Chapter 8
The Spatial Dimension of "Pop-Up Cycle Paths" in Metropolitan Areas a Comparative Study of France and Colombia

Florent Demoraes, Nicolas Ovtracht, Kamila Tabaka, Sarah Duché, Boris Mericskay, and Camille Sieper

Abstract This chapter goes over how Covid-19 pandemic impacted in space and time on cycling infrastructure in four French cities (Grenoble, Lyon, Montpellier, and Rennes) which we have compared with Bogotá (Colombia). It shows that local authorities implemented different strategies to develop their networks during this unusual period running from 2020 to 2021. The sizeable task of researching, refining, harmonising, and comparing several sources was formalised to ensure reproducibility, and a typology drawn up to compare the five cities. Certain local authorities installed equipment mainly in central spaces, while others also extended infrastructure to the outskirts, in certain cases duplicating pre-existing cycling facilities. In some cities,

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F. Demoraes (✉) · B. Mericskay
UMR 6590 Espaces et Sociétés (ESO-Rennes), Université Rennes 2, Place du Recteur Henri Le Moal CS 24307, 35043 Rennes Cedex, France
e-mail: florent.demoraes@univ-rennes2.fr

B. Mericskay
e-mail: boris.mericskay@univ-rennes2.fr

N. Ovtracht
Laboratoire, LAET UMR 5593, CNRS, Université de Lyon, 14 Avenue Berthelot, 69007 Lyon, France
e-mail: nicolas.ovtracht@cnrs.fr

K. Tabaka · S. Duché
Laboratoire PACTE UMR 5194, Université Grenoble Alpes UGA, 14 Av. Marie Reynoard, BP 48, 38040 Grenoble Cedex 9, France
e-mail: kamila.tabaka@univ-grenoble-alpes.fr

S. Duché
e-mail: sarah.duche@univ-grenoble-alpes.fr

C. Sieper
Laboratoire LAET UMR, Camille Sieper, CNRS, Université de Lyon, 5593—3 Rue Maurice Audin, 69518 Vaulx-en-Velin Cedex, France

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such as Montpellier, Grenoble, and even more markedly Bogotá, low-income districts also benefited to a certain extent from pop-up cycling infrastructure. Concerning the extent of coverage, two years after the beginning of the pandemic, most of the pop-up cycling infrastructure in the cities under study had been dismantled, or else retained on the already dense parts of the network. In several cases pop-up tracks were used to make up for missing links in the pre-existing network. They also sometimes provided a way of improving certain connections, but given the small number of pop-up paths which became lasting facilities, they have not fundamentally expanded the scale of the networks as the pandemic recedes, nor have they made the cities significantly more cycle-friendly overall.

Keywords Covid-19 pandemic · Pop-up cycle paths · Cycling network · Tactical urbanism · Spatial approach · Reproducible method · Cartography · Metropolitan areas · France · Colombia

8.1 Introduction[1]

This chapter looks at how the Covid-19 pandemic impacted in space and time on cycling infrastructure in five study areas—Grenoble, Lyon, Montpellier and Rennes in France, and Bogota in Colombia—bringing out the many different strategies implemented by local authorities to develop their networks during this singular period. This entailed ascertaining the characteristics of the pre-pandemic cycle networks and identifying the pop-up paths deployed as of March 2020 in certain cities. This choice stemmed directly from field studies on which the authors of this chapter were working, making it possible to study the same phenomenon in cities of varying size and in two different countries.

Taking their inspiration from transitory tactical urbanism approaches (Awada et al. 2018), the deployment of pop-up paths occurred over the course of several months in 2020. There were two main objectives. In Bogotá, it was a matter of providing alternatives to public transport, whose modal share stood at 31.4% pre-pandemic, and so avoiding high concentrations of bus passengers conducive to the spread of the virus. In France, the concern was likewise to avoid contagion in public transport, and also to avoid passengers shifting massively over to cars, an environmentally harmful mode of individual transport which additionally compounds urban congestion. Our comparison brings out major differences in the scale of the cycle networks prior to the pandemic (Sect. 8.3.3), as well as in efforts by the five cities under study to deploy pop-up paths (Sects. 8.3.4 and 8.3.5). These differences indirectly illustrate divergences in the overall orientation of cycling policies implemented locally (see Chap. 3).

[1] This chapter stems from work conducted as part of Vélotactique, an 18-month programme funded by the Agence Nationale de la Recherche française and coordinated by Nathalie Ortar.

Our approach involved collecting and structuring data from different sources available in most countries and in many cities. Although certain databases are produced to well-defined specifications (such as IGN[2] data for France), others are either specific to a single city, or else issue from input by volunteer contributors (OpenStreetMap, OSM),[3] and are therefore fairly heterogenous. The datasets used in this chapter were downloaded between late 2020 and early 2021. Additional research was undertaken to trace when pop-up paths were opened, removed, or established as permanent fixtures in certain cities. To be in a position to analyse the different cities using a single interpretive framework, extensive work was conducted harmonising and comparing the various sources. We then developed a simplified nomenclature applicable to all the cities studied to enable us to compare their cycle networks.

After rapidly presenting the various study areas (Sect. 8.2), this chapter examines the main methodological challenges, the choices made, and the approach followed in putting together the simplified nomenclature (Sects. 8.3.1 and 8.3.2), enabling us to bring out the different levels of cycling equipment from one city to another (Sect. 8.3.3). The method is explained with an eye to reproducibility and in the spirit of open science.[4] Our analysis allows us to objectify and map the cycling infrastructure, be it permanent or temporary.

To place pop-up paths in their specific metropolitan context (Sect. 8.3.4), and to understand the main characteristics of the districts and territories newly connected to the network (Sect. 8.4), we have compared the siting of new infrastructure for each city using the same set of indicators (density, socio-economic level, and slope). These indicators have been mapped and are available in an online collection.[5] Lastly, taking the example of Bogotá, we study how pop-up paths have helped improved the safety of cycling routes in certain parts of the city (Sect. 8.4.3). This chapter closes on general discussion of the main findings and limitations of this study and lines of future research (Sect. 8.5).

[2] Institut Géographique National.

[3] Collaborative mapping project developed by a community of volunteers around the world.

[4] "Open science seeks to build an ecosystem in which science is more cumulative, better backed up by data, more transparent, more rapid, and more universally accessible. It induces a democratisation in access to knowledge, which is useful for research, training, the economy, and society", according to the French national plan for open science (https://www.enseignementsup-recherche.gouv.fr/fr/le-plan-national-pour-la-science-ouverte-les-resultats-de-la-recherche-scientifique-ouverts-tous-49241).

[5] https://rpubs.com/corona_lanes

Table 8.1 Population, density, surface area, and cycling modal share for commutes in the five cities under study

Cities	Lyon	Grenoble	Rennes	Montpellier	Bogotá DC/ urban perimeter
Surface area (km^2)	538	545.5	705	422	1776/636[6]
Population (in thousands)	1402	445	452	481	7744/7711
Average density (inhab./km^2)	2606	816	641	1141	4360
Central density (inhab./km^2)	10,834	8696	4321	5099	12,124 (urban perimeter)
Modal share of bikes plus e-bikes,[7] solely in the central district	8.77	17.44	10.15	7.96	8.7

Sources INSEE 2018—France, EMU-2019 and DANE 2018—Colombia

8.2 Presentation of the Five Zones Under Study

The cities differ markedly in their demographic size and surface area (Table 8.1). The perimeter of the four study zones in France refers to the administrative boundaries of the metropolitan areas. For Bogotá, we only retained the District Capital, which at the latest census in 2018 was home to over 80% of the population in the metropolitan area. Bogotá is by far the most populous of the five, with 7.7 million inhabitants, well ahead of Lyon (with 1.4 million). These are followed by Montpellier, Rennes, and Grenoble, each with fewer than 500,000 inhabitants. Differences in population size were accompanied by major gaps in density. Bogotá and Lyon are the densest, with respectively 2600 and 4360 inhabitants/km^2 on average, and over 10,000 inhabitants/km^2 in their central spaces. Lastly, the surface area of the five cities varied by a factor of four, with Bogotá the most sprawling and Montpellier the smallest. Having said that, if we look solely at the urban perimeter of Bogotá, the surface area of the five zones under study is of the same order of magnitude. Finally, the city of Grenoble emerges from this comparison as the most cycle-friendly of the five, with a cycling modal share for commutes of 17.44%.

Comparing the density of the cycling network to population size (Table 8.2) also brings out the disparities in cycling facilities from one city to another.[8] The cities of Rennes and Grenoble come top with over 10 km of cycle network per 10,000 inhabitants. Conversely, the District Capital of Bogotá has just under 1 km

[6] The District Capital of Bogotá includes different types of space: mountains, rural zones, and *páramos* (high altitude prairies). The urbanised part of the District Capital of Bogotá, for its part, covers 636 km^2, a comparable expanse to that of the four French cities analysed in this chapter.

[7] Modal share is expressed as a percentage of all commutes: here, it represents those by bike and/or e-bike solely in the central district (INSEE 2018 for France, and EMU-2019 for Bogotá).

[8] The types of equipment composing cycling networks are detailed in part 2.

Table 8.2 Comparison of length of permanent cycling paths in the five cities prior to the instalment of pop-up paths

	Length of cycling track (in km)	Length of cycling network (in km) per 10,000 inhabitants	Length of cycling network (in km) per surface unit (km^2)
Bogotá (urban perimeter)	661	0.8	0.95
Grenoble metropolitan area	485	10.9	0.89
Lyon metropolitan area	1113	5.4	1.41
Montpellier metropolitan area	449	9.3	1.06
Rennes metropolitan area	789	17.5	1.12

per 10,000 inhabitants, nevertheless making it one of the densest cycling networks in Latin America due to the markedly pro-cycling local policies implemented over the past 20 or so years (see Chap. 9).

8.3 Permanent and Temporary Cycling Infrastructure: Databases and Typology

8.3.1 Assembling Homogenous Geographical Databases About Permanent Cycling Networks: Challenges and Method

To understand the effects of the Covid-19 pandemic on rapid changes to cycling infrastructure in the five cities,[9] and to bring out the various strategies employed by local authorities, it was first essential to ascertain the characteristics of the pre-pandemic cycling infrastructure and to identify the temporary or pop-up paths deployed as of March 2020.[10] We therefore collected, structured, and harmonised

[9] It should be pointed out that in France, as of April 2020, CEREMA (Centre d'Etudes et d'expertise sur les Risques, l'Environnement, la Mobilité et l'Aménagement) published a handbook called "Aménagements cyclables provisoires: tester pour aménager durablement" for local and mobility authorities ahead of the planned lifting of lockdown in May 2020: https://www.cerema.fr/fr/actualites/velo-deconfinement-guide-express-amenagements-cyclables.

[10] Temporary cycling infrastructure put in place as a matter of urgency to reorganise travelling due to the introduction of social distancing measures (lockdown and the lifting of lockdown in spring 2020).

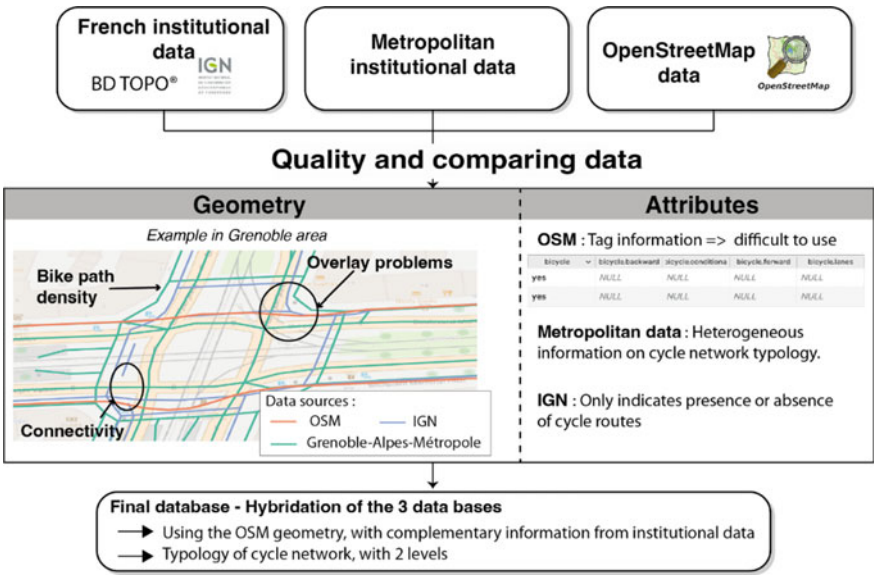


Fig. 8.1 Data sources and main problems encountered in using geographic databases about cycle networks

various data sources. We here go over the considerations presiding over this undertaking, present the main data sources used, and discuss the main methodological challenges they posed.

In both France and Colombia there are spatial databases modelling and describing cycling infrastructure (tracks, lanes, crossings, etc.) and cycling-related equipment (stands, secure bike-parking, inflators, etc.). This data is produced either by public authorities of varying powers and scale, or by participative mapping projects such as OpenStreetMap (OSM). There are however no ready-to-use datasets for comparing cycling infrastructure from one town to another, for they are heterogenous in terms of their modelling, spatial extent, and year produced. Their attributes also differ. For our study, we pooled three sources of spatial data (cf. Fig. 8.1)[11]: OSM data, data produced by local authorities' services, and, for France, that contained in the IGN's BD Topo.[12] The first stage consisted in examining and comparing the content of these various data sources for each city to identify their advantages and drawbacks. This stage brought several difficulties to light.

First, it transpired that the cycle path network contained in the IGN's BD Topo (version 2.x, year 2018) is incomplete and offers only succinct descriptions of cycling infrastructure. Second, the bases produced by cities are not always up-to-date, and,

[11] The data used for this work was downloaded between late 2020 and early 2021; most of it dates from 2018 to 2020.

[12] The BD Topo is a vectorial database describing French territory in 3D (features of the territory and infrastructure). For further information: https://geoservices.ign.fr/bdtopo.

especially, the attributes used to describe the networks differ from one city to the next. Data put together by OSM contributors offers the fullest picture of the cycling network and has the advantage of being available for a very large number of countries. However, the tag system used to describe geographical objects provides different levels of completeness depending on the contributor. Consequently, for any given city the description of segments is very heterogenous, making it hard to use for comparing one city to the next.

The three data sources present problems relating to geometry and spatial accuracy. Overlaying the three datasets shows that spatial objects are not aligned (cf. Fig. 8.1: the lines showing the road network and cycling infrastructure from different databases are not traced in the same way and do not exactly overlay), making it difficult to use them conjointly. Lastly, cycle networks are very often fragmented and tend not to be topologically connected to the road network, making it impossible to calculate cycle itineraries, an aspect not developed here.

Given this heterogeneity in the spatial data sources, and to make the most of their complementarity, we decided to hybridise the bases to construct a single more coherent dataset better suited to our needs. For the four French cities we thus decided to use the geometric component from the OSM databases, which is topologically correct. We then directly obtained the roads and cycle networks for the four French cities. The attributes of these networks were supplemented using information from the IGN's BD or from the databases put together by city services. For Bogotá, we used the municipality's road database which includes cycling infrastructure.

Furthermore, we chose to incorporate information about the positioning and characteristics of pop-up paths for the five cities, obtained either directly from city authorities or from press articles and blogs. As far as possible, this information was then checked on the ground by our team or via immersive views on Google Street View and Mapillary.

Using these harmonised and consolidated databases, we put together a nomenclature or common typology for all cycling infrastructure in order to compare the networks from one city to the next using identical criteria. Three typologies, ranging from the most aggregated to the least aggregated, are thus proposed for each city.

8.3.2 Building a Common Typology for Cycling Infrastructure

The first stage was to directly compare existing typologies for France and check if they were directly usable for our study which included a city in Colombia. In France, there are two coexisting national typologies (Table 8.3). The first is the CEREMA[13] typology, a relatively simple classification based on the proximity of cycling infrastructure to road traffic. This typology is valid not just for France, corresponding to

[13] CEREMA—*fr.* Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement, a French public institution depending on the Ministry of Territory Cohesion.

work conducted internationally (Houde et al. 2018, Hull and O'Holleran 2014). A second typology has been drawn up by the French inter-ministerial directorate for digital issues (DINUM)[14] as part of the National Database for Cycling Infrastructure (BNAC).[15] This classification of infrastructure provided in public datasets stems from consultation between transport.data.gouv, the national platform for public data on transport, and an association, "Vélo & territoires".[16] There is also the cycling infrastructure nomenclature developed by each of the French study areas. While these local nomenclatures have many elements in common, they display particularities in the way networks are described.

In early 2021, the BNAC typology, which was being assembled at the time, presented certain limitations concerning its exhaustiveness and categorisation of cycling infrastructure (Ovtracht et al. 2021). To attain an intermediary level typology between levels 1 (CEREMA) and 2 (BNAC) which would be comparable from one city to the next, the descriptions of the cycling infrastructure contained in the city and OSM databases were combined then recoded. This enabled us to develop a simplified level 2 typology. For reasons of map readability and to conduct a comparison with Bogotá, this chapter presents the findings obtained using level 1 (CEREMA) typology, which we applied to all five cities.

8.3.3 Maps of Permanent Cycling Infrastructure by Type

This work consolidating and hybridising the databases was followed by classifying the infrastructure using typology level 1 (CEREMA). We here provide a series of maps of cycling networks for the five cities, in both static (Map 8.1) and interactive modes (Map 8.2). The latter complement the former as they enable readers to zoom in on certain sectors, click to obtain details about the infrastructure, and so ultimately explore each study zone in greater detail, including with photos. The interactive maps were devised using uMap, an open-source online service based on OSM architecture.[17] The scales used on Map 8.1 allow readers to view the entire cycle networks and their positioning in urban space.

[14] DINUM—*fr.* Direction Interministérielle du Numérique.

[15] BNAC—*fr.* Base Nationale des Aménagements Cyclables.

[16] Vélo & Territoires, founded in 1999, is a network of 160 local authorities working collegiately to "construct France by bike by 2030" (https://www.velo-territoires.org/lassociation/presentation/#).

[17] https://umap.openstreetmap.fr

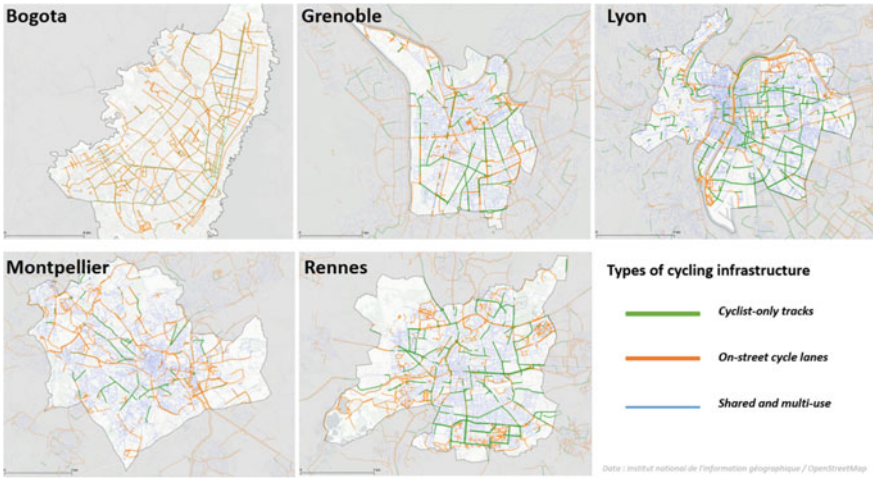
Table 8.3 Three types of cycling infrastructure in France with examples from the city of Rennes

Illustrations (*photos taken in Rennes*)	Level 1 (CEREMA)	Level 2 (simplified)	Level 2 (BNAC)
	1—Cyclist-only tracks	Cycle track	Walking and cycling path
			Mixed pedestrian/bike infrastructure (other than walking and cycling paths)
			Cycle track
			Two-way cycle track
	2—On-street cycle lanes	Cycle lane	Cycle lane
			Surfaced shoulder Road with shared central lane
			Two-way cycle lanes
	3—Shared and multi-use on-street cycle lanes	Bus + bike corridor	Bus + bike corridor
		Active mobility path	Other
		Two-way cycle lanes	
		Pedestrian area	

Photo credits Nicolas Bourgeais[18]

Map 8.1 shows the diversity in the overall distribution of permanent cycling tracks in the five cities, the infrastructure having been progressively installed on the edges of the cities at varying distance from their centres. The permanent cycling networks are composed primarily of cycle tracks, whose proportion ranges from 51% of the total network in Lyon to 86% in Bogotá and Montpellier (Graph 8.1). This is followed by cycle lanes, which represent only 5% of the network in Bogotá and 30% in Lyon.

[18] It will be noted that these types of infrastructure offer very different degrees of comfort and perceived safety. Type 2 and 3 infrastructures imply bikes sharing with motorised transport.

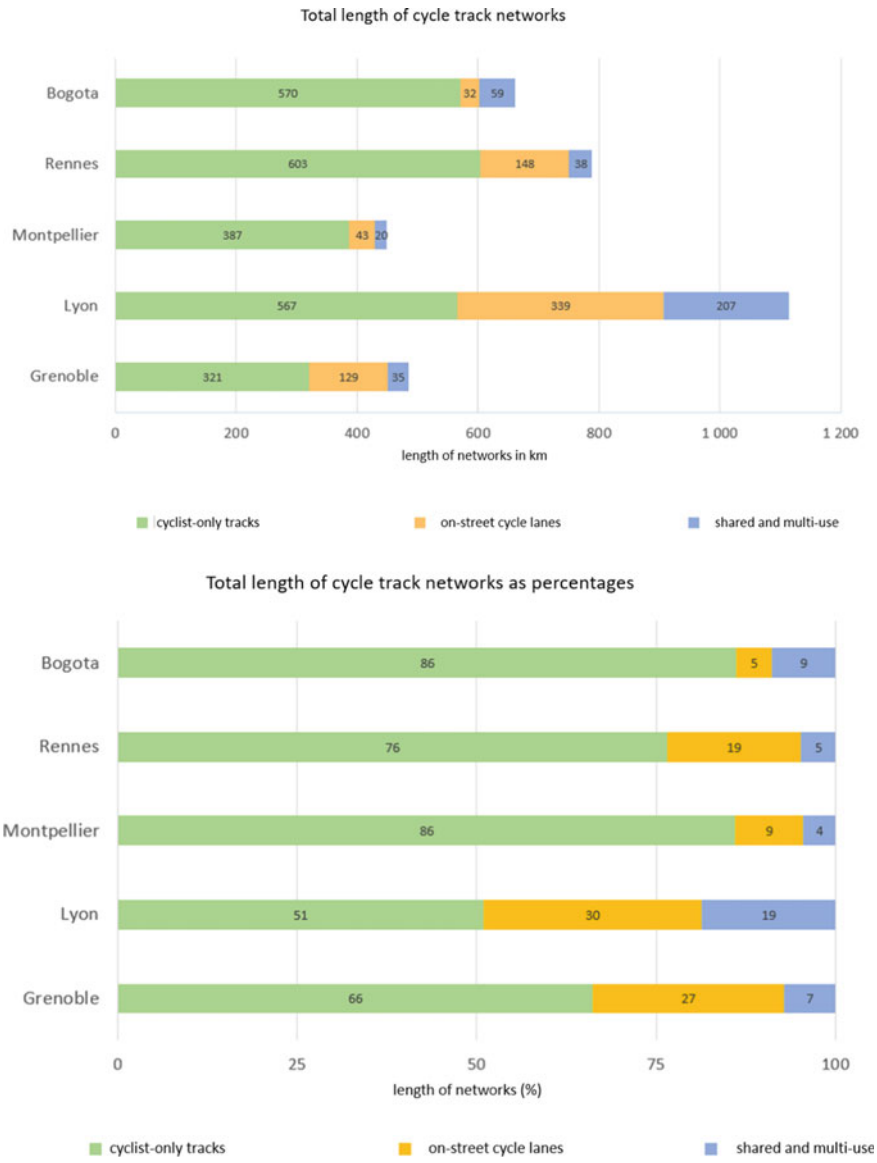


Map 8.1 Positioning of cycle networks in the five cities using "level I" typology (CEREMA)

Shared and multi-use lanes are found mainly in Lyon (where they account for 19% of the total) (Map 8.2).

8.3.4 The Siting and Scale of Temporary Cycling Networks

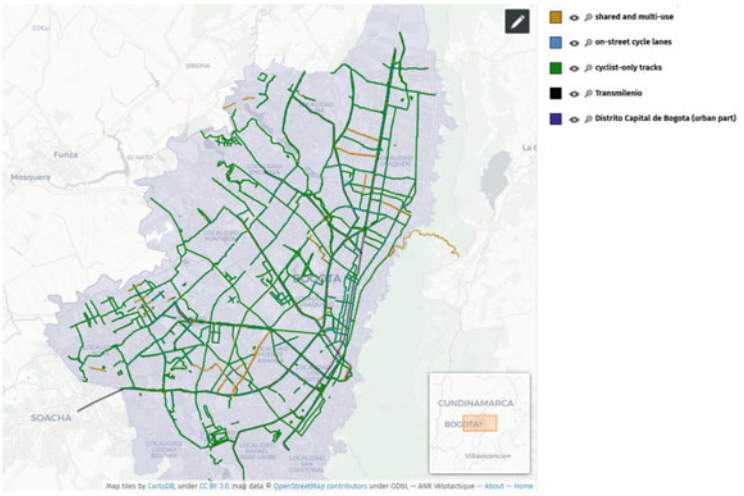
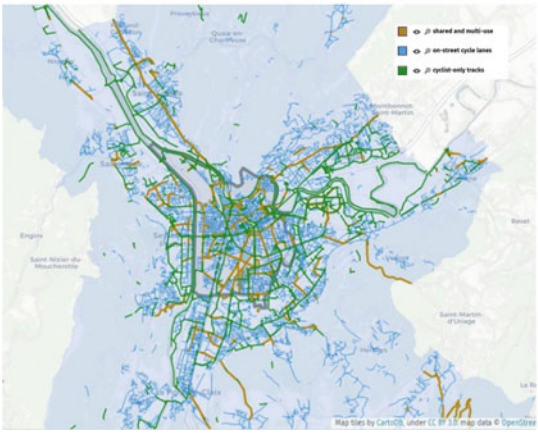
Looking now at the siting of pop-up tracks in the metropolitan spaces, they clearly differ from one city to the next (Map 8.3), once again revealing divergences in the policies adopted. The circle visible on the maps indicates the same distance from the city centre, to compare scales and the extent of the network. While the deployment of temporary tracks in Grenoble and Montpellier mainly concerned the central district where there was already much cycling infrastructure, in Lyon, in addition to being installed in the centre, temporary tracks were also introduced in the north-west and to a lesser extent in the east of the city, which had less cycling infrastructure. In Lyon we may thus note a political choice during the pandemic which helped at least partially rebalance discrepancies in equipment levels. In Rennes, the pop-up infrastructure was installed in the very centre of the city, and also around the edge of the central district along thoroughfares linking it to the intermediate and outer suburbs, and in the centres of peri-urban settlements, thus improving links across the territory. In Bogotá, the temporary tracks ran across the town along the main thoroughfares linking the southern and western outskirts to the space where jobs are concentrated, running northwards from *La Candelaria.* As explained in Chap. 9, the temporary tracks were initially devised for commutes by low-income workers along the main thoroughfares and corridors of the *Transmilenio*, Bogotá's BRT (Bus Rapid



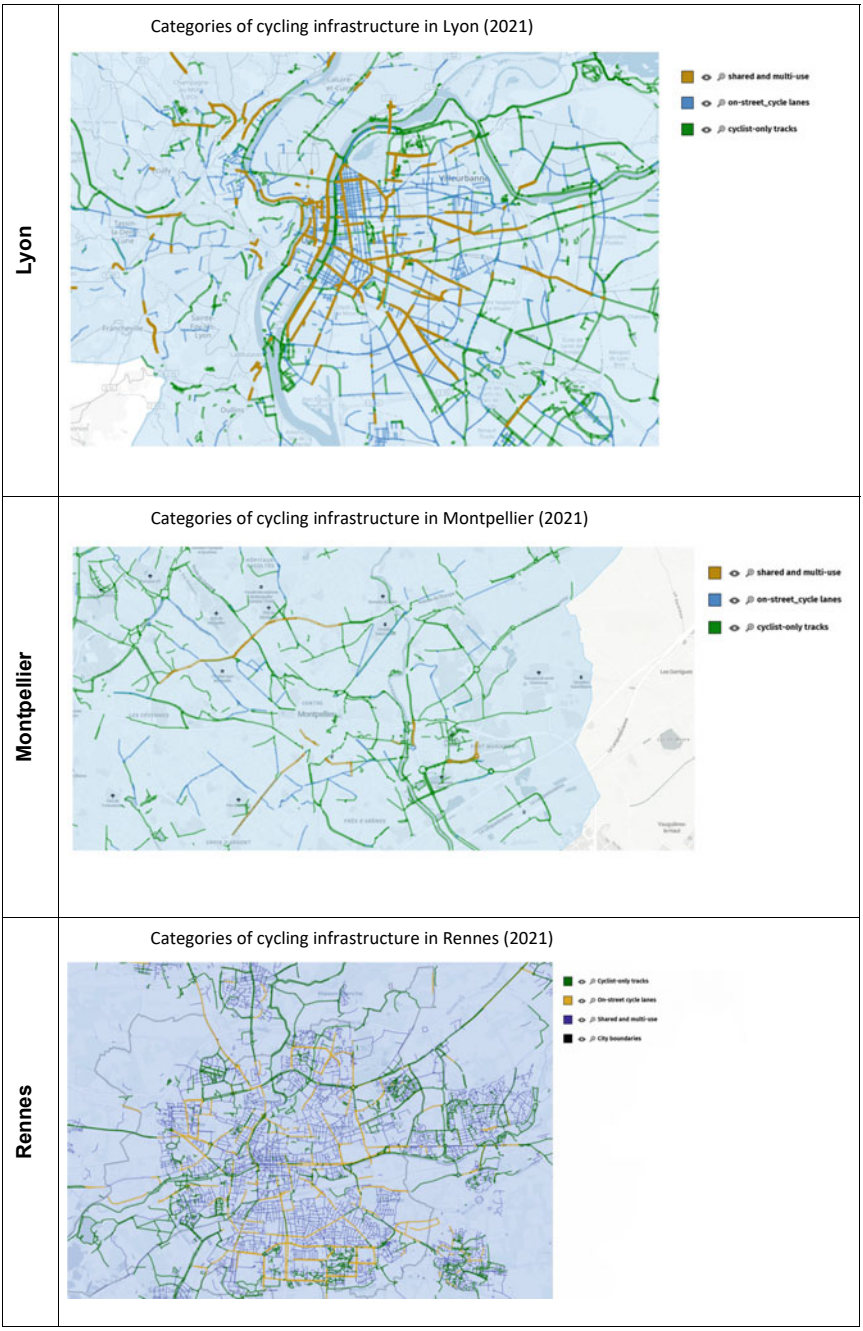
Graph 8.1 Lengths of cycle networks in the five study areas. *Sources* Data from OSM, IGN and local authorities. Data were aggregated by the authors using the "level I" of the 2020-CEREMA-categorisation.[19]

Transit system). More locally, they acted as "links" for previously missing cycling connections.

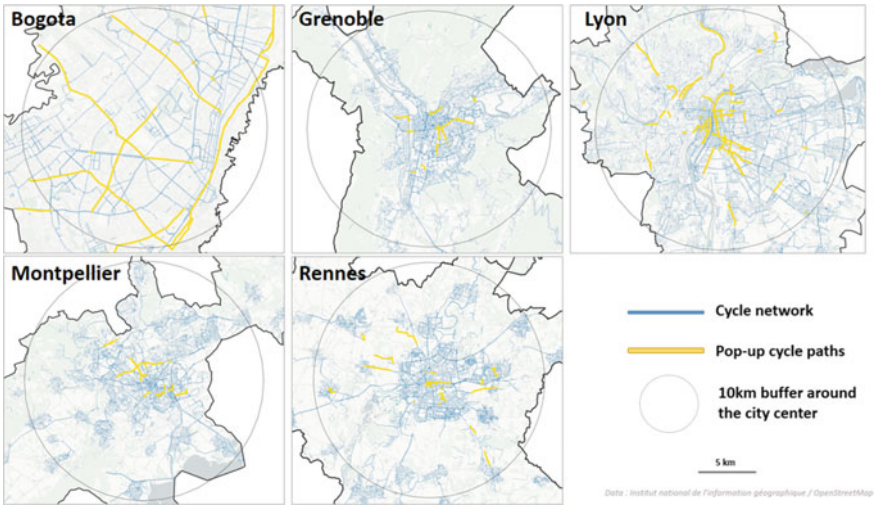
[19] https://www.cerema.fr/fr/actualites/velo-deconfinement-guide-express-amenagements-cyclables

	Pictures below refer to an on-line maps collection, hosted on uMap server.
Bogotá	Categories of cycling infrastructure in Bogotá (2020) 
Grenoble	Categories of cycling infrastructure in Grenoble (2021)  *To display typology of cycling network on interactive map, please activate the corresponding layers in the table of content, on the left and zoom out*

Map 8.2 Interactive maps of the cycling networks in the five study areas using "level I" typology (CEREMA).
Categories of cycling infrastructure in Bogotá (2020) - https://umap.openstreetmap.fr/en/map/categories-damenagements-cyclables-a-bogota-2020-c_649719#12/4.6666/-74.0985;
Categories of cycling infrastructure in Grenoble (2021) - https://umap.openstreetmap.fr/fr/map/reseau-cyclable-permanent-et-transitoire-grenoble_656508#14/45.1766/5.7434;
Categories of cycling infrastructure in Lyon (2021) - http://umap.openstreetmap.fr/fr/map/lyon-reseau-cyclable_779573#13/45.7589/4.8707;
Categories of cycling infrastructure in Montpellier (2021) - http://umap.openstreetmap.fr/fr/map/montpellier-reseau-cyclable-permanent-et-transitoi_766514;
Categories of cycling infrastructure in Rennes (2021) - https://umap.openstreetmap.fr/en/map/velotactiquerennes_817119#13/48.1144/-1.6529



Map 8.2 (continued)



Map 8.3 Cycle network in the five cities under study with the pop-up tracks present in late 2020

Among the zones under study, Bogotá and Lyon are the two cities where the temporary cycling networks were most extensive,[20] reaching 12.7% and 6.6% respectively of their permanent cycling networks (Table 8.4). This indicates the public authorities' strong commitment to providing additional safe itineraries for city dwellers to enable them to travel by bike during the pandemic (see Chaps. 3 and 9).

Several types of pop-up infrastructure were installed (Fig. 8.2). In France, some pop-up tracks were indicated by yellow ground markings, either just for bikes or else combined with bus lanes, and/or signalled by signage. In places where cycle routes were already present, the provisional infrastructure either resulted in the route changing category (e.g. going from a lane to a track), or in duplicated infrastructure (a lane running alongside a pre-existing track). In Bogotá, most of the temporary tracks were initially indicated on the road using traffic cones, and subsequently by installing movable modular barriers, sometimes in concrete but more often in plastic. Nevertheless, contrary to the situation in France, road markings were not extensively used. The theft of modular separators or their removal by city services has resulted in the temporary roads becoming "invisible".

[20] The maximum length in kilometres of the temporary cycling network at the height of the pandemic.

Table 8.4 Length of the temporary cycling networks at their greatest extent in comparison to the extent of the permanent network pre-pandemic, in the five cities

	Length of temporary cycling networks at their greatest extent (in km)	Proportion (as a %) of temporary cycling networks at their greatest extent in comparison to the extent of the permanent network prior to the pandemic (This percentage is obtained by dividing the length of all the pop-up tracks based on their greatest extent at the height of the pandemic, by the total length of the pre-pandemic cycling network in late 2019 or early 2020.)
Bogotá (perimeter)	84	12.7
Grenoble metropolitan area	14	2.9
Lyon metropolitan area	74	6.6
Montpellier metropolitan area	18	4.0
Rennes metropolitan area	24	3.0

8.3.5 Pop-Up Tracks in Space and Over Time: Opening, Closing, and Transformation into Permanent Fixtures

Going over the chronology of the introduction of pop-up tracks in space and time brings out the local authorities' different levels of commitment and responsiveness to providing city dwellers with alternatives for travelling by bike and reducing the risk of contagion. Piecing this together was a difficult task, for while the databases used contain information on the existence of temporary infrastructure, the dates when they were installed is not known, nor the length of time they remained in place or when they were dismantled (where applicable). Local services, working with reduced staff levels for months on end, and often remotely, tended not to systematically record the various stages in this process, the archives for which are therefore incomplete. In certain cases, infrastructure which had been in the pipeline for a long while was also completed over the same period. Furthermore, given the type of light movable infrastructure used to signal the pop-up tracks, the latter were easy to dismantle and rearrange, and so underwent many alterations in time and space. Extensive investigation of official websites backed up by field observations and interviews with institutional stakeholders was thus undertaken.[21] While pop-up infrastructure in Bogotá

[21] In Bogotá, in July 2021, we contacted Lina Marcela Quiñones Sanchez and Maryury Alzate Betancur from the *Dirección de Inteligencia para la Movilidad* at the *Secretaría Distrital de Movilidad*, enabling us to obtain plans of the pop-up tracks at various dates. In Grenoble, we contacted the Syndicat Mixte des Mobilités de l'Aire Grenobloise and managed to obtain the cycling network database. Additionally, an intern conducted an interview with a technician from this organisation, and on several occasions went round the town to see if the pop-up tracks still existed.

	New pop-up cycling infrastructures	
Additional road marking: bus and bike		**Lyon** Metropolitan Area
Road marking for bike		**Montpellier** Metropolitan Area
Indicated as new pop-up cycling, with a special road sign		**Montpellier** Metropolitan Area
New pop-up cycling, with a classical road sign		**Lyon** Metropolitan Area
Existing facilities, reinforced with yellow road marking		**Lyon** Metropolitan Area
Preexisting cycling facility, with additional crossing-road facilities		**Grenoble** Metropolitan Area
Installation of a modular separator		**Bogotá DC**

Fig. 8.2 Illustration of the different types of pop-up infrastructure installed in the five cities. *Credits* Adrien Poisson (a, b, c), Nathalie Ortar (e, f), Mathieu Muccardi (g), Maëlle Lucas (h)

was decided within just a few days after the beginning of the first lockdown in mid-March 2020, the other cities under study took longer to install equipment, between a few weeks and a few months. Here we look solely at the cases of Bogotá[22] and Grenoble, once again using interactive maps (Fig. 8.3). These maps may be used to navigate and explore temporary cycling infrastructure and to display descriptions and photos of the equipment. One may see that certain segments were retained after the initial months of experimentation, while others were removed after varying lengths of time.

In Bogotá, the network of temporary tracks stabilised at 84 km, before decreasing as of August 2020. Part of the network was progressively established as a permanent fixture, such as that along *Séptima* Avenue (Photo 8.1), but most of it was dismantled (Robert et al. 2022). In May 2022, the Bogotá authorities announced there were still 18 km of temporary tracks, corresponding to a 2.7% increase in the cycle network in comparison to pre-pandemic.

In Grenoble, while some provisional routes (locally called "tempo vélo") were dismantled fairly soon—such as that along the banks of the Isère or that running from Saint-Martin d'Hères to the east—other pop-up infrastructure was left in place for longer, largely running alongside pre-existing cycling facilities, such as along the tramway towards La Villeneuve to the south. These were placed on the road, the public authorities' objective being to diminish the room taken up by cars, and, in certain cases, to leave more room for pedestrians. In spring 2021, one year after the first lockdown, there were still 16.2 km of temporary tracks in Grenoble, corresponding to a 3.3% increase in the cycle network on pre-pandemic levels. These remaining temporary tracks were later delineated as permanent fixtures with white-colour markings over the yellow (temporary) ones.

The opening and closing of these pop-up tracks in unprecedented and experimental circumstances in Bogotá and Grenoble, as in most cities, brought out the multifaceted and conflicting demands of cycling advocates, motorists, and public stakeholders (see Chaps. 3 and 9).

8.4 Placing Temporary Cycling Infrastructure in City Contexts

The purpose of this part is to analyse the siting of temporary cycling infrastructure in the light of characteristics of the newly connected districts, using a single set of indicators: density, socio-economic level,[23] and slope. These simple and widely available indicators for the five cities provide a way of examining the deployment of

[22] Drawing on work conducted by Maëlle Lucas in 2021 for her doctoral thesis (UMR ESO—Université Rennes 2)—https://perso.univ-rennes2.fr/maelle.lucas.

[23] For the four French cities, the indicator used was the number of households deemed poor in 2015 given their income tax as measured by the French tax authorities (the DGFiP) and published by the French statistics Institute (INSEE) (https://www.insee.fr/fr/statistiques/4176281). For Bogotá,

	Pictures below refer to on-line maps hosted on uMap server.
Bogotá	Use of temporary cycling infrastructure in Bogotá (2020-2021)  *Comment for the displayed picture: The temporary track along Avenue 68, which was entirely disassembled during the Paro (nationwide demonstrations in April-May 2021), was used very extensively during rush hour. There were frequent thefts of cones and modular separators, meaning there was no separation from cars along several hundred metres. It was also frequently used by motorbikes.*
Grenoble	Use of temporary cycling infrastructure in Grenoble (2020-2021)  *Comment for the displayed picture: Avenue Gabriel Péri is a major thoroughfare to the Grenoble campus in Saint Martin d'Hères. It is thus used by many students. The pop-up infrastructure along this avenue (a cycle lane in places, and bus + cycle corridor in others) was removed, probably because of traffic jams. The cycling network was thus returned to its initial state, that is, one-way cycle tracks along the pavement on either side of the avenue.*

Fig. 8.3 Interactive maps of pop-up tracks in Bogotá and Grenoble with access to a photo bank and description of infrastructure.
Use of temporary cycling infrastructure in Bogotá (2020–2021) - https://umap.openstreetmap.fr/fr/map/usages-des-amenagements-cyclables-temporaires-a-bo_667850#12/4.6474/-74.0424;
Use of temporary cycling infrastructure in Grenoble (2020–2021) - https://umap.openstreetmap.fr/fr/map/reseau-cyclable-permanent-et-transitoire-grenoble_656508#14/45.1766/5.7434

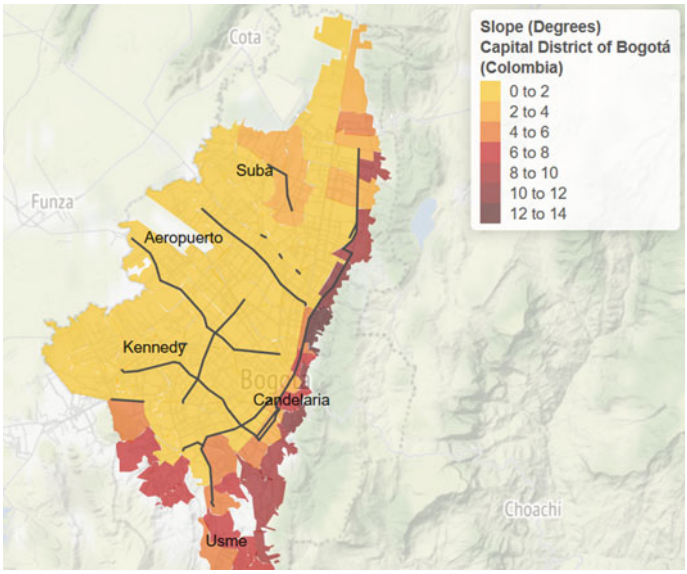
Photo 8.1 Avenue *Séptima* in Bogotá along which a pop-up track has been established as a lasting fixture. *Photo credit* Florent Demoraes

pop-up infrastructure in the light of criteria relating to socio-spatial fairness (Firth et al. 2021; Dill and Haggerty 2009; Houde et al. 2018), even though further study is of course needed on who actually uses this infrastructure to hone the analysis, a limitation of which we are well aware. The indicators have been mapped and may be consulted in an online collection whose web links are indicated in Table 8.5. We then examine the role these pop-up tracks played in making certain cycling routes safer, looking at the example of Bogotá.

Table 8.5 Location of pop-up tracks in the light of the cities' topographical and socio-demographic characteristics

Click on a link to access full-size interactive map hosted on RPubs website			
	Population density	Socio-economic level	Slope
Bogotá	https://bit.ly/3Pwbvh1	https://bit.ly/3VW98X5	https://bit.ly/3FNL0jS
Grenoble	https://bit.ly/3FOfVfS	https://bit.ly/3ByGMu2	https://bit.ly/3UQKzJT
Lyon	https://bit.ly/3j0APj6	https://bit.ly/3WcseZ0	https://bit.ly/3PpJPu3
Montpellier	https://bit.ly/3HygGeh	https://bit.ly/3hi9NmV	https://bit.ly/3WhvIsX
Rennes	https://bit.ly/3WbmwXa	https://bit.ly/3HzZaXm	https://bit.ly/3HyHMlQ

we used the Household Social Condition indicator (Demoraes et al. 2020) calculated using 2018 individual census data (DANE). Only the two poorest classes are represented.



Map 8.4 Location of pop-up tracks and relief in Bogotá[25]

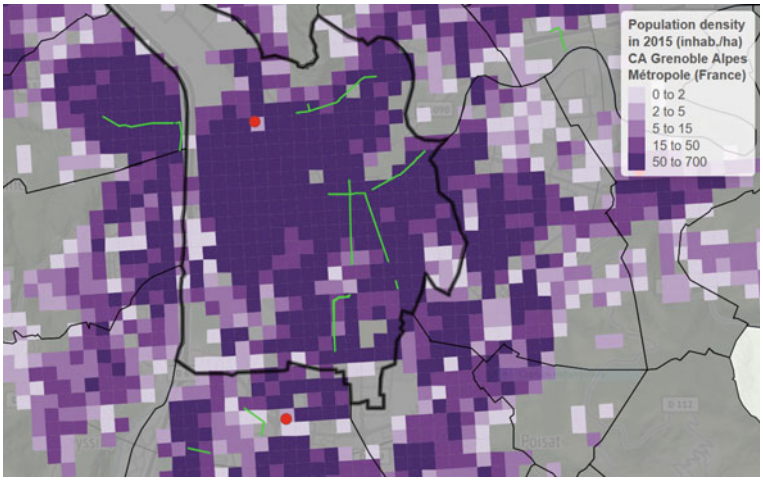
8.4.1 Different Topographical Constraints from One City to the Next

Morphological constraints (climbs, slopes) are of varying significance in the five cities. They are very present in Grenoble and Lyon, and on the southern and eastern edges of Bogotá. These constraints to cycling may broadly explain the lesser extent of permanent cycling tracks in these three cities' most hilly sectors.[24] Adding new temporary segments did not significantly alter the situation, except in Bogotá (Map 8.4) where a cycle route was installed to the south of the town towards the *Usme* district, where the topography tends to become hillier once one leaves the main thoroughfare (cf. Map 8.4). The pop-up track running north–south to the east of the city at the foot of the mountain chain (*Avenida Séptima*) lies beneath the hilly districts and does not have any significant incline.

In Lyon, temporary cycling infrastructure in the north-west of the city was installed in a hilly zone, especially the Monts d'Or.

[24] Generally, cycling infrastructure is found in flat sectors, even though some segments are an exception and may have steep inclines, such as La Croix Rousse in Lyon. This distribution is due to the characteristics of the sites, the cities under study having been built primarily on flat or nearly flat land.

[25] An interactive version of this map may be consulted at: https://rpubs.com/corona_lanes/Bogota_slope.



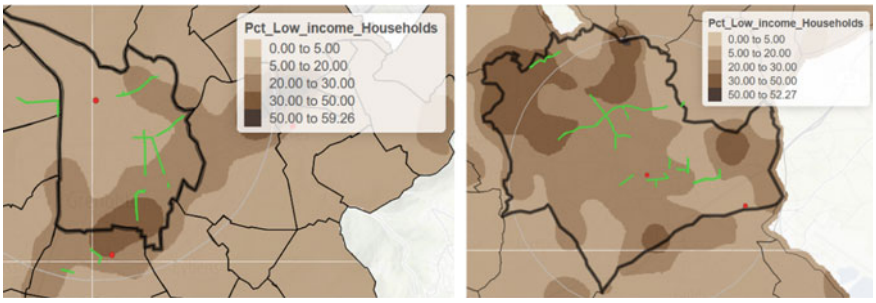
Map 8.5 Location of pop-up tracks and population density in Grenoble[26]

8.4.2 Density and Socio-economic Level: Who Benefited from the Pop-Up Tracks?

Due to their siting (Sect. 8.3.4), the pop-up tracks made it possible to connect districts with different profiles, with varying population densities depending on the city under consideration. In Grenoble, where the permanent cycling network links up the most densely populated parts of the city, the installing of pop-up tracks enhanced the bike accessibility of these same places (Map 8.5) since cycling infrastructure along certain thoroughfares was duplicated to take more cyclists by reducing the room available for cars. Having said that there was not much temporary infrastructure (Sect. 8.3.4), partly because of the existence of a dense network prior to the pandemic (Map 8.2). In parallel to this, such infrastructure was not installed in less dense outlying communes (Map 8.5).

Despite differences in surface area, the same principle in deploying pop-up tracks may be observed in the densely populated central district of Montpellier. In Rennes, pop-up tracks were deployed in dense central spaces, and temporary tracks were installed along thoroughfares leading in and out of the city through sparsely populated spaces, acting as connections for the more densely populated settlement centres in the intermediate and outer suburbs. In Lyon, there was a "median" deployment: in addition to being concentrated in the dense centre, pop-up tracks were laid out in such a way as to connect the city of Lyon with its intermediate and outer suburbs. They were also installed between less densely populated peri-urban districts. In Bogotá,

[26] An interactive version of this map may be consulted at: https://rpubs.com/corona_lanes/Grenoble_density_X1.



Map 8.6 Location of pop-up tracks and percentage of poor households in Grenoble (left) and Montpellier (right)[30]

as we have seen, the temporary tracks connected densely populated peripheries to the west and south with the central space where most jobs are.

Looking now at the socio-economic level of the newly connected districts, the situation differs once again from one city to the next.[27] In Grenoble and Montpellier (Map 8.6),[28] some provisional cycling routes connected the city centres to specific outlying deprived districts called "banlieue", a situation not found as clearly in the other two French cities. Nevertheless, it should be noted that the cycling equipment existing prior to the pandemic (Map 8.2) partly determined the opening of pop-up tracks in the least connected districts. In Rennes, for example, Le Blosne and Villejean, two priority districts under national town policy where a high proportion of low-income households live,[29] already had good permanent cycling infrastructure and did not receive any additional equipment.

In Bogotá, the poorest households are primarily found in the south and south-west of the city. Before the pandemic, the hilly south had very few cycle tracks. The creation of a pop-up track to *Usme* thus plugged a gap, but only temporarily (from April 2022 to May 2021), and only partially for this track did not run very far south. The creation of pop-up tracks in the south-west and west provided low-income inhabitants in these outskirts with cycling routes to the centre over the same period.[31]

These observations also need to be compared with the profile of cyclists in the five cities. While in France (as in most European countries) cyclists often tend to be workers from the middle and upper classes (Tallet 2017; NTS UK), in Bogotá

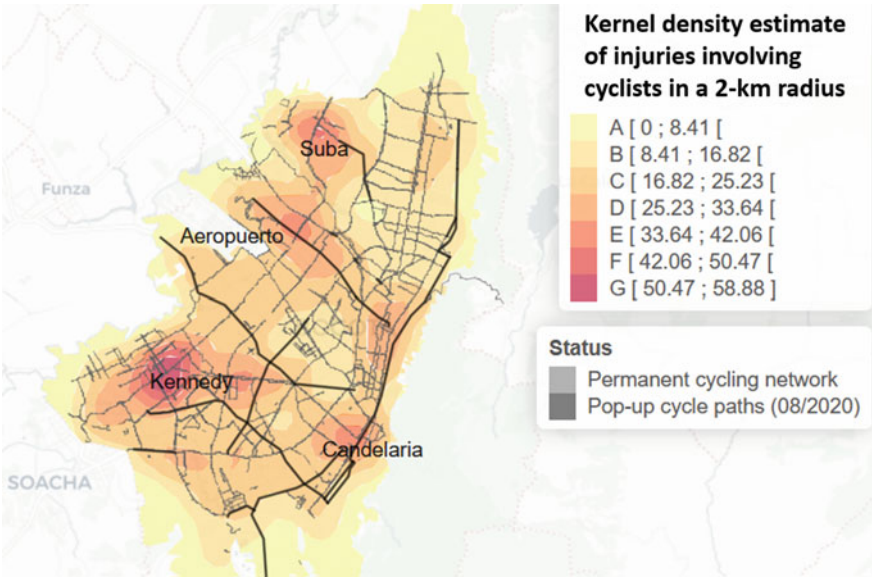
[27] Obviously, social divisions in space are not as strong in the four French study areas as compared to Bogotá.

[28] These concentration maps were obtained by spatial smoothing using the kernel method (Silverman 1986). It provides a way of generalising information, in these cases the home location of low-income household in the city.

[29] Policies for the urban renewal and regeneration of low-income districts.

[30] Interactive versions of these map may be consulted at: https://rpubs.com/corona_lanes/Grenoble_mod_pop_X1_Smooth and https://rpubs.com/corona_lanes/Montp_mod_pop_X1_Smooth.

[31] The "paro nacional" was a period of intense social protest across Colombia running from April to May 2021, leading to the dismantling of certain segments of the temporary network (see this chapter), particularly along *Avenida Calle 17* to the west.



Map 8.7 Temporary cycling network (August 2020) and cycling crashes (2015–2019) in the District Capital of Bogotá[33]

cyclists are rather low-income men (Lucas 2021), mostly in jobs for which remote work is not possible, thus making it all the more essential that they travel despite lockdown and pared back public transport services (with less frequent services and reduced passenger capacity).

8.4.3 Pop-Up Tracks and Cycling Crashes: The Example of Bogotá

In this final section we look at how, in certain cases, pop-up tracks helped improve safety on cycling routes. We look at the example of Bogotá which has a rich database including date and place of crashes together with the profile of those involved (pedestrians, cyclists, bikers, motorists, etc.). This database records 12,780 crashes involving cyclists, including 394 deaths between 2015 and 2019, that is, before the pandemic. Map 8.7 shows the five main sectors with a concentration of crashes involving cyclists[32]: Kennedy, Suba, east of the airport, near the historic centre in *La Candelaria*, and to its north.

[32] This concentration map was also obtained by spatial smoothing.

[33] An interactive version of this map is available at: https://rpubs.com/corona_lanes/Bogota_Cyclist_Accidents.

Overlaying the location of pop-up tracks and the places with the highest crash frequency, we may see, for example, that a provisional route was set up in the historic centre (*La Candelaría*), where a large number of crashes involve cyclists. Equally, a pop-up track was installed along *Calle 72* linking the centre to the district of Engativá (between the airport and Suba), a route where there tends to be a large number of crashes. Having said that, in the absence of more recent statistics it is hard to state whether installing provisional tracks really reduced the number of cyclists involved in crashes. Nevertheless, several sources seem to indicate an improvement in cycling safety during the pandemic. According to Sebastián Posada,[34] who works for the subdirectorate of cyclists and pedestrians at the *Secretaría de Movilidad*, pop-up infrastructure did indeed reduce the number of crashes along certain routes, such as *Avenida Calle 13*. It is important to bear in mind that the 84 km of temporary cycling routes remained in place for 5 months at most, through to August 2020 (Sect. 8.3.5), at a time when there was a lot less traffic due to lockdown and government-imposed limits on travelling. Over this period, cyclists were thus less exposed, even though temporary cycling routes were not always perfectly separated from road traffic in secure corridors. Lastly, a survey conducted online from June to December 2021, to which 396 cyclists responded, indicates that temporary tracks provided what they viewed as a safe alternative along roads where there had previously been no cycling infrastructure.[35] Thus 69% of respondents said that temporary cycling tracks improved their feeling of safety when travelling by bike.

8.5 Discussion and Future Lines of Research

The purpose of this chapter has been to help understand the impact of the Covid-19 pandemic on cycling infrastructure in four French cities, which we have compared to Bogotá. In particular, it shows how many different strategies were implemented by local authorities to develop their network, in space and time, during this very unusual period running from 2020 to 2021. To conduct this study, extensive research, refining, harmonisation, and comparison of several data sources were carried out, and a typology was devised to compare the five cities.

The results obtained seem to indicate that the local authorities adopted different approaches for deploying temporary cycling infrastructure from one city to the next. Certain cities set up infrastructure mainly in central spaces, while others also installed it on the outskirts and, in certain cases, alongside pre-existing cycle infrastructure. In certain cities, such as Montpellier, Grenoble, and especially Bogotá, the maps show that low-income districts also benefited to a certain extent from temporary cycling infrastructure. This may be linked to an attempt to deliver fairer policies for cycling facilities.

[34] Person interviewed in 2021 by Maëlle Lucas for her thesis (see this chapter).

[35] Online survey also conducted in 2021 by Maëlle Lucas for her thesis (see Chap. 9).

Concerning cycling connectivity in these territories, two years after the beginning of the pandemic we may now observe that most provisional cycling infrastructure has been dismantled or else retained in the already dense parts of the network, sometimes running alongside pre-existing equipment. The local situations have thus not been significantly altered in the medium term. Admittedly, in several cases temporary tracks have been used to plug "missing links" in the pre-existing network. They have also sometimes provided a way of improving certain connections, but given the small number of pop-up tracks established as permanent fixtures (Sect. 8.3.5), they have not fundamentally expanded the scale of networks as the pandemic recedes, nor made the cities significantly more bike-friendly overall. The most significant fact is no doubt the reduced room for cars due to pop-up tracks, including in places where cyclist-only paths already existed (sometimes shared with pedestrians), a policy target introduced in France under the 1996 LAURE law.

Furthermore, in the unprecedented situation caused by the global pandemic and requiring urgent public action, being able to draw on reliable, exhaustive, and up-to-date spatial data is a fundamental necessity for monitoring changes, but also a challenge where collaborative mapping may be of assistance. As we have seen, the data put together by OSM contributors about the cycling network is the most complete, and is available for a very large number of countries. Nevertheless, the tag system used to describe geographical objects may vary, and there is great heterogeneity in the description of network segments. Given the mass of data that needs to be urgently collected, citizen input is precious, but it may also generate confusion and imprecision. Synergies with local public services no doubt need to be developed or enhanced to provide systematic checks and corrections. An important milestone has perhaps been reached in France, with the recent creation of the National Database of Cycling Infrastructure (Base Nationale des Aménagements Cyclables (BNAC)), which has become the benchmark in this country.

Finally, in parallel to politicians' speeches and cyclists' feelings, it is important to document and objectify using indicators, maps, and graphs (including data on usage). The creation of an original technique and methodological apparatus for preparing, analysing, and exploiting data has been an additional benefit of the Vélotactique research programme, which we have sought to communicate in this chapter.

Appendix

Data sources

https://www.openstreetmap.org/about

https://ign.fr/

https://www.google.com/streetview/

https://www.mapillary.com/platform

https://www.numerique.gouv.fr/dinum/

https://www.etalab.gouv.fr/

https://www.data.gouv.fr/fr/

https://www.velo-territoires.org/

Type of information	Download link
District Capital of Bogotá cycling network	
Metropolitan area of Bogotá road network	https://datosabiertos.bogota.gov.co/dataset/red-biciusuarios-bogota-d-c
Limit of the District Capital of Bogotá (urban part)	https://geoportal.dane.gov.co/servicios/descarga-y-metadatos/descarga-mgn-marco-geoestadistico-nacional/
Transmilenio (bus rapid transit with dedicated corridors) in the District Capital of Bogotá	https://datosabiertos.bogota.gov.co/organization/transmilenio
Orthophoto of the District Capital of Bogotá 2014 (WMS)	https://serviciosgis.catastrobogota.gov.co/arcgis/rest/services/imagenes/Ortho2014/MapServer/WMTS/1.0.0/WMTSCapabilities.xml
District Capital road network	https://datosabiertos.bogota.gov.co/dataset/malla-vial-integral-bogota-d-c1
"Temporary" cycle tracks installed by the Secretaría de Movilidad as of the beginning of the pandemic (March 2020) in the District Capital of Bogotá	Sources: https://www.movilidadbogota.gov.co/web/noticia/a_partir_de_manana_habra_cambios_en_ciclovias_temporales https://www.movilidadbogota.gov.co/web/noticia/bogota_dispone_de_117_kilometros_de_ciclovias_temporales_0 https://www.movilidadbogota.gov.co/web/muevete-en-bici-por-bogota https://www.movilidadbogota.gov.co/web/noticia/bogota_alcanza_los_80_kilometros_de_ciclovias_temporales
Road crashes in the District Capital of Bogotá	https://datosabiertos.bogota.gov.co/dataset/siniestros-viales-consolidados-bogota-d-c

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