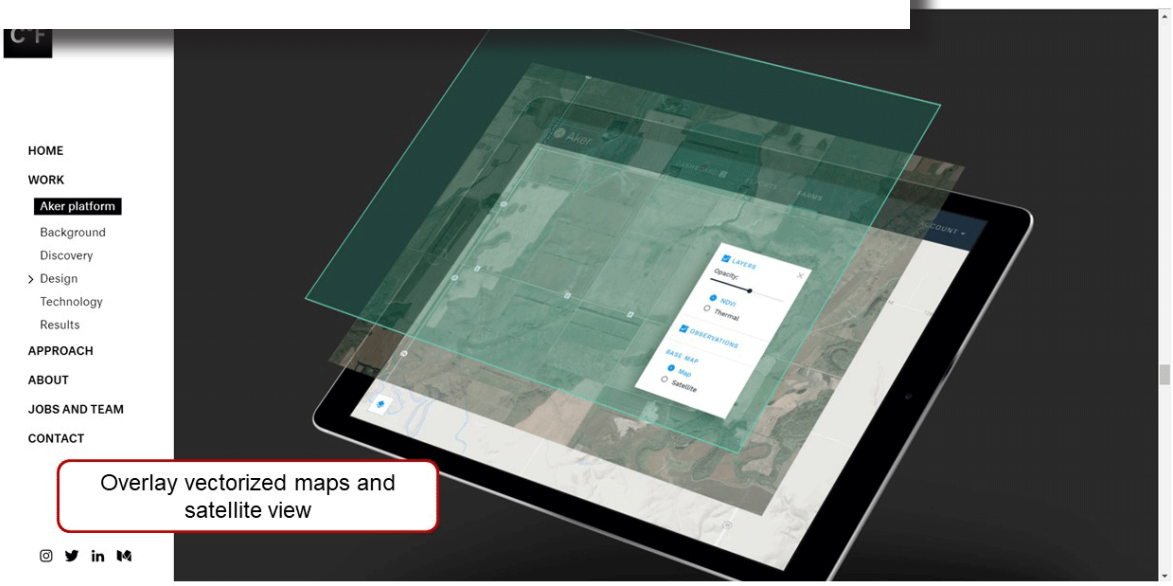
Integrate qualitative aspect of space in data visualization

Why ?

Associating data to a physical territory

Show disparities and contrasts between data and terrain characteristics and quality

Interactive maps as a possible answer.



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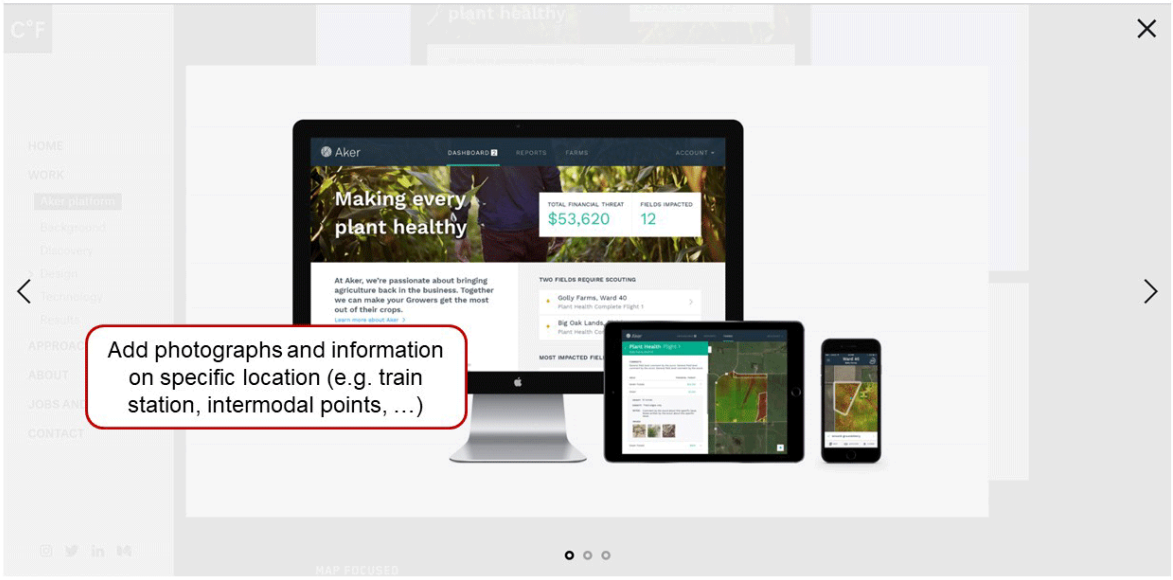

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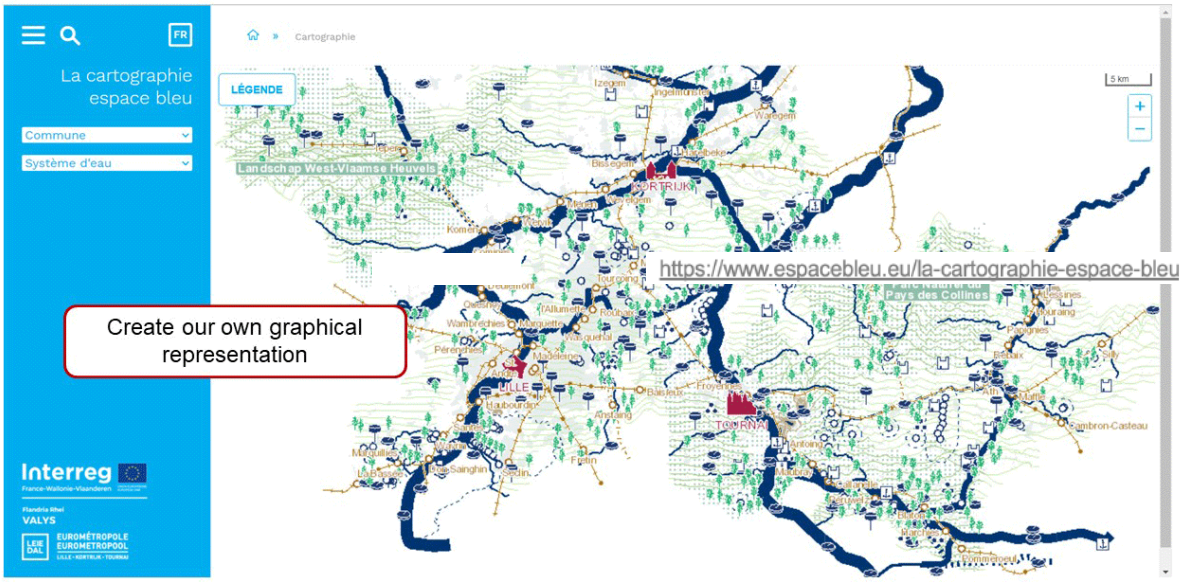

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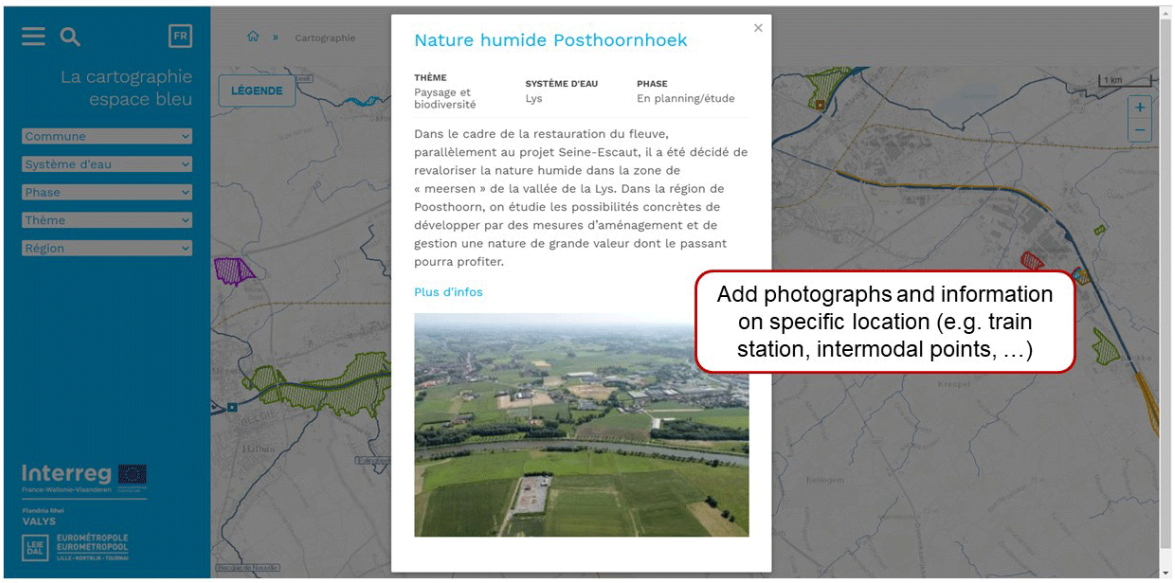
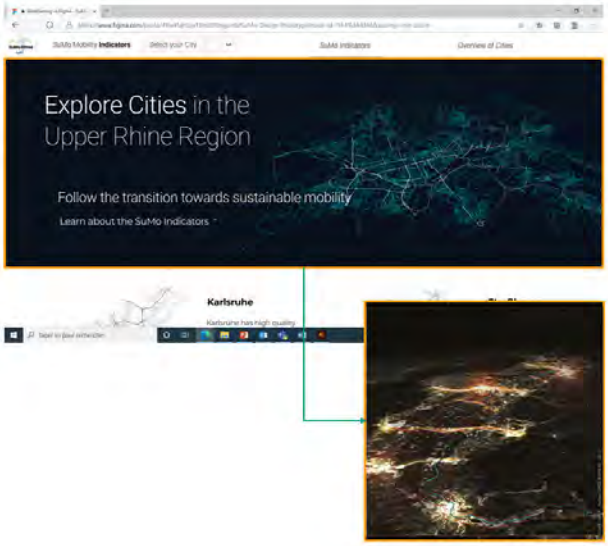


https://www.espacebleu.eu/la-cartographie-espace-bleu

Overview

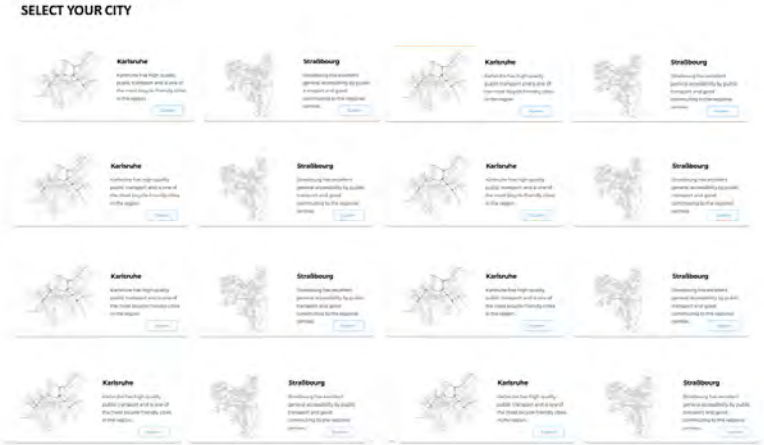
Overview (no literal translation necessary)

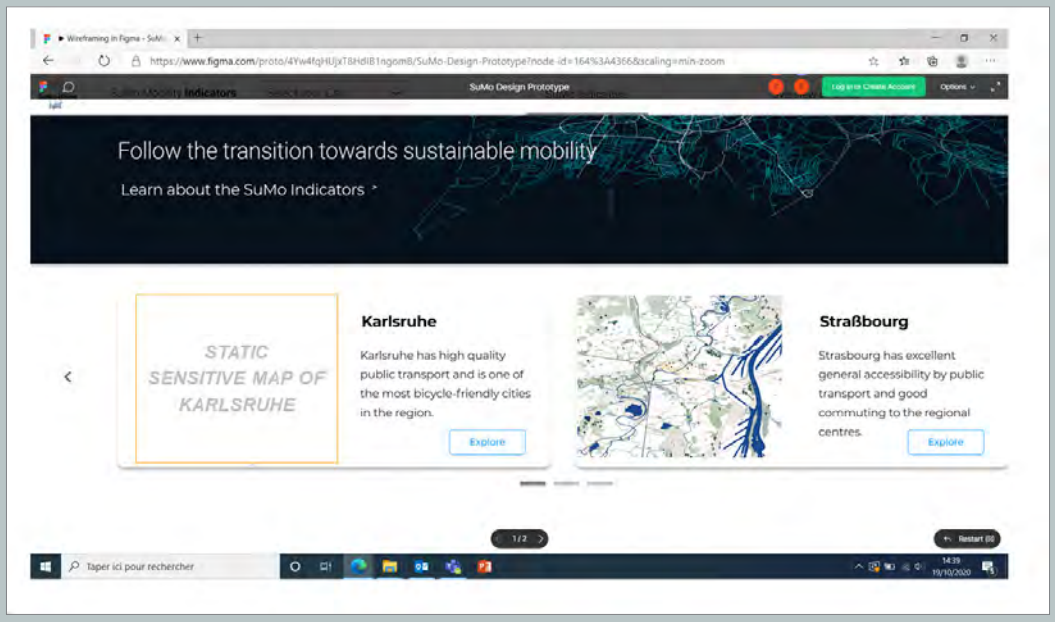
- First View
  - Welcome Claim (Header)
  - Title
    - SUstainable MObility in the Upper Rhine Region
    - Explore the mobility system in your city
    - Learn more about the SuMo Project
  - Visualization
    - Show a city or the region
  - City Gallery
    - sdfds
- City Index
  - Title
    - SuMo City Index
  - Subtitle
    - Compare cities using the 18 SuMo Indicators
  - Explanation
    - The SuMo City Index shows areas of action in sustainable mobility, and how neighboring cities perform compared to the regional average.

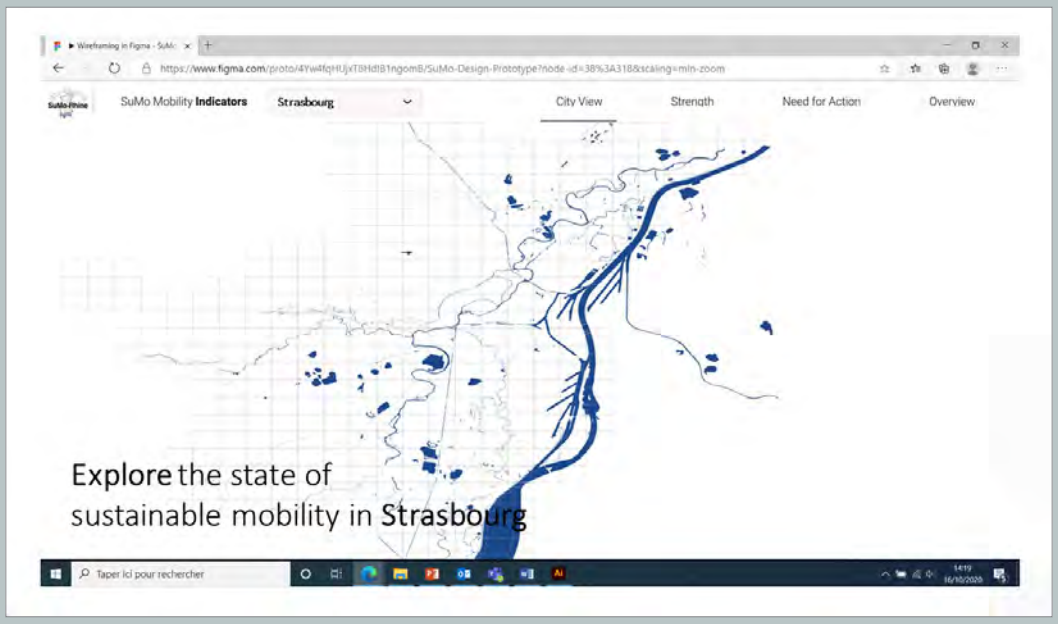


Landing page mosaic

City view gallery







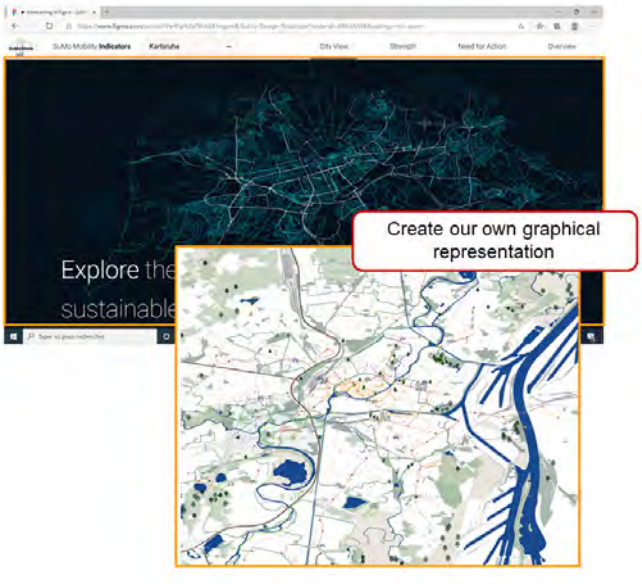
City view

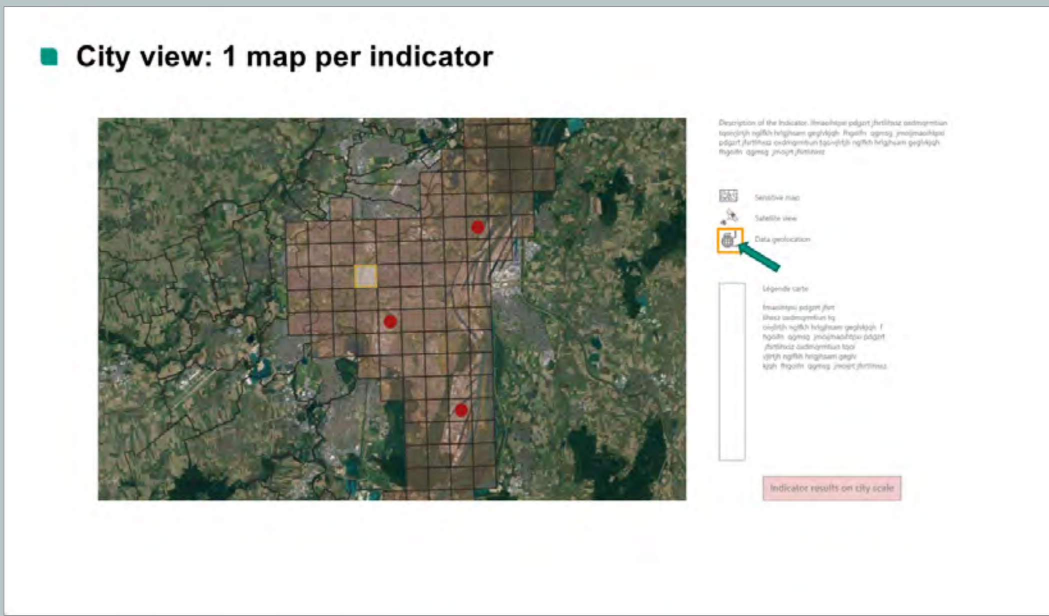
City View

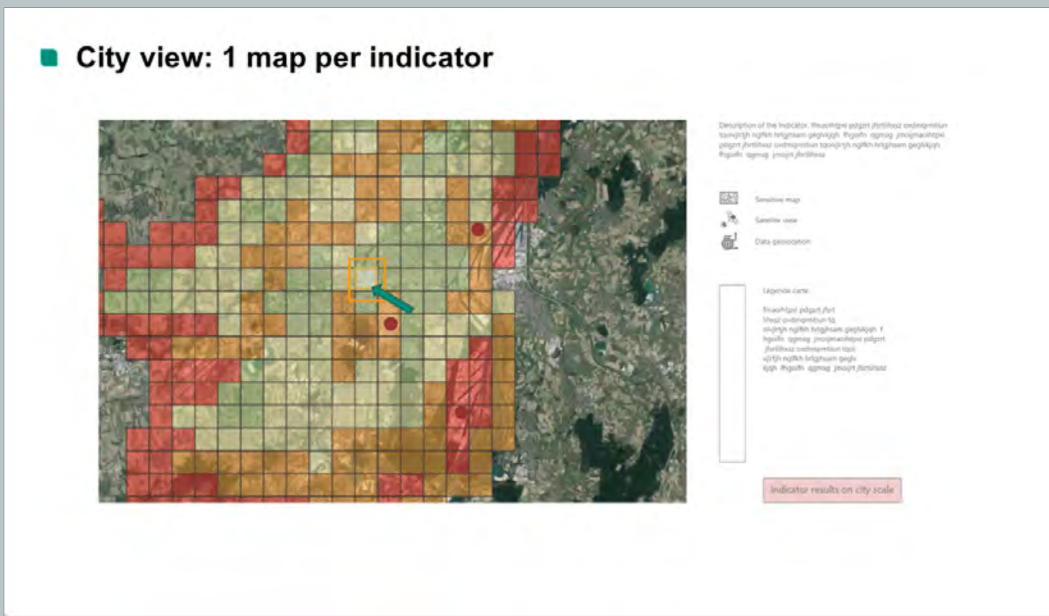
- Overview
  - Title
    - Analyse/Exploring sustainable mobility in ka
- City Overview
  - Title
    - City Overview
  - Subtitle
    - Sustainable Mobility in CITYNAME at a glance
    - CITYNAME on the way towards sustainable mobility
- Strength
- Area of Action
- Indicator view
  - Title
    - City indicators in detail
  - Subtitle
    - Key factors instead of sub-indicators

First view | Banner image:

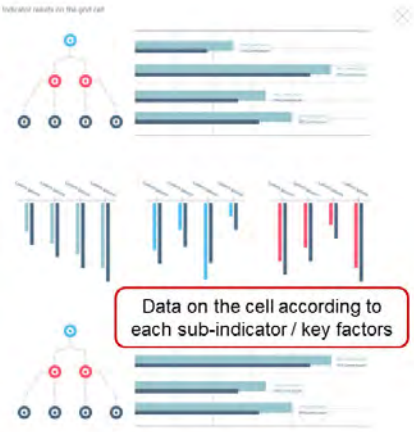
Sensitive maps of mobility networks with a GIF / loop video




City view: 1 map per indicator
Description of the Indicator.
Sensitive map
Satellite view
Data geolocation
Légende carte
Indicator results on city scale

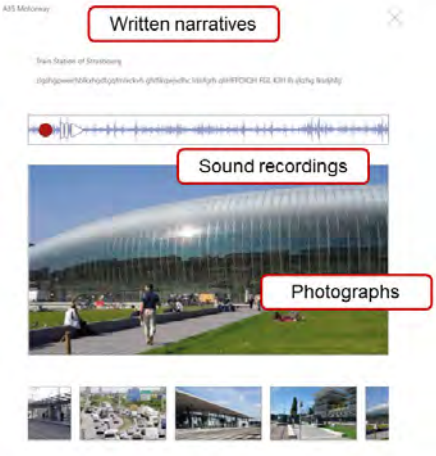

City view: 1 map per indicator
Description of the Indicator.
Sensitive map
Satellite view
Data geolocation
Légende carte
Indicator results on city scale

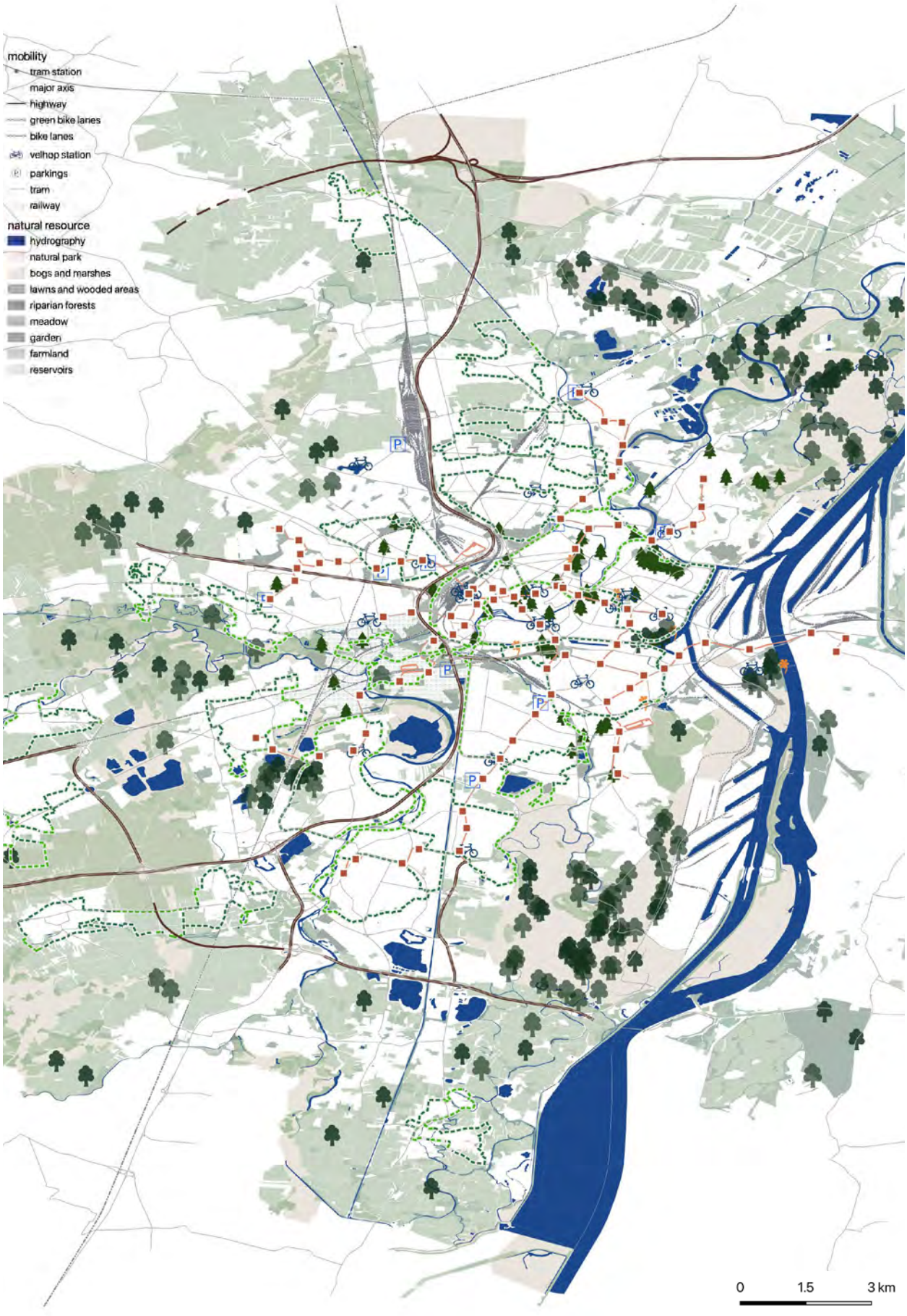
City view



City view

+ animated 3D view, sketches…





Interactive 3D mapping database for the SuMo web platform - *Proposition 2020*

CONCLUSION & PERSPECTIVES

Mobility and urbanity in the making in the Upper Rhine, for a plural, hybrid, and complex understanding of mobility territories

The Upper Rhine region, due to its trinational and cross-border character, suffers from the absence of systematised and comparable data relating to its territory, particularly in terms of mobility. Hence the ambition of our consortium to build the Indicator System, by developing methods and applications to fill this gap and build common frameworks for thinking about sustainable mobility in the future. In these shared efforts, the central concern of our team has been to produce supports for analysing the sustainability of mobility, in its relation to the spatial organisation of the territories studied and to the societal issues and projects that shape them. In the following paragraphs we propose to briefly review the different aspects of our contribution and outline the avenues for reflection and research that it has opened up.

Based in particular on an automated data processing approach using the SuMo Indicator System, the evaluation tool (implemented via the online platform - aka KINaMo) produces a diagnosis of the urban mobility systems of the Upper Rhine that allows inter-city comparison according to different criteria through quantitative results. To complete these results, but also to avoid the temptation of territorial competition through the ranking of the values obtained (and the risk of political appropriation of the tool), we have proposed a first multi-scalar and multi-criteria cartography, a basis for the construction of the SuMo Rhine Atlas (see Axis 1). It allows to refine the results of the Indicator System by spatializing them, in order to support cross-analyses between the different indicators, but also between the distribution of the values obtained and the configurations, structures and rationalities specific to each territory studied, in order to detect possible correspondences or even interdependencies. In this sense, the work of development and critical interpretation should be continued. These first maps served above all as a «proof of concept» to show the potential and the limits of the approach: its high level of abstraction despite everything, but also the possibility of going beyond the level of numerical measurements through a more territorial and nuanced reading of the results. At the same time, these first maps have also made it possible to test the Indicator System as a producer of knowledge on current mobility systems, revealing its interest - that of making mobility systems and their territorial organisation comparable in the three Upper Rhine countries - but also its weaknesses and possible avenues for improvement. We are thinking in particular of the inevitable simplification imposed by the logic of the indicators, the difficulty of objectifying the qualitative dimension of mobility and its spaces without losing the nuances of its complexity, as well as the biases introduced by the choices made to define and calculate them (the case of Haguenau which we studied in Axis 1 is revealing in this sense). Developing more systematically such a work of confrontation - of the spatialized results of the Indicator System with more qualitative spatial analyses - from different fields, would be a way to ensure the validity of the whole tool. In addition, a selection of several cross-border strips of territory, defined without taking administrative boundaries into account, would be interesting to consider as cases of in-depth studies based on cross-analyses: geolocalised results of the indicators + qualitative analyses (spatial, practices, etc.) + analyses of mobility policies, etc. This type of comparative (between different countries) and multi-approach study would allow a better understanding of the impacts of mobility, urban planning, and planning policies, as well as the possible lack of articulation between the different territories, in order to reflect on possible levers for improvement.

Secondly, in our questioning of sustainable mobility and the evolution of a Rhine city such as Strasbourg, we understood the scenario as a critical tool (Secchi, 2001; Grigorovschi, 2017) to highlight the possible postures and levers for the transition of mobilities as a support for the ecological transition of the (Euro)metropolitan territory of Strasbourg (see Axis 2). For if the Indicator System can

be useful to understand by deconstructing the different aspects of the current mobility models and their degrees of (un)sustainability, it is not able to operate a comprehensive analysis of the complex interactions that define them in order to provide action levers for their improvement, and even less for their deep transition. This is especially so because, although there is a consensus on the climate issues and the carbon neutrality objectives to which this transition must respond, the way in which this is to be achieved remains a subject of debate. The scenario approach has thus made it possible to open up the reflection on the meanings that sustainable urban mobility could take in the context of a large Upper Rhine city such as Strasbourg, but also to reflect on the contemporary territorial project. The proposed explorations are inspired by local doctrines that carry two different visions of the relationship between the city project and mobility: The first, motivated by ecological awareness, rejects the ideology of growth, questions the principle of urban densification and gives primacy to soft and active mobility and the renaturalisation of the city; the second, attached to success in terms of economic development and international influence, aims to assume growth by making it compatible with an environmental approach which is embodied in the ideas of density and compactness, with the help of a massive development of public transport (particularly rail).

Inspired by the new approaches and theories of the architectural, urban and landscape project (those of the project of the void, the project of the ground or the project of open spaces which supports relational and pluriscalar thinking - Secchi, 1986, 2000; that of the project as a producer of knowledge - Viganò, 2012, or the theories of the local project - Magnaghi, 2000; the bioregionalist approaches - Rollot, Schaffner, 2021; etc.), the territorial design exercise of these two visions, although limited, allows us to provide elements of understanding and consideration of the territory envisaged, but also to open up a field of reflection on the levers, processes, metrics and values that the bioclimatic project calls for in order to reconsider mobility and the city as «living territories» (Rollot, 2018) and as resources whose renewal capacities must not be exceeded.

Thus, although the constraints encountered (technical, deadlines, resources) limited this exercise to the state of intentional diagrams without being able to question, for example, the scales of relevance of mobility systems in relation to metropolitan realities (including cross-border ones), the scenarisation approach is useful both in terms of its results (possible futures preparatory to the political debate) and its process (construction of common knowledge that is the subject of a formatting and a narrative). And this is because one of the major challenges for the success of the transition to low-carbon mobility and urban systems is to build a narrative and a collective imagination that makes the transition not only possible, but above all desirable and tangible.

It deserves to be pursued by strengthening its participatory and interdisciplinary dimension, and more firmly rooted in a careful, qualitative, and critical reading of the conditions and processes that shape the relationships between mobility and territories - from the most consolidated to the most experimental and committed to a decarbonised metabolism, their scales and temporalities, the territorial resources on which they depend, etc.

Beyond this register, for designers, measurement tools such as operationalised indicators or multi-agent type models could compensate for the current lack of software to evaluate projects and scenarios that go beyond the architectural scale (the only scale where these instruments exist today, and which allow for a dynamic simulation of changes and evolutions of the project). Although some tools exist today, such as those of the Visum type used by municipalities for road traffic planning, their diversification and development for a more global consideration of mobility in its link to the city and to individual and collective practices is desirable. On the one hand, for designers (architects and urban planners), because the use of such simulation and evaluation tools in the design phase could help to avoid certain pitfalls by introducing feedback loops into the project process, without replacing the human being in their sensitive approach and their thorough understanding of the complexities of each territory.

On the other hand, for the debate and mirroring of projects and scenarios. For example, the prospect of eventually measuring the environmental footprint of current and future urban mobility systems, through an evaluation using indicators and the multi-agent model, is an objective to be pursued. This would allow a repositioning of the value of the different scenarios envisaged from their conception, but this variable would also make it possible to complicate the reasoning which governs the arbitration processes by adding the parameter of the environmental cost to the relationships of the type of urban quality / efficiency of mobility / economic cost.

Finally, as we have outlined more explicitly in the last part of this report, one of the challenges for us remains how to link quantitative approaches and studies to other types of knowledge, to a more situated and contextual understanding of the quantitative results, to knowledge grasped on a human scale which would be able to link up with an overall view of the territory of the Upper Rhine, with urban cultures, with the collective practices and imaginaries at work in this shared space, to enable them to take on more meaning. In other words, to confront the quantitative value with the value that we give individually and collectively, as societies, to our environments and our mobility. This linkage could help to interpret and problematise the results of the Indicator System more fully, and above all, to place them at the heart of the citizen debate. It is in the direction of such a hybridisation of quantitative and qualitative knowledge that our proposal for the construction of an interactive and augmented online cartography (see Axis 3) focuses on the places and territories of mobility of the Upper Rhine, and in particular on cross-border transversalities. This would involve the development of the SuMo Atlas and its enrichment by more qualitative cross-border cartographies, as well as the interactive web tool which would enable them to be linked. In the long term, this web platform could evolve towards a participative cartography, where users could add qualitative inserts or report dysfunctions or errors in the evaluation of their living territory.

The challenge for the continuation of the SuMo Rhine project thus lies in the fact that these tools should evolve to allow for a more complex approach to mobility, and the appropriation of the Indicator System by the actors and citizens who would enrich and update it with their knowledge from practice and from living. In other words, it is by supporting the finesse and plurality of views and the expression of our collective intelligence that we will be able to cultivate a reflective and critical spirit to think about the mobility of our trinational territory and its future.

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Research Team:

Sc. Dir. ENSAS: Andreea Grigorovschi
ENSAS Research Team: Jeremy Hawkins, Marie Fruiquière

In collaboration with: Janusch Jehle (FELIS), Sven Decker (FELIS),
Nadège Blond (Unistra-LIVE / CNRS), Paul Salze (Unistra-LIVE / CNRS)

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