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# Developing a combined mapping representation of air and noise pollutions

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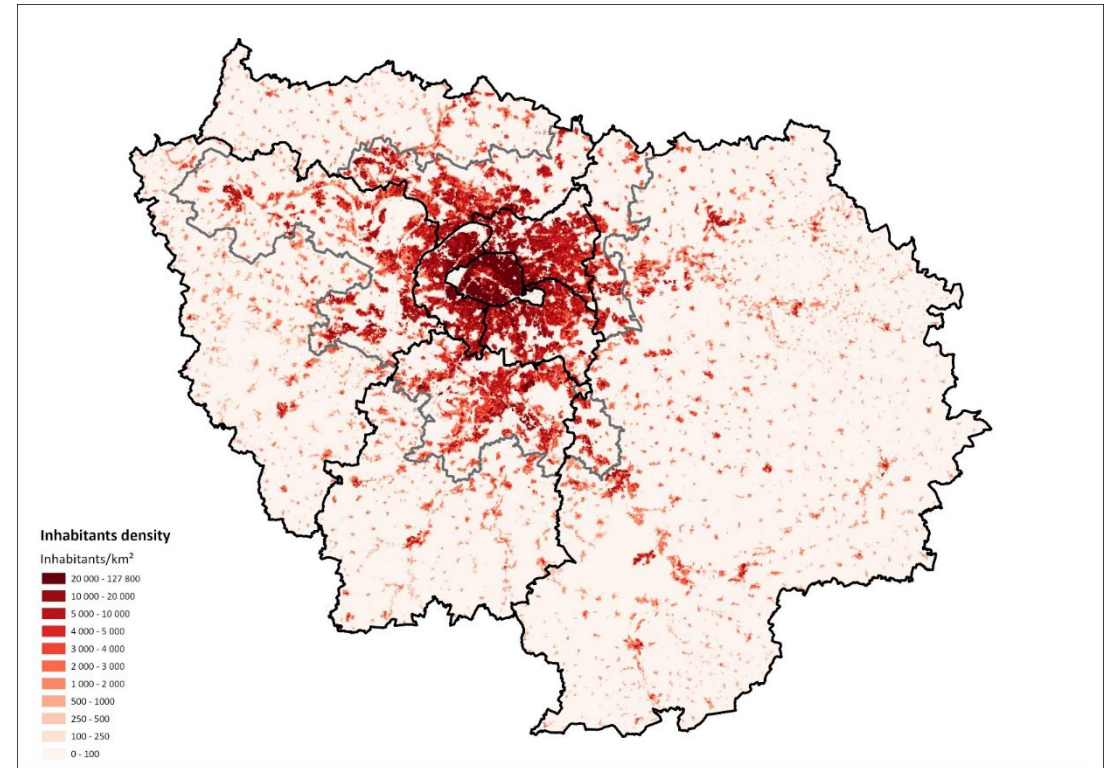
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# Introduction

## The Ile-de-France region

- 12.2 millions of inhabitants = 18% of the French population
- Highly density and strong disparity
- Very highly and dense transport and infrastructures : (40,000 km of roads, 1 000 km of railways, 2 major international airports Paris-Charles de Gaulle, Paris-Orly, 1 business airport Le Bourget)
- Great concern related to air pollution and noise are cited like a major disadvantage of living in Ile-de-France for 36% of inhabitants for noise and 38% for air pollution.



## Health effect of exposure:

- Air pollution : cardiovascular disease, respiratory disease and lung cancer
- Noise : annoyance, sleep disturbance, cardiovascular disease, and diminished learning capacity

**Airparif and Bruitparif develop an original method of mapping representation of the co-exposure to noise and air pollution**

# Input and representation scale

- **Air pollution**

Airparif used the strategic air quality map which take into account three major air pollutants (PM<sub>10</sub>, PM<sub>2.5</sub> and NO<sub>2</sub>)

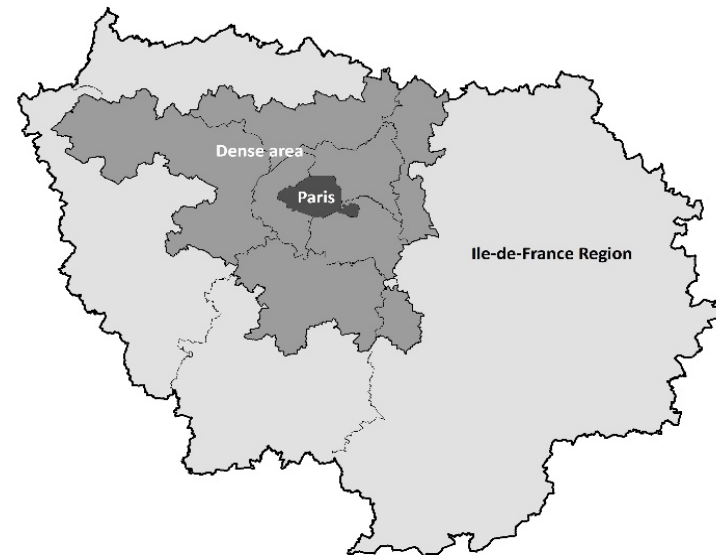
The map is available throughout the Ile-de-France region

- **Noise**

Bruitparif used the strategic noise maps concerning transport noise (road, rail and air traffics).

These maps are available at a high resolution for all the infrastructures within the dense area and only for the major infrastructures in the rest of the Ile-de-France region

- **In this study, we used three scales of mapping:**



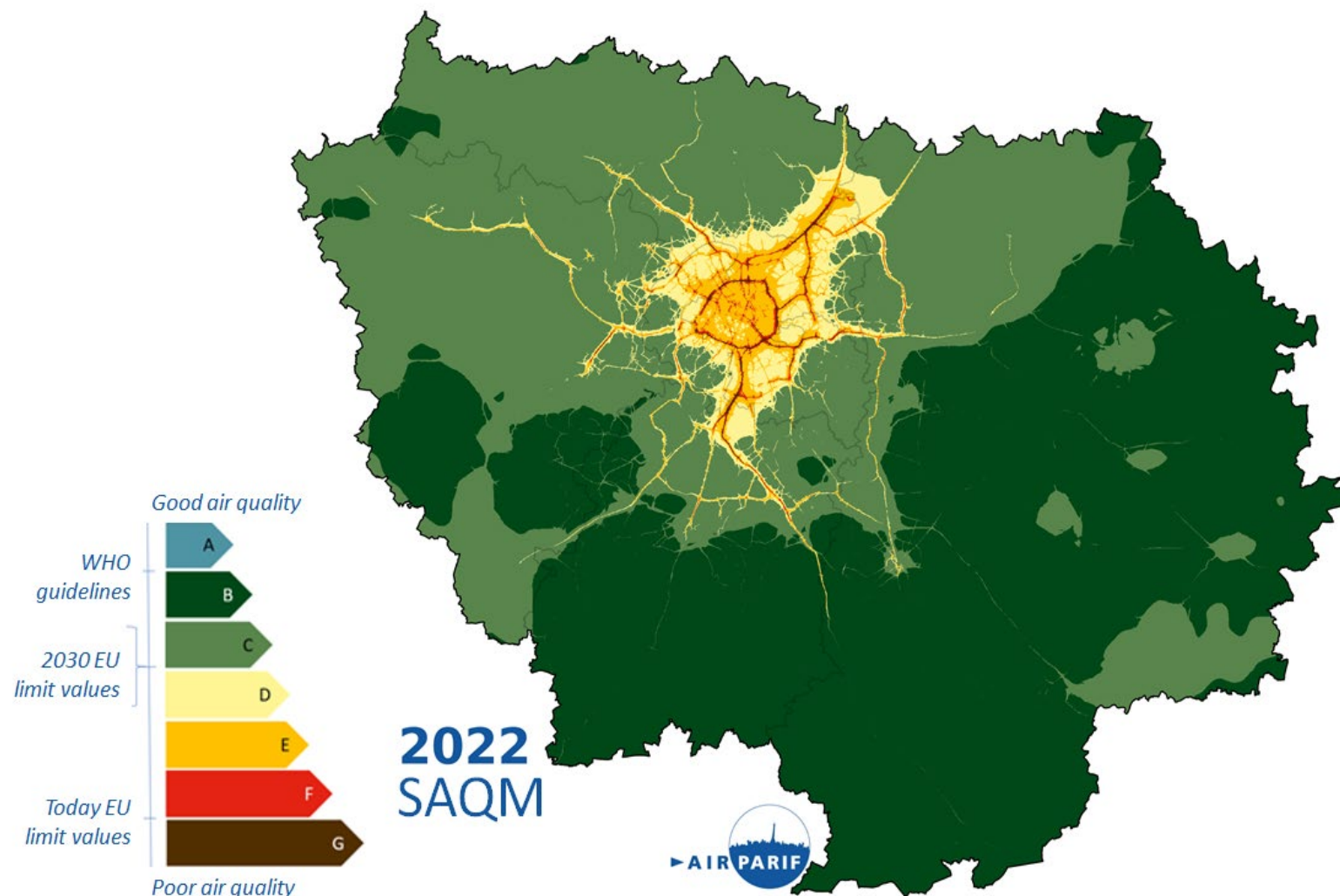
# Determination of a global index for air quality

The reference values retained are:

- The air quality guidelines issued by the WHO, which are health-based recommendations for air quality management
- The limit values defined by the European Ambient Air Quality Directives and transcribed into French law, which are legally binding standards
- The limit values to not exceed from 2030, proposed in the on-going revision of the European Ambient Air Quality Directives, which aims at improving the EU's air quality standards for zero pollution by 2050.

Max value	NO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2,5</sub>	
	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	
<b>A</b>	≤10	≤15	≤ 5	Compliance with WHO guidelines
<b>B</b>	]10,16]	]15,16]	]5,8]	Exceedance of WHO guidelines
<b>C</b>	]16,20]	]16,20]	]8,10]	Risk of exceeding the 2030 limit values (> 80% * 2030 limit values)
<b>D</b>	]20,24]	]20,24]	]10,12]	Exceedance of 2030 limit values
<b>E</b>	]24,32]	]24,32]	]12,20]	Significant exceedance of 2030 limit values (>120% * 2030 limit values)
<b>F</b>	]32,40]	]32,40]	]20,25]	Risk of exceeding the EU limit values (>80% * EU limit values)
<b>G</b>	>40	>40	>25	Exceedance of EU limit values

# Determination of a global index for air quality



# Determination of a global index for transport noise

The strategic noise maps are produced for 3 sources of transports and 2 indicators.

→ Choice of the Lden indicator

We want only one map to cross with air pollution map

We test different approaches to combine noise maps:

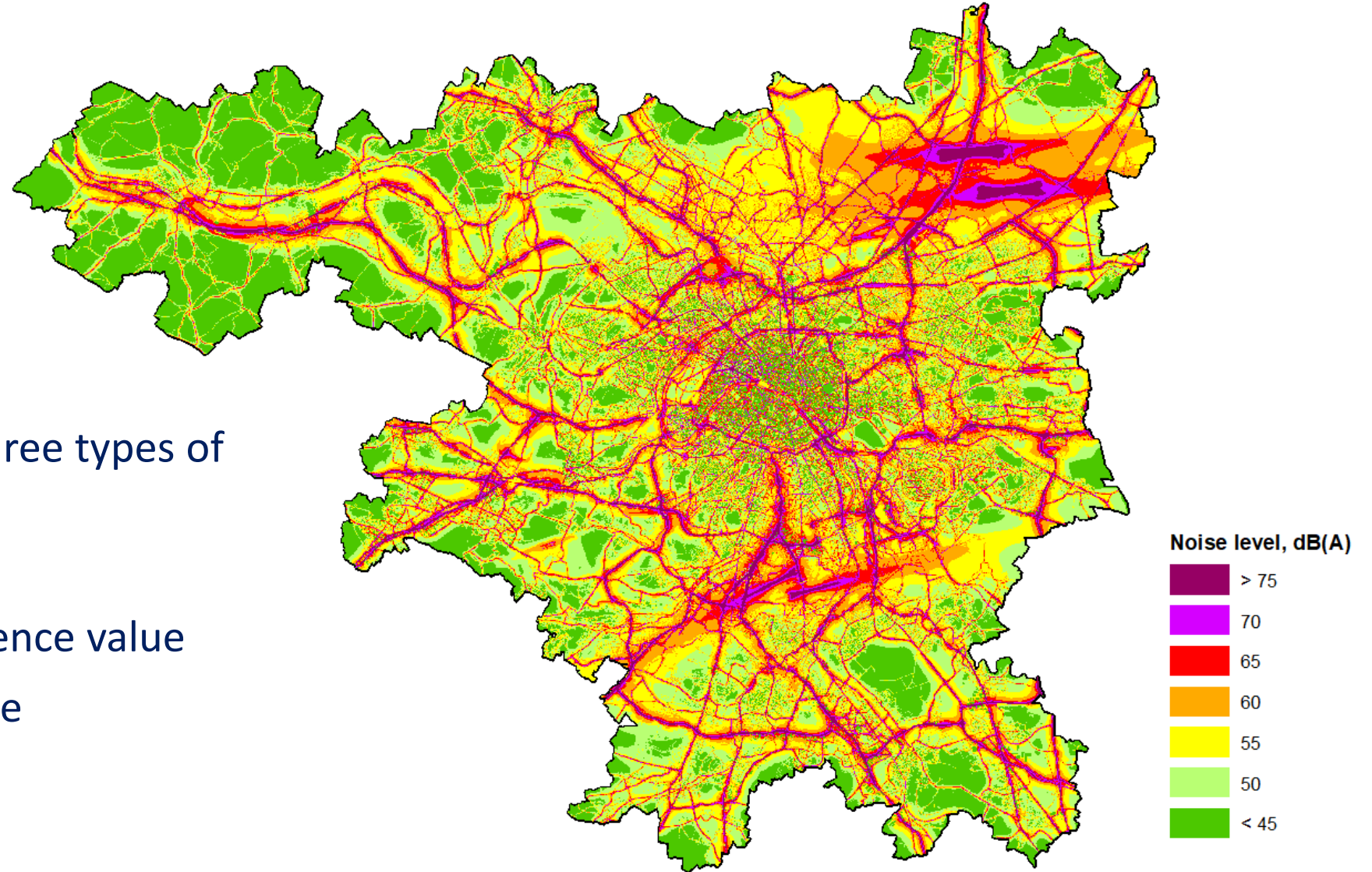
- 1<sup>st</sup> : Cumulative transport noise
- 2<sup>nd</sup> : Situation compared to reference values (similar way as for air quality)
- 3<sup>rd</sup> : Multi-exposure transport noise map based on the annoyance equivalent model



# First approach : Cumulative transport noise

Cumulative noise from the three types of transport

Easy to produce but no reference value for cumulative transport noise

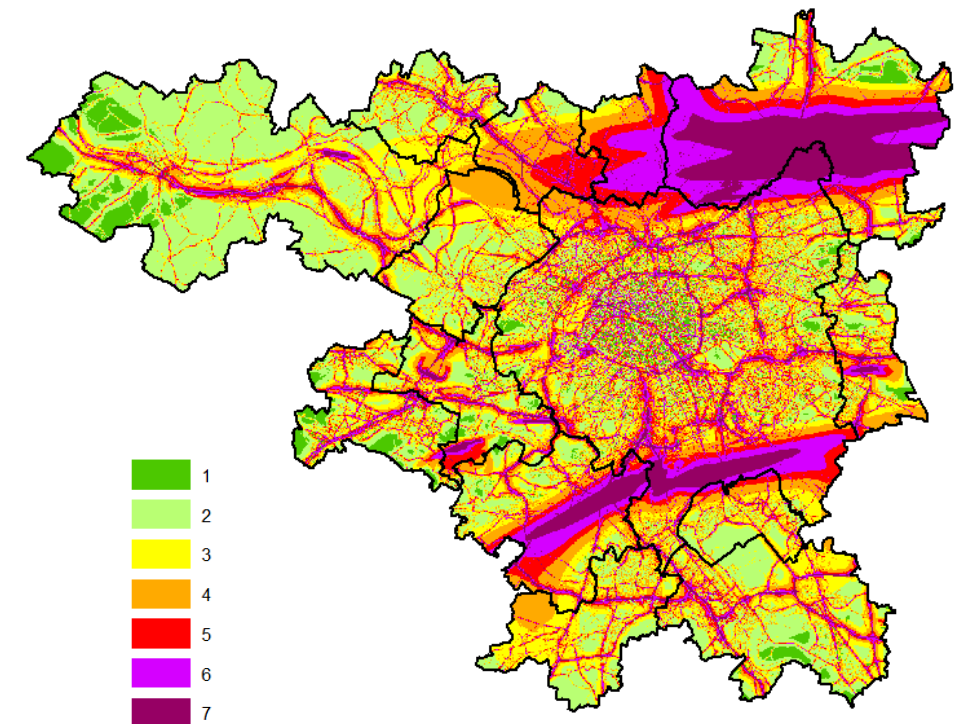


# Second approach : Situation compared to reference value

Determination of a noise class for each point in the territory based on the reference values:

- the WHO recommendations corresponding to quality objectives
- the regulatory limit values in France for the strategic noise maps

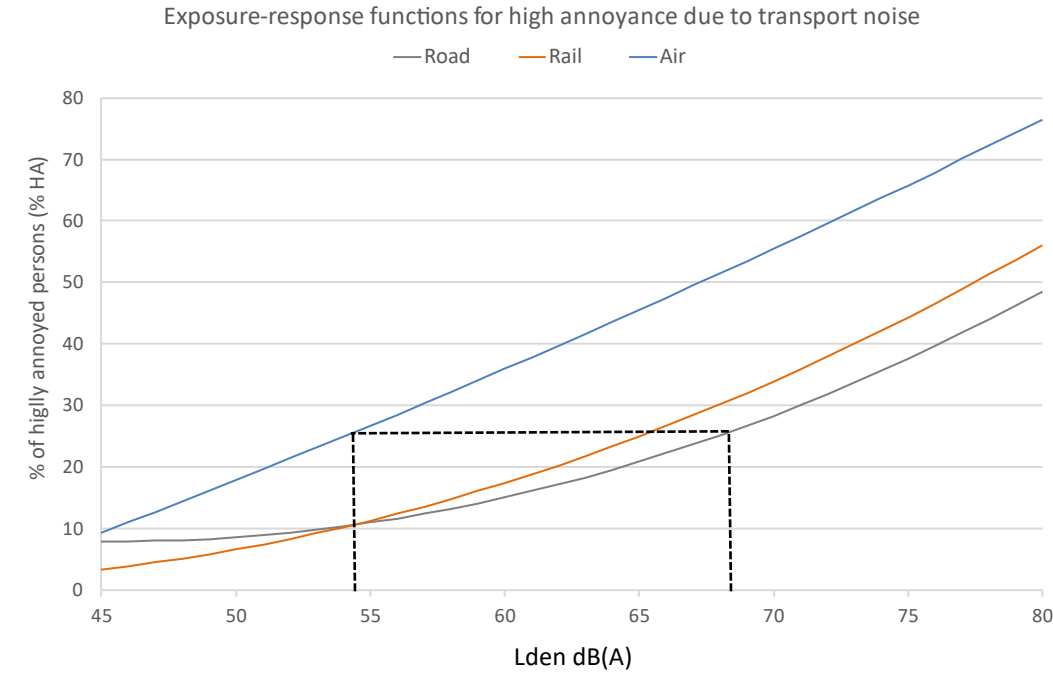
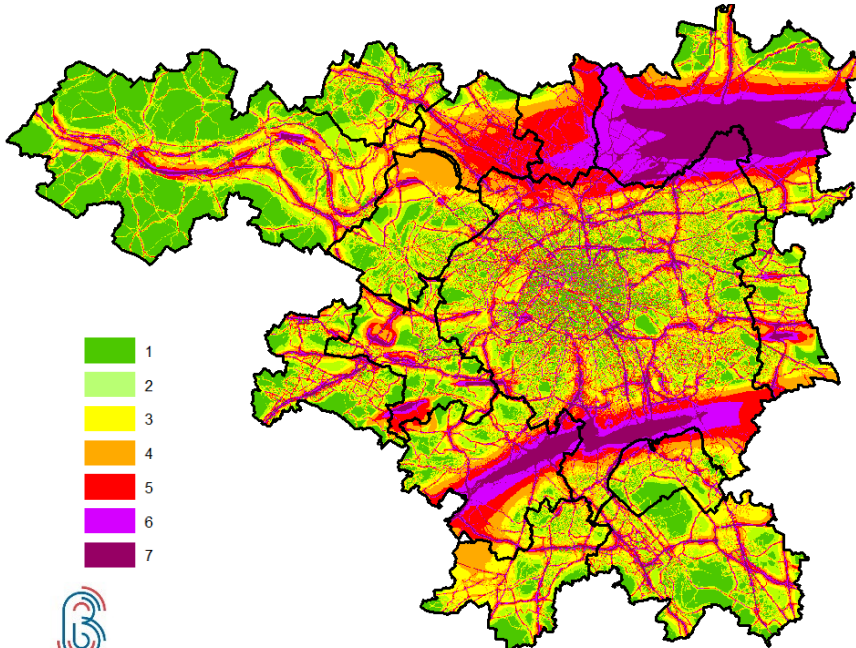
Noise classes	Road noise Lden dBA	Rail noise Lden dBA	Air traffic noise Lden dBA	Significance
1	< 45	< 45	Area not overflowed	Compliance with WHO recommendations
2	[ 45 - 53 [	[ 45 - 54 [	Area overflowed, < 45	
3	[ 53 - 58 [	[ 54 - 60 [	[ 45 - 48 [	Between WHO recommendations and limit values
4	[ 58 - 63 [	[ 60 - 67 [	[ 48 - 52 [	
5	[ 63 - 68 [	[ 67 - 73 [	[ 52 - 55 [	
6	[ 68 - 75 [	[ 73 - 80 [	[ 55 - 60 [	Above at least one limit value
7	≥ 75	≥ 80	≥ 60	





# Third approach : Multi-exposure transport noise map based on the annoyance equivalents model

1. Determination of an exposure to noise (Lden indicator) from an annoyance based on a dataset published by WHO. The method involves calculating equivalent noise levels in Lden for rail and air traffic noise, which would correspond to the Lden levels of road noise that would be required to generate equivalent rates of highly annoyed people.

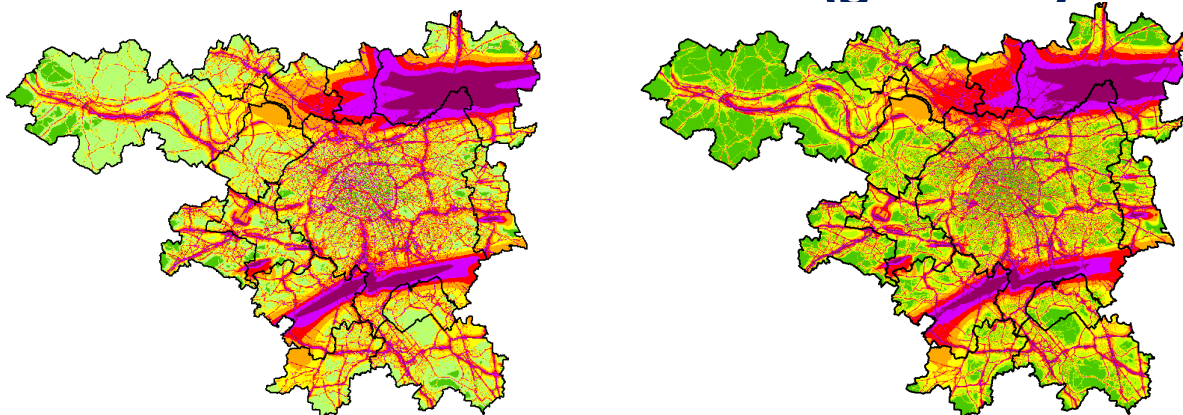


2. Sum of the road equivalent rail and air traffic noise with the road noise level to obtain the overall road-equivalent project

# Choice of a multi-exposure index for transport noise

	Advantages	Drawbacks
1st approach		Lack of reference values for cumulative noise
2 <sup>nd</sup> approach	<ul style="list-style-type: none"> <li>• Can be use directly by public authorities</li> <li>• Similarity with the air pollution method</li> </ul>	<ul style="list-style-type: none"> <li>• Different references values for country in the UE</li> <li>• Relevance of the limit values in terms of health impacts?</li> </ul> <p>Example of the 73 dB(A) limit value for rail in France higher than the road one (68 dB(A)), whereas annoyance caused by rail noise is greater</p>
3rd approach	<ul style="list-style-type: none"> <li>• Already used and tested in France by the ORHANE observatory</li> <li>• Based on scientific principles, with ERF validated by WHO</li> </ul>	<ul style="list-style-type: none"> <li>• Based on the assumption that annoyances by sources can be added (WHO warns that estimated impact should not be added together because it leads to an overestimation)</li> </ul>

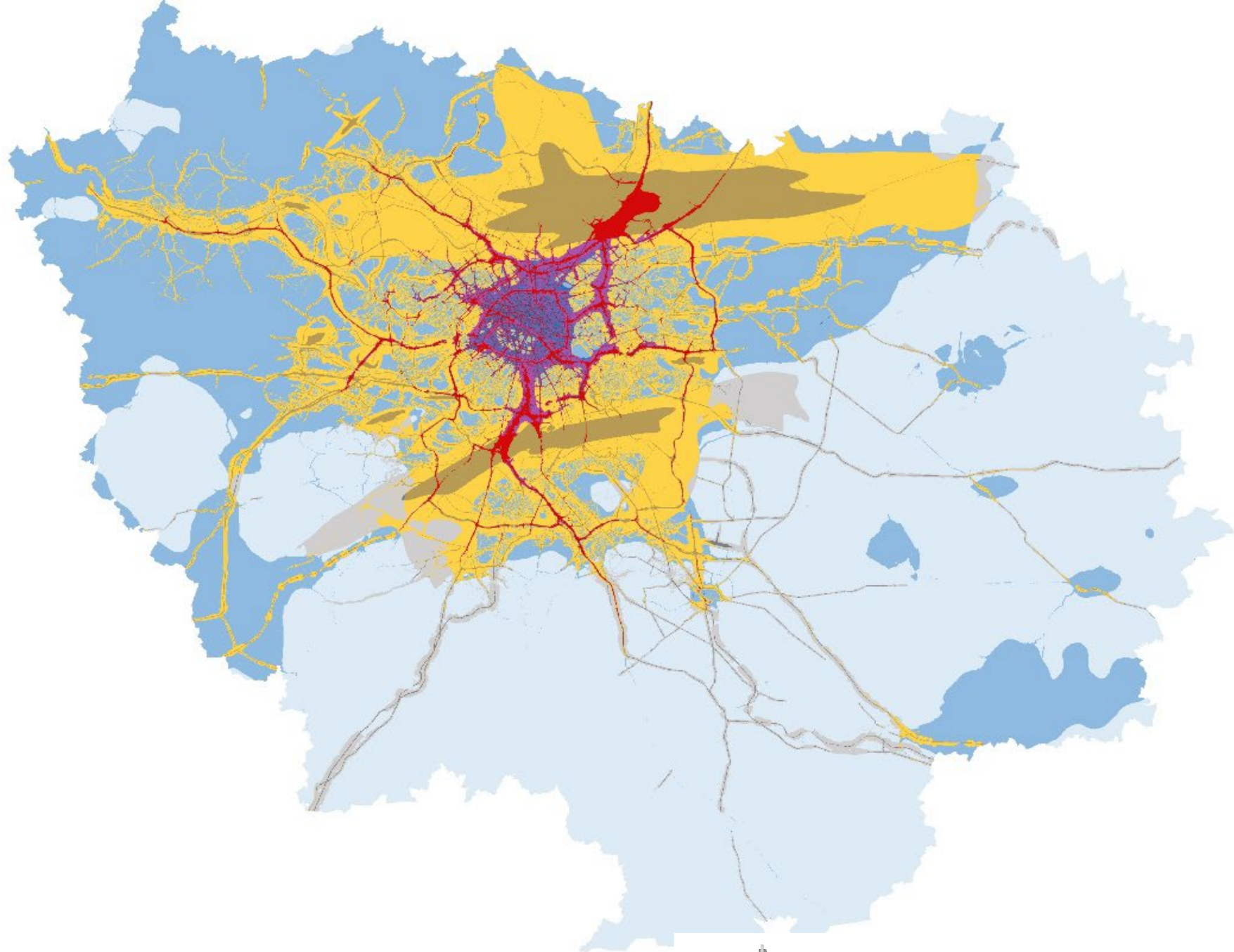
→ Choice of the last two variants (give very similar maps)



# Mapping representation: two-dimensional colour scale

Air pollution index	G	> limit values in force	7	Blue	Blue	Purple	Purple	Purple	Red	Red
	F	> 80% limit values in force	6	Blue	Blue	Purple	Purple	Purple	Red	Red
	E	> 120% projected limit values in 2030	5	Blue	Blue	Purple	Purple	Purple	Red	Red
	D	> projected limit values in 2030	4	Light Blue	Light Blue	Yellow	Yellow	Yellow	Olive	Olive
	C	> 80% projected limit values in 2030	3	Light Blue	Light Blue	Yellow	Yellow	Yellow	Olive	Olive
	B	> WHO recommendations	2	Light Blue	Light Blue	Grey	Grey	Grey	Dark Grey	Dark Grey
	A	<= WHO recommendations	1	Light Blue	Light Blue	Grey	Grey	Grey	Dark Grey	Dark Grey
				1	2	3	4	5	6	7
Approach 2 - Comparison with reference values				< WHO recommendations		≥ WHO recommendations < limit values			≥ limit values	
Approach 3 - Indicator Lden equ. road				<50 dBA	50-55 dBA	55-60 dBA	60-65 dBA	65-70 dBA	70-75 dBA	≥75 dBA
Noise pollution index										

# Map result



A  
I  
R



Noise



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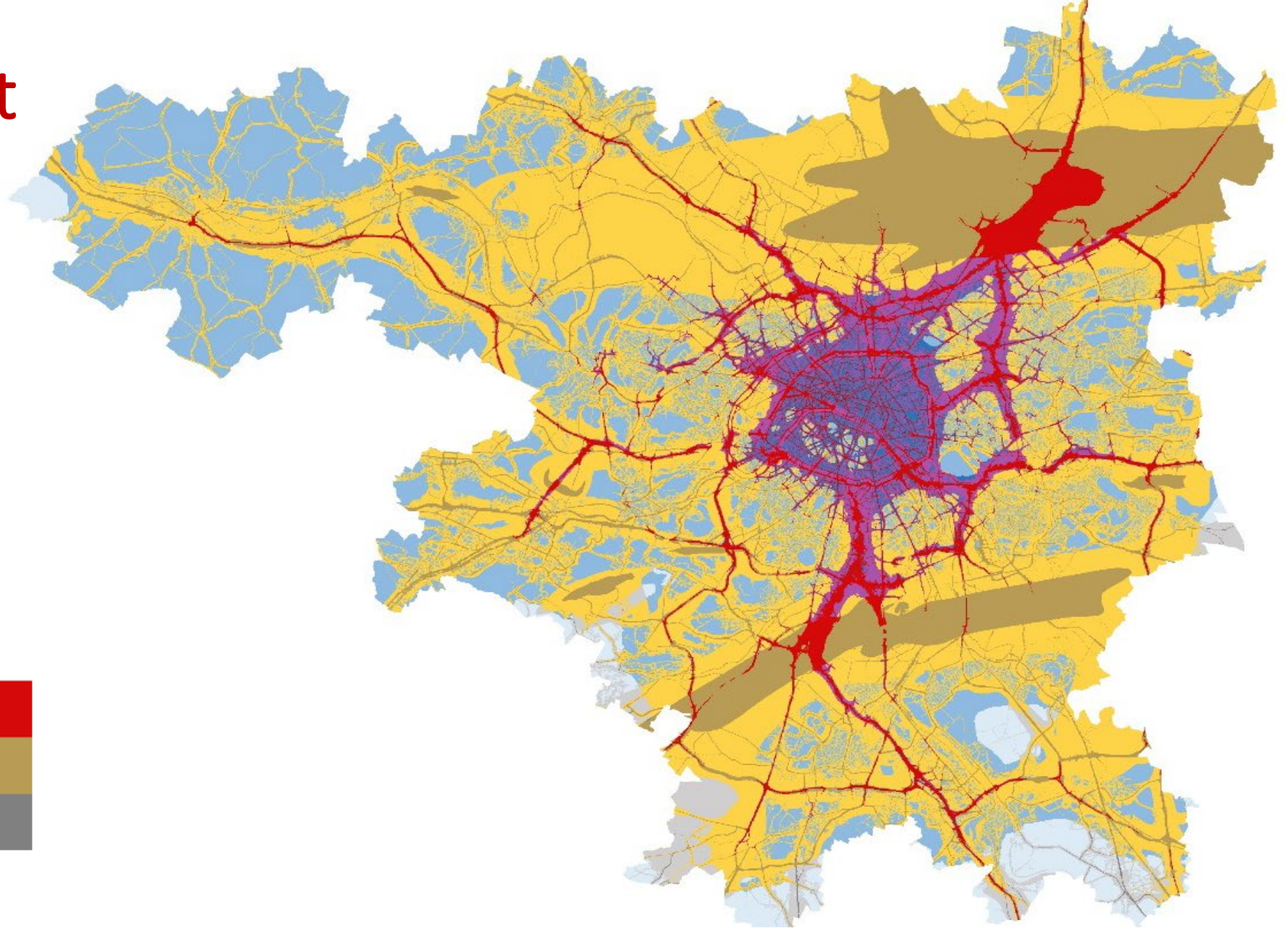


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# Map result



A  
I  
R



Noise



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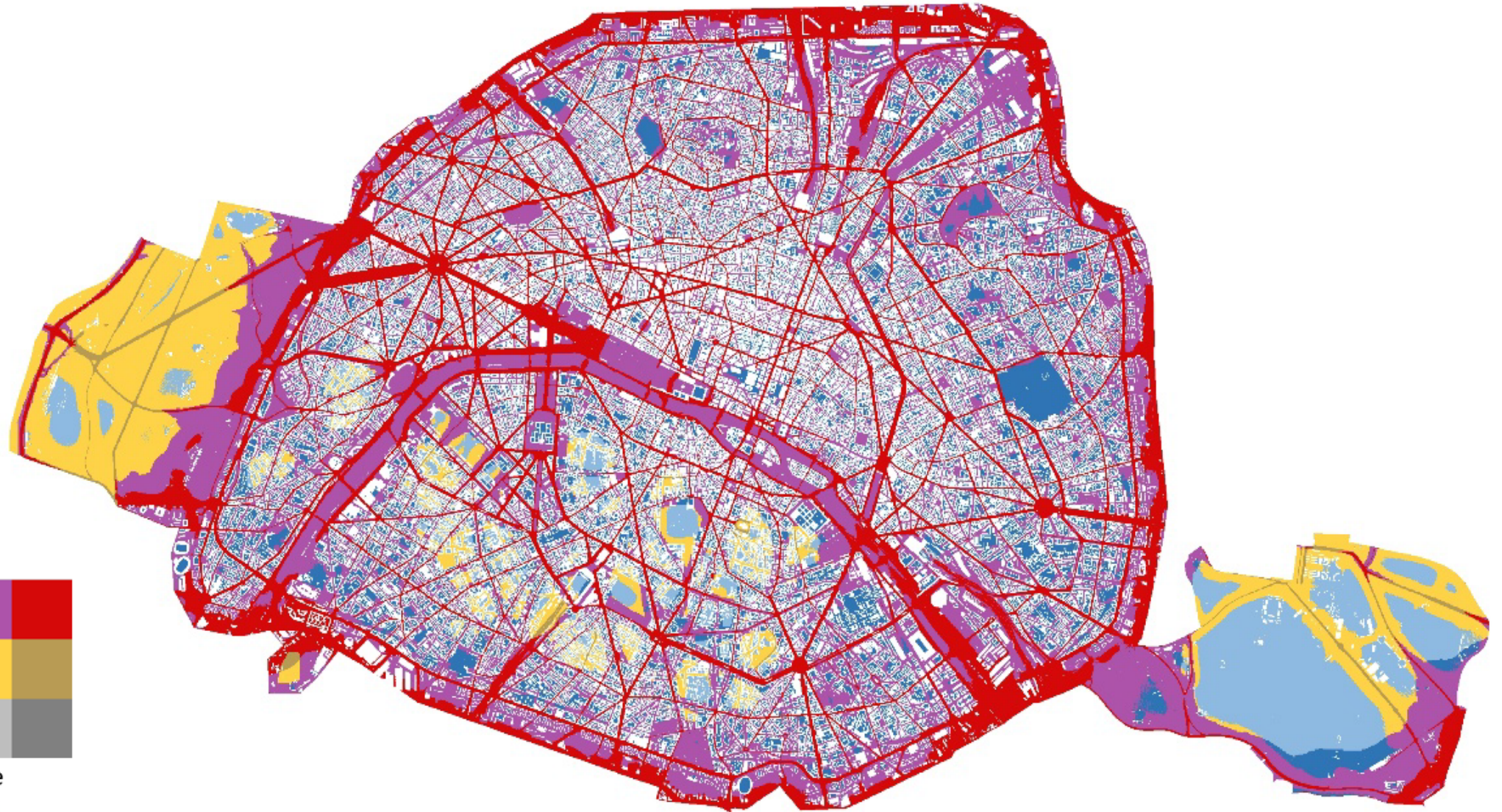


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# Map result



A  
I  
R



Noise



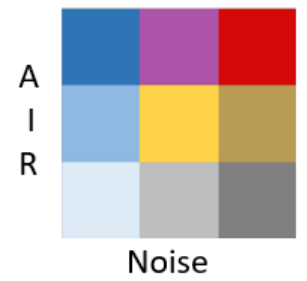
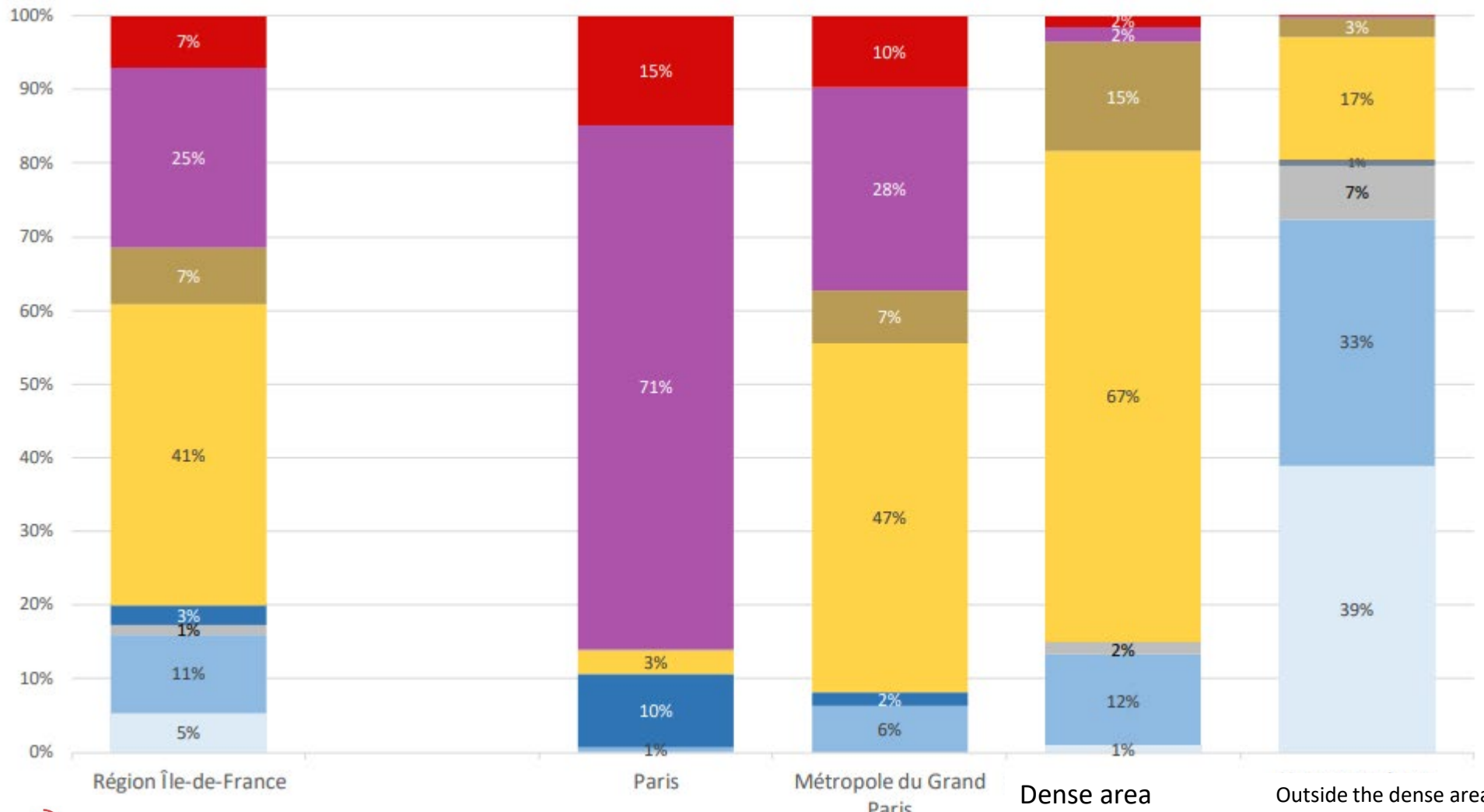
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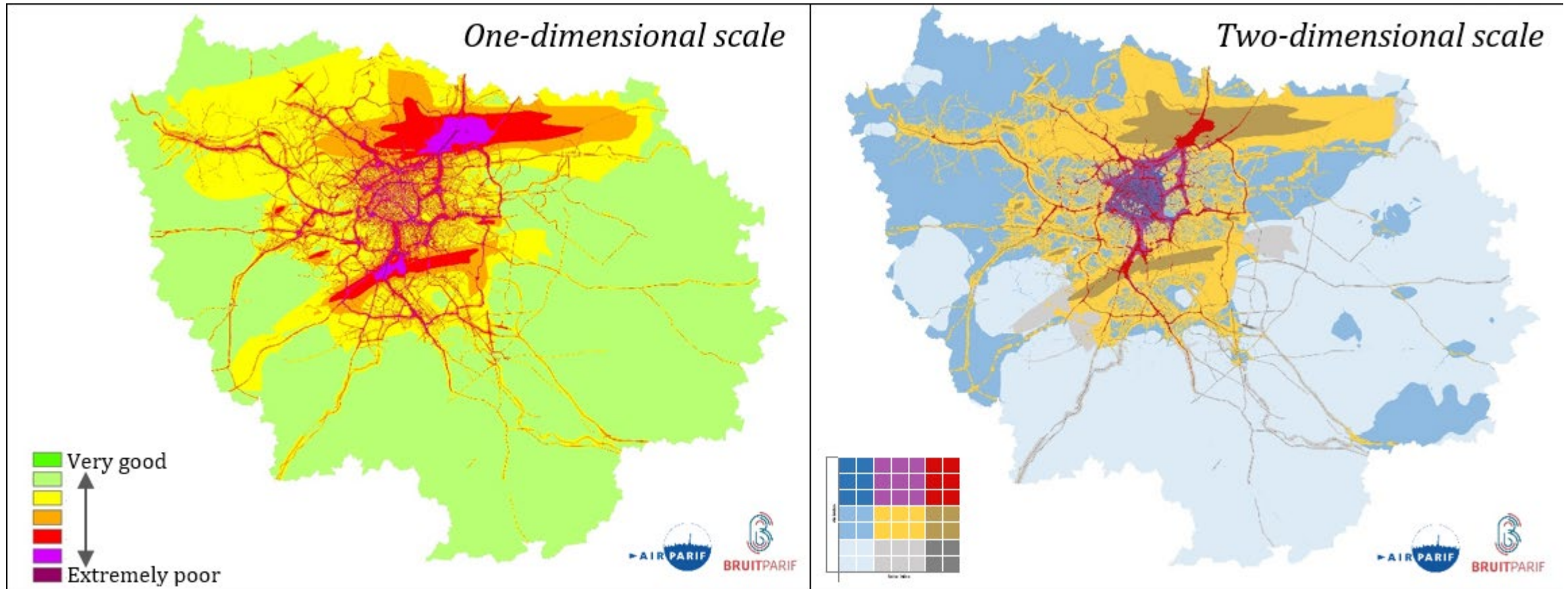
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# Distribution of the population in different territories





# The one-dimensional-scale: Compare with the method used in the Orhane observatory



The one-scale dimension calculated the average of the Air and Noise index, rounded up to the upper whole number

# Conclusion

- Mapping combining air and noise pollutions is an efficient and operational diagnostic tool for local authorities.
- The approach demonstrates its ability to make the various issues of exposure to air and noise pollutions in the region easily understandable and reachable by the cartographic platform : <https://carto.airparif.bruitparif.fr/>
- This makes it possible to identify the areas at stake:
  - Preserved areas should be protected,
  - Highly exposed areas where measures must be implemented.
- It offers a wide range of uses, like cross-referencing of air-noise data with the location of establishments receiving vulnerable groups or making comparison with socio-economic data and health indicators.