

Andresa Lêdo Marques

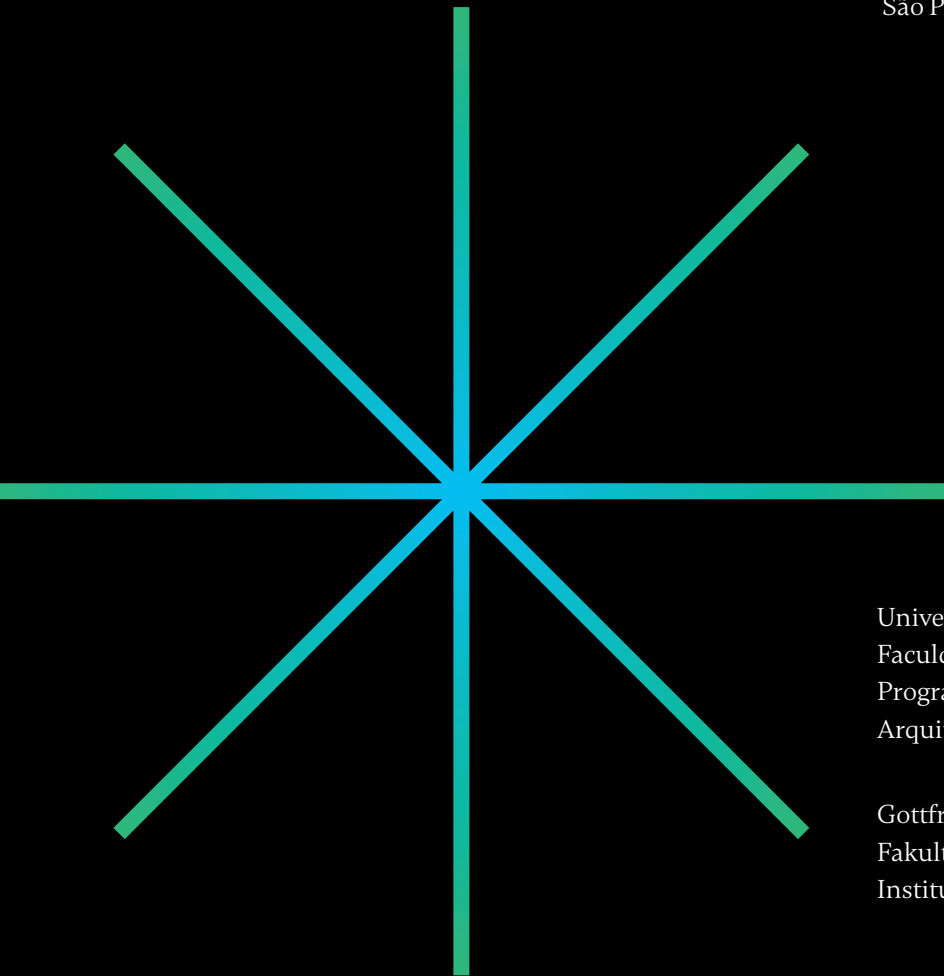
METROPOLITAN FRINGES TOWARDS RESILIENCE IN THE CONTEXT OF CLIMATE CHANGE.

Planning pathways for the Juqueri-Cantareira sub-basin (São Paulo Metropolitan Region, Brazil)

Franjas metropolitanas rumo à resiliência no contexto da mudança climática.
Caminhos de planejamento para a sub-bacia Juqueri-Cantareira (Região Metropolitana de São Paulo, Brasil)

Universidade Presbiteriana Mackenzie
Faculdade de Arquitetura e Urbanismo
Programa de Pós-Graduação em
Arquitetura e Urbanismo

Gottfried Wilhelm Leibniz Universität Hannover
Fakultät für Architektur und Landschaft
Institut für Entwerfen und Städtebau



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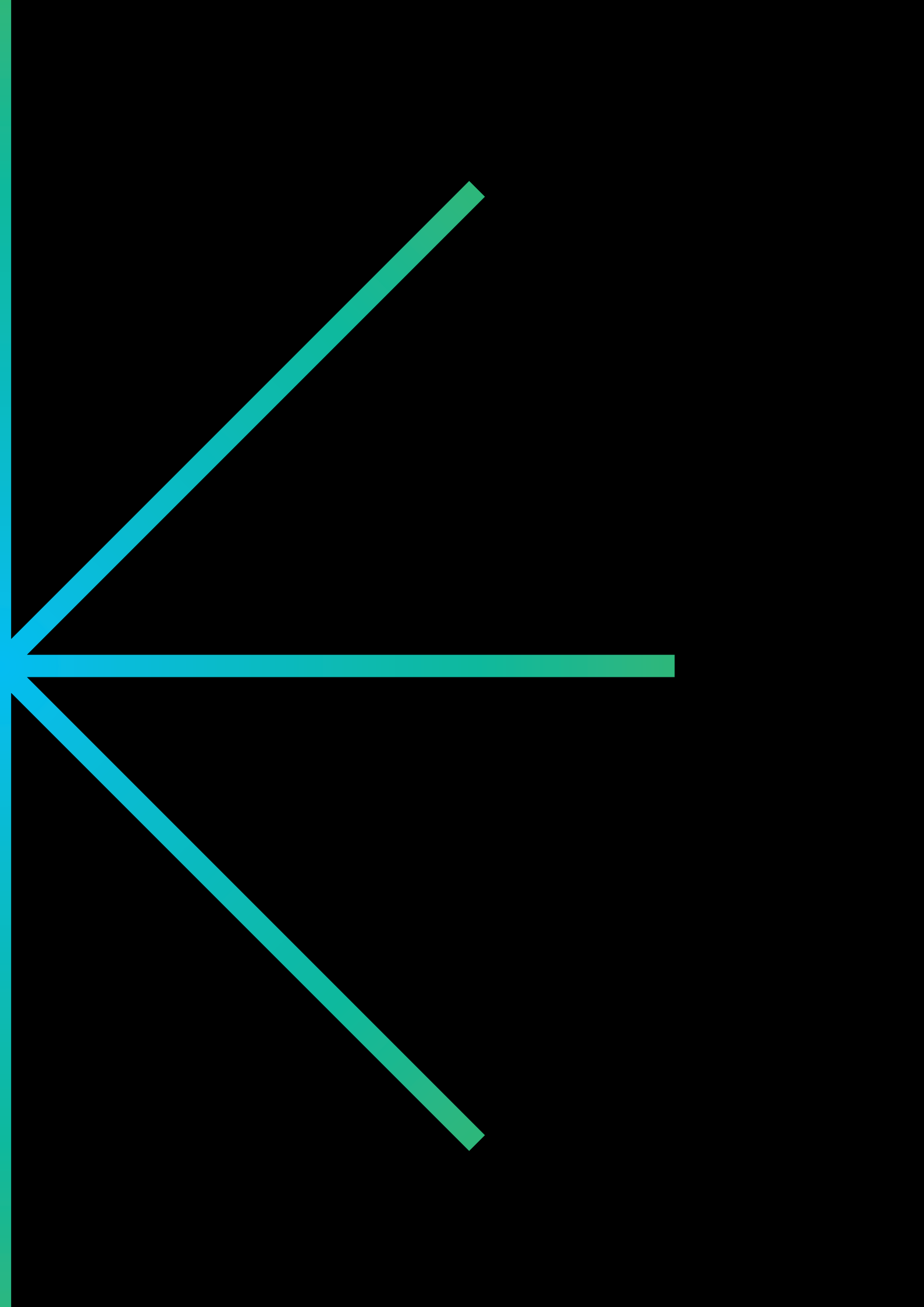
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Abstract

This thesis, a result of a cotutelle and double degree agreement between Universidade Presbiteriana Mackenzie and Leibniz Universität Hannover, aims to demonstrate that the integration of planning scales and prioritising sustainable development in metropolitan fringe areas are crucial for the resilience of these territories in the face of climate change. It argues that the implementation of a new governance model for urban and regional planning in metropolitan areas is imperative, connecting different scales and planning sectors and promoting inter-municipal cooperation to develop urban strategies and interventions that consider local specificities without ignoring regional implications. The hypothesis is that, in the face of the challenges posed by climate change, the absence of an urban planning process that articulates regional instruments together with a multi-scale and inter-sectoral governance model is the main obstacle to creating pathways for sustainable and resilient development in the metropolitan fringes of Brazilian cities. The object of study is the Juqueri-Cantareira sub-basin, located in the northern part of the São Paulo Metropolitan Region, Brazil. The methodology includes document analysis, semi-structured interviews, field research, and georeferenced data. The work is structured in four chapters. The first introduces concepts related to climate change and socio-ecological resilience, in light of the emergence of an ecological and regenerative paradigm in urban and regional planning. The second examines international examples from three metropolitan areas (Barcelona, Paris, Medellín), extracting lessons and principles for urban and regional planning linked to climate change plans. The third chapter correlates theoretical discussion and case studies, culminating in the creation of a method for analysing urban and regional plans. In chapter 4, the focus is on the Juqueri-Cantareira sub-basin; the method for analysing selected urban and regional planning instruments is applied to substantiate the initial hypothesis. The results demonstrate that the climate issue and the concept of resilience have not yet been substantially incorporated into the region's urban and regional planning. It is assessed that existing urban climate policies are embryonic and focus on risk management, neglecting the necessary territorial transformation. Local master plans corroborate urban expansion and reduction of green areas. Regional policies exhibit sectoral and conflicting logics between environmental protection and infrastructure projects serving regional interests, without necessarily promoting new local dynamics for sustainable development. The conclusion articulates and synthesises the work, showing that the methodological effort adopted benefits from the complexity inherent in the planning perspective addressed and highlights the need to develop methods focused on integrating multiple scales and incorporating new planning principles. The recommendations suggest new pathways for urban and regional planning in the Juqueri-Cantareira sub-basin, which can be replicated in other contexts, as long as local specificities are respected. It recommends the restructuring of metropolitan governance, the creation of institutions responsible for inter-municipal coordination at the sub-basin scale, support for urban and regional planning incorporating climate data, and the implementation of urban projects that guide the sustainable development of metropolitan fringes.

Keywords: metropolitan fringes, metropolitan planning, urban and regional planning, resilience, socio-ecological resilience, climate change, Juqueri Cantareira sub-basin, São Paulo Metropolitan Region.

Zusammenfassung

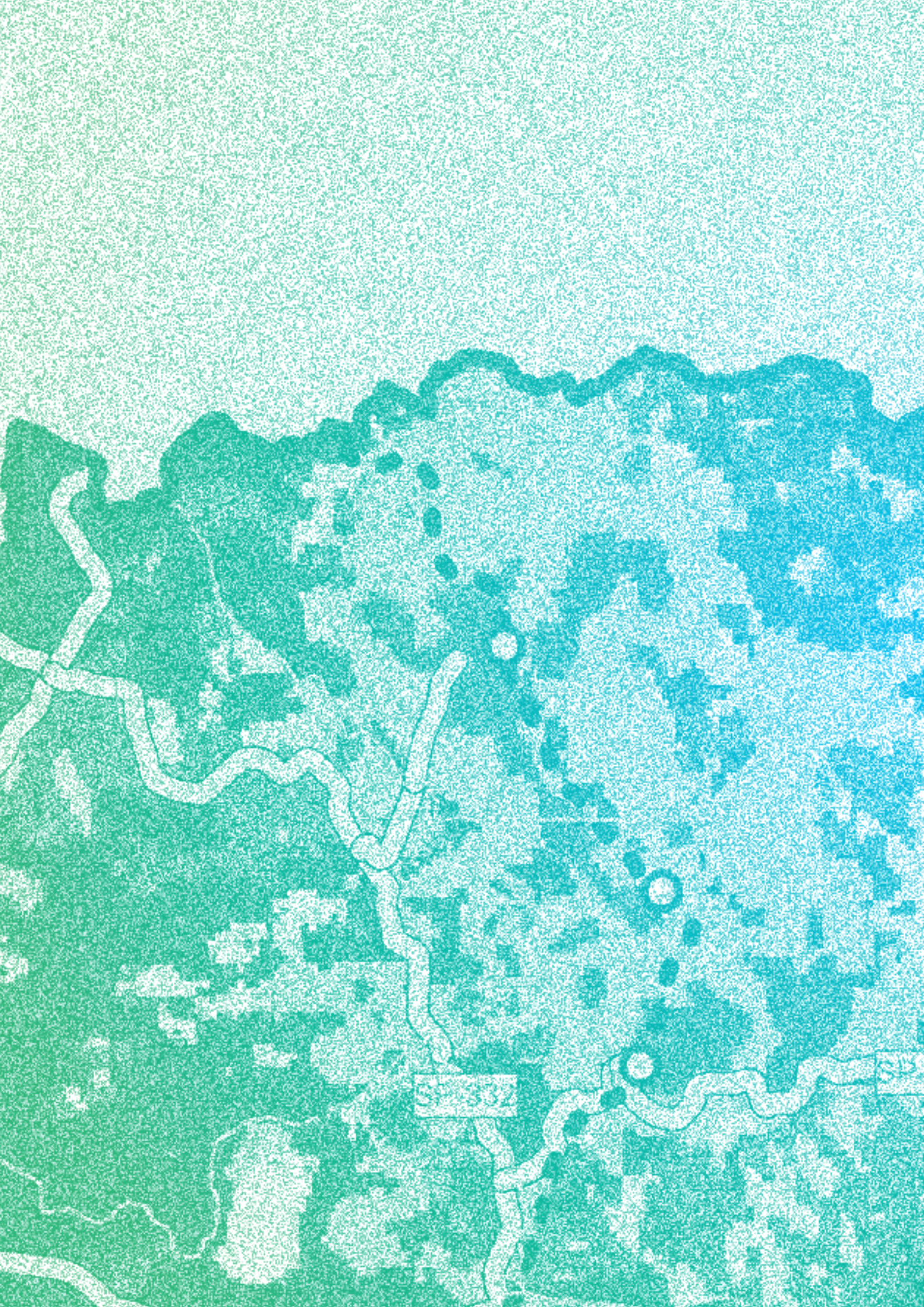
Diese Dissertation, entstanden im Rahmen einer Cotutelle-Vereinbarung zwischen der Universidade Presbiteriana Mackenzie und der Leibniz Universität Hannover, zielt darauf ab, zu zeigen, dass die Integration von Planungsskalen und die Priorisierung nachhaltiger Entwicklung in den Randgebieten von Metropolen entscheidend für die Resilienz dieser Territorien angesichts des Klimawandels sind. Es wird argumentiert, dass die Implementierung eines neuen Governance-Modells für die städtische und regionale Planung in Metropolregionen zwingend erforderlich ist, um verschiedene Planungsskalen und -sektoren zu verbinden und interkommunale Zusammenarbeit zu fördern, um Strategien und städtische Eingriffe zu entwickeln, die lokale Besonderheiten berücksichtigen, ohne regionale Implikationen zu ignorieren. Die Hypothese ist, dass angesichts der durch den Klimawandel gestellten Herausforderungen die Abwesenheit eines städtischen Planungsprozesses, der regionale Instrumente artikuliert, in Verbindung mit einem multiskalaren und sektorübergreifenden Governance-Modell das Haupthindernis für die Entwicklung nachhaltiger und resilienter Wege in den Metropolrändern brasilianischer Städte darstellt. Als Untersuchungsgegenstand dient das Subbecken Juqueri-Cantareira, gelegen im Norden der Metropolregion São Paulo, Brasilien. Die Methodik umfasst Dokumentenanalyse, semistrukturierte Interviews, Feldforschung und georeferenzierte Daten. Die Arbeit ist in vier Kapitel gegliedert. Das erste Kapitel führt Konzepte bezüglich des Klimawandels und sozio-ökologischer Resilienz ein, im Hinblick auf das Aufkommen eines ökologischen und regenerativen Paradigmas im Bereich der städtischen und regionalen Planung. Im zweiten Kapitel werden internationale Beispiele von drei Metropolregionen (Barcelona, Paris, Medellín) untersucht, aus denen Lehren und Prinzipien für die städtische und regionale Planung in Verbindung mit Klimawandelplänen abgeleitet werden. Das dritte Kapitel verbindet die theoretische Diskussion mit den Referenzfällen und mündet in der Entwicklung einer Methode zur Analyse städtischer und regionaler Pläne. Im vierten Kapitel konzentriert sich die Untersuchung auf das Subbecken Juqueri-Cantareira; die Analysemethoden werden auf ausgewählte Instrumente der städtischen und regionalen Planung angewendet, um die anfängliche Hypothese zu überprüfen. Die Ergebnisse zeigen, dass die Klimafrage und das Konzept der Resilienz noch nicht substantiell in die städtische und regionale Planung der Region integriert wurden. Es wird festgestellt, dass die vorhandenen städtischen Klimapolitiken rudimentär sind und sich auf Risikomanagement konzentrieren, während die notwendige territoriale Transformation vernachlässigt wird. Die lokalen Flächennutzungspläne unterstützen die städtische Expansion und die Reduktion von Grünflächen. Die regionalen Politiken weisen sektorale und konfliktreiche Logiken zwischen Umweltschutz und Infrastrukturprojekten auf, die regionalen Interessen dienen, ohne notwendigerweise neue lokale Dynamiken für nachhaltige Entwicklung zu fördern. Die Schlussfolgerung verbindet und synthetisiert die Arbeit, indem sie zeigt, dass der methodologische Ansatz von der inhärenten Komplexität der betrachteten Planungsperspektive profitiert und die Notwendigkeit hervorhebt, Methoden zu entwickeln, die auf die Integration mehrerer Maßstäbe und die Einführung neuer Planungsprinzipien ausgerichtet sind. Die Empfehlungen schlagen neue Wege für die städtische und regionale Planung im Subbecken des Juqueri-Cantareira vor, die auf andere Kontexte übertragen werden können, sofern die lokalen Besonderheiten berücksichtigt werden. Es wird die Umstrukturierung der metropolitanen Governance, die Schaffung von Institutionen, die für die interkommunale Koordination auf der Ebene der Subbassin verantwortlich sind, die Unterstützung der Stadt- und Regionalplanung durch die Einbeziehung von Klimadaten sowie die Implementierung von städtischen Projekten, die die nachhaltige Entwicklung der metropolitanen Ränder leiten, empfohlen.

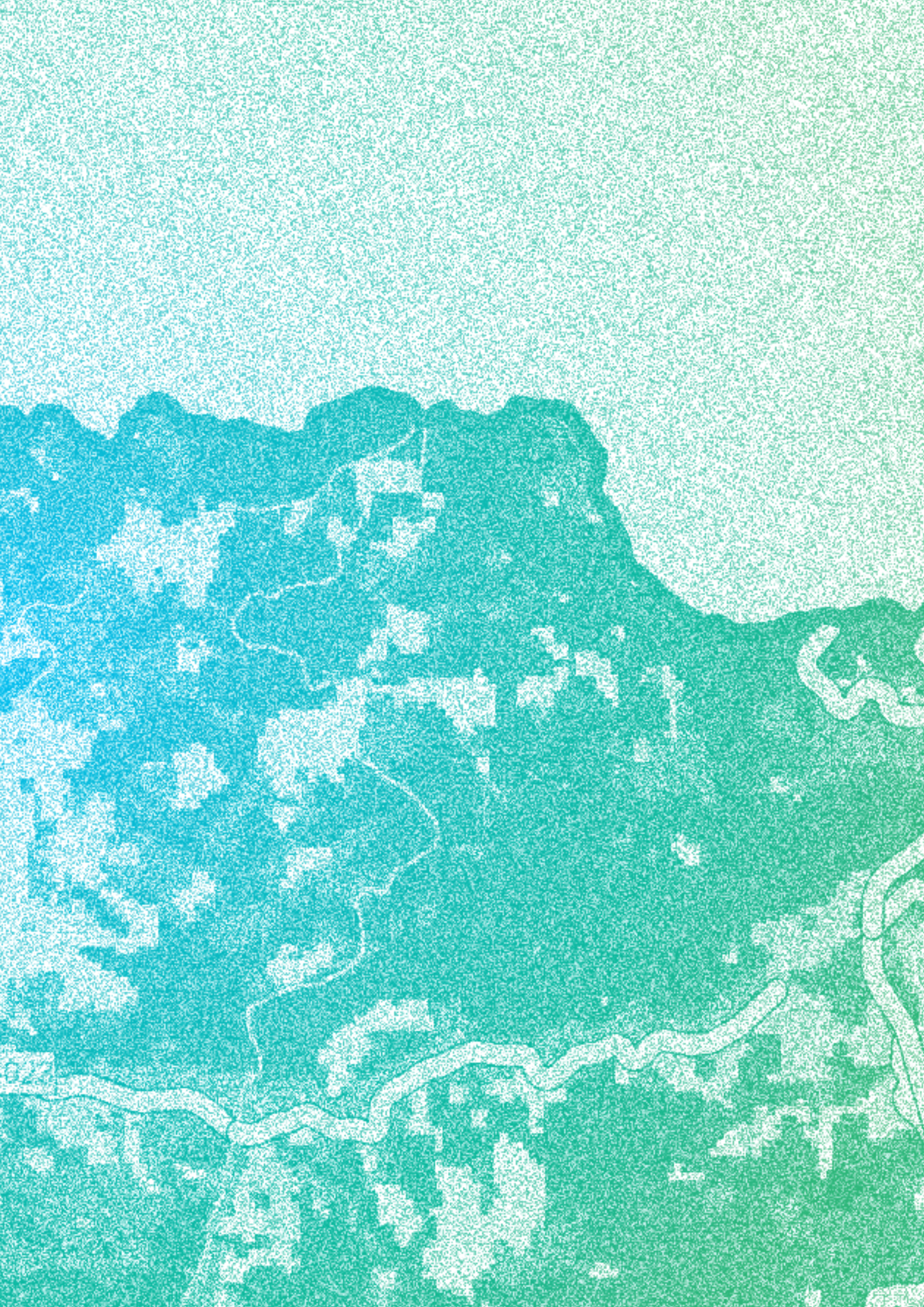
Stichworte: Maßstabsübergreifende Planung, Governance und Entwicklung von Metropolregionen, Stadtplanung, regionale Entwicklung, sozio-ökologische Resilienz, Klimawandel, Gebiet Juqueri Cantareira, Metropolregion São Paulo.

Resumo

Esta Tese, fruto de um acordo de cotutela e dupla titulação entre a Universidade Presbiteriana Mackenzie e a Leibniz Universität Hannover, visa demonstrar que a integração das escalas de planejamento e a priorização do desenvolvimento sustentável em áreas de franjas metropolitanas são cruciais para a resiliência desses territórios face à mudança climática. Argumenta-se que a implementação de um novo modelo de governança para o planejamento urbano e regional em áreas metropolitanas é imperativa, conectando diferentes escalas e setores de planejamento e promovendo cooperação intermunicipal para desenvolver estratégias e intervenções urbanas que considerem especificidades locais sem ignorar implicações regionais. A hipótese é que diante dos desafios impostos pela mudança climática, a ausência de um processo de planejamento urbano que articule instrumentos regionais aliado a um modelo de governança multiescalar e intersectorial constitui o principal obstáculo para construir caminhos para o desenvolvimento sustentável e resiliente nas franjas metropolitanas de cidades brasileiras. Tendo como objeto de estudo a sub-bacia Juqueri-Cantareira, localizada na porção norte da Região Metropolitana de São Paulo, Brasil, a metodologia, incorpora a análise documental, entrevistas semiestruturadas, pesquisa de campo e dados georreferenciados. O trabalho está estruturado em quatro capítulos. O primeiro introduz conceitos relativos à mudança climática e resiliência socioecológica, tendo em vista a emergência de um paradigma ecológico e regenerativo no âmbito do planejamento urbano e regional. No segundo, examinam-se exemplos internacionais de três áreas metropolitanas (Barcelona, Paris, Medellín), extraem-se ensinamentos e princípios para o planejamento urbano e regional articulado à planos de mudança climática. O terceiro capítulo correlaciona a discussão teórica e os casos referenciais, culminando na criação de um método de análise de planos urbanos e regionais. No capítulo 4, focaliza-se a sub-bacia Juqueri-Cantareira; aplica-se o método de análise dos instrumentos de planejamento urbano e regional selecionados, de modo a comprovar a hipótese inicial. Os resultados demonstram que a questão climática e o conceito de resiliência ainda não foram substancialmente incorporados ao planejamento urbano e regional da região. Afere-se que as políticas climáticas urbanas existentes são embrionárias e se concentram na gestão de riscos, negligenciando a transformação territorial necessária. Os planos diretores locais corroboram com a expansão urbana e redução de áreas verdes. As políticas regionais apresentam lógicas setoriais e conflitantes entre proteção ambiental e projetos de infraestrutura atendendo a interesses regionais, sem necessariamente promover novas dinâmicas locais para o desenvolvimento sustentável. A conclusão articula e sintetiza o trabalho, demonstrando que o esforço metodológico adotado se beneficia da complexidade inerente à perspectiva de planejamento abordada e destaca a necessidade de desenvolver métodos focados na integração de múltiplas escalas e na incorporação de novos princípios de planejamento. As recomendações sugerem novos caminhos para o planejamento urbano e regional na sub-bacia do Juqueri-Cantareira, que podem ser replicados para outros contextos, desde que se respeite as especificidades locais. Recomenda-se a reestruturação da governança metropolitana, a criação de instituições responsáveis pela coordenação intermunicipal na escala da sub-bacia, o apoio ao planejamento urbano e regional incorporando dados climáticos e a implementação de projetos urbanos que orientem o desenvolvimento sustentável das franjas metropolitanas.

Palavras-chave: franjas metropolitanas, planejamento metropolitano, planejamento urbano e regional, resiliência, resiliência socioecológica, mudança climática, sub-bacia Juqueri-Cantareira, Região Metropolitana de São Paulo.





- Figure 1 - General methodological approach • 38
- Figure 2 - Diagram illustrating the way in which the research questions relate to the objectives and overall structure of the thesis. • 43
- Figure 3 - Population increase and global demands in different sectors from 1750 to 2000. • 50
- Figure 4 - Rising global temperatures, rising sea levels and increasing greenhouse gas emissions highlighting human action in this process. • 51
- Figure 5 - Why are cities the hotspots of global warming? • 52
- Figure 6 - Timeline of key institutional milestones of the UN on climate change. • 54
- Figure 7 - Conceptual framework of the interactions between biodiversity, ecosystem services, human well-being, and transformation factors. • 56
- Figure 8 - Bibliometric review research protocol • 56
- Figure 9 - Ecology of cities • 60
- Figure 10 - Different approaches for resilience • 61
- Figure 11 - Mitigation, adaptation, and resilience. • 62
- Figure 12 - Societal choices, illustrative development pathways, and future outcomes. • 62
- Figure 13 - Transformative actions and systems transitions • 62
- Figure 14 - Diagram of the concepts of urban areas and peri-urban areas. • 64
- Figure 15 - Evolution of the Urban Area in the Metropolitan Region of São Paulo versus Protected Areas. • 66
- Figure 16 - Spatial scales relevant to urban planning and urban design for climate change mitigation and adaptation. • 67
- Figure 17: AMB and Besòs territory (in purple). • 80
- Figure 18: The four strategic projects of Besòs territory. • 81
- Figure 19: Master Plan for the urban transformation of the Vallbona district - Agrovallbona • 83
- Figure 20: Photovoltaic installation on public space - Vallbona, Barcelona. • 83
- Figure 21: Pedestrian connection between Barcelona and Montcada i Reixac. • 83
- Figure 22: Urban transformation of former Mercedes-benz fabric - Internal mobility scheme, project situation, and illustrative images. • 81
- Figure 23: The scales of Grand Paris • 85
- Figure 24: Political administrative limits of Metropole du Grand Paris, EPCI and Communes • 87
- Figure 25: Competences of MGP, EPTs and municipalities (communes) • 88
- Figure 26: Articulation of the plans and regulations surrounding the Territorial Climate and Energy Plans • 90
- Figure 27: GHG emissions assessment of the Greater Paris Region - Extended approach (Scopes 1+2+3) – 2012 • 91
- Figure 28: GHG emissions balance of the Greater Paris Region - Cadastral approach – 2012 • 91
- Figure 29: Low Emission Zone (ZFE) in MGP • 92
- Figure 30: Est Ensemble strategic Projects. • 94
- Figure 31: Maps of the project's axes • 95
- Figure 32: Public walking session along the Promenade des hauteurs and the l'Ourcq canal • 96
- Figure 33: Cité Maraîchère in Romainville • 97
- Figure 34: Les Lilas - Fort de Romainville. • 98
- Figure 35: Les Lilas - Fort de Romainville. • 98
- Figure 36: ZAC Boissière-Acacia Montreuil • 99
- Figure 37: Metropolitan Area of Valle de Aburrá • 101
- Figure 38: Main planning scales in AMVA • 102
- Figure 39: Climate instruments and policies in the context of AMVA • 103
- Figure 40: Prioritised adaptation measures according to super-criteria. • 104

- Figure 41: Mitigation target of GHG emissions by sector • 105
- Figure 42: Metropolitan green belt of the Aburrá Valley • 107
- Figure 43: Medellín's strategic intervention areas and macro-projects • 108
- Figure 44: Jardim Circunvalar de Medellín's Masterplans • 108
- Figure 45: Cerro Pan de Azúcar's Masterplan • 109
- Figure 46: Five attributes of the Jardim Circunvalar de Medellín • 109
- Figure 47: Sustainable neighbourhoods' strategy • 110
- Figure 48: Housing resettlement project (Before and after) - Polígono Trece de Noviembre • 111
- Figure 49: Construction of grey and green infrastructure for risk mitigation • 111
- Figure 50: Schema of the Integral Connectivity Plan • 112
- Figure 51: Civic-pedagogic urbanism model • 112
- Figure 52: EDU planning model • 113
- Figure 53 - Regional strategies of the Ile de France • 116
- Figure 54 - La Mercedes Ecodistrict in Barcelona • 117
- Figure 55 - Promenade Des Hauteurs and the Transformation of Streets and Public Spaces • 117
- Figure 56 - Local projects in Jardim Circunvalar - Medellín • 117
- Figure 57 - Relationship between the metropolitan, intermediate and local scales. • 119
- Figure 58 - Milestones of urban and climate policies in Brazil • 136
- Figure 59 - Limit of the Metropolitan Region of São Paulo and its municipalities overlapping with the limit of the Upper Tietê Basin (BAT-UGRHI-06) and its division into sub-basins. • 141
- Figure 60 - São Paulo Metropolitan Region urban sprawl evolution versus environmental protected areas. • 142
- Figure 61 - Employment density and environmental protected areas in São Paulo Metropolitan Region. • 143
- Figure 62 - São Paulo Metropolitan Region's subregions, metropolitan and regional centralities. • 143
- Figure 63 - Geometric Rate of Annual Growth of the Municipalities of RMSP - 2010-2020 • 144
- Figure 64 - Brazilian urban planning system • 145
- Figure 65 - PDUI Macro-zoning • 146
- Figure 66 - Juqueri-Cantareira Sub-basin – general characteristics • 147
- Figure 67 - Juqueri-Cantareira sub-basin Land cover in 1990 • 148
- Figure 68 - Juqueri-Cantareira sub-basin Land cover in 2000 • 148
- Figure 69 - Juqueri-Cantareira sub-basin Land cover in 2010 • 149
- Figure 70 - Juqueri-Cantareira sub-basin Land cover in 2021 • 149
- Figure 71 - Juqueri-Cantareira Sub-Basin: APRM-AJ, properties under protection by CONDEPHAAT and preservation areas. • 150
- Figure 72 – Juqueri-Cantareira sub-basin – Density (Inhabitants per hectares). • 151
- Figure 73 - Juqueri-Cantareira sub-basin - Local Climate Zones • 152
- Figure 74 - Local Climate Zones - Built and land cover types • 153
- Figure 75 – Juqueri-Cantareira sub-basin - Annual Geometric Growth Rates (AGGR), 2000-2010 • 153
- Figure 76 – Juqueri-Cantareira Sub-basin - Average monthly nominal income of people responsible for household, 2010. • 155
- Figure 77 – Juqueri-Cantareira sub-basin - Slums • 155
- Figure 78 - Juqueri Sub-basin - Paulista Social Vulnerability Index, 2010. • 156
- Figure 79 - Emissions by municipality and sector • 157
- Figure 80 - Percentage of emissions by municipality and sector • 157
- Figure 81 - Juqueri-Cantareira sub-basin Land cover in 2021 • 160
- Figure 82 - Juqueri-Cantareira sub-basin municipal zoning mosaic. • 160
- Figure 83 - Juqueri-Cantareira sub-basin PDUI Macro-zoning • 161
- Figure 84 - Current scenario and planning scenario for Franco da Rocha in the municipal and metropolitan instruments. • 161

- Figure 85 - Potential GHG emission reduction of the Ambitious Scenario compared to the Trend Scenario (tCO₂e/year) • **163**
- Figure 86 - Area around Perus station: zoning, susceptibility and risks to landsliding and flooding. • **168**
- Figure 87 - Field visit with CIAM-Clima researchers to the Perus-Pirapora Railway • **168**
- Figure 88 - Field visit with CIAM-Clima researchers to the former Cement Factory • **169**
- Figure 89 - Current scenario and planning scenario for Caieiras and Franco da Rocha's eastern vector in the municipal and metropolitan instruments. • **170**
- Figure 90 - Capacity to provide ecosystem services in the RBCV • **171**
- Figure 91 - Caieiras municipal EcoPark. In the background, an area earmarked for urban expansion by the municipal plan. • **172**
- Figure 92 - Municipal Park Benedito Bueno de Moraes in Franco da Rocha. • **174**
- Figure 93 - Infrastructure works to reduce flooding along the Juqueri River around the Baltazar Fidelis train station in Franco da Rocha • **174**
- Figure 94 - São Paulo State Government projects on anti-flooding infrastructure in the city of Franco da Rocha. • **175**
- Figure 95 - Central area of Franco da Rocha, zoning, susceptibility and risk of flooding and landslides. • **175**
- Figure 96 - Diagram illustrating the relationship between main territorial challenges, strategic visions of planning documents and strategies towards a more resilient model • **178**
- Figure 97 - Diagram illustrating multiple planning scales and their articulations. • **187**
- Figure 98 - Diagram illustrating another strategic perspective on the territory • **188**

Table 1 - Impacts of climate change on urban areas. • **53**

Table 2 - Analysis of the most relevant articles selected from the review of the literature. • **58**

Table 3 - Example of the hierarchy of territorial administration levels • **67**

Table 4: General characteristics and documents analysed at metropolitan and intermediate scales. • **74**

Table 5: Analytical dimension and key questions • **75**

Table 6: Department and institution of the technicians/professionals interviewed at the metropolitan, intermediate and local scales. • **76**

Table 7: Governance and institutional characteristics of Barcelona Metropolitan Area • **78**

Table 8: General metropolitan characteristics, main climate risks and adaptation strategies. • **79**

Table 9: Governance and institutional characteristics of Métropole du Grand Paris • **87**

Table 10: General metropolitan characteristics, main climate risks and adaptation strategies. • **91**

Table 11: Governance and institutional characteristics of the Valle de Aburrá Metropolitan Area • **101**

Table 12: Scales and planning instruments in Colombia • **102**

Table 13: Mitigation - Prioritisation of measures • **105**

Table 14: General metropolitan characteristics, main climate risks and adaptation strategies in AMVA • **106**

Table 15 - Summary of the main outcomes of referential cases. • **120**

Table 16 - Definition of dimensions • **120**

Table 17 - Analytical framework integrating resilience factors • **122**

Table 18 - Analytical table containing the dimensions and elements used in the documentary analysis. • **125**

Table 19 - Documents analysed at metropolitan intermediate and municipal scales. • **126**

Table 20 - Department and institution of technicians / professionals interviewed on the metropolitan, intermediate, and municipal scales. • **128**

Table 21 - Characterization of Brazilian municipalities regarding demographic aspects and urban risks in the context of climate change • **135**

Table 22 - Priority guidelines for promoting adaptation under the PNA “Cities” strategy. • **137**

Table 23 - General characteristics of São Paulo Metropolitan Region. • **140**

Table 24 - Annual Geometric Growth Rate (AGGR) by sub-region of the São Paulo Metropolitan Region from 2000 to 2050 • **144**

Table 25 - General data and characteristics of the municipalities and districts of the Juqueri-Cantareira sub-basin • **154**

Table 26 - Summary of documental analysis on urban dynamics • **158**

Table 27 - Actions needed to realise PlanClima SP’s Ambitious Scenario by 2050. • **163**

Table 28 - Summary of documental analysis on Water and Ecosystem Services • **165**

Table 29 - Summary of documental analysis on Risks and Vulnerabilities • **173**

Table 30 - Summary of recommendations by planning scale • **186**

PRESENTATION AND RESEARCH MOTIVATION • 26

INTRODUCTION • 28

Topic and Relevance • 28

Research Problem • 30

Hypothesis • 34

Thesis • 35

Objectives • 35

Methodology • 36

Overall methodological approach • 36

Methodological tools • 38

Materials and Sources • 41

Thesis structure • 43

1. THEORETICAL PERSPECTIVE: CLIMATE CHANGE, RESILIENCE AND URBAN AND REGIONAL PLANNING FOR METROPOLITAN FRINGES • 48

1.1. Climate Change: General Causes and Effects in Urban Areas • 50

1.2. Responses to the climate crisis: towards resilience as transformation • 53

1.3. Conceptualising metropolitan fringes • 63

1.4. Metropolitan Fringes: Dynamics, Scales, and Opportunities • 64

2. REFERENTIAL CASES: BUILDING RESILIENCE STRATEGIES AT THE FRINGES • 72

2.1. Analysis method • 73

2.2. Barcelona Metropolitan Area – Spain • 76

2.2.1. Metropolitan context • 76

2.2.2. Contemporary metropolitan planning and governance • 77

2.2.3. Climate change and resilience in urban polices • 78

2.2.4. Innovations at the metropolitan scale • 79

2.2.5. Focus fringe area: Besòs territory • 80

2.2.6. Innovations at the intermediate and local scale • 81

2.3. Greater Paris Metropolis – France • 85

2.3.1. Regional and metropolitan context: transformations and visions for fringe areas • 85

2.3.2. Contemporary metropolitan planning and governance • 86

2.3.3. Climate change and resilience in urban polices • 89

2.3.4. Innovations at the metropolitan scale • 92

2.3.5. Focus fringe area: Est ensemble and the Parc des Hauteurs • 93

2.3.6. Innovations at the intermediary and local scale • 96

2.4. Metropolitan Area of the Aburrá Valley – Colombia • 99

2.4.1. Metropolitan context • 99

2.4.2. Contemporary metropolitan planning and governance • 100

2.4.3. Climate change and resilience in urban polices • 102

2.4.4. Innovations on the metropolitan scale • 106

2.4.5. Focus fringe area: Jardín Circunvalar de Medellín • 108

2.4.6. Innovations on the local scale • 110

3. THE CONSTRUCTION OF A METHOD FOR ANALYSING URBAN AND REGIONAL PLANNING OF THE SÃO PAULO METROPOLITAN FRINGE • 114

- 3.1. Lessons learnt from the referential cases • 115**
3.2. Building a general framework: combining theory and the referential cases lessons • 120
3.3. Framework contextualisation to São Paulo Metropolitan Region • 123
3.4. Complementing the analysis: zoning mosaic, field visits, and interviews • 126
-

4. THE FRINGES OF SÃO PAULO METROPOLITAN REGION: CRITICAL ANALYSIS AND POSSIBLE PLANNING PATHWAYS TOWARDS RESILIENCE • 132

- 4.1. Urban and climate policies in Brazil and the State of São Paulo • 134**
Brazil • 134
State of São Paulo • 137
- 4.2. São Paulo Metropolitan Region: context and planning visions for the fringes • 140**
4.2.1. Context and general information • 140
4.2.2. São Paulo Metropolitan Region Integrated Development Plan (PDUI-RMSP) • 145
- 4.3. Focus fringe area: The Juqueri-Cantareira sub-basin • 147**
4.3.1. Context • 147
4.3.2. Results and discussion on Urban dynamics • 157
4.3.3. Results and discussion on Water and ecosystem services • 164
4.3.4. Results and discussion on risks and vulnerabilities • 172
- 4.4. Advances, limits, and challenges • 177**
-

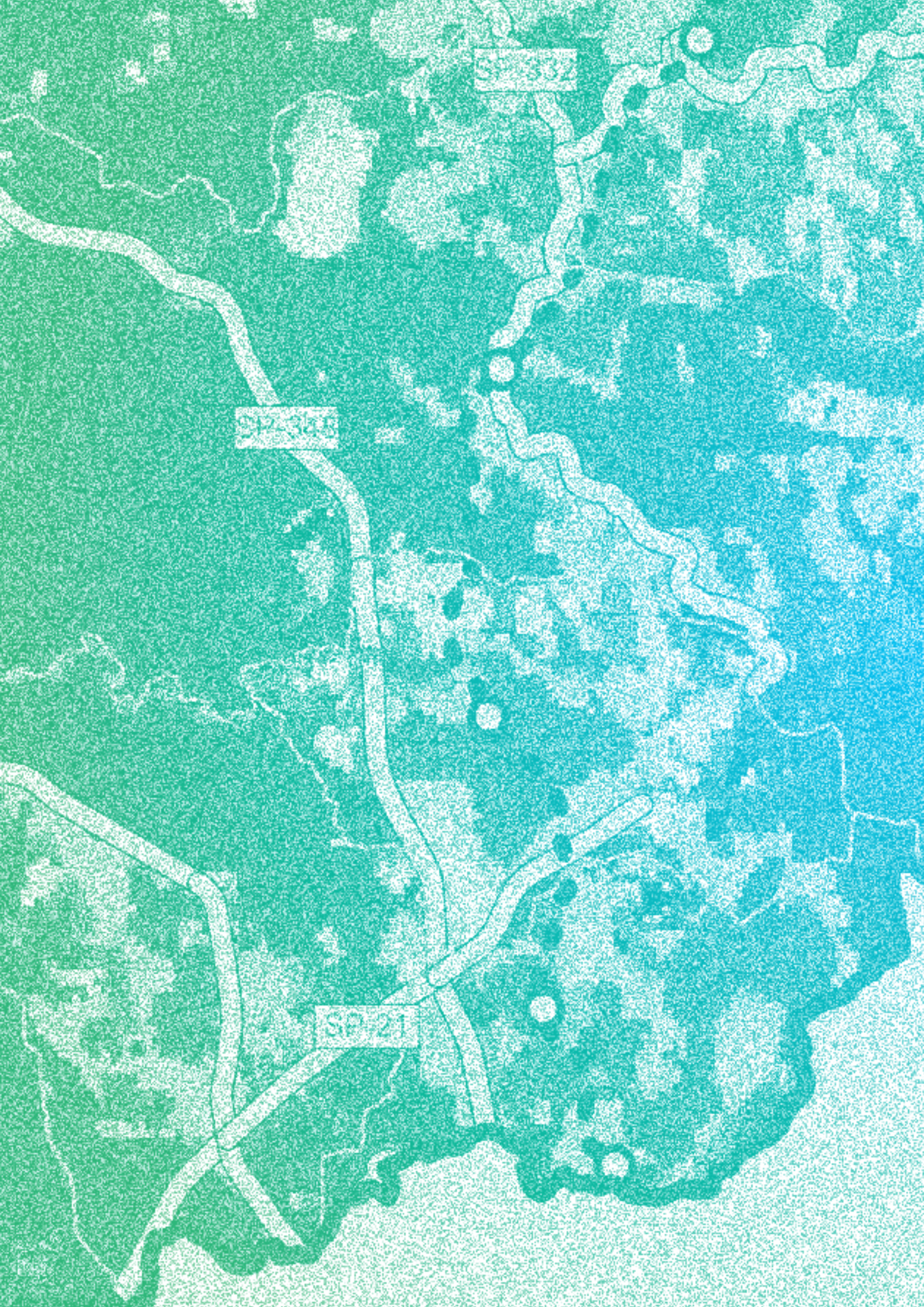
5. CONCLUSIONS • 180

- 5.1. Overall conclusions • 181**
5.2. Recommendations: different planning scales and approaches towards a more resilient model • 184
5.3. Transferability: contributions to urban and regional planning and other areas of knowledge • 189
5.4. Limitations of the research and avenues for further development • 190
-

REFERENCES • 194

APPENDIX • 212

- Appendix A – Informed Consent Form – TCLE • 214
Appendix B – Semi-structured Interview Roadmap • 216
Appendix C – Compatibility and simplification of municipal zoning • 218
Appendix D – Summary of the analytical framework applied to the selected plans • 220
São Paulo Metropolitan Region - PDUI • 220
São Paulo – Municipal Strategic Masterplan • 224
São Paulo – Municipal Climate Action Plan (PlanClima) • 228
São Paulo - Perus • 232
Caieiras Municipal Master Plan • 234
Franco Da Rocha - Municipal Master Plan • 238
Francisco Morato - Municipal Master Plan • 242
Francisco Morato - Climate Adaptation and Resilience Plan • 244
Mairiporã - Municipal Master Plan • 248
Cajamar - Municipal Master Plan • 252





Presentation and research motivation

This thesis summarises the processes, findings, and discussions of a doctoral research developed over nearly four years in a double degree programme between the Postgraduate Programme in Architecture and Urbanism of Mackenzie Presbyterian University (CAPES PROEX Scholarship⁴) and the Faculty of Architecture and Landscape Design of Leibniz University Hannover⁵ (DAAD Scholarship⁶), under the supervision of Prof. Dr. Angélica Benatti Alvim and Prof. Dipl.-Ing. Univ. Jörg Schröder.

Nevertheless, this research extends beyond the four years mentioned and originates from my personal experiences that prompted me to investigate sustainable urban development from an academic standpoint. I was raised in Caieiras, a small town on the fringes of the Sao Paulo Metropolitan Region, where my passion for nature and the city began. In my childhood, I was always concerned about environmental issues, which were frequently discussed in and out of the classroom.

While studying architecture and urbanism in my undergraduate program at Mackenzie Presbyterian University, I noticed that most class discussions were centred on Sao Paulo's city level, with little attention given to the cities surrounding the metropolis and how to develop them. During my exchange programme at the University of Technology in Sydney (Australia), I gained a deeper understanding of the relationship between urban areas and the environment on other city scales. This experience allowed me to see my hometown from a new perspective and recognise its potential.

Later, in 2017, I began my master's degree at Mackenzie Presbyterian University (CAPES PROEX Scholarship), supervised by Prof. Dr. Angélica Benatti Alvim. During this period, I was able to actively participate in her research group. Under her guidance, my research and interests expanded to include sustainable urban planning and development at the metropolitan level, more specifically addressing the northern zone of the São Paulo Metropolitan Region.

During this process, I met Prof. Jörg Schröder and his research on "Dynamics of Periphery: Atlas for Emerging Creative and Resilient Habitats", which contributed to enrich-

4_ Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Programa de Excelência Acadêmica (Proex)

5_ Institute of Urban Design and Planning (Institut für Entwerfen und Städtebau)

6_ Deutscher Akademischer Austauschdienst - Research Grant - Bi-nationally Supervised Doctoral Degrees / Cotutelle

ing my vision of the peripheries and their possibilities. When I started my PhD in 2020, I continued working in the same territory as my master's degree, but now discussing the fringes of the metropolis as strategic areas for resilience with a CAPES PROEX scholarship. In 2021, with the support of my supervisors, I obtained a DAAD scholarship that allowed me to develop my thesis in a double degree programme. This experience further broadened my research horizons through constant exchange with my supervisors and other researchers in Brazilian, German, and European contexts.

During my doctoral research, I was fortunate to interview various professionals working in urban/regional planning and climate issues at different institutions. Additionally, I conducted field visits, allowing for insightful and varied experiences and perspectives in diverse contexts. This highlighted the complex nature of the topic and the kindness of numerous individuals and organisations who shared their knowledge and expertise. Furthermore, I had the opportunity to participate in several academic debates with other researchers on the subject in the European and Brazilian context, presenting and publishing my research at different congresses, such as AESOP, UIA, Urban Transitions, IALE, ENANPARQ, among others; and publishing in different scientific journals such as *Sustainability*, *Frontiers in Sustainable Cities*, *Arquitextos*, *Cities*, and *International Planning Studies*.

The research was also part of the research group “Contemporary Urbanism: Networks, Systems and Processes”, led by Prof. Dr. Angélica Benatti Alvim and the research project “City, Infrastructure and Adaptation to Climate Change” coordinated by Prof. Dr. Renato Anelli. The case study of this thesis is one of the areas of study addressed by the group, with extensive discussions and contributions from different researchers and universities.

Throughout this process, I have achieved significant personal, professional, and academic growth through various experiences, crossed by the challenges imposed by the pandemic. All this was accompanied by fruitful discussions with my supervisors, both in person and virtually, which expanded my understanding of the chosen theme, its scales, and its complexities.

The culmination of these almost four years of research and exchanges is summarised in this thesis, published in a bilingual format, and organised in two volumes, the first in Portuguese and the second in English. Hopefully, the discussions presented here will contribute to sustainable and resilient urban development - in Brazilian cities and beyond - at their different scales.

Introduction

TOPIC AND RELEVANCE

Cities and urban agglomerations, which form the habitat of most of the world's population, are impacted by the adverse effects of climate change, a global phenomenon strongly influenced by human action (Dodman *et al.*, 2023). This phenomenon has emerged as one of the most pressing challenges of our time, requiring urgent action and innovative solutions across various sectors. When discussing climate change in the context of cities, it is crucial to emphasise that although cities contribute significantly to the problem of the climate crisis, they also have the potential to make a fundamental contribution to building solutions and ecological transitions.

The prevailing model of planning and building cities in the past century was deeply entrenched in an extractivist mindset and heavily reliant on carbon-intensive practices, creating a profound rupture between the city and nature (Herzog, 2013). Still prevalent today, this model has contributed to perpetuating the climate crisis. Indeed, cities are responsible for approximately 70% of global carbon emissions (Crippa *et al.*, 2021). Therefore, it is imperative that the urgent need to shift from this unsustainable approach is recognised, and that innovative ways of planning cities and regions that reduce carbon dependency and promote resilience in the face of climate change are explored.

As the world becomes increasingly urbanised, the challenges posed by climate change are deeply intertwined with urban dynamics. Rising temperatures, changing precipitation patterns, and extreme weather events directly impact urban infrastructure and socioeconomic systems (IPCC, 2014a, 2018).

Although there is acknowledgement in the literature that the climate issue must be addressed from a multi-scalar perspective, most urban and climate change adaptation policies focus on the local scale to the detriment of the metropolitan scale, disregarding the high degree of interdependencies and inequalities present in these territories. Since the adaptive capacity between municipalities is unequal, there is a need to create regional networks and equalise planning resources. Multiple levels of coordination and support are required for effective and long-term local actions (Dinshaw, Lane and Elias-Trostmann, 2017; Shi, 2019).

Shi (2019) points out some limitations related to local adaptation, such as the high costs of developing local plans and vulnerability analysis, the demand for access to data and information, and the lack of technical expertise and political leadership. Although the core cities in metropolitan areas tend to have more resources and staff to develop local actions related to adaptation and resilience, cities on the fringes of metropolitan areas often lack the same resources, resulting in a lower level of adaptive capacity in terms of technical and financial resources.

From this perspective, it is necessary to construct urban and regional planning that takes account of the climate issue. Heymans et al. (2019) argue that in the context of ecological urbanism and its implications for urban planning and design, different perspectives emerge to form a new paradigm of urban planning, aiming to apply Systems Thinking to cities, which are considered to be new complex ecosystems.

The complexity of urban systems demands that cities be understood as complex and diverse new ecosystems resulting from a human-nature co-evolution process (Hobbs, Higgs and Hall, 2013). From a social-ecological perspective, constructing resilient and sustainable urban environments involves transforming urban systems into a (re) connection between human needs and biosphere capacity. This perspective challenges the traditional planning paradigm, which is based on the idea of stability and predictability (Heymans *et al.*, 2019).

The concept of resilience has been widely used in research related to urban planning; however, many studies approach the concept unclearly, with an inconsistent definition (Meerow, Newell and Stults, 2016). Nevertheless, Suárez et al. (2019) point out that although the concept of resilience has different definitions, there are three dominant interpretations in the literature: (1) Engineering, focusing on the return to equilibrium of a given system after exposure to disturbances; (2) Ecological, focusing on the system's ability to absorb disturbances and maintain its functions while transforming; and (3) Socio-ecological, which focuses on the ability of a complex socio-ecological system to adapt and transform itself in response to disturbances.

From a social-ecological perspective, resilience not only refers to adapting to crises but also to transforming social-ecological systems towards sustainability, where resilience is understood as transformative capacities connected to learning and innovation (Wolfram, Borgström and Farrelly, 2019; Folke *et al.*, 2021).

In this regard, there is a need for transformation that in-

volves new forms of production and consumption and the (re)connection of societal needs to the capacity of the biosphere and essential ecosystem services (Folke *et al.*, 2011). Thus, it is essential to consider strategies for integrating city and nature and concerting efforts to ensure effective communication between the potential paths ahead. This could foster not only adaptation and mitigation in the cities, but also their potential transformations towards an ecological perspective, along with the uncertainties involved.

In this context, urban and regional planning requires the acceptance of non-equilibrium, the recognition of inherent uncertainty and continuous evolution. Its role must be to guide urban development towards sustainable and ecologically desirable outcomes. There are no universal solutions, but rather a need for flexibility, different approaches, and context-specific solutions. Plans and projects should be viewed as opportunities for adaptive learning, promoting cross-disciplinary integration, and the sharing of knowledge among stakeholders (Heymans *et al.*, 2019). Therefore, research is needed to formulate answers (and questions) related to the broad framework for transitioning to more ecological and resilient urban models, addressing different urban scales and possible articulations.

RESEARCH PROBLEM

In Brazil, the historical model of sprawling, dispersed urbanisation has prompted the occupation of ecologically sensitive areas, exacerbating social, urban and environmental problems. Extreme events associated with climate change are increasingly devastating in Brazil's highly urbanised areas, especially in metropolitan regions and large cities (Nobre *et al.*, 2011).

Given that academic and scientific communities recognise the importance of cities in building resilience to climate change and the role of integrating nature (ecosystem services⁷ and biodiversity) in this process, the metropolitan fringes can be considered strategic for building resilient regions from a transformation perspective, as these areas are located on the outskirts of the metropolis, in complex areas with urban, rural and environmental characteristics.

In order to properly exploit the potential of these areas, profound changes are needed in the process of urban and regional planning and management of Brazilian metropolises, presupposing a new model of governance that takes into account environmental specificities, social dynamics,

7_ Ecosystem services are the benefits that people derive from ecosystems, including, for example, the provision of food, water and timber (provisioning services), climate regulation and air purification (regulating services), soil formation and nutrient cycling (supporting services), and non-material aspects such as mental, aesthetic and spiritual benefits (cultural services) (MEA, 2005).

the various scales of territorial planning and the multiple actors operating in the territory.

It is essential to recognise that the issue of geographical scales is part of the relationship between social processes and spatial forms, which are intertwined in such a way that separating and distinguishing them, even for the purposes of analysis, is problematic (Zioni *et al.*, 2007). This is because many of the processes that are attributed to the local scale are linked to wider regional, national or global processes that transcend it and condition or determine the limits of the actions that take place therein.

The current institutional design of Brazilian urban policies, outlined by the Brazilian Federal Constitution of 1988, tends to obscure the inter-scalar dimension of socio-spatial processes, regional and environmental issues and the modes of political action of the various actors at stake, especially in its regulations on urban policy, by circumscribing specific instruments of local action. In other words, the institutional reform, in particular in its sections on urban policy (articles 182 and 183, which are regulated by the Statute of the City, Federal Law 10.257/2001), introduces new standards for local management that strengthen the role of the municipality in the process of formulating and implementing urban policy, even to the detriment of the role of other spheres of political decision-making that are fundamental to the planning and management of the territory, such as the region and/or environmental units.

In the context of this important legal framework, metropolitan regions, urban agglomerations, and micro-regions (Article 25), which are regional units that were intended to manage common problems of their territory, were deliberately left under the responsibility of the States. Despite the establishment of several metropolitan regions in the country, metropolitan planning and management instruments were defined through the Metropolitan Statute (Federal Law No. 13,089/2015).

In particular, the environmental policy (Article 225) and the water policy (Article 21), which are fundamental to the understanding of this research, have been defined in the 1988 Federal Constitution as concurrent policies; that is, they are common competences of the three levels of government. Thus, whenever there is a need for action that goes beyond the political and administrative limits of the municipality, the hierarchically superior level of government must be considered (Alvim, Bruna and Kato, 2008).

Despite the progress made under the Federal Constitution, especially since the introduction of a democratic municipal planning process and the regulation of its main articles, the planning and management of metropolitan

areas have not been effective. The sectoral vision of public policy that still prevails in urban and state governance adds to the historical deficiencies of metropolitan planning in the Brazilian context, where a municipalist model prevails, making it difficult to solve common problems, especially environmental ones (Alvim, 2019).

In the context of climate change, the formulation of public policies is even more complex, as adaptation plans are not mandatory and specific instruments have only recently been formulated. For example, at the federal level, there is the National Policy on Climate Change (PNMC) of 2009 and the National Adaptation Plan (PNA) of 2016; and existing at the state level are the State Policy on Climate Change (PEMC) of 2009 and the recently adopted Climate Action Plan 2050 (PAC2050) of 2022. However, the visions of these instruments are still partially territorial, without the effective and necessary articulation with urban and regional planning instruments, showing significant gaps in their application.

The lack of a territorial approach to climate change and of a governance model that integrates public policies and various actors (public, private and social) represents a major challenge in building resilient cities and regions.

In the State of São Paulo, and especially in its metropolitan regions⁸, studies emphasise the importance of the regional and multi-scalar perspective and the challenges of integrating territorial policies and governance structures into the climate crisis. They highlight the way in which these issues are linked to socio-spatial inequalities and a scenario in which Brazilian public policies have been weakened in recent years (Campello Torres *et al.*, 2020; Jacobi *et al.*, 2022).

In the context of the São Paulo Metropolitan Region (RMSP)⁹, the most populous metropolitan region in the country, it is the cities and districts of the fringe areas that have shown the highest rate of urban population growth in recent decades, demonstrating intense dynamism and multi-scalar spatial relations that go beyond the existing

8_ The state of São Paulo has eight metropolitan regions established by law: the São Paulo Metropolitan Region (created in 1973, and reorganised by Complementary Law No. 1,139/2011), the Campinas Metropolitan Region (Complementary Law No. 870/2000), the Vale do Paraíba and Litoral Norte Metropolitan Region (Complementary Law No. 1,166/2012), the Sorocaba Metropolitan Region (Complementary Law No. 1,241/2014), the Ribeirão Preto Metropolitan Region (Complementary Law No. 1,290/2016), the Jundiaí Metropolitan Region (Complementary Law No. 1,362/2021), the Piracicaba Metropolitan Region (Complementary Law No. 1,360/2021) and the São José do Rio Preto Metropolitan Region (Complementary Law No. 1,359/2021).

9_ RMSP is composed of 39 municipalities. It contains 21.57 million inhabitants, which is equivalent to 47% of the population of the State of São Paulo, and approximately 10.47% of Brazil's population, more than 50% of the Gross Domestic Product (GDP) of the State of São Paulo and 17.7% of Brazil's GDP. Data available at: <https://emplasa.sp.gov.br/RMSP>. Accessed on: September 30, 2020.

political-administrative boundaries. On the other hand, these areas are home to significant natural remnants and protected areas that provide essential ecosystem services to the metropolis (Marques, 2019; Marques & Alvim, 2021; Mello-Théry & Théry, 2018; São Paulo (Estado). Secretaria de Infraestrutura e Meio Ambiente & Florestal., 2020). This presupposes intense urban and environmental conflicts and complex multi-scalar socio-spatial relations.

The northern region of the Sao Paulo Metropolitan Region, where the Juqueri-Cantareira sub-basin is located, stands out as an area of intense urban population growth, with a number of protected areas and important natural remnants that provide ecosystem services to the metropolis, such as water production and climate regulation.

In the context of urban and regional planning, this sub-basin has been approached with conflicting visions, sometimes serving general regional interests without necessarily developing new local dynamics with a view to sustainable development. On the one hand, the State Government of São Paulo has established environmental protection instruments in the Area of Protection and Recovery of Springs-Alto Juquery (APRM-AJ), with the aim of guaranteeing a water supply to more than 50 per cent of the population of the RMSP. On the other hand, major infrastructure and logistics projects are underway or planned, such as the Rodoanel Norte (North Ring Road), the Ferroanel Norte (North Ring Railway) and large logistics areas such as the New São Paulo Warehouse (NESP) and industrial zones, in a development dynamic that disregards the region's potential for sustainability.

Evidently, the numerous socio-spatial conflicts in the sub-basin are jeopardising both its environmental characteristics and the sustainability of the metropolis. This region is based on a model of urban development that has contributed to an increase in the population growth rate, as evidenced by the latest IBGE population censuses, promoting a model of urban occupation that disregards the fragility of the physical environment associated with the expansion of urban sprawl, which, in a vicious circle, leads to further environmental losses. Having analysed the relationship between vegetation, surface temperature and urban morphology in the metropolitan region of São Paulo, Ferreira (2019) illustrated the environmental problems in the region by highlighting the negative impact of the suppression of vegetation by urban sprawl in the northern subregion, leading to an increase in surface temperature and heat islands in areas with little vegetation.

By recognising similar problems, several metropolitan areas across the globe are currently engaged in the imple-

mentation of plans and projects aimed at fostering resilience in their fringe areas. Such initiatives, despite certain limitations, involve a governance model that presupposes planning that articulates the city, society, and nature, at its multiple scales, from the construction of pathways that signal an ecologically sustainable development model.

In this context, understanding the potential of metropolitan fringes as strategic areas for building resilience in the context of climate change and drawing lessons from reference cases are fundamental to this research.

Using the Juqueri-Cantareira sub-basin (in the northern region of the RMSP) as the object of study, it is assumed that city planning in the Anthropocene era, the first geological era shaped by human activity (Steffen *et al.*, 2011), needs to move toward a new paradigm of territorial planning. This involves a model that, in addition to the implementation of mitigation (reduction of greenhouse gases) and adaptation (reduction of vulnerability) actions, provides for a substantial change in the way in which the urban environment is planned in balance with the natural environment, even if it is anthropised, in order to achieve resilience in a transformative approach. Thus, there is a movement from a linear and extractivist perspective to an approach that integrates city and nature in a regenerative perspective (Heymans *et al.*, 2019; Schröder, 2022a).

Therefore, the following set of key questions guides this research:

1. Why are metropolitan fringes strategic in transforming urban/regional planning towards resilience in the context of climate change?
2. What lessons can be drawn from referential case studies of multiscale planning in metropolitan fringe areas that have contributed to enhancing resilience?
3. What framework can be conceptualised from theoretical and referential cases, regarding the RMSP fringe context, in order to transform fringe areas towards resilience?
4. How can the application of a framework for the assessment of urban and regional plans shed light on pathways to transform the fringes of the RMSP towards resilience?

HYPOTHESIS

The central hypothesis of this research is as follows:

In Brazil, in the face of the challenges posed by climate change, the absence of an urban planning process that articulates regional instruments in the territory, combined with a multiscale and intersectoral governance model that enables new urban development paradigms, consti-

tutes the main obstacle to building pathways for sustainable and resilient development of the metropolitan fringes. Based on the case study of the Juqueri-Cantareira sub-basin in the RMSP, the hypothesis is demonstrated through the conflicts, limitations and challenges of urban planning in the municipalities and districts that comprise this fringe area, in contrast to various regional instruments. The absence of a territorial approach that articulates scales, actors and new planning paradigms results in the maintenance of a planning model based on the fragmented and dispersed city. In the metropolitan fringe areas, the perpetuation of this model disregards the potential of the territory and the possibility of its transformation into a more resilient development model.

THESIS

The broad scope of the research is intended to demonstrate that integrating planning scales and prioritising sustainable development in metropolitan fringe areas are crucial steps for enhancing the resilience of these territories in the face of climate change. It is argued that in the context of metropolitan regions, it is imperative to implement a new governance model for urban and regional planning that articulates different planning scales and sectors, and at the same time promotes inter-municipal cooperation with a view to developing urban strategies and interventions that take account of local specifics, without ignoring regional implications. This approach necessitates a feedback loop from the regional to the local level, whereby plans and projects are developed with consideration of the unique local context, ultimately leading to new territorial dynamics based on a resilient and regenerative paradigm.

OBJECTIVES

This research aims to contribute to the formulation of public policies and academic discussions based on a territorial approach to building resilience by discussing planning pathways towards resilience in metropolitan fringes and viewing these areas as being strategic for the implementation of resilience strategies based on elements drawn from the literature review and referential case analysis.

SPECIFIC OBJECTIVES ARE THEREFORE AS FOLLOWS:

1. To discuss the role of metropolitan fringes and planning in the process of the transformation of urban/metropolitan systems in order to build resilience.
2. To extract lessons from the analysis of referential case

studies of multiscale planning in metropolitan fringe areas, understanding the strategies, policies, and approaches needed to promote resilience.

3. To develop a comprehensive framework articulating planning scales and strategies that can be employed in metropolitan fringe areas to foster resilience and contextualise the framework to the case of the São Paulo Metropolitan Region.

4. To apply the framework to the plans of a focus fringe area in the São Paulo Metropolitan Region to elaborate a set of recommendations for the urban and regional planning of its fringes to promote resilience.

METHODOLOGY

Overall methodological approach

Based on a systemic approach to the research problem and understanding the city as a complex system with multiple dimensions, the research was conducted using a qualitative methodology, although it uses quantitative data for some of its foundations, such as demographic data and greenhouse gas emissions, among others.

Given that climate change is a complex, anthropogenic phenomenon resulting from a development model reliant on non-renewable fossil fuels and an unsustainable pattern of development, and that urban areas play a contributing role in this dynamic, this research adopts a perspective of socio-ecological resilience as a transformative concept (Folke *et al.*, 2011; Elmqvist *et al.*, 2019; Suárez, Gómez-Baggethun and Onaindia, 2019).

In the context of urban and regional planning, and considering the need for profound transformations in the planning model, the methodology was permeated by the understanding that urban systems are comprised of multiple interdependent dimensions associated with governance networks that articulate different actors and scales (Suárez, Gómez-Baggethun and Onaindia, 2019; Wolfram, Borgström and Farrelly, 2019; Krueger *et al.*, 2022).

Applying this debate to the context of the São Paulo Metropolitan Region implied an exploratory and inductive research approach that sought to combine academic discussions on the issue of climate change and urban areas, considering not only the risks and vulnerabilities to which cities are exposed but also the need to transform urban systems towards a more resilient model that combines an ecological urbanism perspective, incorporating various scales, actors and the transformation of urban space with mitigation and adaptation.

Thus, an attempt was made to explore the ways in which the metropolitan areas of global cities have addressed this issue in their respective urban plans and strategies. Three metropolitan areas were chosen: two in the European context (Barcelona and Paris) and one in the Latin American context (Medellin).

An inductive method was therefore adopted to draw lessons and conclusions based on observation and analytical thinking. Due to the complex and interdisciplinary nature of the subject, different methods were used to meet the specific objectives of the research. A combination of theoretical reflections with semi-structured interviews, field visits¹⁰ and the analysis of planning documents ensured a solid foundation on which the research's theoretical framework and practical implications were built.

This methodological trajectory culminated in one of the main innovations of the thesis: the construction of an analytical framework that signposts planning pathways towards resilience, articulating four urban dimensions (Governance; Ecological; Urban; and Socioeconomic) and seven resilience factors (Diversity and Redundancy; Managing Connectivity and Modularity; Flexibility and Innovation; Circularity and Climate Neutrality; Culture; Equity; and Risk Management). Its construction combines the elements and lessons learnt from analysing the reference cases as well as the existing literature on the subject, such as the studies of Suárez, Gómez-Bagetthun, and Onaindia (2019), Marta Berbés-Blázquez et al. (2021) and Krueger *et al.* (2022).

With flexibility, the framework was contextualised to the case of the Juqueri-Cantareira sub-basin, the northern fringe of the São Paulo Metropolitan Region, considering the region's main territorial challenges: (1) Urban Dynamics; (2) Water and Ecosystem Services; and (3) Risks and Vulnerabilities. This therefore allows for urban and regional planning to be analysed in this context and for the advantages, limitations, and recommendations to be discussed with the support of the documental analysis, the spatialisation of the zoning and macro-zoning proposed for the region and the semi-structured interviews.

Figure 1 illustrates this general methodological approach of articulating theoretical reflections, the lessons learnt from reference cases and the construction of the analytical framework applied to a focus area on the fringes of the São Paulo Metropolitan Region.

10_ In the case of Medellin, field visits were not carried out due to the impossibility of travelling. Consequently, the interviews were conducted online.

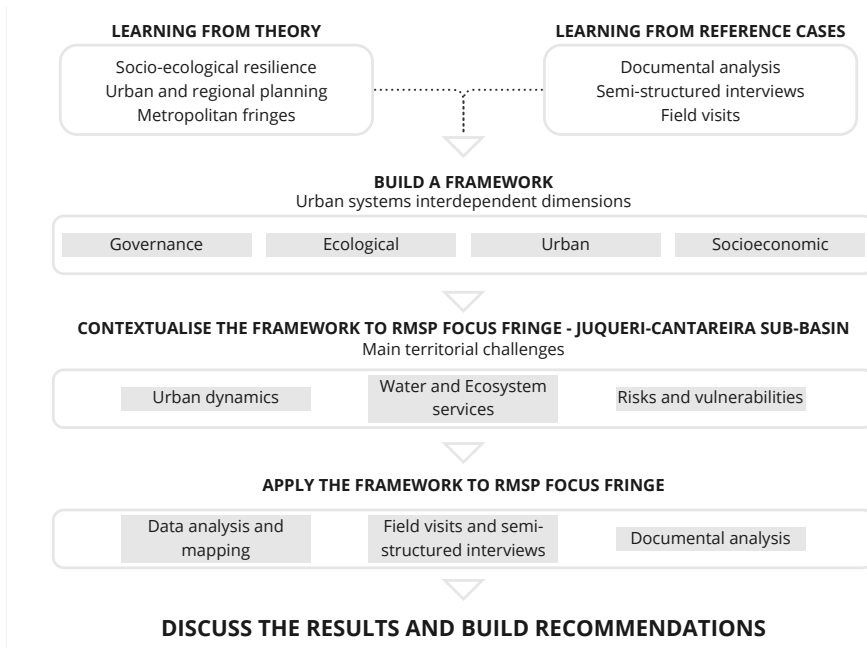


Figure 1 - General methodological approach
Source: prepared by the author.

Regarding the empirical object of this thesis, it is important to emphasize that, in the context of the São Paulo Metropolitan Region, the dynamics of metropolitan and regionalisation are articulated between the metropolitan section (administrative region) and the environmental section (hydrographic basin). The São Paulo Metropolitan Region is divided into five sub-regions¹¹, in addition to the municipality of São Paulo. Meanwhile, the Alto Tietê Hydrographic Basin (metropolitan basin) is divided into six sub-basins¹² that almost coincide with the sub-regions, but the peripheral ones contain part of the territory of São Paulo capital within their boundaries. In this thesis, the sub-basin was chosen as the empirical section for analysis due to the importance of these overlaps and basin sub-committees in the metropolitan region. Additionally, the sub-basin includes part of the territory of São Paulo capital, which cannot be disregarded in territorial dynamics.

Without pretending to exhaust the complexity of the subject or disregard the importance and contribution of sectoral research, this thesis sought to approach the problem from a systemic perspective, combining different scales and dimensions and advocating a territorial and multi-scalar perspective of resilience.

Methodological tools

The methodological tools were articulated based on six interconnected stages: (1) Bibliographical review; (2) Analysis of reference cases; (3) Construction of the analytical frame-

11_ Sub-regions North, East, Southeast, Southwest, West, in addition to the municipality of São Paulo.

12_(1) Alto Tietê-Cabeceiras, (2) Billings-Tamanduateí, (3) Cotia-Guarapiranga, (4) Juqueri-Cantareira, (5) Penha-Pinheiros and (6) Pinheiros-Pirapora.

work; (4) Documentary research; (5) General characterisation and analysis of the Juqueri-Cantareira sub-basin; and (6) Application of the analytical framework.

1. Bibliographical review

First, a rigorous exploration of the existing academic body of knowledge was undertaken. The first phase of the literature review was carried out using the bibliometric analysis method, a quantitative method of statistically analysing published articles and citations to measure their respective impacts, thereby allowing an understanding of a broader picture of the research area and its evolution (Moral-Muñoz *et al.*, 2020). This phase was conducted in the RStudio software (version 4.0.4) using the R bibliometrix package and the BiblioShiny application (Aria and Cuccurullo, 2017), utilising the Web of Science (WoS) online database.

This initial stage, characterised by an extensive literature review, was the foundation for subsequent methodological efforts. It enabled the identification of key concepts and a reflection on the theoretical foundations that have led to a change in the research direction, from an approach focused on adaptation and ecosystem services towards the concept of resilience and a broader understanding focused on the transformation of socio-ecological systems.

2. Analysis of reference cases

To extract elements and lessons from urban and regional planning practice, three referential cases were analysed. These were the Barcelona Metropolitan Area (Spain), the Greater Paris Metropolis (France), and the Metropolitan Area of the Aburrá Valley (Colombia).

The purpose of the analysis was not to compare the three cases, but rather to identify patterns and key reference points for urban policies and strategies related to resilience, specifically in metropolitan fringe areas. A qualitative approach was taken, with the documentary analysis stage involving an examination of the planning documents at the metropolitan, intermediate (in metropolitan fringe areas), and local (urban projects that align with the plans' guidelines) scales.

To complement the analysis of the plans and obtain a more comprehensive outlook, semi-structured interviews were conducted with professionals in diverse roles and positions within the field of urban planning. These interviews were crucial in understanding the intricate interplay of political-administrative dynamics, guiding principles of plans and projects, and strategic trajectories that encompass both metropolitan and urban planning processes geared towards resilience.

3. Construction of the analytical framework

To thoroughly examine the Juqueri-Cantareira sub-basin in the São Paulo Metropolitan Region, a comprehensive analytical framework was crafted by merging theoretical reflections and reference case elements. Next, this step was further refined by adapting a general analytical framework to the specific challenges of the sub-basin through research colloquia held at both Mackenzie Presbyterian University and Leibniz University Hannover. Additionally, the input and guidance of thesis supervisors were crucial in shaping the framework. It was then contextualised in accordance with the primary challenges facing the study area and developed in conjunction with a general characterisation of the region.

4. Documentary research

During this stage, texts and documents from various sources related to the research topic and the empirical object of study were collected and analysed. The intention was to gain a comprehensive understanding of the current state of urban and climate policies in Brazil and the state of São Paulo. After gaining a better understanding of this general panorama, documents formulated by municipalities and the state for the Juqueri-Cantareira sub-basin were collected.

Subsequently, due to the large amount of information collected, the focus was placed on the Master Plans (urban and metropolitan) and Climate Change Adaptation Plans that were drawn up since the City Statute (Law 10.257/2001) and up to 2022, given the timeframe available for the development of this research. However, it is recognised that there are other important sectoral instruments, such as the Macro Drainage Plan and the Mobility Plan, among others.

5. General characterisation and analysis of the Juqueri-Cantareira sub-basin

The region's primary demographic, urban, and socio-economic data were collected, systematised and geo-referenced. The research incorporated Geographic Information System (GIS) technology, specifically the use of QGIS for mapping, thus providing an in-depth contextualisation of the study region and elucidating the intricate spatial relationships, patterns and configurations underlying urban and regional planning strategies, contributing to an understanding of the dynamics of the region and its planning visions.

An attempt was made to spatialise the urban legislation that affects the Juqueri-Cantareira sub-basin, formulated up to 2022, especially the land use and occupation laws

(zoning), to discuss the different public policy approaches concerning its territorial development. Field visits were also carried out at this stage.

6. Application of the analytical framework

This stage involved analysing the planning documents selected in the documentary research stage by applying the analytical framework. The aim was to understand the alignment - or lack thereof - between the strategies contained in these documents and the elements of resilience drawn from the combination of literature review and analysis of reference cases. In addition, a further objective was to understand the ways in which the urban and climate change adaptation plans align or conflict with each other.

This analytical approach served as a lens through which to examine the ways in which the planning strategies reflected the broader theoretical underpinnings. Due to the number of documents, the analysis was developed in MAXQDA software.

To complement the analysis of the plans, semi-structured interviews were conducted with technicians and civil society stakeholders who were actively involved in planning initiatives in the study area.

Materials and Sources

The research draws upon a combination of primary and secondary sources, as well as semi-structured interviews with professionals working in various positions and scales within the field of urban planning and climate adaptation. These sources collectively provide a comprehensive foundation for this thesis, as exemplified below.

1. Primary Sources

The primary sources used in this study comprise a corpus of urban and regional planning documents obtained directly from the municipal authorities and planning agencies of the selected metropolitan regions. As original, unmediated sources of information, these documents offer invaluable insights into the planning strategies, policies, and initiatives adopted in the metropolitan fringes of Barcelona, Paris, Medellin, and São Paulo.

For the reference cases, urban and climate plans were analysed at the metropolitan, intermediate scale (inter-municipal area selected in the fringe) and local (urban projects that exemplify the guidelines adopted at the other scales) level.

In the case of the São Paulo Metropolitan Region, urban and climate plans in the Juqueri-Cantareira sub-basin were analysed, such as the Urban Development Plan for the São

Paulo Metropolitan Region (PDUI-RMSP), the Master Plans of the municipalities that comprise the sub-basin, the climate change adaptation plans (existing only in São Paulo and Francisco Morato) and the District Plan of the Perus Sub-prefecture. In addition, all municipal zoning maps were collected, with a uniform legend being assigned to these urban instruments, before spatialising them to understand the general overview of urban planning in the region.

A detailed list of all of the analysed plans is described in Chapter 2 (reference cases) and Chapter 3 (Juqueri-Cantareira sub-basin, São Paulo Metropolitan Region). These documents are essential for gaining firsthand knowledge of the urban planning dynamics in different scales.

2. Secondary Sources

In terms of bibliography, the secondary sources employed in this thesis cover two distinct categories. Firstly, an extensive collection of literature relating to the intersection of urban and regional planning, resilience and climate change was utilised, and secondly, a specialised set of sources was compiled, focusing on reference cases and particularly on the São Paulo Metropolitan Region.

In the first category, this thesis draws on a rich and varied body of academic literature and research articles. These sources offer critical analyses, interpretations and comprehensive syntheses of concepts and theories. Additionally, the thesis delves into a more specialised set of secondary sources from the second category. These sources are dedicated to examining the reference cases and the case of the São Paulo Metropolitan Region, their respective contexts and urban and climate policies. In both cases, the main sources were the Web of Science database and Google Scholar.

In addition to the bibliography, another source of secondary data used refers to the data used for the general characterisation of the Juqueri-Cantareira sub-basin and São Paulo Metropolitan Region, such as demographic data from the IBGE Census (2010), Fundação Seade, Environmental Spatial Data Infrastructure for the State of São Paulo (DataGeo), São Paulo Geological Institute (IG), Brazilian Geological Service (CPRM), MapBiomas and System Gas Emissions Estimation (SEEG).

3. Semi-Structured Interviews

In addition to primary and secondary sources, semi-structured interviews were conducted with urban planning professionals from various roles and scales in selected metropolitan areas. In all cases, the emphasis was on pro-

professionals involved in urban and regional planning and the climate issue, but in the São Paulo Metropolitan Region some civil society actors involved in the planning process were also interviewed. A detailed list of all the interviews is described in Chapter 2 (reference cases) and Chapter 3 (Juqueri-Cantareira sub-basin, São Paulo Metropolitan Region). The names of the interviewees have been kept confidential.

In order to better understand the planning process, conflicts and limitations, a semi-structured format allowed for flexibility in exploring the interviewees' perspectives. Such insights provide additional inputs to the documentary analysis.

Primary and secondary sources, complemented by insights from the semi-structured interviews, form the cornerstone of the materials and sources used in the methodology. Specifically, the primary sources ground the study in the specific planning contexts of the selected metropolitan regions, while the secondary sources provide the theoretical and conceptual framework. Furthermore, the interviews bring real-world experiences and practitioners' perspectives into the academic discourse, facilitating a well-rounded and general analysis of urban and regional planning in the metropolitan areas of Barcelona, Paris, Medellín and, more specifically, São Paulo.

Thesis structure

The integration of diverse materials and sources, through the presentation of arguments, discussions, and reflections, has been structured and navigated throughout the chapters. To this end, the thesis is structured in four chapters, aligned with the research questions and objectives, in addition to this introduction and the conclusion (Figure 2).

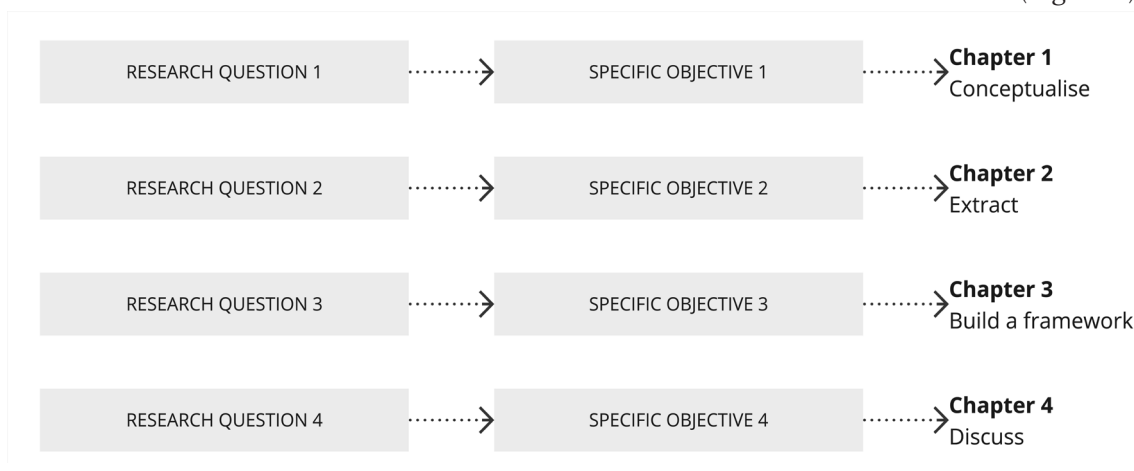


Figure 2 - Diagram illustrating how the research questions relate to the objectives and overall structure of the thesis.
Source: prepared by the author.

Chapter 1 contains a discussion of the theoretical-conceptual framework of the research, introducing its main concepts. First, an introduction to climate change, its general causes and impacts on urban areas is presented. Then,

an overview of the different responses to the climate and environmental crisis is outlined, addressing the main international agreements, and deepening a discussion on mitigation, adaptation, and resilience, focusing on urban areas.

Initially, the research focused on adaptation to climate change and the ecosystem services concept and framework in the context of urban planning. However, after a comprehensive review of the literature through bibliometric analysis, the research changed direction, focusing instead on the concept of resilience. This new direction encompasses the integration of nature within cities and, consequently, the enhancement of urban ecosystem services, but with an understanding of the necessity of profound transformations in urban and regional planning, and from a more ecological and regenerative perspective.

In this sense, socio-ecological resilience is used, which considers the capacity of a society and its ecological systems to adapt and transform in the face of changes and disturbances. The concept of socio-ecological resilience seeks a broader and more integrated understanding of urban dynamics, recognising the interactions between the built and natural environments. In this way, cities and regions must transform profoundly (McPhearson *et al.*, 2016; Heymans *et al.*, 2019). Finally, the role of urban and regional planning in the transformation process is discussed, focusing on the fringes as strategic areas and taking into consideration their dynamics, scales, and opportunities.

Chapter 2 contains an analysis of the urban and adaptation plans in three metropolitan areas: Barcelona Metropolitan Area (Spain), the Greater Paris Metropolis (France), and the Metropolitan Area of the Aburrá Valley (Colombia).

The analysis of the reference cases relied on an analytical research methodology involving documentary analysis, field visits, and interviews. Its purpose was not to establish a comparison between the three cases but rather to find patterns and the main points of reference of urban policies and strategies related to resilience, focusing on metropolitan fringe areas.

Next, Chapter 3 is dedicated to constructing a method for analysing São Paulo Metropolitan fringe planning visions framing resilience. At first, a general analytical framework was formulated based on theoretical insights and the analysis of reference cases, which was crucial for obtaining a comprehensive understanding of the theme and establishing an initial conceptual basis. However, due to its generic nature, which resulted from the systematisation and homogenisation of crucial elements from the reference cases, it was necessary to contextualise the framework to the specific case of the Metropolitan Region of Sao

Paulo, with a particular emphasis on the empirical object of this research: the Juqueri-Cantareira sub-basin.

The contextualisation involved reviewing the literature and planning policies to gain an understanding of the Brazilian urban planning system and its integration with climate-related matters, which provided an overview of the contextual setting for urban and climate policies in Brazil, with an emphasis on the State of São Paulo and the São Paulo Metropolitan Region (RMSP). In addition, a detailed analysis of the RMSP fringes was conducted, focusing on the Juqueri-Cantareira sub-basin. This stage highlighted the critical urban, environmental, and social characteristics of the region.

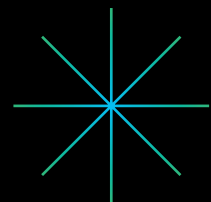
After analysing the data and gaining a deeper understanding of the challenges of the territory, a final step in the contextualisation of the framework was conducted. Discussions were held in Colloquia at Mackenzie Presbyterian University and Leibniz University Hannover, and in supervision sessions with Prof. Dr. Angélica Benatti Alvim and Prof. Dipl.-Ing. Jörg Schröder, to identify the main issues and challenges of the territory. Consequently, three categories were identified, namely: (1) urban dynamics; (2) water and ecosystem services; and (3) risks and vulnerabilities.

Finally, Chapter 4 consisted of applying the framework and discussing the results, including a critical analysis of the existing planning instruments. The contextualised framework was applied to the analysis of the São Paulo Metropolitan Region, focusing on urban and adaptation plans at regional and local planning scales.

To enhance the analysis of the plans, semi-structured interviews were conducted with actors involved in urban and climate planning at various levels, as well as civil society representatives. Additionally, QGIS software was used to perform spatial analysis of pertinent data in the region. Individual and group¹⁵ field visits were also conducted.

13_ One of these visits was developed under the research network “Cities, Infrastructure and Adaptation to Climate Change” in the “1st International Workshop on Infrastructure, Resilience and Adaptation of Cities” and counted with researchers from different Brazilian and international universities, who could visit and discuss the territory.

**Theoretical Perspective:
Climate Change,
Resilience and Urban and
Regional Planning for
Metropolitan Fringes**



This chapter delves into the theoretical and conceptual framework of the research, outlining the main guiding concepts of the thesis. The focus centers on the pressing issue of climate change, examining the concept of resilience from an urban and regional planning perspective. Particular emphasis is placed on the role of metropolitan fringe areas and their planning perspectives within this context. Through this discussion, the aim is to explore the critical role of metropolitan fringes and planning in the transformation of urban/metropolitan systems, ultimately in building resilience.

To this end the chapter is structured in four parts. First, a brief introduction to the issue of climate change, its causes, and its effects on urban areas is argued. It is discussed how urban areas contribute to the climate crisis through high emissions and resource demand. Given this current setting, there is a need to build a new urban planning paradigm that is based on ecological and regenerative principles.

Thus, the concept of socio-ecological resilience is explored, which, when discussed in the urban context, focuses on the capacity of a complex urban system to adapt, and transform in response to this crisis scenario. Building resilient urban environments involves transforming urban systems into a connection between human needs and the biosphere's capacity. This perspective challenges the traditional planning paradigm based on stability and predictability and calls for an understanding of resilience as transformation.

Subsequently, the concept of Metropolitan Fringe is discussed and defined as complex areas made up of small and medium-sized districts and municipalities on the border of metropolitan areas with urban, environmental, and rural characteristics. The argumentation draws on the importance of the dynamics present in these areas, such as urban population growth, their environmental and territorial characteristics, and the multiple scales that relate to these complex territories will be emphasised and explored throughout the chapter.

Finally, the role of urban and regional planning in metropolitan fringe areas is put into perspective, considering the necessary transformation and paradigm shift process that the current scenario of climate change imposes on us. Based on this, it is argued that metropolitan fringes are in a strategic position to build resilience through planning and governance, offering innovative possibilities and pathways for their territorial development.

1.1 CLIMATE CHANGE: GENERAL CAUSES AND EFFECTS IN URBAN AREAS

The complexity and challenges of the contemporary world require interdisciplinary approaches that aim to address the main challenges of this century from a systemic perspective. The discussion about sustainable development has gained increasing prominence in the public debate, pointed out by authors from different areas of knowledge as one of the main challenges of the 21st century (Martins and Ferreira, 2011; Raworth, 2019).

Before discussing the scale of cities or urban agglomerations, it is necessary to realise that drastic changes in production and consumption patterns, especially during the 20th century, have brought about significant transformations in the planet's climate, which unfold at global, regional, and local levels.

The idea that technological advances and economic growth alone have translated into constructing a fairer and more equal society has not materialised. Although several indicators demonstrate progress, such as the increase in the middle class and life expectancy, there is concrete evidence that human activities have exerted tremendous pressure on natural systems that consequently have generated changes in climate. Since the Industrial Revolution, the world has undergone profound demographic and economic changes that have transformed global production and consumption patterns and generated intense pressure on natural ecosystems. The second half of the 20th century presented the most intense and rapid transformations in global ecosystems ever documented in human history, resulting in the degradation of the biodiversity of terrestrial and aquatic systems, species extinction, and increased emission of polluting gases into the atmosphere (IPCC, 2007; Steffen *et al.*, 2011; Raworth, 2019).

Throughout the twentieth century, cities were shaped by a paradigm of unlimited economic growth, dependence on fossil fuels for industry and mobility, and the inexhaustible use of natural resources (Herzog, 2013).

The graph below illustrates the demographic changes and consumption growth in some sectors on a global scale from 1750 to 2000, clearly showing the growth in world population after the industrial revolution and a convergence in the growth curve of urban population, gross domestic product, foreign investment and consumption of water, fertiliser, transport, communication and other services from the 1950s onwards (Figure 3).

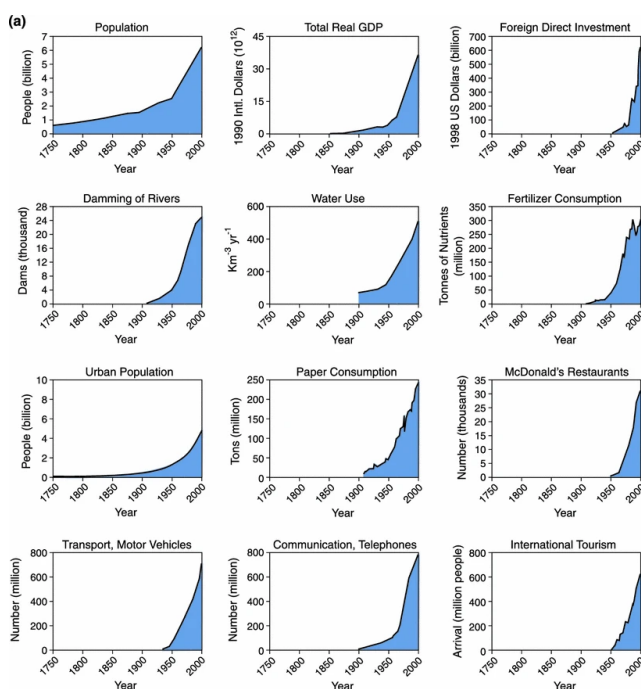


Figure 3 - Population increase and global demands in different sectors from 1750 to 2000. The growth in population, economy, and demand for different products and services after 1950 stands out. Source: Steffen *et al.*, 2011

Data from the Fifth Report of the Intergovernmental Panel on Climate Change (IPCC, 2014a) show that the leading cause of global temperature rise is human action, mainly through the emission of greenhouse gases (GHG) into the atmosphere from forestry and other land use changes, as well as fossil fuel burning, cement production, and combustion.

The growing number of GHG emissions has implied an average increase of 0.85°C in global temperature, combining land and ocean surfaces between 1880 and 2012, and rising sea level (Figure 4). In this context of significant transformations in global ecosystems and scientific consensus on the increase in global temperature and its implications for the Earth’s climate, the concept of Climate Change emerges¹⁴. With human activities at the centre of the causes of climate change, we have moved as a society into the Anthropocene era, the first geological era shaped by human activity.

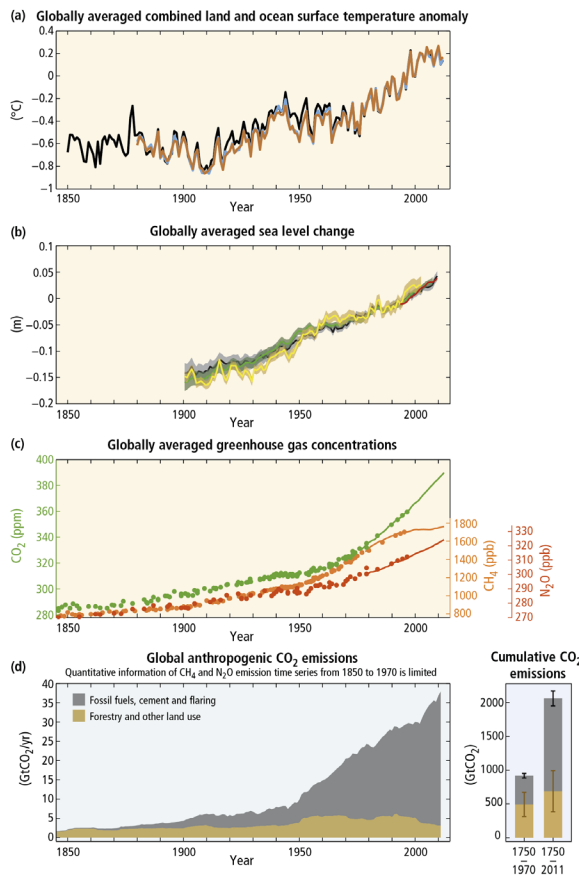


Figure 4 - Rising global temperatures, rising sea levels and increasing greenhouse gas emissions highlighting human action in this process. Source: IPCC, 2014

In this new era, the global environment is experiencing a high level of environmental degradation and biodiversity loss that jeopardises the climatic conditions that have ensured humans an appropriate setting for their activities over the past 10,000 years (Steffen *et al.*, 2011).

This scenario requires changes in different sectors of society, new forms of production, consumption, and lifestyle to achieve sustainability, defined as meeting the societal needs of the present without compromising the capacity of future generations to meet their own needs (Brundtland, 1987).

14_ For the IPCC “climate change refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or variability of its properties and that persists for an extended period, typically decades or longer. Climate change can be due to natural internal processes or external forcings such as modulation of solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or land use.” (IPCC - 2018 p.55)

In this discussion, cities have stood out since the urban settlements are home to more than half of the world’s population and concentrates a large part of greenhouse gas emissions.

In this perspective and considering that urban population growth is a trend for the coming years, a scenario arises in which cities play a fundamental role in the balance and sustainability of the planet. Different institutions and international agreements, such as the United Nations (UN) and the Intergovernmental Panel on Climate Change (IPCC)¹⁵, have recognised and highlighted the importance of urban settlements in tackling climate change to promote adaptation and mitigation.

The UN, in the document “Transforming Our World: The 2030 Agenda for Sustainable Development (UN, 2015) recognises the relevance of urban development as an instrument capable of improving the quality of life in cities and promoting sustainability, in particular, goal 11 “Make cities inclusive, safe, resilient, and sustainable”. Additionally, the New Urban Agenda, adopted by the General Assembly of the United Nations in 2016, is directly related to the Sustainable Development Goals, providing a framework for achieving SDG 11 and the other SDGs based on three pillars: inclusion and justice, resilience and sustainability, and governance and participation.

Still on the importance of cities, the fifth IPCC report has a chapter of Working Group 2 dedicated to the urban environment (Chapter 8 - Urban Areas) and Working Group 3 also has a chapter dedicated to transport (Chapter 8) and buildings (Chapter 9) (IPCC, 2014b, 2014a). The IPCC has also produced a special report that discusses climate change and land use (IPCC, 2019), and the Brazilian Panel on Climate Change (PBMC) has a specific report on climate change and cities, which addresses the contribution of urban areas to global warming and the impacts of climate change on cities, especially those in Brazil (PBMC, 2016).

The latest IPCC report (AR6) has a chapter focused on Cities, Settlements, and Key Infrastructure (AR6 WGII Chapter 6) (Dodman *et al.*, 2023). Furthermore, AR6 emphasises in other chapters that urban areas are global warming hotspots. Factors such as urban form, local human activities, and materials used are among the factors that contribute to the phenomenon of heat islands in urban areas. In addition, elements such as green and blue infrastruc-

ture, which diminish the effects of heat islands and reduce temperature, are generally scarce in urban areas (Figure 5).

FAQ 10.2: Why are cities the hotspots of global warming?

Cities are usually warmer than their surrounding areas due to **factors that trap and release heat** and a lack of **natural cooling influences**, such as water and vegetation.

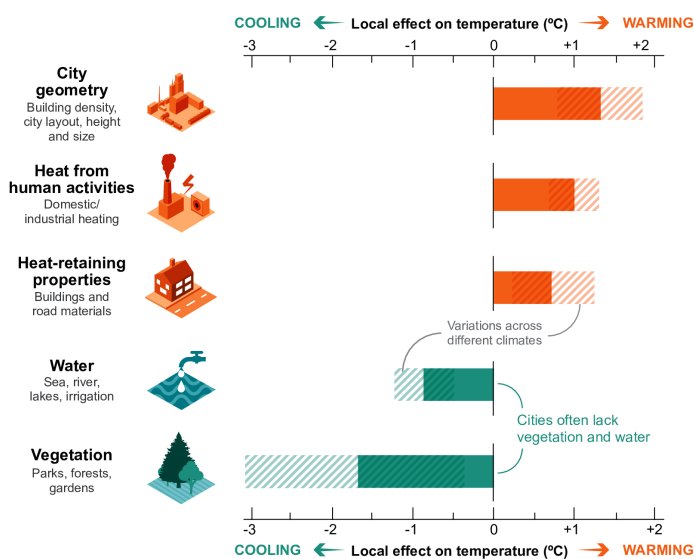


Figure 5 - Why are cities the hotspots of global warming?Source: IPCC AR6 WGI Chapter 10 p. 1463 (Doblas-Reyes *et al.*, 2021)

15_ The IPCC was created in 1988 by the World Meteorological Organization (WMO) and the United Nations Environmental Programme (UNEP) and currently has 195 member countries, including Brazil. The central objective of the IPCC is to provide scientific information to subsidise climate policies.

According to data from the mentioned reports, the risks, vulnerabilities, and impacts of climate change are increasing in all urban areas of the planet, in cities of all scales and socioeconomic characteristics. However, at the global level, the fastest urban vulnerability growth occurred, especially in unplanned and informal settlements in low- and middle-income countries and in smaller and medium-sized cities, where adaptation capacity is limited (IPCC, 2014a; Dodman *et al.*, 2023).

Regarding the scale of cities, it is essential to emphasise that the increase in urban population has occurred mainly in medium and small cities and in developing countries (ALLEN, M.R. *et al.*, 2018) which corroborates Brazilian projections (IPEA, 2015). With the recent COVID-19 pandemic, population migration to these cities in search of a better quality of life may intensify, demonstrating the relevance of discussing the fringes of metropolises.

Despite the many uncertainties around measuring the actual adverse effects of climate change on urban settlements, some of the main expected impacts are sea level rise; storms and extreme precipitation events; heat stress and heat islands; floods; landslides; droughts; pollution; water scarcity; fires; and parasitic infections and diseases (IPCC, 2014a, 2018). Table 1 summarises the main impacts of climate change on urban areas based on three classifications: changes in averages, extremes, and phenomena.

CLIMATE CHANGE	IMPACTS IN URBAN AREAS
CHANGES IN AVERAGES	
Temperature	Increasing energy demand (heating/air-conditioning); deteriorating air quality; heat islands.
Precipitation	Increased risk of flooding; increased risk of landslides; migration from rural areas; disruption of food supply networks.
Sea Level Rise	Coastal flooding; reduced income from agriculture and tourism; salinisation of water sources.
CHANGES IN EXTREMES	
Extreme rainfall/tropical cyclones	More frequent flooding; increased risk of landslides; damage to homes, factories, and urban infrastructure
Droughts	Water scarcity; higher food prices; disruptions to the hydroelectric system; migration from rural areas
Heat/cold waves	Higher energy demand in the short term (heater/air conditioning)
Abrupt climate change (still unlikely, but increasingly considered)	Possible impacts of extreme sea level rise; possible impacts of a rapid and extreme rise in temperatures
CHANGES IN EXPOSURE	
Population movements	Migration from affected rural habitats
Biological Changes	Increase in disease vectors

Table 1 - Impacts of climate change on urban areas. Source: Martins and Ferreira (2011).

Since 70% of global carbon emissions originate in cities, and they are particularly vulnerable to climate change effects, urban areas are recognised as key to the ecological transition process (Crippa *et al.*, 2021). Urban agglomerations must devise strategies in this regard that will enhance the resilience of local communities.

1.2 RESPONSES TO THE CLIMATE CRISIS: TOWARDS RESILIENCE AS TRANSFORMATION

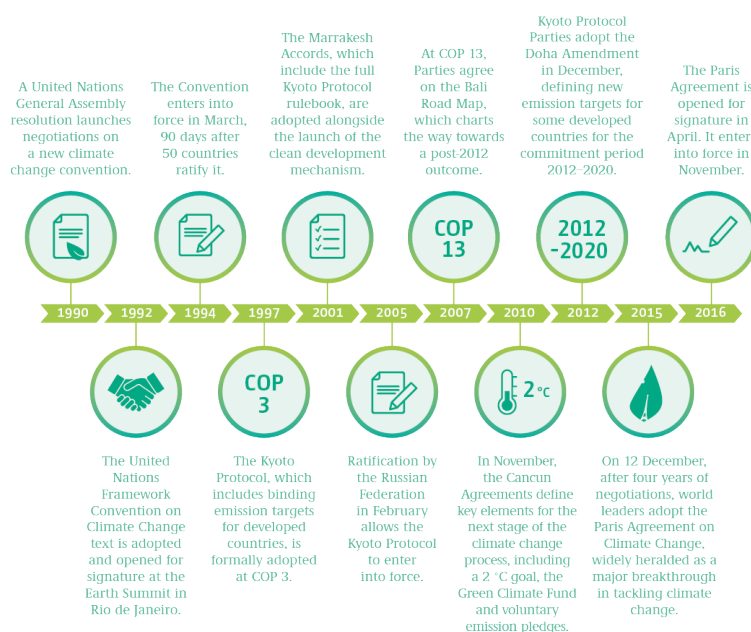
Several fields of knowledge and institutions have sought to build answers to the climate crisis. In this context, it is worth highlighting the main concepts that emerge from this debate and the leading international agreements.

The concept of sustainable development arises in response to the crisis of the traditional vision of development, a notion that, based on the discourse of economic growth, treats the environment as a source of inexhaustible resources to be exploited (Bellen, 2007; Sachs, 2009). Although there is a scientific consensus¹⁶ on climate change and its causes, there is no consensus on what “sustainability” means. On the contrary, sustainability is a concept under construction and disputes that encompasses authors from different spectrums.

In the 1960s and 1970s environmental discourse, the predominant perspective pointed to sustainable development paths with a majority of State participation. In the 1990s, especially after the Brundtland report, the idea of incorporating other actors - including the market - in constructing agendas and public policies aimed at sustainability became predominant (Kull, Sartre, De and Castro-Larrañaga, 2015).

Within the discussions about environmental degradation and the need to rethink the current development model, some critical international milestones emerge in which the UN plays a fundamental political-institutional role. Rio92¹⁷ played a central role in the formulation of guidelines and the global agenda for tackling climate change, since it was at this conference that the United Nations Framework Convention on Climate Change¹⁸ (UNFCCC) was signed, including the commitment of most industrialised countries to implement the framework's guidelines and stabilise their GHG emissions (Martins and Ferreira, 2011).

After Rio 92, there were other important milestones with more ambitious targets, such as the Kyoto Protocol signed at the Third Conference of the Parties (COP3) in 1997. Subsequently, other COPs and agreements were signed between UN member countries. Since the Paris Agreement, in addition to the adherence of nation-states to climate commitments, there has been the recognition of non-state actors, i.e., companies, civil society organisations, and subnational governments (e.g., municipalities, states, and metropolitan governments) as key actors. For Macedo and Jacobi (2019) this possibility highlighted the role of cities and local actions in tackling climate change and strengthening mitigation and adaptation efforts.



Although there are many criticisms of the noncompliance with these agreements and the need to establish more effective governance models to fulfil the targets (Jacobi and Sinisgalli, 2012), such agreements still play an important role in the international arena (Figure 6).

Figure 6 - Timeline of key institutional milestones of the UN on climate change. Source: United Nations Climate Change. Available at: <https://unfccc.int/resource/annualreport/>. Access in July 2023.

16_ It is widely accepted among the scientific community that global temperatures are increasing, and that this is leading to climate change. The evidence suggests that both natural events, such as solar cycles and volcanic eruptions, and human activities, such as greenhouse gas emissions and changes in land use, are contributing factors. More information can be found at: <https://climate.nasa.gov/scientific-consensus/>. Accessed on 20th December, 2022.

17 _ United Nations Conference on Environment and Development.

18_ Article 01 of the Framework Convention defines climate change as: “a change in climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to the natural climate variability observed over comparable time periods.” ((UN, 1992)

In the context of this work, one of the notable initiatives fostered by the UN is the Millennium Ecosystem Assessment (MEA). Called for by the then-Secretary-General of the UN, Kofi Annan, in the 2000s, the MEA addressed sustainable development from a systemic perspective, considering human well-being and the guarantee of ecosystem services as pivotal elements for new development perspectives.

The assessment was designed to understand the consequences of ecosystem change on human well-being and the scientific basis for developing studies and public policies that address this issue. The work involved over 1,300 experts worldwide who, in collaboration, produced a scientific-technical report containing five volumes whose findings revealed declines in biodiversity and cultural services, clean water (for human consumption and production), air quality and climate regulation (particularly at local and regional levels), among other factors.

The concept of Ecosystem Services (ES) developed in the context of the MEA encompasses not only the benefits related to the environmental dimension of ecosystems but also includes social and cultural aspects in building integration between man and nature. Based on previous studies (Costanza *et al.*, 1997; Daily, 1997), the MEA defined the concept of ESs as the benefits that humans obtain from ecosystems and established four categories for assessing these services, namely:

Support services: elements necessary for producing ecosystem services (e.g., soil formation and nutrient cycling).

Provisioning services: goods produced or provided by ecosystems (e.g., food, water, wood, and fuel).

Regulating services: benefits arising from the natural regulation provided by ecosystems (e.g., climate regulation, flood regulation, water purification).

Cultural services: non-material benefits promoted by ecosystems (e.g., leisure, aesthetics, spirituality, and education).

All these categories are related to the concept of human well-being, defined in the report as the guarantee of material and non-material conditions which promote well-being, including safe and adequate means of living, food, shelter, and access to goods, health, a healthy physical environment, and freedom of choice, all within a framework of balance between ecosystems and human needs.

This relationship allows us to reflect on the dependence of human species on nature and the strength of the influence of ecosystem services and other economic, social, technological, and cultural factors on human well-being, and vice versa, as illustrated in Figure 7. The results of the assessment point in general to degradation¹⁹ socio-environmental caused by a predatory use of human and natural capital that jeopardises the quality of life of future generations.

19_ At the global scale, there has been a reduction in biodiversity, a reduction in freshwater (for human consumption and production), a worsening of air quality and climate regulation (especially at the local and regional level), among other factors. Regarding cultural services, there has been a decrease in natural areas intended for aesthetic uses (recreation and contemplation) and rapid decline of sacred fields and species. The assessment also indicated that about 60% of the SE assessed (15 out of 24) are in a state of degradation or have been used unsustainably. The report gathered evidence that some changes in ecosystems are potentially irreversible and have important consequences for human well-being, such as increased disease, decreased quality of life and changes in regional/local climate (MEA, 2005).

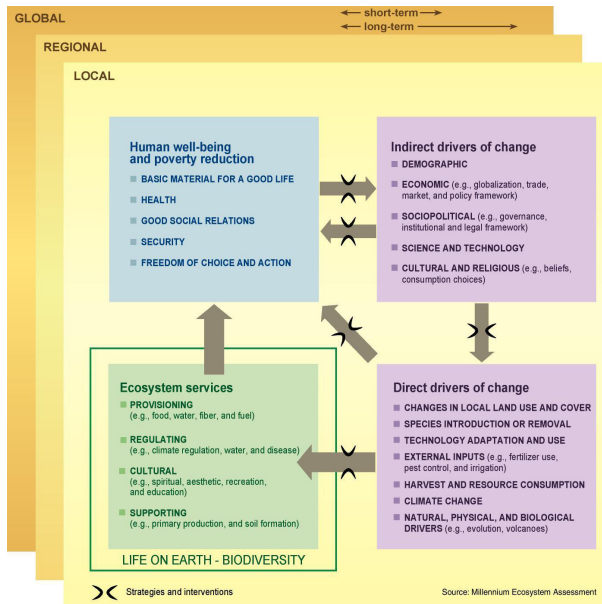


Figure 7 - Conceptual framework of the interactions between biodiversity, ecosystem services, human well-being, and transformation factors. Source: Millennium Ecosystem Assessment, 2005, p. VII.

At the beginning of the development of this thesis, the focus of the research was on adaptation to climate change and the Ecosystem Services approach in the context of urban planning. However, after a comprehensive review of the literature, there was a change of direction, starting to focus on the concept of resilience.

The first phase of the review was performed using the bibliometric analysis method, a quantitative method of statistical analysis of published articles and citations to measure their respective impacts. Given the large volume of academic and scientific production, the bibliometric method provides a structured analysis of a large volume of information, allowing the researcher to understand a broader picture of a research area (Moral-Muñoz *et al.*, 2020). This phase was conducted in the Software RStudio (version 4.0.4) with the use of the bibliometrix R-package and BiblioShiny app (Aria and Cuccurullo, 2017) to carry out a quantitative analysis of the articles retrieved from the Web of Science (WoS) online database, following the steps shown in Figure 8.

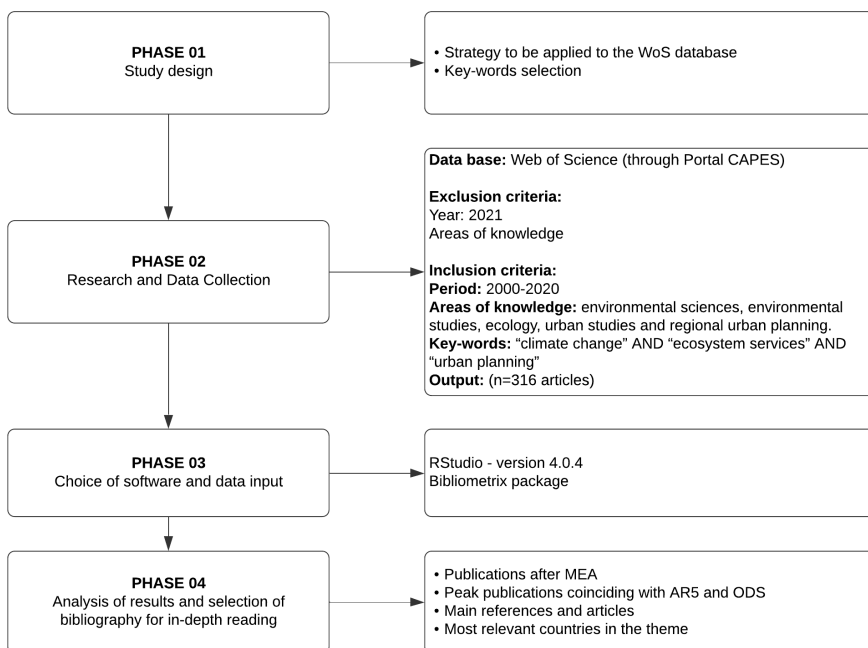


Figure 8 - Bibliometric review research protocol. Source: Prepared by the author.

After the quantitative analysis, which allowed the identification of trends, prominent authors, countries, and references that address the theme, a second stage began with a qualitative analysis character. Based on the number of citations, the twelve articles with the highest impact were selected for a detailed reading to understand whether the authors established a relationship between ES and the challenge of climate change in the urban context and to identify the method proposed by each publication (Table 2). During the screening of this second phase, the article “Managing aquatic ecosystems and water resources under multiple stress - An introduction to the MARS project” by H. Gering and “Biogeochemical C and N cycles in urban soils” by K. Lorenz was excluded because it addressed particular aspects which were not closely related to urban issues.

	Relationship between Ecosystem Services and tackling climate change in the urban context addressed?	Method employed?
Sandifer, Sutton-Grier and Ward (2015)	Partially. The study made an association between ESs and adaptation to climate change but focused more on health-related benefits in the form of human well-being. The authors highlighted the need for a new vision of urban planning focused on human well-being and a fresh interdisciplinary approach.	The review of the literature focused on high-relevance peer-reviewed articles. Given the interdisciplinary nature of the subject matter, articles from different knowledge areas were reviewed (ecology and ecosystem services, public health, biomedicine, urban planning, psychology, among others).
Norton et al. (2015)	Yes. The study reports a direct relationship between ESs provided by green infrastructure and adaptation to climate change, with an emphasis on mitigating high temperatures in urban areas, citing other complementary benefits.	Quantitative assessment with the use of GIS software combining census/demographic data, temperature, land use, and social vulnerability.
Demuzere et al. (2014)	Yes. The article notes that green areas/infrastructure promote ecosystem services that yield biophysical and psychological benefits, while also helping toward adaptation to and mitigation of climate change. The categories showing the greatest evidence were: health and restoration benefits, social and individual response capacity, and education; flood reduction, improvement in water quality, and reduction in CO ₂ .	Systematisation of evidence found in the literature on benefits of urban green infrastructure for adaptation and mitigation of climate change on three different scales.
Lovell and Taylor (2013)	Yes. The authors argue that cities are socioecological systems and that promoting ecosystem services in urban areas through green infrastructure, together with the participative process, increases resilience and adaptation to the challenges of climate change.	Review of the literature, description of tools supporting the application of green infrastructure, and selecting strategies to engage the community in the planning process.
Niemelä et al. (2010)	Yes. The authors show that the ESs approach provides an opportunity for urban region planning from a more ecological and sustainable perspective and that conservation of ecosystems and urban planning can mitigate the effects of climate change on urban regions.	Qualitative assessment on how the ESs approach has been used in planning and conservation of green areas based on the case of Finland.
Kabisch et al. (2016)	Yes. However, the authors used the concept of NbS, pointing to the benefits of ecosystem-based solutions for adapting and mitigation of climate change in the context of cities. The authors recognise that the NbS concept is linked to other concepts involving ecology aspects proposing solutions for cities, such as "green infrastructure", "ecosystem-based adaptation", among others.	Qualitative assessment based on a workshop involving experts from different disciplines addressing NbS and their relationship with adaptation and mitigation of climate change. The workgroups discussed: (1) indicators to measure the effectiveness of NbS for mitigation and adaptation to climate change and associated benefits; (2) gaps in knowledge on the effectiveness of NbS in cities; (3) barriers to implementing NbS; and (4) opportunities to facilitate NbS action.
Haase et al. (2012)	Partially. The article does not make a direct reference to the climate change issue, but touches on the role of ESs in urban regions for improving local climatic conditions, potential for the areas of recreation and biodiversity, food production, and carbon absorption.	A quali-quantitative assessment using GIS software drawing on land cover data (1990, 2000 & 2006) and ES indicators of local climate regulation, carbon storage above land, biodiversity potential, food production and recreation potential.
Matthews, Lo and Byrne (2015)	Yes. However, the authors focus on the concept of green infrastructure.	Qualitative method of reviewing the literature and conducting semi-structured interviews with urban planners from academic and both public and private sectors engaged in climate change, land planning, and green infrastructure.
Salmond et al. (2016)	Yes. The results highlight ESs that benefit the local context and help promote adaptation to climate change, but also reveal ecosystem "disservices" at a local scale, such as increasing pollen and allergies.	Qualitative method of reviewing the literature based on a matrix of ecosystem services focused on urban areas at a local scale.
Meerow and Newell (2019)	No. The article provides a critical analysis of the urban resilience concept, associated with climate change, showing its tensions, conflicts, and trade-offs.	Qualitative method with scenario modelling using GIS software.
Gill et al. (2008)	Partially. The article cites the potential of ES services and green infrastructure in the context of climate change, but its scope centres on methodologies for characterising urban areas (land cover, more accurate mapping of green areas) to support plans and projects related to the issue.	Urban morphology type mapping and land surface analysis to support ES assessments and aid green infrastructure planning and strategies for adaptation to climate change based on the case of a region in Manchester (UK).
Grêt-Regamey et al. (2008)	No. The articles involve a model for assessing and valuing ESs for building scenarios to aid decision-makers in visualising impacts. The authors make an association between ESs and local benefits, but not with climate change.	Scenario building, process of modelling, and economic evaluation, all integrated in GIS software, followed by building scenarios for assessing impacts.

Table 2 - Analysis of the most relevant articles selected from the review of the literature.

The results of this review were published in the Sustainability Journal (Marques, Alvim and Schröder, 2022) and demonstrated the emergence of scientific interest in the relationship between ecosystem services and adaptation to climate change. The ESs concept has made a significant contribution in the area of urban planning, integrating different areas of knowledge to help weigh the importance of the benefits that humans can obtain from nature and establish new models of development and planning in cities and approaches promoting adaptation to climate change.

Within the area of urban planning, the concepts of Ecosystem Services (ESs), Green Infrastructure (GI), Ecosystem-based Adaptation (EbA) and Nature-based solutions (NbS) overlap in many ways yet differ concerning the clarity of their definitions and practical applicability in the urban planning process. For instance, the Green Infrastructure (GI) concept is the most consolidated as regards application, whereas Ecosystem Services has a more well-established definition over a more extended period, but in the urban planning field, it commonly requires other concepts to allow its more comprehensive implementation. Although all of these concepts address climate change to some extent, EbA and NbS are more focused on strategies for adaptation to climate change (Pauleit *et al.*, 2017).

The pattern that seems to be present in the background of these concepts applied to urban planning is the incorporation of nature as a central element for the adaptation of cities in the face of climate change, as part of the quest for connection between human needs and the capacity of the biosphere. This interpretation is close to the concept of resilience from a social-ecological perspective that is based on the idea that building resilience not only means adapting or responding to crisis and change but also transforming social-ecological systems toward sustainability, understanding resilience as transformational capacities, which involves new ways of planning cities and thinking the relationship between the natural and the built environment (Wolfram, Borgström and Farrelly, 2019; Folke *et al.*, 2021).

This theoretical thoughtfulness unfolded into a reflection on the evolution of addressing the climate issue in the context of urban planning. Although the issue of integrating nature is a central factor when considering the scope of urban and regional planning, this issue cannot be incorporated in a sectoral manner. In other words, it is not just a matter of incorporating green infrastructure into cities but of seeking to transform the current unsustainable and disintegrated system on which the cities of the 20th century were based.

In this sense, research in the field of urban ecology produced by many of the seminal authors found in the review of the literature has moved from ‘ecology in cities’ to ‘ecology of cities’. “Ecology in cities” focusses on understanding ecological patterns and processes in urban areas and how urbanisation affects organisms in urban habitats. On the other hand, the “ecology of cities” takes a more comprehensive and integrative approach, considering the city itself as an ecosystem with social and ecological components that interact and shape the urban environment (McPhearson *et al.*, 2016).

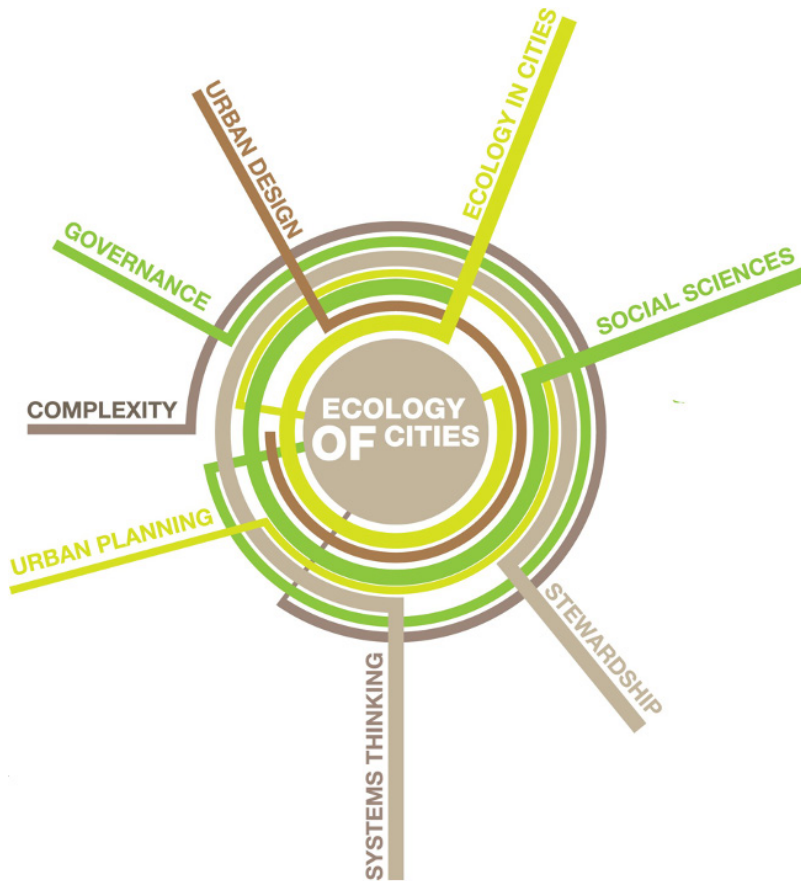


Figure 9 - Ecology of cities
Source: McPhearson et al. (2016)

As enlightened by Heymans *et al.* (2019) in the context of ecological urbanism and its implications for urban planning and design, different perspectives emerge looking to form a new paradigm of urban planning, seeking to apply Systems Thinking to Cities, in which cities are considered new complex ecosystems, highlighting the interconnectivity of biological components with social structures and infrastructure. Also, according to the authors, the socio-ecological perspective challenges the traditional planning paradigm, which assumes stability and predictability.

The complexity of urban systems demands that research understand cities as complex and diverse new ecosystems resulting from a human-nature coevolution process (Hobbs, Higgs and Hall, 2013). From a social-ecological perspective, constructing resilient and sustainable urban environments involves transforming urban systems into a connection between human needs and biosphere capacity. In this sense, it is essential to consider ways of integrating city and nature, concerting efforts to ensure effective communication of the potential paths ahead to foster not only adaptation and mitigation in the cities but its potential transformative capacities towards this ecological perspective along with the pros, cons and uncertainties involved.

The concept of resilience has been widely used in research related to urban planning. However, many researchers approach it unclearly, with inconsistent definitions (Meerow, Newell and Stults, 2016). Suárez *et al.* (2019) point out that although the concept of resilience has different meanings, there are three dominant interpretations in the literature: (1) engineering, focussing on the return to equilibrium of a given system after exposure to disturbances; (2) ecological, focussing on the ability to absorb disturbances, maintain its functions while undergoing transformations, and (3) socio-ecological, which focusses on the ability of a complex socio-ecological system to adapt and transform itself in response to disturbances (Figure 10).

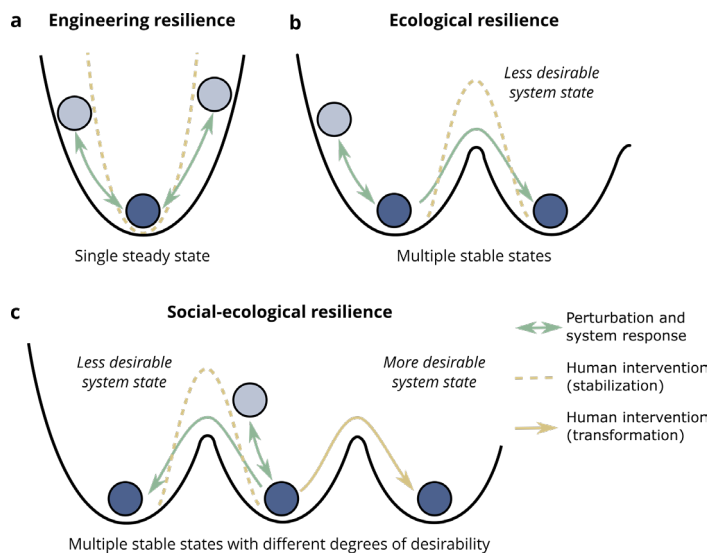


Figure 10 - Different approaches for resilience
Source: Rölfer, Celliers and Abson (2022)

In this way, it can be said that conceptually the engineering and ecological resilience views are based on the idea that a system can reach a point of equilibrium, although in the engineering conception the focus is on the “recovery” of the system, while in the ecological perspective there are several possible states of equilibrium that a system can enter after the occurrence of a shock or disturbance. Socio-ecological resilience, on the other hand, focuses on constant evolution, emphasising that systems are constantly changing and that there is therefore no state of equilibrium to which systems can return or advance after a disturbance. In this sense, its focus is on transformation and the ability to promote interventions capable of decreasing, sustaining or increasing resilience (Suárez, Gómez-Baggethun and Onaindia, 2019).

According to a social-ecological perspective, resilience refers to adapting to crises and changes and transforming social-ecological systems towards sustainability, where resilience is understood as transformative capacities connected to learning and innovation (Wolfram, Borgström and Farrelly, 2019; Folke *et al.*, 2021).

In this perspective, there is a need for transformation that involves new forms of production and consumption and the (re)connection of the societal needs to the capacity of the biosphere and essential ecosystem services (Folke *et al.*, 2011) - which involves new ways of planning cities and thinking about the relationship between the natural and the built environment - moving from a linear perspective to a regenerative standpoint of development (Ellen MacArthur Foundation, 2017, 2019; Atanasova *et al.*, 2021).

This theoretical perspective requires urban planning to acknowledge systems’ inherent uncertainty and continuous evolution, recognising nonequilibrium. The role of the discipline is to guide urban development towards desirable results based on ecological principles. There is no universal solution, but rather the need for flexibility, different approaches, and context-specific solutions. Plans and projects should be seen as opportunities for adaptive learning, strengthening cross-disciplinary partnerships, and facilitating knowledge sharing among stakeholders (Heymans *et al.*, 2019).

Within this discussion, the transformation of urban environments is a critical factor for sustainability and resilience. There is a gradual shift in research toward the importance of urban environments in this context, which has migrated from an exclusive focus on mitigation, which implies reducing GHG emissions into the atmosphere, and adaptation, with a focus on adapting to adverse effects and new climate conditions, to a systemic perspective, working on the importance of transformative actions within territories (Wolfram, Borgström and Farrelly, 2019; Schröder, 2022b).



Figure 11 - Mitigation, adaptation, and resilience. Source: Prepared by the author.

Following this pattern, AR6 seeks to address a more systemic perspective by illustrating the different trajectories and uncertainties regarding the future. Using the concept of Climate Resilient Development Pathways (CRD), it addresses a reflection on the importance of transformative and integrated actions to build a sustainable future. Figure 12 illustrates how different trajectories of actions and inactions imply different future outcomes. Figure 13 shows the importance of integrative and transformative actions instead of business-as-usual and fragmented actions.

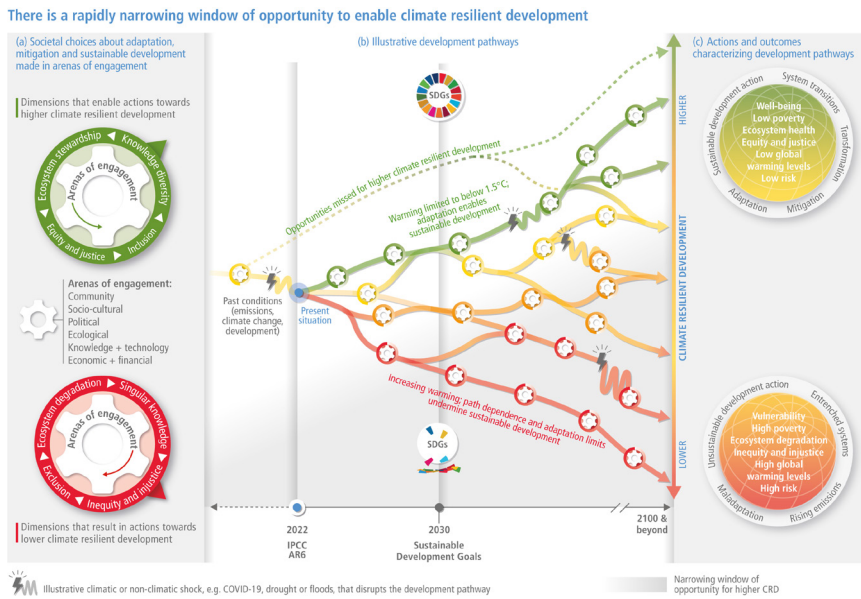


Figure 12 - Societal choices, illustrative development pathways, and future outcomes. Source: AR6 WGII Chapter 18 (Schipper et al., 2023, p. 2662)

Transformative actions and system transitions

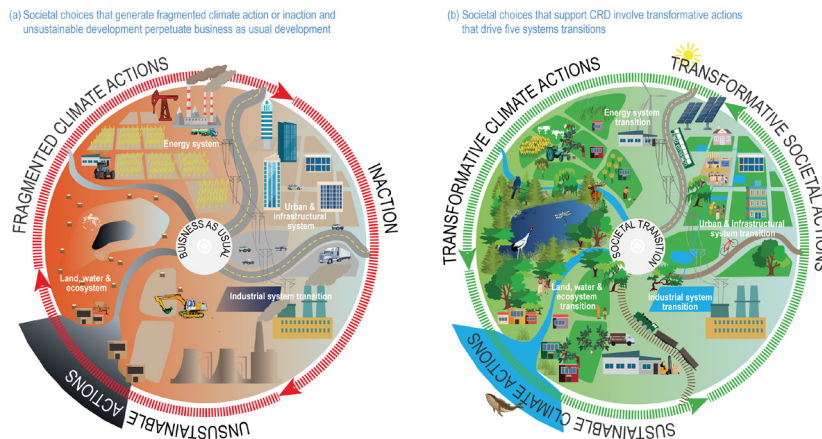


Figure 13 - Transformative actions and systems transitions. Source: AR6 WGII Chapter 18 (Schipper et al., 2023, p. 2665)

The ongoing climate crisis and increased awareness of the need for change in our current system have opened up opportunities for innovation and transformation inside and outside large metropolitan centres toward reducing carbon emissions and promoting integration with nature. However, this comes with the challenge of navigating uncertainty and complexity combined with flexibility and innovation.

1.3 CONCEPTUALISING METROPOLITAN FRINGES

Metropolitan regions are not only a spatial form of unprecedented scale with regard to population concentration and activity. It is a contemporary spatial form that concentrates urbanised areas with agricultural land, preservation areas, open space, and residential zones that do not correspond to traditional division between rural and urban, centre and peripheries. Environmental elements, the interdependencies of metropolitan regions, and their challenges in sustainable transitions transcend municipal political-administrative boundaries and force joint action and cooperation between different actors, requiring substantial changes in planning and further studies discussing the metropolitan and regional scale (Dinshaw, Lane and Elias-Trostmann, 2017; Elmqvist *et al.*, 2019).

In general, the studies developed on Brazilian metropolitan regions' production and occupation process focus more on urban issues, their dynamics, uses and complexities. Little is discussed about the border areas of metropolises with a view that goes beyond the urban and considers the diversity and potential of these spaces (Travassos *et al.*, 2021).

The concept of fringe²⁰ is complex and has been approached in different ways by various researchers with related concepts such as periurban areas, urban-rural fringe, and rural-urban fringe, whereas the last two are commonly used in the Anglo-Saxon literature (Rocha *et al.*, 2005).

According to Scott *et al.* (2013), there are two different approaches that divide the international literature on fringes with urban and rural characteristics: urban-rural fringes and rural-urban fringes. The first line of reasoning is more focused on the urban dimension and sees the fringe territory as a transitional space for a growing set of demands centred on urban issues such as housing, leisure, employment, and infrastructure. The second line of reasoning is more focused on rural issues and considers these territories as potentially suitable spaces for conservation and environmental protection, such as community planting, and forestation.

In establishing an overview of the concept of fringes, the authors point to the way these areas have been seen and conceptualised as landscapes on the edge, transitional spaces and urban sprawl, in addition to the number of negative views about the fringes, and argue that these territories are often inserted in limbo, waiting for plans, projects and decisions, bringing reflection on the strategic character, especially from a sustainability point of view.

The fringes have rather imprecise boundaries and a variety of uses (e.g., environmental preservation areas, agricultural production, mineral extraction, and urban uses) that often generate conflicts between the different actors involved, highlighting the economic, social, cultural and landscape values of these highly complex transition zones. This variety is characterised by a set of distinct situations since only a portion of its space has been assimilated by urban growth, and a significant part has rural or environmental characteristics.

Figure 14 illustrates the multiple combinations of urban and peri-urban areas in a wider regional context, which would be the Urban-Rural Region, containing several

20_ Many authors refer to such regions as peripheral areas. Some (Bonduki and Rolnik, 1979; Maricato, 2001) discuss the term periphery or peripheries from the perspective of the relationship between centre-periphery or precarious areas and central areas; others from the perspective of intra-urban differences in peripheries linked to the ways of living (Caldeira, 2000). This research aims to take a different approach, despite the importance and overlap of such concepts and authors.

polycentric settlements in its perimeter, which are configured by a central urban area composed of the urban centre, intraurban, and suburban areas; and by the peri-urban area, composed of the urban fringe and the urban periphery. This diagram is applied to the European reality (Piorr, Ravetz and Tosics, 2011) which is quite different from the Brazilian one due to several demographic, social, and economic factors, but it allows us to visualise in a simplified way the gradient and main differences between urban and peri-urban areas.

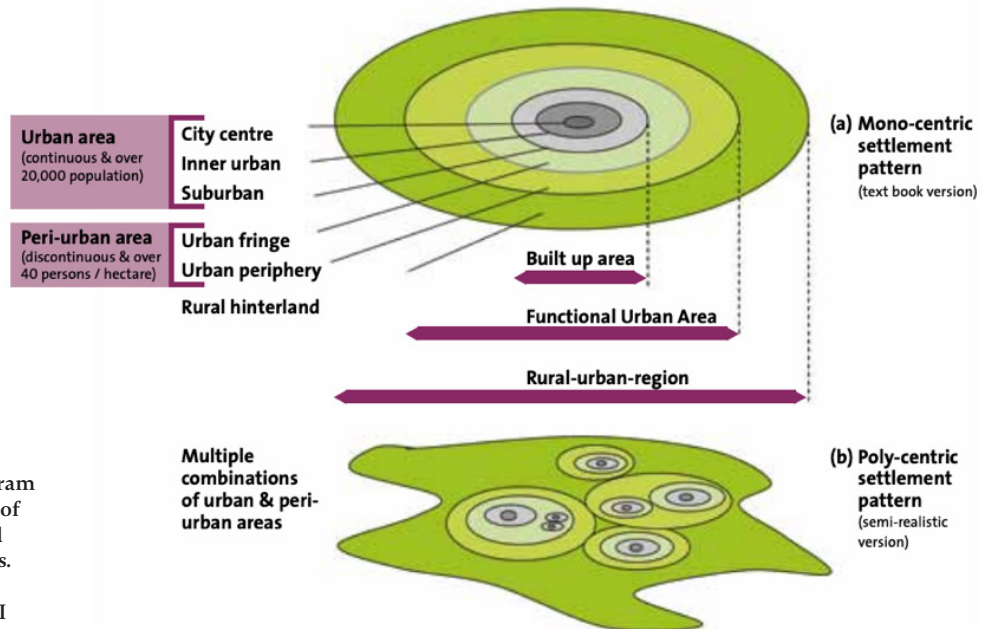


Figure 14 - Diagram of the concepts of urban areas and peri-urban areas. Source: Piorr A, Ravetz J, Tosics I (2011), p. 25

Despite recognising the overlaps and similarities between fringes and peri-urban areas, in this thesis the term “Metropolitan Fringes” was chosen to emphasise these peripheral areas in the regional and metropolitan context.

Thus, Metropolitan Fringes consist of districts and small and medium-sized municipalities on the border of metropolitan areas with urban, environmental, and rural characteristics, configuring complex territories often pressured by diverse demands and actors (Marques, 2019). It refers to the outermost edge of a metropolitan area, which encompasses multiple municipalities or local administrative units and represents the collective periphery of the entire metropolitan region.

The use of the term ‘metropolitan fringe’ seeks to deepen the understanding of a territory that houses, in addition to the relations of disputes represented by the occupation of different social classes, environmental, urban, and social attributes that characterise fundamental values for the sustainability of the metropolis itself, approaching the discussions about constructing new dynamics, possibilities and potentialities of the peripheries (Schröder *et al.*, 2018).

1.4 METROPOLITAN FRINGES: DYNAMICS, SCALES, AND OPPORTUNITIES

Considering the current scenario of climate crisis and at the same time the projections of urban population growth that point to higher rates in medium and small cities, especially in developing countries, the conflict and pressure on fringe areas are evident. In this context, several questions arise, such as: preserve or urbanise? Expand or densify? Is it possible to reconcile development and sustainability? How to plan these territories?

Context-wise, there is a need for urban instruments and legislation, such as master plans, to incorporate urban adaptation strategies and promote the increase of population resilience (Lemos, 2010). Most policies on urban planning and adaptation to climate change

have been carried out on a local scale to the detriment of the metropolitan scale. However, while adaptation and resilience have an essential local component, it is vital to recognise the connections and interdependencies that characterise metropolitan areas. The multiple flows of people, information, services, infrastructure, and natural resources blur municipalities' political and administrative boundaries and require new modes of governance and coordination (Bulkeley and Luque-Ayala, 2017; Dinshaw, Lane and Elias-Trostmann, 2017).

Urban resilience has a vital local component, since it is at the local scale that communities feel the intensity of extreme events. However, in metropolitan areas with a high degree of interdependence and inequality, the resilience of these systems requires a multiscale planning approach. Since adaptive capacity between municipalities is unequal, creating regional networks and equalising planning resources are necessary; multiple levels of coordination and support are required for effective and long-term local actions (Dinshaw, Lane and Elias-Trostmann, 2017; Shi, 2019).

Shi (2019) points out some limits related to local adaptation, such as the high costs of developing local plans and vulnerability analysis, difficult access to data and information, lack of technical expertise, and political leadership. Metropolitan fringe cities and districts are commonly affected by these barriers. Although the core city in metropolitan areas tends to have more resources and staff to develop local actions related to adaptation and resilience, peripheral towns and districts usually do not have the same resources, resulting in a lower adaptive capacity with respect to technical and financial resources.

Despite this inequality of resources when discussing metropolitan fringe areas, three factors should be emphasised: the new dynamics present in these territories, the relationship between different scales, and the opportunities that arise.

In terms of dynamics, in the global context and particularly in the Latin American context, accelerated urban population growth does not occur with greater intensity in the metropolises' core cities but in smaller cities on their peripheries, especially those on their fringes. In Brazil, according to the Institute for Applied Economic Research (IPEA, 2015) it is estimated that, by 2030, small and medium cities will represent an even more significant proportion of the urban population. Small and medium-sized urban centres will account for 45% of the expected increase in the world's urban population between 2009 and 2025, a trend likely to continue until 2030.

According to IPCC, the most significant opportunities for future urban GHG emission reductions lie in small- to medium-sized cities in developing countries, where urban form and infrastructure are not locked in. However, significant challenges exist in these regions, such as governance, technical, financial, and institutional capacity constraints. Addressing these limitations is essential to unlock the potential for emissions reduction and foster sustainable urban development, contributing to global climate change mitigation efforts (Seto *et al.*, 2014).

In the context of the São Paulo Metropolitan Region, the peripheral districts and municipalities located on the fringes of the metropolis have shown higher population growth rates than the capital, as will be explored more fully in Chapter 4, generating strong urban pressure towards protected areas and natural remnants. This trend was already indicated in the last two demographic censuses. Figure 15 demonstrates this population growth and the expansion of the urbanised area towards the protected zones.

This dynamic of urban population growth is one of the most striking and challenging aspects of planning medium-sized cities on the metropolitan fringes. These regions experience significant population growth rates, which calls for a careful and strategic approach to urban planning. The rapid population increase implies several challenges, such as the demand for housing, infrastructure, public services, and environmental preservation.

In addition to population growth, another important characteristic of these cities is the presence of natural remnants and environmental protection areas in their vicinity. These natural resources are of strategic value, contributing to quality of life and mitigating adverse impacts such as flooding and climate change. Unlike the central areas of the Capital, which are already highly impermeabilised, these cities on the fringes still have preserved natural areas. Therefore, it is essential that urban and regional planning values and preserves these natural remnants, incorporating them as an integral part of urban development strategies.

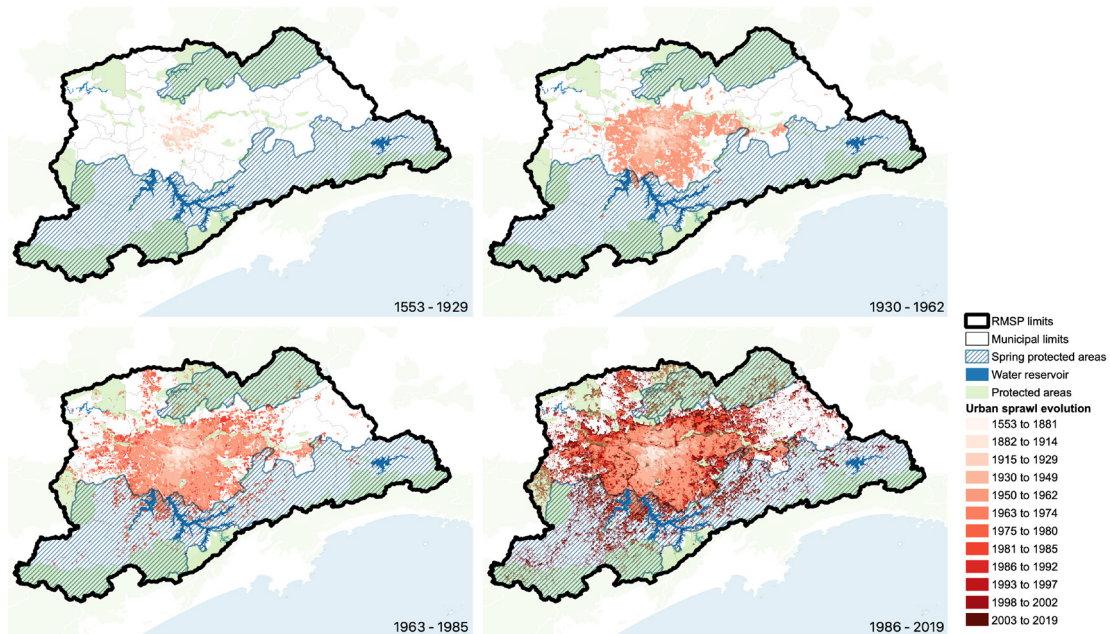


Figure 15 - Evolution of the Urban Area in the Metropolitan Region of São Paulo versus Protected Areas. Data source: Secretariat of the Environment of the State of São Paulo, Ministry of the Environment, IBGE, EMLPLASA and DataGEO. Available at: <<http://datageo.ambiente.sp.gov.br>> Access: July 2019

As will be explored in more depth in Chapter 4, in RMSP, these cities have mainly low-density, low-rise urbanised areas. This scenario offers a unique opportunity to plan these areas sustainably, in line with the 21st-century planning paradigms. Unlike large urban centres, which often face complex redevelopment and densification challenges, medium-sized cities can adopt innovative strategies from the outset, prioritising environmental sustainability, efficient use of resources, and social integration. Such conscious planning can contribute to creating more balanced and resilient cities with a higher quality of life.

The complexity and dynamics of metropolitan fringe areas challenge the traditional ways of dividing spaces between “urban” and “rural”, as well as “peripheries” and “centralities”; as a result, these areas are commonly treated in a fragmented way, lacking an integrated planning process to consider their complexities and optimise their potentialities (Rauws and Roo, De, 2011; Scott *et al.*, 2013).

In this perspective, it is essential to emphasise the interrelationships between the planning scales present in these territories. These urban and environmental dynamics go beyond municipalities’ political and administrative boundaries and pose the need for integrated planning that contrasts with the current fragmentation scenario and the need for coordination among municipalities. Understanding the differences between planning scales and their possible integration is essential for this debate.

For Costa Lobo (2022), the concept of the city has evolved into a broader approach, considering a city-mosaic, as opposed to the dichotomous division between urban and rural

areas. In this context, urban planning aims to prepare coordinated and integrated plans for the development of humanised space and local and regional communities. It is a multi-dimensional and multidisciplinary process, covering the whole territory and appropriate scales. Planning is based on forecasting methods, recognising their inherent uncertainty, and uses iterative approaches and continuous monitoring.

The author emphasises the role of planning scales by highlighting that the administrative hierarchy of the territory should be established at regular intervals, allowing problems to be solved at the most appropriate level. Lobo gives as an example three levels of territorial administration:

16 000 000 4 000 000 1 000 000	State Region Level I (Coordination Region) Region Level I (management sub-region)	Regional levels
250 000 65 000	Planned area (Association of municipalities) Municipality	Municipal levels
16 000 4 000	Urban unit (neighbourhood association) Neighbourhood	Community-levels

Table 3 - Example of the hierarchy of territorial administration levels Source: Costa Lobo (2022) p. 53

Regarding planning, each scale, or administration level, should delegate responsibilities to lower levels wherever possible and intervene when solidarity between levels is necessary to solve problems that cannot be dealt with effectively at lower levels. It is essential to have urban planning services at each level, with technicians available to act as intermediaries (Costa Lobo, 2022).

The issue of scales in urban planning is critical and can vary in different contexts considering the local population and issues related to governance and political-administrative divisions. The current climate challenges intertwined with the territorial challenges and dynamics present in the territory demand joint actions at all scales, considering local particularities and the interdependence of the local scale with the metropolitan region and regional policies and strategies (Raven *et al.*, 2018; Landauer, Juhola and Klein, 2019) (Figure 16).

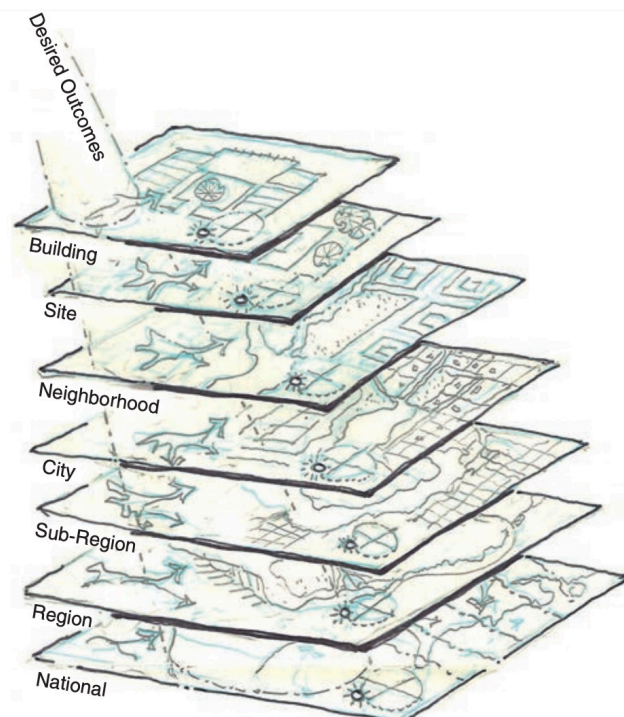


Figure 16 - Spatial scales relevant to urban planning and urban design for climate change mitigation and adaptation. Source; Jeffrey Raven, 2008 - apud in Raven *et al.* (2018).

Considering the geographical and population scale of the metropolitan regions addressed in this work as well as the specific focus on fringe areas, the analysis of the reference cases and the object of this thesis were divided into three scales: regional/metropolitan, intermediate (inter-municipal) and municipal, and complemented with examples at the local scale, as defined below:

Regional/Metropolitan scale: involves planning over a wider geographical region, encompassing different municipalities in a metropolitan area. It is a more abstract scale, focussing on regional aspects such as transport integration, infrastructure, economic development, housing policies, and natural resource management.

Intermediate (inter-municipal) scale: in large metropolitan regions, there is a vast distance between the regional/metropolitan scale and the municipal scale. In this sense, the intermediate scale refers to inter-municipal planning, composing an intermediate scale between the regional and the municipal scale, aiming to coordinate and integrate different interests and needs based on cooperation between different municipalities.

Municipal scale: Focusses on planning an individual city and addresses specific aspects of the urban environment. This includes zoning, land use, transport planning, infrastructure provision, public services, the development of parks and public spaces, among others.

Local scale: refers to planning in smaller areas, such as neighbourhoods or specific sectors within a city. At this scale, spatial organisation and urban design are considered. The participatory process can be more intense and integrated because it is a more specific area and close to the local population.

Integrating regional and urban planning scales is crucial to ensure the effectiveness of planned policies and actions. Coordination between planning levels allows for a more comprehensive and integrated approach, considering local particularities and their relations with the metropolitan region. This implies the development of local projects, which are elaborated according to the guidelines and strategies defined on supramunicipal levels.

The transformation of metropolitan fringe areas, due to their complexity in terms of actors and administrative boundaries, highlights the need to create new forms of governance, new ways of planning the territory based on ecological principles, and the search for a territorial approach that integrates the climate issue with existing territorial challenges.

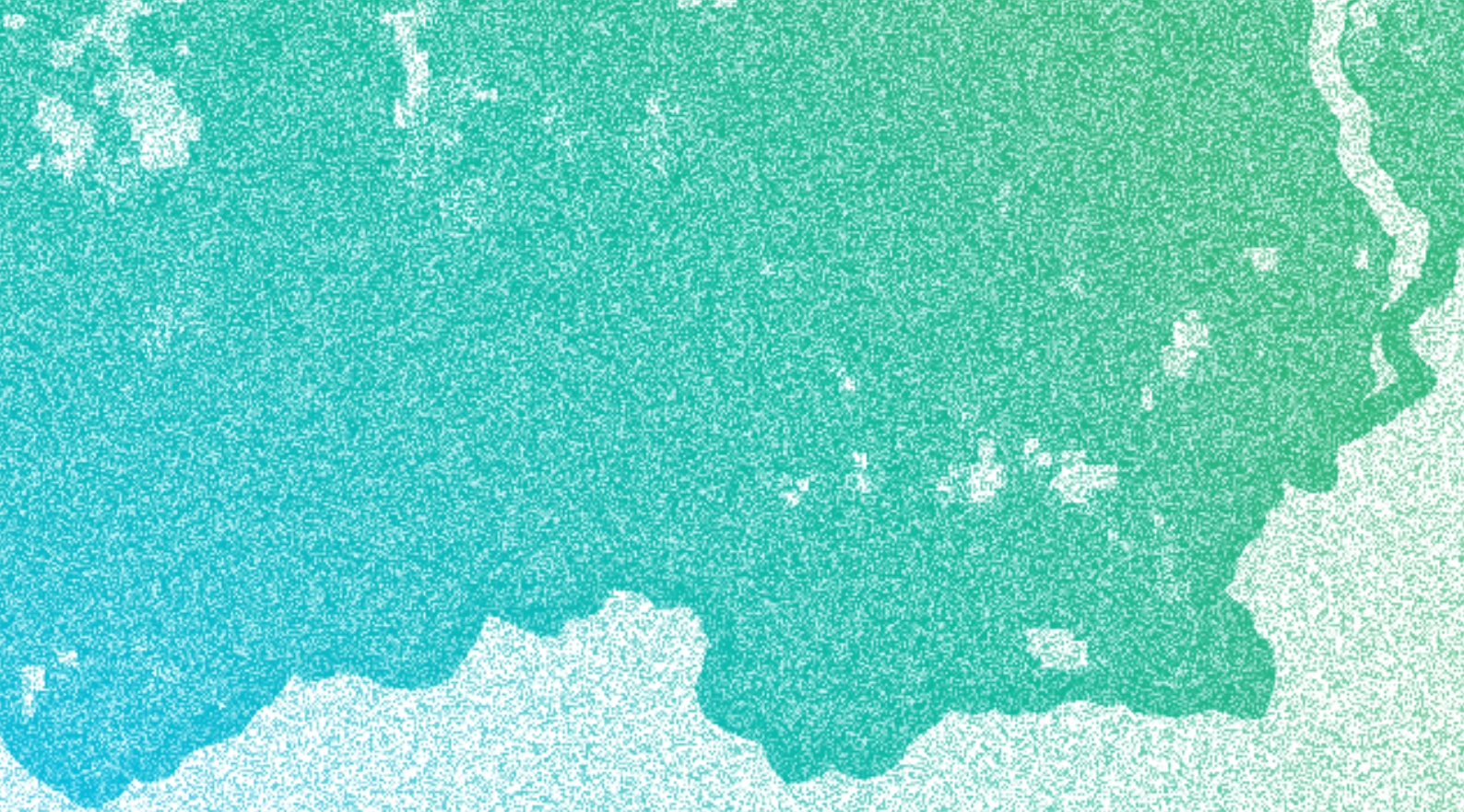
Thus, these fringe areas that have commonly been assimilated as disintegrated spaces, or as in the case of the Metropolitan Region of São Paulo, under the stigma of marginalisation, can be understood from a broader territorial perspective and a recognition of the interdependencies between actors and territorial attributes (environmental, cultural, social and economic), favouring that peripheral and/or economically vulnerable areas have access to conditions of development and innovation, through distributive and innovative actions and policies (Carta, 2016; Schröder *et al.*, 2018).

As Moscarelli and Bugs (2021) point out, the lack of integration between the environment and urbanisation is one of the major problems of the Brazilian planning system, which results from the lack of intersectoral and interscale articulation between the various planning instruments existing at different scales. More specifically, on metropol-

itan fringes, as Travassos *et al.* (2021) argue, the absence of instruments and regional planning directed to areas with such diverse urban, rural, and environmental characteristics is reflected in an institutional void, and the natural remnants present in these areas are seen as land reserves for urban expansion.

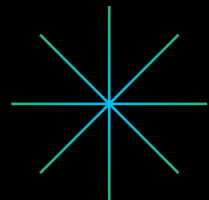
In the upcoming chapter, an attempt is made to contribute to this debate by examining reference cases and extracting innovative strategies, possibilities, and models for the fringe areas through the lens of resilient development. The reference cases discussed seek to work, albeit with limitations, on the potential of these territories, generating new urban dynamics that combine social and economic development, better integration between the natural and built environment and sustainable mobility dynamics. The approach is multi-scalar and integrated, building bridges between sectoral policies, plans, and projects and taking into account the various instances that make up city planning from a territorial perspective.





Referential cases: building resilience strategies at the fringes

2



This chapter aims to extract valuable lessons and innovative urban and regional planning strategies by analysing reference cases of resilience building in metropolitan fringes. The purpose is to compose a collection of contemporary plans and projects that, when combined with the theoretical discussions presented in the first chapter, can form a strong basis for the analysis and recommendations concerning the object of this thesis within the São Paulo Metropolitan Region.

The current chapter is structured in two distinct parts. The first part outlines the analytical methodology employed to analyse the reference cases. The second part, on the other hand, presents the findings and discussions deriving from the analysis conducted.

The reference cases analysed are the metropolitan areas of Barcelona, Paris, and Medellín. In this thesis, a systemic perspective of urban systems was taken into account while analysing different cases. The focus was on urban and climate change adaptation plans at various planning scales, and additionally, interviews were conducted with technicians involved in this process across different levels of planning. Furthermore, the discussion also included specific examples of urban projects that emphasised the proposals and provided a spatial dimension.

The cases demonstrate the complexity of urban and regional planning and the diversity of possible institutional arrangements. Although the principles and strategies present a number of similarities, such as avoiding urban sprawl, reducing displacement (proximity and mixed uses), promoting low-carbon urban mobility and renewing urban infrastructure, the spatialisation of these strategies took place in different ways and depended on contextualisation both in spatial, institutional and social terms. It demonstrated the importance of context, multiscale, strategic planning and the diversity of institutions and actors for the effectiveness of planning that is not immune to contradictions and limits.

2.1 ANALYSIS METHOD

The analysis of the reference cases was based on an analytical research methodology. The purpose was not to compare the three cases analysed but rather to identify patterns and main points of reference for urban policies and strategies related to resilience, with a focus on metropolitan fringe areas.

The methodology used a qualitative approach consisting of four interconnected stages. This approach enabled a deeper understanding of each analysed case (Yin, 2009). In the first stage, the study analysed planning documents at the metropolitan scale and gained a general understanding of the urban and climate policies of the area and their main characteristics. The aim of this stage was to establish a general understanding of metropolitan resilience strategies.

In the second stage, a focal area on the fringes of the Metropolitan Area was selected to gain further insight into the applicable strategies and planning instruments. Table 4 provides details on the area of focus for each referential case and its analysed documents.

	BARCELONA METROPOLITAN AREA	GREATER PARIS METROPOLIS	ABURRÁ VALLEY METROPOLITAN AREA
Population	3.2 million inhabitants	7.2 million inhabitants (10.7 million in Paris Urban Agglomeration)	4 million inhabitants
Number of municipalities	36 municipalities (ajuntaments)	131 municipalities (communes) 12 territories	10 municipalities
% of state's population	42,6% of Catalonia's population	58% of Île de France's population	58% of Antioquia's population
Area	636 km ²	814 km ²	1152 km ²
% of natural land	Open spaces occupy 54.6% of the territory, the vast majority of which are protected (49.4% of the metropolitan area)	14% of natural areas and 86% of artificial soil in MGP	70,49% of natural soil (812km ²) 29,51% of urban soil (340km ²)
% of country's GDP	54,6% of Catalonia's GDP (2019)	25% of France's GDP	14% of Colombia's GDP
Metropolitan fringes characteristics	The fringes of the AMB are bounded by the Llobregat and Besòs rivers and the Collserola Mountains.	Boulevard Périphérique is a clear boundary marking the fringes of the first crown.	Areas of high slope with urban and rural characteristics occupied by low-income population in the northwest and northeast slopes and higher income population in the southeast and southwest areas.
Focus area	Name: Besòs territory Municipalities: Barcelona (Nou Barris, Sant Andreu and Sant Martí de Barcelona), Badalona, Montcada i Reixac, Sant Adrià de Besòs and Santa Coloma de Gramenet. Population: 1 million inhabitants (30% of the population of AMB and 12% of the population of Catalonia) Area: 80 km ²	Name: Est ensemble Municipalities: Bagnole, Bobigny, Bondy, Le Pré Saint-Gervais, Les Lilas, Montreuil, Noisy-Le-Sec, Pantin and Romainville. (Parc des Hauteurs also includes Rosny-sous-Bois, Fontenay-sous-Bois, and Paris) Population: 426 389 inhabitants in Est Ensemble (920.000 inhabitants in Parc des Hauteurs) Area: 39,2 km ² (Est ensemble)	Name: Borde urbano rural (BUR) Nororiental Municipalities: Medellín Population: 434 349 Area: 15,71 km ²
Analysed planning documents – Metropolitan scale ²¹	Climate and Energy Plan 2030 Metropolitan Urban Development Plan (PDU) - Development Document	Metropolitan Climate, Air and Energy Plan (PCAEM) Territorial Coherence Plan (SCoT) - Development Document	Plan de Acción ante el cambio y la variabilidad climática del Área Metropolitana del Valle de Aburrá 2019 –2030 (PAC&VC) Plan BIO 2030
Analysed planning documents – Intermediate scale	Besòs Agenda	Local Urban Intercommunal Plan (PLUI) – Est Ensemble	Jardín Circunvalar De Medellín

Table 4: General characteristics and documents analysed at metropolitan and intermediate scales. Sources: Àrea Metropolitana de Barcelona (2018) and Barcelona Regional (2018), Métropolis Barcelona²², Urban LEDS²³ and BIO 2030.

21_ Greater emphasis was given to the Climate Change Adaptation Plan. The analysis of the urban/metropolitan plan aimed to verify synergies between the two instruments.

22_ Available at: https://agenciaeconomica.amb.cat/eines-i-serveis/dades_estadistiques. Accessed on September 15th, 2023.

23_ Available at: <https://urban-leds.org/countries-cities/colombia/#aburra-valley>. Accessed on September 15th, 2023.

The following criteria permeated the choice of reference cases:

- 1- Metropolitan Areas of Global Cities.
- 2- Metropolitan areas with climate change adaptation plans.
- 3- Metropolitan areas indicated by the literature as a reference in urban innovation.
- 4- Access to information, possibility of visits and interviews (Europe and Latin America).
- 5- Focus area in a metropolitan fringe area with a strong presence of natural remnants and a socio-economically vulnerable population in its context.

The analysis of the two scales planning documents was conducted from four dimensions (Table 5) to extract the main guidelines and strategies related to resilience at both scales. The analytical dimensions were based on the interpretation of cities from a systemic perspective by assuming that urban areas behave according to multiple interdependent dimensions and taking into account the dependence of cities on complex socio-ecological systems and the reliance of these systems on governance networks capable of coordinating actors across different scales (Suárez, Gómez-Baggethun and Onaindia, 2019; Krueger *et al.*, 2022).

Analytical dimension	Key-questions
Governance	What is the role of planning institutions? Who are the main actors involved in the process?
Ecological	What are the proposed strategies integrating ecosystem services and biodiversity?
Urban	What are the proposed strategies in terms of infrastructure (energy, water, and waste)? What strategies are proposed regarding mobility? What strategies are proposed regarding the built environment and climate risks?
Socio-economic	What is the role of the participation of different social actors? What are the visions related to employment and income generation? How is the issue of equity addressed?

Table 5: Analytical dimension and key questions. Source: Prepared by the author.

In the third stage, field visits and semi-structured interviews were conducted with key technicians at multiple planning scales (Table 6). The semi-structured interviews aimed to collect information and perspectives from professionals working in different positions and scales in urban planning in the analysed area, seeking to understand the main (1) political-administrative processes and structure, (2) guidelines, and (3) strategies of metropolitan and urban planning pathways towards resilience. To this end, professionals who work in urban planning and have expertise in managing and/or coordinating policies and projects relevant to metropolitan resilience in the context of climate change were selected. The fourth stage aimed to identify urban projects that illustrate and spatialise the general strategies proposed at supra-municipal levels.

	AMB	MGP	AMVA
SCALE	DEPARTMENT / INSTITUTION		
Metropolitan/ Regional	<ul style="list-style-type: none"> - Climate Emergency Service and environmental education - Ecology Area / Barcelona Metropolitan Area - Innovation and Infrastructure / Barcelona Metropolitan Area 	<ul style="list-style-type: none"> - Climate and adaptation plan project officer / Regional Energy and Climate Agency (AREC) - Environment, Water and Climate Department / Greater Paris Metropolis - International affairs / Planning Agency for the Paris Region (IAU Ile-de-France) 	<ul style="list-style-type: none"> - Environmental Subdirection / Metropolitan Area of the Aburrá Valley - Climate change team / Area of the Aburrá Valley - Environmental Sustainability and Climate Change / Government of Antioquia
Intermediate	<ul style="list-style-type: none"> - Area of Environment and Energy Efficiency/ Barcelona Regional - General management/ Besòs Consortium 	<ul style="list-style-type: none"> - Strategic Planning / Planning Agency for the Paris Region (IAU Ile-de-France) 	EDU
Local	<ul style="list-style-type: none"> - Urban ecology - Direction of Strategy and Culture of Sustainability / Barcelona City Council 	<ul style="list-style-type: none"> - Project development / Agence TER 	

Table 6: Department and institution of the technicians/professionals interviewed at the metropolitan, intermediate and local scales. Source: Prepared by the authors. Note: The identity of the people interviewed was preserved following the procedures adopted in the Interview Consent Form approved by the Ethics Committee in Process 56852922.7.0000.0084

2.2 BARCELONA METROPOLITAN AREA – SPAIN

2.2.1 METROPOLITAN CONTEXT

The Barcelona Metropolitan Area (AMB) is situated on the Mediterranean Sea coast in Spain. The territory's occupation is limited by three distinct geographical features: the Llobregat and Besòs rivers, the Colserolla mountain range, and the Mediterranean Sea, with the city of Barcelona serving as its nucleus. In this study, the areas of Llobregat and Besòs rivers, and Sierra de la Colserolla are considered fringe areas of the Barcelona metropolis. The Besòs area, in particular, is significant and will be examined in detail as a referential case. Barcelona's fringe areas have undergone a series of transformations throughout the development of the metropolis, with distinct visions about their importance and role in metropolitan planning.

The Comarcal Plan (1953)²⁴, is the first development plan that approaches the metropolitan scale of Barcelona. The aim of this plan was to organize the urban expansion of Barcelona and its peripheral spaces, facing a scenario of disordered demographic and industrial growth (Riu, 2019). In the 1950s and 1960s, Barcelona experienced an influx of people and an increase in car ownership. As a result, the metropolitan area faced several challenges, including the need for new road infrastructure, a rise in vacation property development, increased urban mobility, and the relocation of industries (Àrea Metropolitana de Barcelona, 2020).

In the Comarcal Plan, the banks of the Llobregat River were destined for agricultural activities and those of the Besòs River for industrial activities. The proposal of the plan aimed to contain the urbanisation process, but the dynamics of demographic and economic growth exceeded the planning guidelines, which were not able to contain the urban sprawl (Andrade Neto, 2015; Riu, 2019).

In 1968 the Master Plan for the Barcelona Metropolitan Area was approved, which had no legal implications and was marked by a series of technical and political conflicts in a period of dictatorship (Andrade Neto, 2015). Faced with these complexities and tensions, added to the decline of industrial activities in the 1970s, the metropolis underwent important urban transformations aimed at overcoming its main challenges. The creation of the Autonomous

24_ Covered Barcelona and 26 surrounding municipalities in an area of 476 km².

Communities after the end of Franco's dictatorship guaranteed planning competencies to Catalonia and the creation of the General Metropolitan Plan of Barcelona (PGM) in 1976 (Subirats and Tomàs, 2006).

The Barcelona PGM approved at a time of democratic transition, has as a proposal for the fringes a metropolitan green belt, the construction of major road infrastructures and the integration of the Besòs riverbanks into the metropolitan system of parks and green areas, which laid the foundations for the urban-environmental transformation on the banks of the Besòs River.

Another crucial point for the development of the metropolis was Spain's entry into the European Union (1986) and the hosting of major international events, such as the 1992 Olympics, which brought investment to the metropolis. These opportunities were converted into strategic urban interventions for the transformation of the metropolis and its insertion in the international scene (Palermo and Ponzini, 2014).

At present, the PGM remains in force while the approval of the Metropolitan Development Plan (PDU) is not finalised. The PDU under development bases its planning guidelines on the analysis of urban metabolism, integrating ecosystems, urban environments and the flows of matter and energy towards a regenerative vision, ensuring the protection and enhancement of areas of ecological importance and organising urban areas in an efficient manner integrated with these ecosystems (Cirera *et al.*, 2020).

In the PDU, the blue-green infrastructure is one of the main elements of territorial planning, which configures the fringe areas as strategic for metropolitan development and poly-centralities. There is an integrated relationship between urbanism, integral water cycle and biodiversity conservation, including local food preservation. The spaces preserved and/or conditioned to special uses are the most strategic for water infiltration and aquifer recharge, spaces that promote ecological connectivity, or even those offering higher flood risk and/or greater vulnerability to climate change impacts (Cirera *et al.*, 2020).

2.2.2 CONTEMPORARY METROPOLITAN PLANNING AND GOVERNANCE

After redemocratisation, the Spanish Constitution of 1978 established three levels of government, the central, the regional or Autonomous Communities (CCAA), and the local (made up of municipalities and provinces)²⁵. Founded in 2010, the AMB is an administrative boundary and a public planning institution based in Catalunya, Spain. With 3.2 million inhabitants, it covers 36 municipalities in a territory of 636km² (Àrea Metropolitana de Barcelona, 2018).

As it pertains to the formation of metropolitan areas in Spain, Mariona Tomàs (2017) notes that the central government lacks a statistical definition of metropolitan areas and has not encouraged the establishment of metropolises on National level. Furthermore, according to the author, the autonomous communities (CCAA) are responsible for the creation, modification, and abolition of metropolitan areas.

In Barcelona, the Catalan Parliament unanimously approved the creation of the AMB through Law 31/2010, and its constitution was enacted in 2011. As part of its integrated planning system, the AMB focuses on a set of competencies (Table 7) that are shared with other instances, such as local and regional.

25. The municipality is the basis of all the territorial organization, and the first level of the citizen's participation in public affairs. The municipality is ruled and administered by the council that is made up of directly elected councillors and a mayor who is elected by the councillors. The province is the second tier of local administration and is indirectly elected. It gives assistance to municipalities through local networks and programs." (Tomàs, 2017, p. 4)

Is the Metropolitan area institutionalised by law?	Yes. The constitution as a public administration was made on 21 July 2011, following Law 31/2010 approved by the Parliament of Catalonia.
Has an administrative and technical body?	Yes.
Institution name	Area Metropolitana de Barcelona
Foundation date	2010
Competencies	Territory Transport and mobility Ecology Housing Economic development Social cohesion
Type of election	Indirect: council of 89 members (delegates from municipalities)
Funding	Transfers (from municipalities and consortiums) and taxes from AMB services.

Table 7: Governance and institutional characteristics of Barcelona Metropolitan Area
Prepared by the author based on information available at: <https://www.amb.cat/s/web/amb/la-institucio/competencies.html>.
Access on: April 20th, 2022.

Among the central objectives of the creation of the AMB was to improve the provision of public services in the metropolitan area and to guarantee the proportional participation of the municipalities. At the time, AMB replaced three existing metropolitan entities, namely (1) la Mancomunitat de Municipis de l'Àrea Metropolitana de Barcelona, (2) l'Entitat del Medi Ambient (EMSHTR) and l'Entitat Metropolitana del Transport. These three entities had been created at the end of the 1980s, when the Barcelona Metropolitan Corporation was abolished^{26 27}.

The establishment of the AMB as a public institution for integrated planning in the metropolitan area represents an advance in the planning system of this region. Although there are criticisms about the territorial cut-off, which could aggregate a more comprehensive area and about the representation system being indirect (Vallbé, Magre and Tomàs, 2018).

2.2.3 CLIMATE CHANGE AND RESILIENCE IN URBAN POLICES

Metropolitan scale

Within the context of the AMB, climate change has been addressed comprehensively across all planning areas. However, it is important to highlight that the commitment to mitigation and adaptation is part of a broader framework, signed under the Paris agreement, signed in 2015 at COP21 and a commitment from the European Union. In addition to these transnational instances, the Parliament of Catalonia approved in 2017 the Climate Change Law (Law 16/2017) which has among its objectives the reduction of greenhouse gas emissions by 40% by 2030 (Àrea Metropolitana de Barcelona, 2018).

Regarding more specifically the metropolitan scale, the law that constitutes the AMB (Law 31/2010) establishes among its attributions the formulation of measures to combat climate change. Since then, some instruments and plans in the scope of the metropolitan area addressed the issue, however, after the Paris agreement the AMB created more robust instruments related to the theme.

There is a transversal approach to this topic in the institution, which means this is considered in various planning sectors. However, the Climate and Energy Plan 2030 (PCE2030) covers this issue in more detail. The plan was approved in 2018 and was complemented by AMB's Climate Emergency Declaration in 2021.

26_ "From 1974 to 1987, there was a metropolitan government, which was abolished by the Catalan Parliament and replaced by two special districts (public transportation and environment) and a voluntary association of inter-municipal cooperation, each one covering a different number of municipalities." (Vallbé, Magre and Tomàs, 2018)

27_ "In 2009, the municipalities of the MAB decided to create the Consortium of the Metropolitan Area of Barcelona, which included the three existing metropolitan entities, to prepare institutional transition to the Metropolitan Area of Barcelona (MAB)." (Vallbé, Magre and Tomàs, 2018)

In the plan, assessments and analyses of the main risks and vulnerabilities related to climate change are presented, along with strategies for mitigation, adaptation, and resilience at three levels: metropolitan, municipal, and institutional.

The climate scenarios were developed within the metropolitan limits (1km resolution) considering the main climate indices for three time periods (2040, 2070 and 2100) and three Green House Gases (GHG) emissions scenarios (optimistic, moderate, and pessimistic) (Maza and Càlix, 2018). These studies were fundamental for the identification of the greatest risks and impacts in the region and to lay the foundations for the definition of metropolitan strategies, as illustrated in Table 8.

Name of the metropolitan area		Barcelona Metropolitan Area (Àrea Metropolitana de Barcelona)
Population		3,2 million
Number of cities		36
Fringe characteristics		The fringes of the AMB are bounded by the Llobregat and Besòs rivers and the Collserola Mountains.
Main plan addressing climate change adaptation		Climate and energy plan 2030 (PCE 2030)
Main climate risks		<p>Temperature</p> <ul style="list-style-type: none"> • Higher average temperatures, especially during the summer months. • Higher frequency and intensity of heatwaves. <p>Rainfall</p> <ul style="list-style-type: none"> • Increase in the frequency of dry months. • Higher probability of torrential rainfall. • Lower rainfall, especially in spring and summer. <p>Sea-level rise</p> <ul style="list-style-type: none"> • Rise in the sea level and in the incidence of sea storms. • Changes in wave intensity and direction.
Adaptation strategies	Renaturalise to become more resilient	Buildings adapted to the new climate conditions. More green, permeable and cooler spaces. More adapted and functional biodiversity. A resilient, long-lasting coastline.
	Promoting the local generation of renewable energy and more efficient use of energy, water and other resources	Supply clean energy for everyone and permanently. More efficient energy management. More efficient water management. Metropolitan infrastructures adapted to extreme conditions. Circular economy as a sustainable metropolitan model.
	An active region and citizens committed to climate justice	Training and education about climate change and adaptation at all levels of society. Training and education about energy and energy efficiency at all levels of society.
	Metropolitan governance coordinated with councils	Better coordination between organisations. More energy and climate training in the AMB.

Table 8: General metropolitan characteristics, main climate risks and adaptation strategies.
Source: prepared by the author based on AMB (2018)

2.2.4 INNOVATIONS AT THE METROPOLITAN SCALE

Technical and financial support to overcome limitations of competencies

The PCE 2030 provides important guidelines and assessments, as shown in Table 8. However, it has some limitations regarding competencies. For instance, the plan's targets are primarily focused on the services and buildings managed by AMB. Nevertheless, the organisation's oversight of waste treatment, water cycle, and mobility services is substantial, allowing it to play an integral role in low-carbon infrastructure and mobility.

Another crucial point to consider is that while local adaptation plans are not mandatory, the AMB provides financial and technical assistance to municipalities that are interested in creating such plans. As a result, the number of local governments that have developed local

plans has increased significantly, with 12 out of 36 metropolitan municipalities already having such plans and 9 more scheduled for development between 2021-2022.

AMB has developed pilot projects to address this gap of competencies and encourage municipalities by constructing local renewable energy projects and energy-generating green roofs, and by building climate shelters in parks and public buildings in the most vulnerable parts of the metropolis. These actions drive the implementation of the strategies proposed in the adaptation plan and, at the same time, allow for testing and subsequent scaling.

The PCE 2030 guidelines are included in other plans at the metropolitan scale due to the cross-cutting nature of the climate issue. An example is the metropolitan urban plan (PDU), which focuses on territorial renaturalisation from an ecological perspective, constructing new metropolitan centralities and fostering sustainable mobility based on green and blue infrastructure.

Given Barcelona's high density of construction, it is the fringe areas of the metropolis that have the potential to improve the quality of metropolitan ecosystems. In these transitional areas, it is possible to rebuild a functional network at the level of ecology, society, and production (Cirera *et al.*, 2020). This strategic vision is clear in Besòs territory, as will be shown further.

2.2.5 FOCUS FRINGE AREA: BESÒS TERRITORY

The fringes of the AMB are bounded by the Llobregat and Besòs rivers and the Collserola Mountains. The selected focus area is the Besòs territory. It encompasses five municipalities within the Metropolitan Area, including Barcelona²⁸, Badalona, Montcada i Reixac, Sant Adrià de Besòs, and Santa Coloma de Gramenet (Figure 17). It has a total population of 1 million inhabitants, representing 30% of the AMB's population (Consorti Besòs and Regional Barcelonès, 2017).

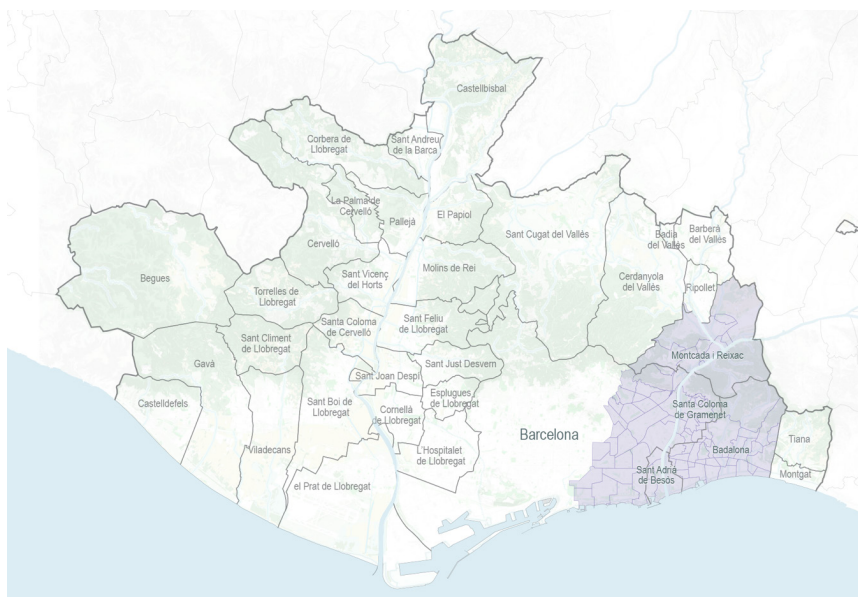


Figure 17: AMB and Besòs territory (in purple). Source: adapted from Barcelona Regional (Consorti Besòs and Regional Barcelonès, 2017)

28_ In the case of Barcelona only the Districts Nou Barris, Sant Andreu e Sant Mart are part of Besòs territory.

It is the most vulnerable region of the AMB, which underwent significant and disorderly urban growth between the 1950s and the 1970s due to industrial development. The Besòs territory is the primary access to Barcelona via the Maresme and concentrates major road and rail infrastructures of high strategic value, generating a fragmented territory (Consorti Besòs and Regional Barcelonal, 2017).

At the beginning of the century, the Besòs River underwent a significant transformation that turned the riverbank into a park and solved existing ecological and flooding problems (Riu, 2019). Utilising the consortium established for this initiative, currently, the Besòs territory has an agenda to bring new transformations.

While this is a stigmatised area that has suffered from long-standing socio-economic problems, it is now considered strategic from an urban and environmental perspective. Among the factors contributing to this is its location, which makes it convenient to access Barcelona, the metropolitan area, and the region, in addition to critical green and blue infrastructure.

The strategic projects for the territory are summarised in four areas: (1) the coastal area, (2) the Central Besòs, (3) the Montcada basin and (4) the fluvial corridor (Figure 18). As an illustration of the spatial implications of the general strategies, the following session will briefly discuss the Montcada basin and the Central Besòs.



Figure 18: The four strategic projects of Besòs territory. Source: Adapted from Barcelona Regional and Consorci Besòs.

2.2.6 INNOVATIONS AT THE INTERMEDIATE AND LOCAL SCALE

Diversity of institutional settings for planning, participation, and consensus-building

The findings from both interviews and project analysis conducted in the Besòs territory have revealed a crucial aspect in the transformation of territories - the need for several instances aimed at consensus-building and strategic planning at various scales. This need is evident despite the limitations of metropolitan plans and supra-municipal institutions.

The Besòs consortium has garnered the participation of all municipalities in the territory and the support of other institutions, including the AMB. To develop the Besòs Agenda, the consortium received technical assistance from the Barcelona Regional and support from two institutes of the Autonomous University of Barcelona²⁹. It is evident that various spaces for discussion and planning, involving both technical and civil participation, are vital for

29_ Institut d'Estudis Regionals i Metropolitans (IERMB) and Institut de Govern i Polítiques Públiques (IGOP).

adequately understanding local demands and needs and introducing a more comprehensive technical perspective.

Of particular importance is the intermediate scale represented by the consortium. The consortium acts as a bridge between supra-municipal instances and municipalities, thereby facilitating communication and cooperation. Interviews conducted revealed that in many cases, small municipalities are lacking the technical resources required to develop strategic

planning to cope with the complexity of Besòs territory. Furthermore, the dynamic and interdependent nature of the area necessitates planning that extends beyond municipal boundaries.

Strategic planning: technical support, multi-scalar perspective, and data availability

An important element of this case study was the availability of data and evaluations to both the general public and the municipalities. The data themselves represent a great step forward, but if they are not integrated into planning and solutions on multiple levels, then this does not necessarily indicate a great advancement since many municipalities lack enough technical staff to utilize these data in local planning.

At this point, the Besòs Agenda provides a good example of how a consortium contributes to bridging local and supra-municipal gaps in cooperation with other institutions. Using the technical support of Barcelona Regional, collaborative work with the Autonomous University of Barcelona, and participation from the municipalities and civil society, the Besòs Agenda was developed based on thematic and transversal diagnostics³⁰ of the region (Barcelona Regional, 2018).

New visions for the fringes: Integrating ecological connectivity, agroecology, and local needs

In the PDU and studies developed by Barcelona Regional within the Besòs Consortium, the Montcada basin is considered vital for the ecological connectivity of the metropolis as it lies at the intersection of two supra-municipal protected areas and the Besòs river corridor. Nonetheless, it is a fragmented region due to significant infrastructures such as railways and highways.

A remnant of agricultural land exists in this area, and it has been subject to conflicts since the 1976 General Metropolitan Plan (PGM) designated the area for urban expansion. Considering the ecological potential of this area and aligning it with the visions of the PDU that is about to be approved, the idea is to make this land more productive and to integrate an ecological approach without disregarding local challenges.

Figure 19 illustrates how the project aims to transform the area into a new metropolitan centre, a centre of urban agroecology, and a gateway to Barcelona's countryside through a combination of environmental education, training, and innovation that will generate local sustainable economic activity. Without disregarding the existing urban challenges, the project proposes to improve local mobility through new connections with other metropolitan areas and enhance local walkability; in addition to providing housing in vacant plots as well as densifying the existing built-up areas, and linking the built and environmental heritage in the territory (Consorti Besòs, 2021).

30_ 1) Social cohesion and neighbourhoods, (2) Economy, work and productive fabric, (3) Accessibility and connectivity, (4) Green and blue infrastructure and (5) Environmental quality.

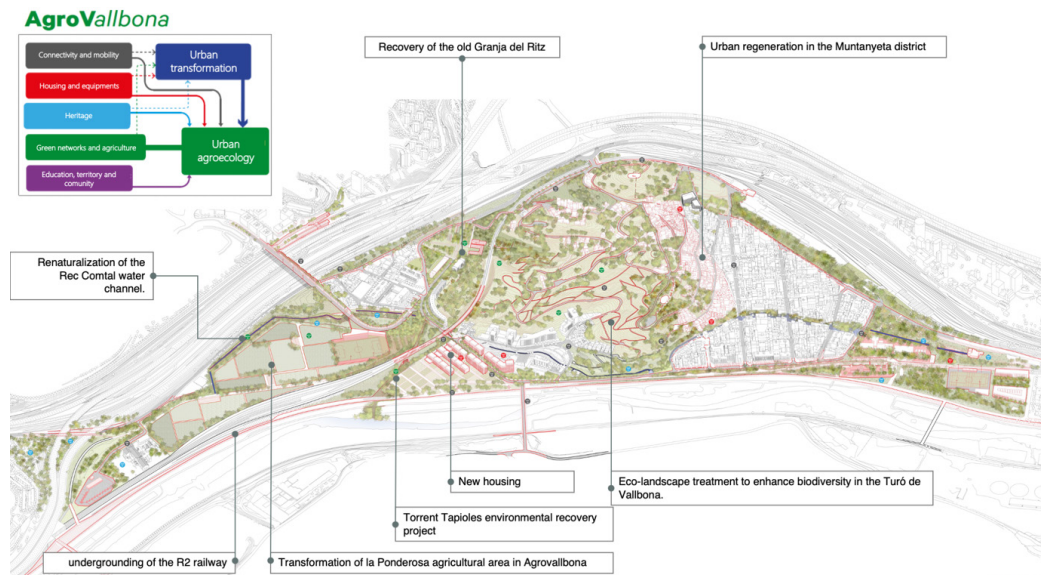


Figure 19: Master Plan for the urban transformation of the Vallbona district - Agrovallbona. Source: adapted from Consorci Besòs (Document del Pla Director de Vallbona. June 2019)

While some of the projects proposed for this area are still ongoing, others have already been completed. Figure 20 shows the renewable energy installation placed in a public space in Vallbona. Figure 21 illustrates the pedestrian connection built between Barcelona and Montcada i Reixac with the aim of connecting the neighbourhood's environmental and cultural heritage as well as providing recreational opportunities for the residents.

Other instruments and plans proposed for the region have worked on strategies aimed at environmental protection and improving ecological connectivity through different uses, such as the Special Plan for the Protection of the Natural Environment and Landscape of the Sierra de Collserola Natural Park (PEPNat), which is a hybrid instrument, both environmental and urban, that combines environmental protection, activation of new dynamics, and sustainable economic activities. The plan presents a flexible strategy to improve ecological and urban connections between the city and the park by creating transition zones with leisure spaces and incorporating existing buildings (Vidal-Casanovas *et al.*, 2020).



Figure 20: Photovoltaic installation on public space - Vallbona, Barcelona. Source: photo from the author's personal collection.

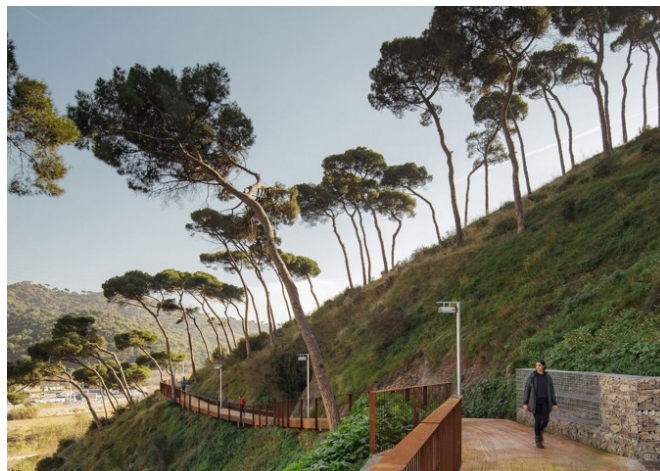


Figure 21: Pedestrian connection between Barcelona and Montcada i Reixac. Source: Jordi Surroca. Available at: https://www.archdaily.com.br/br/966183/conexao-para-pedestres-entre-barcelona-e-montcada-i-reixac-battleiroig/61084191efa7eb016512d120-pedestrian-connection-between-barcelona-and-montcada-i-reixac-battleiroig-photo?next_project=no

Developing new dynamics in industrial districts

The right bank of Central Besòs is an industrial area with former and active industries. An analysis conducted by Barcelona Regional found that the industrial activities of this region are essential for the functioning of the metropolis due to the services they provide. Moving this industrial area outside AMB would therefore be unsustainable, but the redevelopment of urban space and local industry, based on new principles, is nevertheless required. The purpose of this urban transformation is to maintain the existing industries while transforming the area into a hub of sustainable economic activity, mixed uses, and transformation of public spaces.

The redevelopment of the Mercedes Benz fabric is the most developed project in Central Besòs. The former industrial territory will be reused and transformed into a new urban fabric that incorporates housing, productive uses (60% housing and 40% economic activity), and a university campus dedicated to 4.0 industry, circular economy, and creative industries (Ajuntament de Barcelona, 2021).

The transformation incorporated as part of the Barcelona superblock strategy takes a multi-scale approach that considers its relationship with the metropolitan scale in terms of ecological connectivity and sustainable mobility by improving the connectivity with the surrounding neighbourhoods and prioritising pedestrians and active mobility (Figure 22).



Figure 22: Urban transformation of former Mercedes-Benz fabric - Internal mobility scheme, project situation, and illustrative images. Source: Adapted from Barcelona Municipality. Available at: https://ajbcn-decidim-barcelona.s3.amazonaws.com/decidim-barcelona/uploads/decidim/attachment/file/11976/Presentaci%C3%B3_espais_verds.pdf

2.3 GREATER PARIS METROPOLIS – FRANCE

2.3.1. Regional and metropolitan context: transformations and visions for fringe areas

The Île de France Region and Paris, the French capital, occupy a prominent position for French national development and are, therefore, the scene of major national investments and conflicts. Paris Region is composed of more than 12 million inhabitants, distributed in 1,278 municipalities, 82 inter-municipal governments, and eight districts (Buchoud, 2017).

It is commonly divided into four scales, as illustrated in Figure 23: (1) the City of Paris, with 2.2 million inhabitants; (2) the Métropole du Grand Paris (MGP), with 7.2 million inhabitants; (3) the Paris Urban Agglomeration, with 10.7 million inhabitants and (4) the Paris Region with 12.2 million inhabitants.

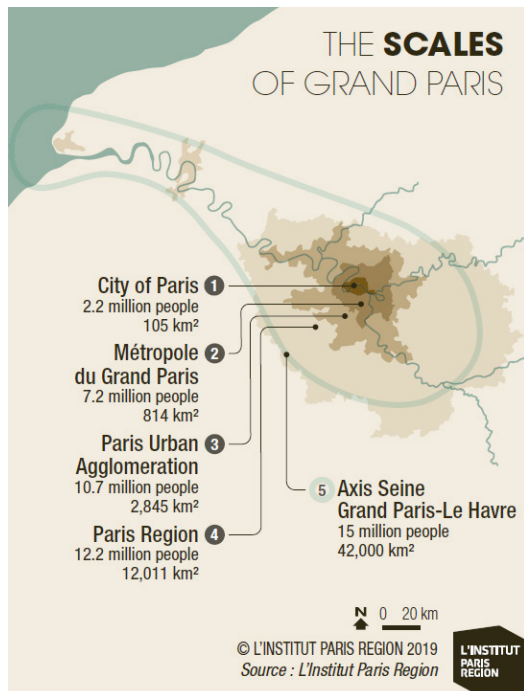


Figure 23: The scales of Grand Paris Source: Available at: <https://en.institutparisregion.fr/know-how/urban-planning/cities-change-the-world/wider-grand-paris-changes-and-debates-for-2050/>. Access 14 June 2022

Île de France has a very complex governance system formed by a series of layers and institutions. Criticism of this complexity and institutional fragmentation has led to a number of initiatives to restructure governance and competences (Enright, 2018).

The restructuring of French territorial organisation and the affirmation of metropolises through the MAPTAM and NOTRe laws, passed respectively in 2014 and 2015, illustrate a response to these criticisms by reducing institutional fragmentation and facilitating cooperation between different municipalities. Despite the criticism related to these laws, especially regarding the favouring of metropolises to the detriment of peripheral and rural areas (Bourdin and Torre, 2021); such laws illustrate a commitment by the French government to the potential of metropolises to sustainable economic development and innovation by encouraging inter-municipal cooperation.

In the case of the Paris Region, other projects add to this logic of cooperation and the creation of a polycentric urban region, such as the Grand Paris Express and the Reinventing the Grand Paris. These projects propose urban development beyond the capital, incorporating the cities of the urban agglomeration, especially those in the inner suburbs.

In the 1980s, in the framework of French decentralisation, a series of competencies and responsibilities were transmitted to the municipalities (in French, *Communes*). However, the significant transformations resulting from deindustrialisation, urban population growth on the metropolitan fringes and the intensification of globalisation generated a series of

complex metropolitan problems. Faced with this scenario, the municipalities accumulated a series of competencies. Still, they did not have enough resources to respond to the impacts of these transformations, such as unemployment and lack of social housing, especially in the peripheral municipalities (Enright, 2018).

Until the early 2000s, a municipalist model prevailed in the Paris region, with limited inter-municipal cooperation. The isolation of the city of Paris and the growing socio-spatial inequalities between municipalities and districts in the fringe areas led to crises that highlighted that these problems affected the whole urban agglomeration (Buchoud, 2017; Enright, 2018).

Based on these new demands, the Metropolitan Conference, Paris Métropole³¹ and the Metropolitan Forum were created in the first decade of the 2000s, spaces dedicated to discussion, cooperation, and consensus-building. There were also responses at national and regional level such as the renewal of regional strategic planning in Île-de-France and the launch of major proposals by the then President Nicolas Sarkozy such as the Grand Paris Express project, the Grand Paris Act and the international competition “Le Grand Pari(s) la agglomération parisienne “ (L’Institut Paris Region, APUR, Forum métropolitain du Grand Paris, 2021).

In parallel to the metropolitan discussions there have been reforms aimed at addressing the environmental crisis and climate change, for example, since early 2000 the national legislative reforms (Grenelle de l’Environnement) have emphasised ecological transition in urban planning documents (Huybrechts, 2018).

These proposals indicate a clear investment by the French government in the potential of the so-called “global metropolises” and the need to promote the ecological transition in these areas. For Theresa Enright (2016), the proposed Grand Paris projects represent a paradigm shift in urban planning for the 21st century by thinking of the core city in conjunction with suburban areas and combining economic development, sustainability, participation and social responsibility. The main strategies are the creation of new centralities in the inner suburbs with a focus on economic development and connectivity of these new centralities through mass mobility infrastructures.

Moreover, the whole process and discussion setting created from these initiatives generated a series of innovations, research, data, and visions of the future of the metropolis. Buchoud (2017) states, based on data from the Grand Paris Alliance for Metropolitan Development, that about 50 initiatives and networks had emerged within civil society, including businesses, due to the Grand Paris process connecting placemaking, sustainability, and mobility.

2.3.2 CONTEMPORARY METROPOLITAN PLANNING AND GOVERNANCE

Governance in the Paris Region has undergone significant transformations since the beginning of the 21st century. These transformations are marked by contradictions, conflicts, and innovations in a mix of top-down and bottom-up initiatives.

After the launch of the Grand Paris as a project of national interest to transform the Paris region into a globally competitive and sustainable metropolis, there was the formalisation of this proposal through the Great Paris Act (2010), which created a public institution for the viability of the Grand Paris Express and objectives related to the construction of housing articulated to the new metropolitan transport network (Buchoud, 2017).

The Grand Paris Express project did not involve the creation of a new layer of institutional governance, although it fostered the debate. This shift came after national administra-

31_ Nowadays, Forum métropolitain du Grand Paris. The aim of the Forum is to support urban planning agencies, provide data and assessments of the territory and give technical support to local authorities.

tive reforms with the approval of the Law on the Modernisation of Territorial Public Action and Affirmation of Metropolises (MAPTAM Law) in 2014 and the New Territorial Organisation of the Republic (NOTRe Law) in 2015. In this new French institutional system, metropolises are intermunicipalities with a special character.

In this context, in 2016, the Métropole du Grand Paris (MGP) was created, comprising 131 municipalities (communes) contained in 11 Public Territorial Establishment (Établissements Publics Territoriaux - EPTs) and the city of Paris (Figure 24). The MGP is a special-status inter-municipality, unique of its type in France (Moreau *et al.*, 2021).

Is the Metropolitan area institutionalised by law?	Yes.
Has an administrative and technical body?	Yes.
Institution name	Métropole du Grand Paris
Foundation date	2016
Competencies	Economic, social and cultural development and planning Environmental protection and environmental policy Development of metropolitan space Local housing policy Management of aquatic environment and flood prevention
Type of election	Indirect: A metropolitan assembly of 208 members elects the president
Funding	Taxes and transfers from other state levels.

Table 9: Governance and institutional characteristics of Métropole du Grand Paris. Source: prepared by the author based on Buchoud (2017) and MGP available at: <https://metropolegrandparis.fr/fr>. Access 14 June 2022.

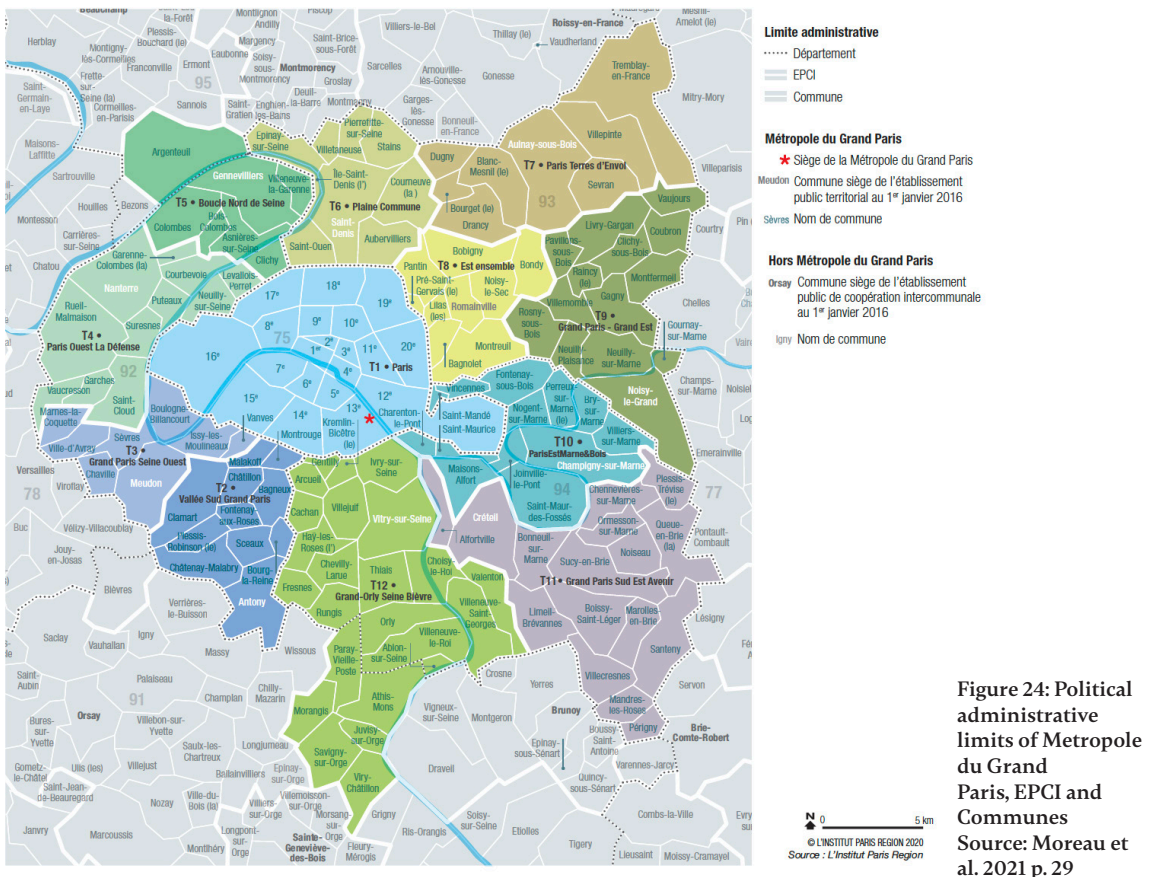
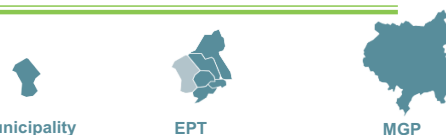


Figure 24: Political administrative limits of Métropole du Grand Paris, EPCI and Communes
Source: Moreau *et al.* 2021 p. 29

The creation of this institution is recent, and some of its competencies still need to be clarified, as it does not replace other administrative structures. Its planning must be compatible with different planning scales, such as Regional and Local. Moreover, the MGP has a relatively minor technical staff and a low budget compared to the region; in this sense, despite the creation of this new institutional layer, the region and its respective institutions remain central actors in metropolitan development, as does the regional government (Buchoud, 2017; Moreau *et al.*, 2021).

The competencies of MGP, EPTs and municipalities (communes) are interconnected, and a number of them are shared; as shown in Figure 25, MGP is mainly active in spatial planning, economic development, environment and housing, and in specific fields of metropolitan interest. The planning documents formulated by MGP enable shared diagnoses and visions for metropolitan development to be outlined and synergies and financial resources earmarked for these visions to be leveraged.

DIVISION OF RESPONSIBILITIES BETWEEN MUNICIPALITIES, EPT AND MGP



		Municipality	EPT	MGP
Security	Police and rescue		✗	✗
Children/ education	Early childhood		✗	✗
	Primary school		✗	✗
Social action and development	Social action		Social action of territorial interest	✗
	Urban policy		Urban policy	✗
Planning, urban development, quality of life and the environment	Planning and regulations	Planning permission	Intercommunal local urban development plan	Metropolitan Territorial Coherence Scheme
	Urban planning and development initiatives and operations			Metropolitan interest : • Development projects • Urban restructuring initiatives • Creating land reserves
	Natural areas			Actions to enhance the natural and landscape heritage of biodiversity
	Risk prevention		✗	Flood prevention
Housing	Planning	✗	✗	Metropolitan housing and accommodation plan
	Housing policy			Housing construction and renovation programmes
	Home improvement			Metropolitan interest : • Improving the building stock • Rehabilitation and reduction of substandard housing
	Social housing		Supervision of public housing offices	Financial aid and initiatives to promote social housing
	Specific audiences			Actions to promote housing for disadvantaged people, Traveller reception areas
Culture and sport and leisure	Construction and operation local amenities		Construction and operation Of cultural and sports facilities of regional interest	Facilities required for housing programmes
Mobility	Organisation of mobility (excluding transport)			Sustainable mobility, combating pollution and noise pollution
	Roads			✗
Economic development / tourism	Attractiveness			Major international or national cultural and sports facilities, Helping to prepare bids for major international cultural and artistic events, etc.
	Economic action			Metropolitan interest : • Economic development initiatives • Business parks
Climate / energy	Planning	✗	Territorial Climate-Air-Energy Plan	Metropolitan Climate-Air-Energy Plan Master plan for metropolitan energy distribution networks
	Actions in favour of the climate and energy management			Support for actions to control energy demand
Urban services	Cleanliness			✗
	Waste	✗		✗
	Water	✗		✗
	Sanitation	✗		✗

Responsibility of the municipality, EPT and/or MGP ✗ No competence



Figure 25: Competences of MGP, EPTs and municipalities (communes)
Source: Moreau *et al.* 2021 p. 31

2.3.3 CLIMATE CHANGE AND RESILIENCE IN URBAN POLICES

A multi-scale and coordinated strategy

The issue of climate change has been a significant concern in French urban policies for several decades. Some cases exemplify this statement such as the Sustainable neighbourhoods' projects³², the Île de France Regional Master Plan and the “Zero net artificialisation” (ZAN)³³.

The Île de France 2030 Regional Master Plan (SDRIF adopted in 2013) presents a set of clear strategies such as compactness, density, multi-polarity, and sustainable modes of transport to reduce GHG emissions. This proposed densification is accompanied by the re-naturalisation of the territory by establishing that municipalities must have at least 10m² of green area per inhabitant (Huybrechts, 2018).

Territorial climate change adaptation plans have existed in France since the early 2000s. Data from Ademe³⁴ (2016) point out that between 2006 and 2015, almost 600 climate plans were launched in the French territory. However, the main founding text of territorial approaches to climate action in France was created in 2010. The Grenelle II law (Law n° 2010-788/2010) establishes the Regional Climate, Air and Energy Plans (SRCAE) and Territorial Climate and Energy Plans (PCET).

Currently, France is in a second generation of climate plans. Since 2015, with the Law on Energy Transition for Green Growth (LTECV) the PCET have been replaced by the Territorial Climate-Air-Energy Plan (PCAET). Before this, climate plans were mandatory for all local authorities with more than 50,000 inhabitants, regardless of their status. After the LTECV these plans became mandatory for all metropolitan areas and inter-municipal authorities (EPCI) with more than 20,000 inhabitants (ADEME, 2016).

This is an important change as the French government has sought to respond to institutional fragmentation through intermunicipalities (*intercommunalités*) (Moreau *et al.*, 2021). In other words, this is essentially a way to improve coordination and collaboration between municipalities (communes) and enable them to work together on joint projects and public policies that would be difficult to achieve individually, especially in France, where municipalities are generally small in scale.

The case of MGP is a particular case in France because the metropolitan area is an inter-municipality with a special character, and it must also have a Climate Plan, in this case, the PCAEM. In this sense, regional, metropolitan, and local, or inter-municipal, plans converge.

In the case of MGP, this articulation occurs as illustrated in Figure 26. This indicates that the PCAET (or PCAEM, in the case of the MGP), the SCOT and the PLU must be compatible and written in a way that is coherent with each other. In addition, the plans must be in consonance with the other planning scales, such as the regional one. That is, there is an attempt to articulate between different scales and to articulate different urban planning documents towards the construction of adapted and resilient cities. As Abascal and Bilbao (2022) point out, the SCoTs play an important role in coordinating territorial planning diagnosis and projects, transversality contributing to territorial coherence in a multi-scale approach. They bring together pre-existing plans and integrate domains such as mobility, ecological coherence, climate and energy issues, and waste control.

32_ More information at: <https://www.institutparisregion.fr/nos-travaux/publications/quartiers-durables-comment-ces-projets-urbains-ont-ils-evolué-en-dix-ans/>

33_ More information at: <https://www.institutparisregion.fr/nos-travaux/publications/zero-artificialisation-nette-un-defi-sans-precedent/>

34_ Agence de la transition écologique (Agency for the ecological transition)

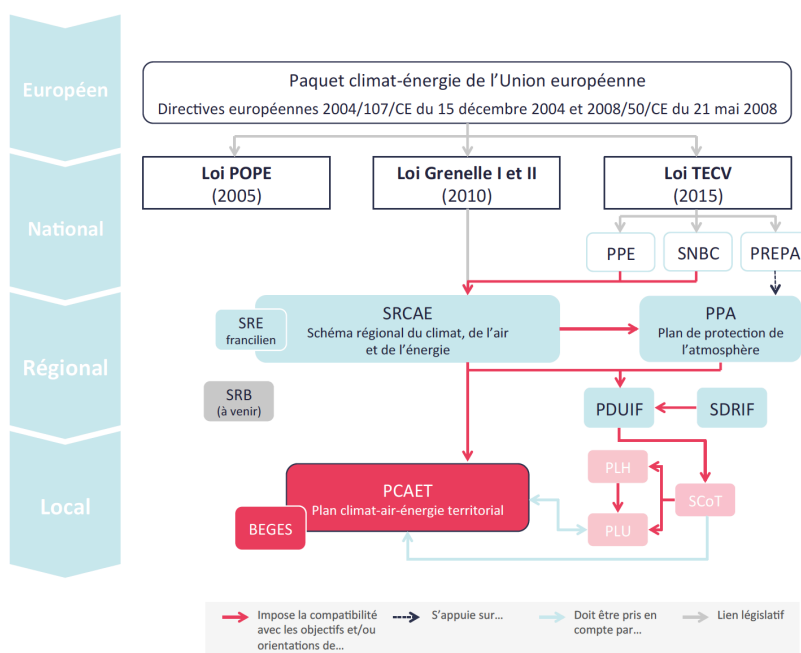


Figure 26: Articulation of the plans and regulations surrounding the Territorial Climate and Energy Plans
Source: (ADEME Île de France, 2018, p. 13)

Metropolitan scale

According to the French public policies regarding climate change and ecological transition, different plans covering the issue have been enacted in the framework of the MGP. At the metropolitan scale, the main plan is the PCAEM (Plan Climat Air Énergie de la Métropole du Grand Paris) which was approved in 2018 by the metropolitan council.

Based on the Paris agreement and Regional Plan for Climate, Air and Energy (SRCAE), the PCAEM aims to propose strategies for a post-carbon Metropolis within the framework of its metropolitan action and aligned with other instruments of local, regional, and national action, and in international cooperation. The PCAEM addresses climate resilience, energy transition and air quality, promoting synergies between local and metropolitan actors and actions.

As part of its preparation, a diagnosis of air quality, GHG³⁵ emissions, energy profile and analysis of the territory's vulnerability to the effects of climate change were carried out.

Regarding emissions, MGP decided to go beyond the cadastral approach (which considers scopes 1 and 2) and evaluate its emissions in a broader perspective, considering emissions linked to activities and population of the territory, whether intra or extra-territorial.

Transport and habitat sectors had the most significant impact in both analyses and were the most focused on achieving carbon neutrality. Nevertheless, the consumption sector accounted for considerable emissions in the broader study. In response, action was considered directed toward producing local products and incentives to change citizens' consumption habits.

35_ The assessment of greenhouse gas (GHG) emissions was carried out in three distinct scopes, namely: Scope 1: direct emissions from fixed or mobile facilities located within the administrative boundaries of the community; Scope 2: includes indirect emissions associated with energy production beyond the administrative boundaries of the territory; and Scope 3: consists of all GHG emissions produced directly or indirectly by the activities and population of the region.

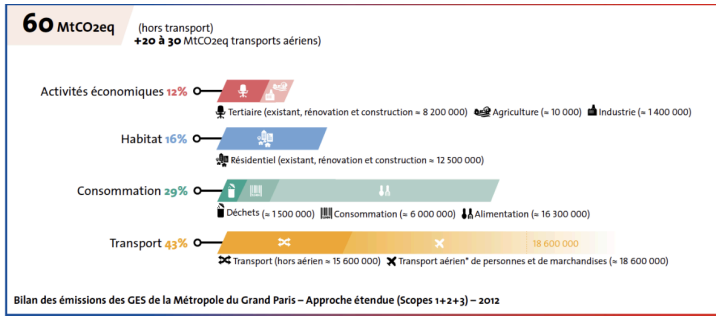


Figure 27: GHG emissions assessment of the Greater Paris Region - Extended approach (Scopes 1+2+3) – 2012
Source: Métropole du Grand Paris, (2019)

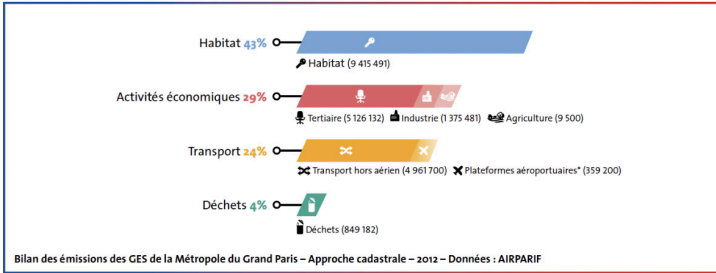


Figure 28: GHG emissions balance of the Greater Paris Region - Cadastral approach – 2012
Source: Métropole du Grand Paris, (2019)

The Plan presents strategies related to resilience, as illustrated in Table 10. In general, the proposed actions are based on metropolitan energy transition, carbon neutrality, transition to a green and circular economy, and social inclusion.

NAME OF THE METROPOLITAN AREA		MÉTROPOLE DU GRAND PARIS
Population		7.2 million inhabitants
Number of cities		131 municipalities (communes) 12 territories
Fringe characteristics		The Peripheric road, Boulevard Périphérique, is a clear boundary marking the fringes of the first crown that concentrates most of the socially vulnerable municipalities and natural remnants of the region.
Main plan addressing climate change adaptation		Metropolitan Climate, Air and Energy Plan (PCAEM)
Main climate risks		Temperature increase Flooding risk Water stress increase
Transversal adaptation strategies	Mobilising and coordinating actors	- coordinate the energy transition of the metropolitan territory - mobilise and engage all stakeholders in the ecological transition - increase and share knowledge of environmental issues - the metropolitan climate plan, a territorial planning tool linked to existing initiatives
	<i>Build an ecological and financial strategy for the metropolitan area</i>	- financing the implementation of the climate plan and energy transition - ensure the coherence and reliability of available financing solutions - mobilise the capital needed to carry out investment projects
	<i>Promote and cooperate at all levels</i>	- increase knowledge of environmental issues - foster international cooperation and the organisation of global events - strengthen inter-territorial cooperation - stimulate inter-municipal cooperation
	<i>Residential: to have a fully low-carbon stock by 2050</i>	- massive energy renovation of the residential stock - mobilise the territory's actors on energy renovation and energy poverty - strengthen the culture of energy sobriety - translate the objectives of the metropolitan air-energy climate plan into requirements for planning documents
	<i>Moving towards a low-carbon economy, serving attractiveness and social cohesion</i>	- support circular economy - foster the reused and bio-sourced of materials in construction sector - promote urban agriculture for a healthy, pleasant, and friendly living environment for city dwellers
	<i>Transport: taking action for cleaner mobility</i>	- Short distance: prioritise active and carbon neutral modes - Long distance: prioritise public transport or shared cars - Logistics:
<i>Consumption, food & waste</i>		- Developing the circular economy for a zero-waste territory - Supporting the transition towards a more sustainable food system

Table 10: General metropolitan characteristics, main climate risks and adaptation strategies. Source: prepared by the author based on PCAEM (2019).

2.3.4 INNOVATIONS AT THE METROPOLITAN SCALE

Coordination, support, and promotion of synergies

The MGP plays an important role in coordinating and aligning the objectives of metropolitan intermunicipalities towards those set out in the PCAEM. In some cases, the MGP has a more central role in the implementation of actions, depending on the degree of adherence to the metropolitan competencies discussed above. An example of this is the implementation of the Low Emission Zone (ZFE) that was implemented in the densest area of MGP. The aim of the ZFE is to limit the circulation of more polluting vehicles and favour the circulation of cleaner vehicles, reducing air pollution and pollutant gas emissions. The proposal is progressive, and the objective is to reach 100% of clean vehicles circulating in the zone by 2030. To this end, the State offers aid and, in some cases, micro-credit to replace vehicles, including aid for electric bicycles. In addition, electric charging stations will be expanded throughout the metropolitan area (Métropole du Grand Paris, 2022).

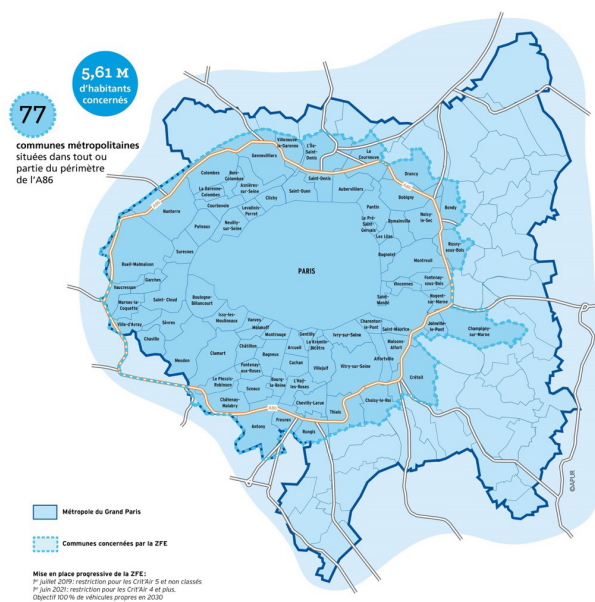


Figure 29: Low Emission Zone (ZFE) in MGP
 Source: Métropole du Grand Paris (2022)

Another important point is the financial support offered to municipalities, EPTs and various projects. An example of this support is the Metropolitan Fund, that finances projects and actions for renovation, renaturalisation, and infrastructure for sustainable mobility, among others. Another example is ADAPTAVILLE³⁶, a project of the Agence Parisienne du Climat, which has MGP, among other institutions, as a partner and financier.

In 2018, it created the Federation of Local Energy and Climate Agencies (ALEC) to have a space for dialogue and collective construction. In addition to these more traditional forms of support and coordination, MGP has also created collaborative digital platforms. For example, the platform focused on information and participation of the PCAEM³⁷, the Circular Economy collaborative platform³⁸ and the Pass'RénoHabitat e CoachCopro platforms, which offer support to families regarding decision-making for energy renovation of their homes; MGP finances local structures that provide free and independent support for citizens.

These platforms, besides facilitating participation, information dissemination and awareness raising, can also promote synergies between different actors and foster a more active participation of society.

36_ More information at: <https://www.adaptaville.fr/>

37_ <https://planclimat-metropolegrandparis.jenparle.net/>

38_ <http://grandpariscirculaire.org/>

Integration of different plans, instruments, and scales - circular economy, innovation and attractiveness

As mentioned previously, the MGP is a new institution in the planning system of the Paris region. The PCAEM and other metropolitan plans articulate plans and instruments from other scales. It points out the objectives and pathways for the MGP to become an attractive, innovative, and low-carbon metropolis. To this end, the plan points to the need for renaturalisation of the territory, investment in circular and low-carbon economy and energy transition.

The plan relies on other scales, it points to the need to create new instruments, plans and programmes, such as ScoT, housing plan, Sustainable Food Plan, logistics, among others. Furthermore, it recognises the need for the co-creation of these strategies with public institutions, civil society, private sector, and international partnerships.

To achieve the goal of carbon neutrality by 2050, the plan establishes some ambitious guidelines that go beyond GHG mitigation strategies focused on the transport sector. It is worth highlighting the focus on the Construction sector (residential and tertiary) through the establishment of low carbon construction practices, development of circular economy in the construction sector and reuse and use of bio-sourced materials.

The MGP focuses on economic growth and seeks to increase the attractiveness of the metropolitan territory to attract businesses focused on circular and sustainable economy, and innovation through the partnership between different sectors. At the same time, the metropolitan area invests in strategies of solidarity and creative economy, as well as professional training.

2.3.5 FOCUS FRINGE AREA: EST ENSEMBLE AND THE PARC DES HAUTEURS

Est Ensemble is a Public Territorial Establishment situated in the eastern part of the MGP, comprising eight municipalities³⁹ and a population of approximately 400,000 inhabitants. It is considered a vulnerable area from a socioeconomic standpoint, being the second poorest area in the metropolitan territory (Est Ensemble, 2020). Nonetheless, it has been deemed as a strategic location for the metropolis due to projects of metropolitan interest which are closely linked to the transformations proposed for the fringe areas of the metropolis led by the Grand Paris Express. The latter aims to improve urban mobility in the suburbs, whilst promoting urban renewal by increasing employment and housing density and curbing urban sprawl. This approach also leverages existing infrastructures.

As a Public Territorial Establishment, Est Ensemble also has a Territorial Climate Air Energy Plan (PCAET). The plan follows the same framework as the PCAEM and is structured around eight actions aimed at promoting energy transition, reducing GHG emissions, promoting a green circular economy and raising citizens' awareness on the issue of climate change.

Aligned with the planning framework discussed above, the Local Plan of Intercommunal Urbanism (PLUI) is integrated into the PCAET strategies and specialises the proposed strategies. The project for the territory of Est Ensemble passes mainly through three major strategic projects: (1) the urban renewal of the road ring and its surroundings in connection with Paris (Le Faubourg), (2) the renewal of the l'Ourcq canal area on connection with urban development projects (la Plaine de l'Ourcq) and (3) the connection of large green spaces by a promenade (Parc des Hauteurs) (Figure 30).

39_ Bagnolet, Bobigny, Bondy, Le Pré Saint-Gervais, Les Lilas, Montreuil, Noisy le Sec, Pantin and Romainville.

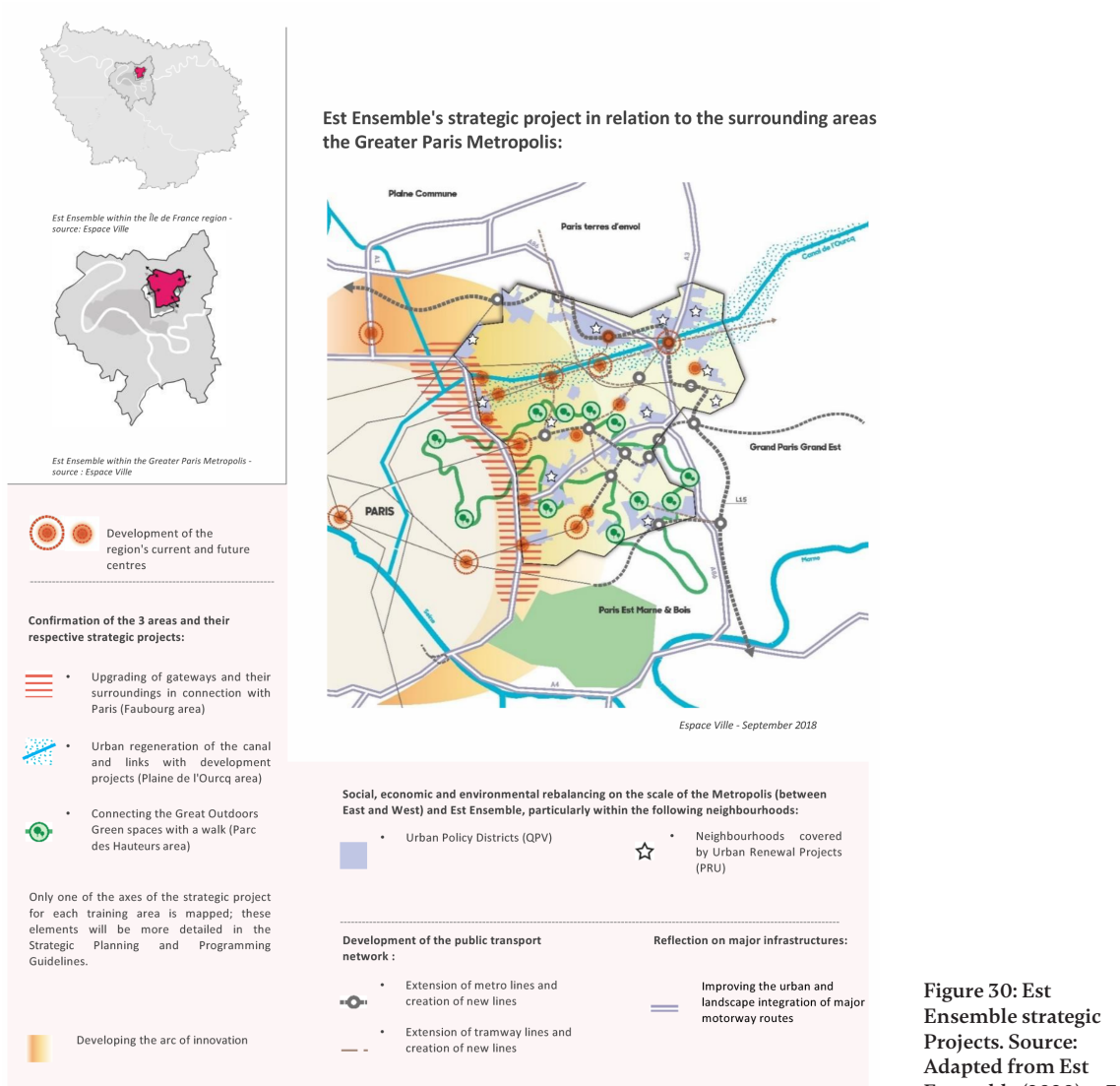


Figure 30: Est Ensemble strategic Projects. Source: Adapted from Est Ensemble (2020) p. 7

The three strategic projects are connected to each other and aim to transform the Est Ensemble region and its relationship with the metropolitan area and the city of Paris. The idea is to transform the region into a new metropolitan centrality while addressing its socio-economic challenges.

Considering the framework of national, regional and metropolitan public policies related to climate change and ecological transition, the PLUi, as well as other local instruments, seeks to leverage the territory's characteristics towards a project that enhances the environmental and cultural heritage of the region and articulates with the Le Grand Paris Express project.

The projects proposed for the Est Ensemble area are strongly influenced by the transport infrastructures proposed for the area, namely the line 15 Est du Grand Paris Express, the T-Zen 3, the T1, the T11 Express and the metro lines 1 and 9. In this sense, these new mobility structures are seen as major vectors of transformation of the region.

The project for the territory is based on territorial dynamism and a strong idea of proximity, in the sense of promoting the local production of products, food and energy, as well as local job creation, guaranteed urban services and citizen participation, especially for young people, since 40% of the local population is under 30 years of age and the unemployment rate among young people is around 30% (Est Ensemble, 2020).

PLUi is based on three principles: (1) Build a renaturalised and high-quality city for all⁴⁰, (2) hospitality and coexistence at the heart of the project, (3) heritage, resilience, and ecological

40_ By improving the relationship between housing and employment, combining different uses and functions, accessibility of green spaces, low carbon, and shared mobility.

transition as drivers of controlled transformations.

Parc des Hauteurs: ecological, urban, and cultural regeneration

The Parc des Hauteurs is a project of local, metropolitan, and regional interest that aims to contribute to the urban and social requalification and economic revitalisation of the territory. Launched by the Institut Paris Region from a working group formed to think about the development of the Est Ensemble urban project, the project has been supported by the Territorial Establishment and local representatives since 2016.

Nevertheless, the idea of connecting the natural remnants of that region was already present in other regional plans such as the Green Regional Plan (*Plan Vert Régional*) (1995) and the Ecological Connectivity Regional Plan (Schéma régional des continuités écologiques) (2013). The Park project goes beyond the political and administrative boundaries of Est Ensemble and involves also part of the city of Paris, Rosny-sous-Bois and Fontenay-sous-Bois, covering an area that computes 920,000 inhabitants (Lecroart, 2021).

Although the area presents significant environmental assets, green areas of public access are scarce. Currently, the territory has 230 hectares of public green spaces, and the goal is to reach 320 hectares by 2030. Furthermore, the region is particularly vulnerable to heat islands due to the density of construction that tends to intensify as the local population increases. It is estimated that by 2030 the region will receive about 60,000 new inhabitants. The area has several green areas and cultural heritage related to the limestone mining areas; however, this environmental and cultural heritage is disarticulated and forms a fragmented territory. Part of this heritage is in a degraded state, blocked by infrastructure or closed to the public. The idea of the project is to connect these assets by promoting ecological continuity and urban connectivity, prioritising active mobility and enhancing new territorial dynamics (Lecroart, 2021).

The project is structured along four axes (Figure 31):

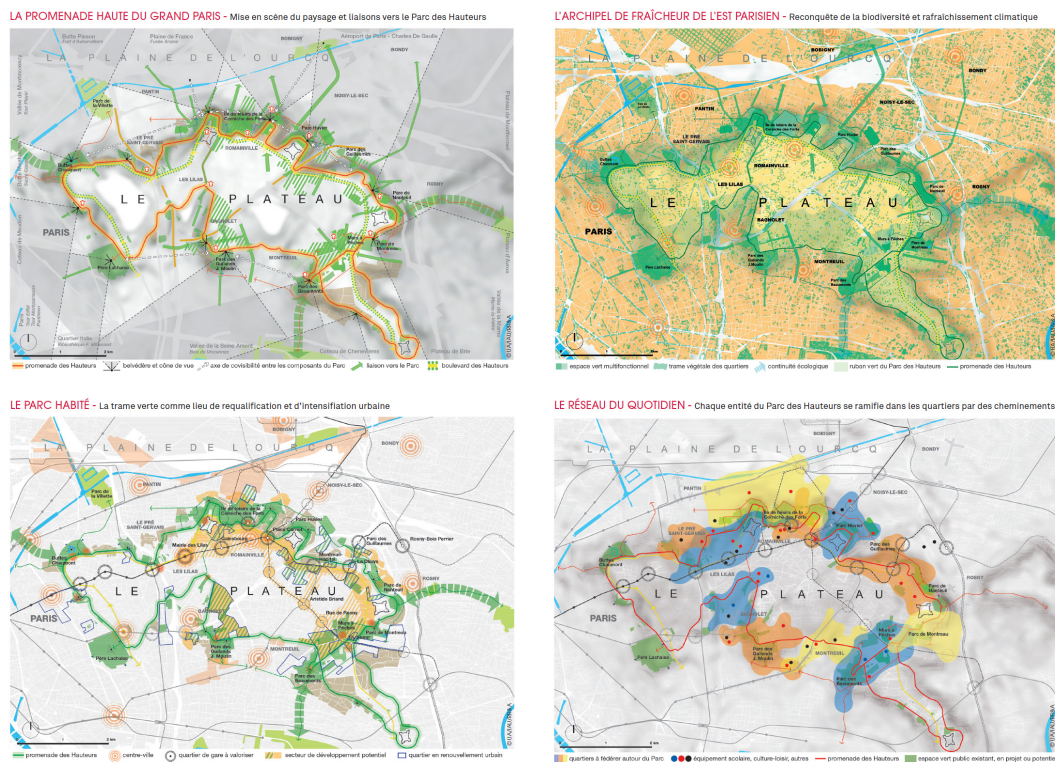


Figure 31: Maps of the project's axes. Source: <https://www.institutparisregion.fr/amenagement-et-territoires/amenagement/le-parc-des-hauteurs/>. Accessed on October 12, 2022.

PROMENADE OF HAUTEURS: a 30km route that aims to connect existing environmental and cultural heritage. The route prioritises green infrastructure and active mobility modes. **ARCHIPELAGO OF FRESHNESS:** aims to combat the effects of the heat island, promote the renaturalisation of the land, integrate the place of water, and urban agriculture projects. **HABITAT AND ACTIVE PARK:** encourages new ways of living, working, and moving around in the territory. It promotes a circular and creative economy. **DAILY NETWORKS:** aims to integrate local districts, improve the network of public spaces and local services

2.3.6 INNOVATIONS AT THE INTERMEDIARY AND LOCAL SCALE

Parc des Hauteurs: An incremental process that articulates different stakeholders and scales

The development process of the Parc des Hauteurs has been incremental, involving various stakeholders and scales, and raising support progressively (Lecroart, 2021). The Promenade des Hauteurs is currently one of the main projects under development by Est Ensemble. The Promenade aims to connect several parks and natural remnants present in the territory through a route that prioritises pedestrians and bicycles, aiming to promote ecological connectivity through green infrastructure, increase the availability of leisure spaces and improve connectivity between districts and cities.

Est Ensemble is acting as project coordinator, accompanied by the Paris Region Institute in structuring, envisioning and animating the overall project. The project has also been designed according to a process of progressive association of the various actors. Est Ensemble and the cities of the region initiated the project, then involved neighbouring cities, other institutional, technical and/or financial partners - the Department of Seine-Saint-Denis, MGP, the Île-de-France Region, the Agence des Espaces Verts, the State, Seine-Saint-Denis Tourisme, the Seine-Saint-Denis Departmental Olympic and Sports Committee, the Seine-Normandie Water Agency, and civil society.

Temporary installations, pilot projects and activities to raise awareness and participation

Between 2019 and 2021, pilot experiments and studies were developed by Agence TER paysagistes, the Cuesta cultural cooperative and the consulting firms *Une Fabrique de la Ville* and *Inddigo*. In this participatory process, various actors worked on the co-creation of guidelines for the territory, such as possible uses, guidelines, and principles of the Promenade to be implemented in the future.

This participatory and sensitisation process in loco drives the continuity of the project and offers space for a more active participation of local actors. This process was developed through artistic and cultural activities, workshops, events, walks, and the construction of temporary installations.

As a researcher, I had the opportunity to participate in one of the walks promoted by Est Ensemble. Hundreds of people of different age groups held a walk on September 25th, 2022, in which the project was presented, and participants had the chance to walk part of the Promenade route, get to know different parks, initiatives and cultural and sustainable institutions present in the region (Figure 32).



Figure 32: Public walking session along the Promenade des hauteurs and the l'Ourcq canal. Source: own collection

Development of urban projects connected to the Parc des Hauteurs

There are several urban renewal and development projects in consolidated areas in the territory connected by the Parc des Hauteurs, including ZACs (*Zone d'Aménagement Concerté Zone*), Inventing the Greater Paris Metropolis (IMGP) sites and the National Urban Renewal Programme (NPNRU). These urban development projects generally aim to increase housing diversity and promote and/or consolidate local economic development potential.

An example of promotion of the local and solidarity-based economy is the Cité Maraîchère in Romainville, which is part of the municipal ecological transition strategy through the Municipal Agency for the Ecological and Solidarity-based Transition (ACTES). This is an urban agriculture centre which is the object of an urban renewal operation on a 10-hectare area. The site is intended for food production in a circular perspective, cultural and educational activities related to environmental and ecological education, as well as research, innovation, professional qualification and local job creation (Ville de Romainville, 2022).

Local food production combines high and low-tech actions such as rainwater recovery, composting of local waste, smart bioclimatic management of growing areas, use of organic materials for insulation, among others. The project has received the French seals of 100 Quartiers innovants écologiques and EcoQuartiers and besides being integrated in ACTES, Cité Maraîchère (Figure 33) is supported by several public institutions such as Île de France, MGP, Seine-Saint-Denis Departmental Council and the State, as well as private partners (Jarrousseau and Hawi, 2017; Ville de Romainville, 2022).



Figure 33: Cité Maraîchère in Romainville. Source: author's own collection

Reuse of the building and introduction of new uses and dynamics

Another innovative example of urban design connected to the park is Les Lilas - Fort de Romainville (in the city of Lilas), which is one of the sites selected for the *Inventons la Métropole du Grand Paris* competition mentioned previously. The winning project⁴¹ was that of the Cibex group which follows the competition guidelines to propose the transformation of the Fort built in the 19th century and which today is unoccupied into a city with dormitory town characteristics and in need of new urban and economic dynamics.

The site covers approximately 6.75 hectares and, in addition to the fort with its panoramic view of the Paris region, has a 140-metre-high radio transmission tower; the tower area will not be transformed as it is a private property.

The project aims to create a centrality in the city by valuing the historic and environmental heritage present there. Part of the Fort will be transformed into a memorial dedicated to the Women in Resistance in the Second World War and to the victims murdered by the Nazis. Another part will house new economic activities linked to the creative industry, urban agriculture, technology, and the social and solidarity economy. The natural

41_ The judging panel was composed of representatives from the State, Est Ensemble, MGP and the City of Lilas.

remnants and parks that are located on the perimeter of the project will be enhanced and connected to new elements of green infrastructure, such as green roofs and public spaces (Ville des Lilas, 2019b).

In the central square area, different types of housing will be built for different social and age groups, with commercial and flexible facilities on the ground floor. Pedestrian access and active mobility are prioritised on the project's perimeter, as well as public transport via metro and cable car. The winning project of the competition went through an initial discussion stage among institutional actors, and in May 2019, the participatory process with the local population was started through visits, exhibitions, meetings and workshops (Ville des Lilas, 2019a, 2019b).

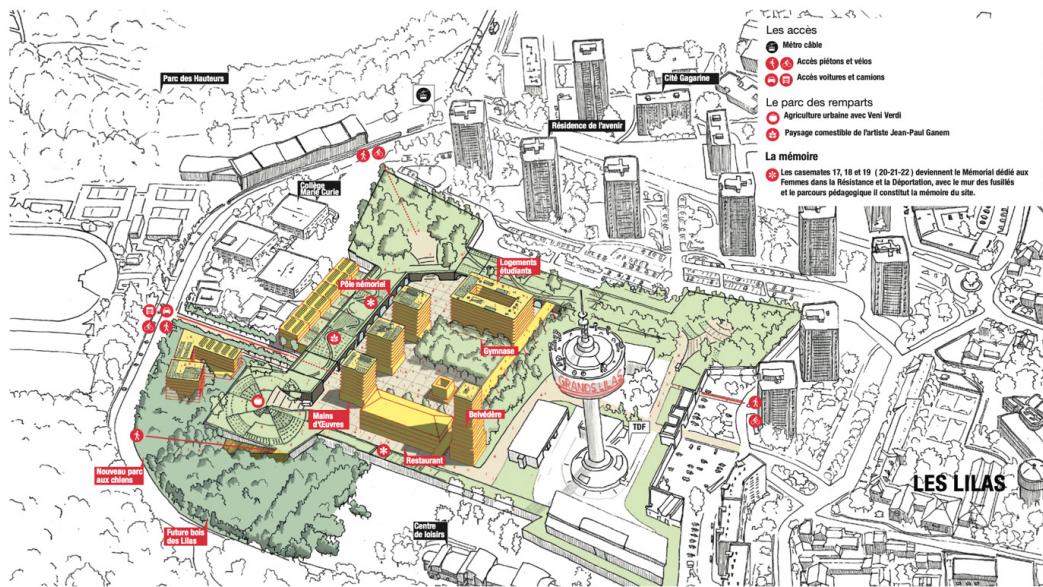


Figure 34: Les Lilas - Fort de Romainville. Source: Ville des Lilas (2019b)



Figure 35: Les Lilas - Fort de Romainville. Source: Ville des Lilas (2019b)

In the perimeter of the MGP, several ZACs⁴² have been developed over the last decades, some of them are successful experiences from the environmental and urban point of view, configuring sustainable neighbourhoods with a mix of uses, housing provision to

42. The ZAC is an urban development zone resulting from a local authority or public institution. It is an intervention polygon that, once defined, is subject to a series of studies to obtain a local diagnosis, objectives and guidelines, and intervention plan. A private entity or public-private partnership can develop the implementation of the urban project through a public tender.

different social classes, and sustainable construction techniques, as for example the well-known case of Saint-Ouen Docks and other *Écoquartiers* (Jarousseau and Hawi, 2017).

On the perimeter of the Parc des Hauteurs, the ZAC Boissière-Acacia (Figure 36) in Montreuil stands out among other examples. Built on a vacant lot on an area of approximately 14 hectares, the urban project has 1200 housing units, 40% of which are for social housing. The project also has 1000m² for economic activities, as well as a school, a kindergarten, a sports centre, and public spaces.



Figure 36: ZAC Boissière-Acacia Montreuil. Source: author's own collection

2.4 METROPOLITAN AREA OF THE ABURRÁ VALLEY – COLOMBIA

2.4.1 METROPOLITAN CONTEXT

Colombia has high urbanisation rates following the trends of other Latin American cities. Currently, 80% of the Colombian population lives in urban areas, and the two most populated cities in the country are Bogotá and Medellín, respectively. The growth of the urban population in Colombia was due to an intense migratory flow of people fleeing violence from armed conflict in rural areas and seeking job opportunities in the cities (Leite *et al.*, 2020).

In Medellín, the demographic growth and occupation of the fringe areas, particularly the slopes, were solidified in this context, especially from the 1950s with the emergence of working-class neighborhoods comprising irregular and precarious settlements with little or no access to public services. This dynamic extended to other metropolitan municipalities such as Bello, Envigado and Itagüí in the 1970s (Alcaldía de Medellín and EDU, 2015).

Due to the history of authoritarian governments and dictatorships in Latin America, metropolitan planning faces a certain resistance for fear of weakening local power; in this context, a municipalist vision predominates in the region, which presents a series of limitations in the face of the interdependencies and complexities of metropolitan regions (Frey, 2013).

Within this context, the Colombian case has been presented in regional and international literature as a reference for governance and urban and metropolitan planning. Salamanca and Bonilla (2021) point out that the constitution of metropolitan areas in Colombia has a long history, with an initial milestone in Legislative Act No. 1 of 1968, which enabled the creation of metropolitan regions between cities in the same department to improve administration or provision of public services.

Since then, a series of changes have occurred in Colombia's political-administrative structure, such as the Urban Reform (Law 9, 1989) and laws that have strengthened transparency and democratic participation in the city planning process (Law 80, 1993 and Law 152/1994).

One of the main milestones of urban development policies is the Colombian Constitution (1991), which, although it adopted a decentralised model in which municipalities have administrative and fiscal autonomy, also allowed municipalities within metropolitan areas to organise themselves as an administrative institution to coordinate the planning of the region, rationalise the provision of public services and execute works of metropolitan interest (Frey, 2013).

In addition to the mention of the metropolitan issue in the Federal Constitution, Colombia has the *Ley Organica de Ordenamiento Territorial* (LOOT, Law 1454 of 2011), which regulates inter-scale integration and inter-municipal consortia, and the Law on the Regulation of Metropolitan Areas (Law no 1,625 of 2013) which repealed the Organic Law of Metropolitan Areas (Law no 128 of 1994) (Abascal and Bilbao, 2016; Salamanca and Bonilla, 2021).

Despite this legal framework, Leyva et al. (2021) point out that there is little consistency in the structuring and coordination of metropolitan policies in Colombia, especially at the national level. There are 18 legally instituted metropolitan areas in Colombia, and only a small part of these have a metropolitan institution dedicated to planning. Bogotá, Cali, and Cartagena, for instance, do not have a metropolitan institution that plays the role of coordinated planning and governance. In this context, the Valle de Aburrá Metropolitan Area (AMVA) is the most successful experience in the country.

Regarding the fringe areas, it is worth highlighting important antecedents in the AMVA context. The concern with urban expansion towards the slopes and the dynamics of the metropolitan scale have been an object of Medellín's planning for decades. The Plano Regulador de Medellín developed by the urban planners Paul Lester Wiener and José Luis Sert in the 1950s already considered these issues. The plan proposed the creation of a green belt to contain urban sprawl, a system of green areas in the city with linear and hillside parks. However, the intense pace of growth and the non-implementation of a series of guidelines resulted in a scenario of sprawling occupation and lack of access to infrastructure and public services (Alcaldía de Medellín and EDU, 2015).

Since then, several plans, programmes and projects have been elaborated with the aim of transforming the fringes of AMVA, especially in the municipality of Medellín. The most recent interventions proposed for these areas aim to promote the integral transformation of the territory with, for example, the *Proyectos Urbanos Integrales* (PUI) and the *Jardin Circunvalar de Medellín*, which aims to combine access to decent housing, environmental preservation, ecological connectivity and promote new territorial dynamics oriented towards the management and integral intervention in the eastern and western slopes of Medellín, as a strategic area of the territorial system, as will be exposed further on.

2.4.2 CONTEMPORARY METROPOLITAN PLANNING AND GOVERNANCE

The Metropolitan Area of Valle de Aburrá (AMVA) is located in the department of Antioquia, Colombia. Founded in 1980, the AMVA is a public-law administrative institution comprising 10 municipalities with a population of more than 4 million inhabitants in a territory of 1152 km².

Geographical context

The Metropolitan Area of the Aburrá Valley is made up of ten municipalities:

- Barbosa
- Girardota
- Copacabana
- Bello
- Medellín
- Itagüí
- Enviado
- Sabaneta
- La Estrella
- Caldas
- Aburrá River Medellín

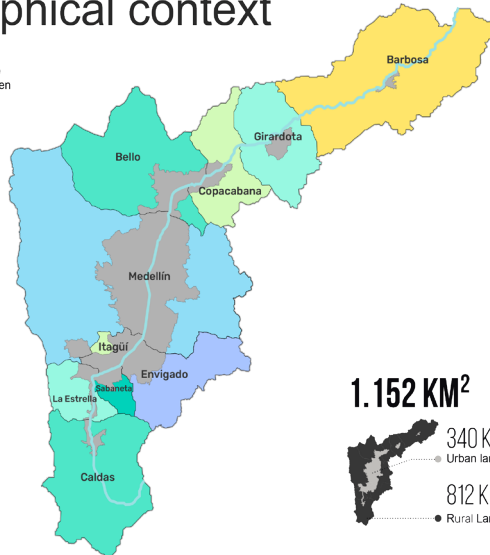


Figure 37: Metropolitan Area of Valle de Aburrá
 Source: adapted from EAFIT and Área Metropolitana del Valle de Aburrá (2021)

It is the oldest metropolitan area in Colombia and is pointed out in the literature as the most consolidated and successful in this context. AMVA was originally created to respond to local fragmentation and problems of metropolitan order (Leyva, Sanabria-Pulido and Rodríguez-Caporalli, 2021). The institution has competencies in the areas of urban and territorial planning, metropolitan public infrastructure, environment and mobility and public transport (Table 11).

Is the Metropolitan area institutionalised by law?	Yes. The metropolitan area was established by Department Order n° 27, 1980.
Has an administrative and technical body?	Yes.
Institution name	Area Metropolitana Valle de Aburrá
Foundation date	2016
Competencies	Harmonious, integrated and sustainable development The rational provision of public services The execution of infrastructure works and projects of social interest. The establishment of land-use planning guidelines
Type of election	Indirect. The Metropolitan Board is composed by the mayors from the 10 member municipalities, a representative of the non-profit entities, a representative of the Medellín council, one of the 9 municipal councils outside of Medellín, a representative of the Ministry of the Interior and the Director of the Metropolitan Area of the Aburrá Valley.
Funding	Taxation for industrial, commercial, and housing.

Table 11: Governance and institutional characteristics of the Valle de Aburrá Metropolitan Area. Sources: AMVA⁴³ and Metropolis⁴⁴

The main planning scales in this context are regional (Antioquia), Metropolitan (AMVA) and Municipal, as illustrated in Figure 38. However, these are articulated with the national and local (neighbourhood) scales, as shown in Table 12.

43_ Available at: <https://www.metropol.gov.co/area.aspx>. Accessed on September 5, 2023.

44_ Available at: <https://use.metropolis.org/case-studies/cuida-vigias-ambientales-risk-prevention-through-citizen-engagement>. Accessed on December 22, 2022.

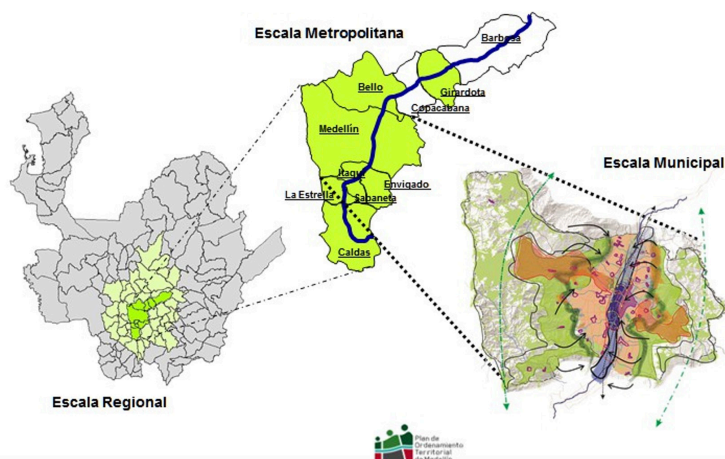


Figure 38: Main planning scales in AMVA
Source: <https://www.concejodemedellin.gov.co/sites/default/files/2018-09/Texto-del-acta-523-de-septiembre-08-de-2014.pdf>. Accessed on September 15, 2023.

SCALE	DEVELOPMENT PLANNING	TERRITORIAL PLANNING
National	National Development Plan	National territorial development policy (CONPES)
Regional	Departmental Development Plan	Territorial Planning Guidelines for Antioquia **
Metropolitan	Integrated Metropolitan Development Plan (PIDM) ⁴⁵	Metropolitan Spatial Planning Guidelines ** Plan BIO 2030**
Municipal	Municipal Development Plan (PDM)	Territorial Management Plan (POT) Thematic Special Plans (Mobility Plan, Public Space Plan)
Zone / Community / District	Local Development Plan**	Special Territorial Plans **
Neighbourhood/ Polygon	Participatory budget*	Regularisation Plans Partial Plans

Table 12: Scales and planning instruments in Colombia *This instrument has been used in some Colombian municipalities. **These instruments are exclusive for Antioquia and Medellín. Source: adapted from EDU, Alcaldía de Medellín and BID (2014) p. 47

The planning model of the metropolitan area is thought from the articulation of these different scales. Metropolitan planning guidelines are mandatorily reflected in the Territorial Planning Plans (POT) of each municipality. The POT is the main planning instrument in the Colombian system and was established by Law 388 of 1997. Another important instrument articulated to the POT is the Partial Plans; these define planning strategies for a specific area of the municipal territory, which can be urban land or a city expansion area (Garcia Ferrari, Smith and Calderon, 2018).

2.4.3 CLIMATE CHANGE AND RESILIENCE IN URBAN POLICES

Colombia has made commitments related to the environmental and climate agenda. In a partnership between UN-Habitat and ICLEI, the country is a member of Urban-LEDS, an initiative to promote Low Emission Development Strategies (LEDS) in cities by integrating a framework for low-emission, green, and inclusive urban economies into existing city development plans and processes (UN Habitat, UrbanLEDS and ICLEI, 2021).

At the national level, Colombia has several instruments and policies aimed at tackling climate change, such as the National Climate Change Policy (2017), the Colombian Low Carbon Development Strategy (2013), National Strategy for Reducing Emissions from Deforestation

45_ According to Restrepo-Mieth, Pérez-Jaramillo and Pino (2020), Colombian Law 1625/2013 requires every metropolitan authority to create a Metropolitan Strategic Land Use Plan (PEMOT), a planning tool used to develop the spatial component of the Integral Metropolitan Development Plan (PIDM). The AMVA PEMOT is the latest planning effort in metropolitan area, covering 2019-2030.

and Forest Degradation (2014), National Plan for Adaptation to Climate, among others. Nevertheless, there remain a number of challenges with the multi-level governance structure and operationalisation of policy instruments, especially regarding financial instruments and subnational coordination strengthening (UN Habitat, UrbanLEDS and ICLEI, 2021).

In the case of AMVA, the multi-scale nature of the policies occurs in a more coordinated manner, as indicated in Figure 39, with the presence of instruments at the regional and metropolitan scale, in addition to the local and national.

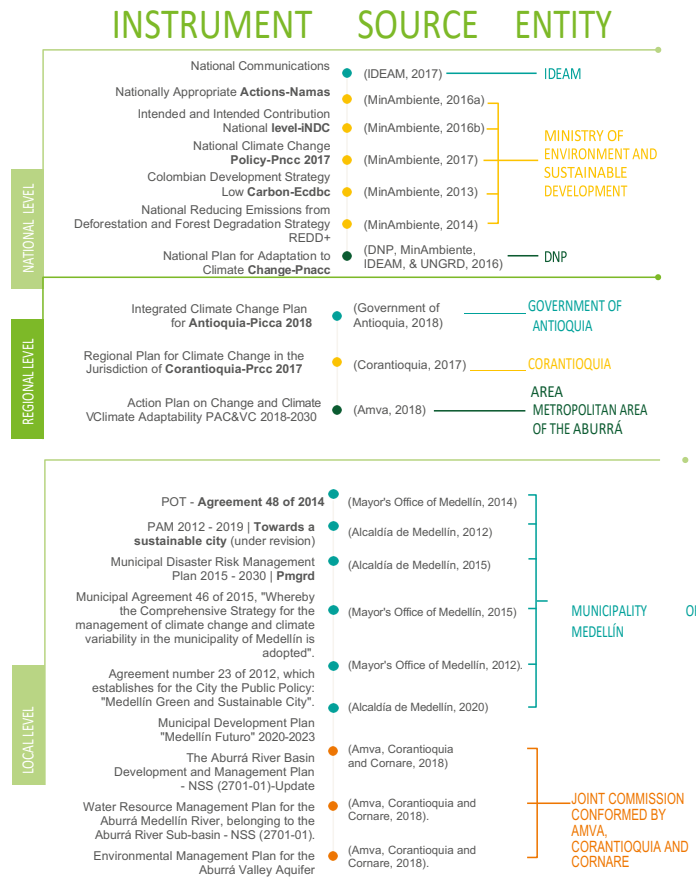


Figure 39: Climate instruments and policies in the context of AMVA
 Source: adapted from Plan de Acción Climática Medellín 2020-2050. p.37

Climate change management guidelines are established under Law No. 1931/2018, which includes diverse actors from different levels of government (Nation, Departments, Municipalities, Metropolitan Areas, and Environmental Authorities).

According to this law, it is the AMVA’s responsibility to develop and implement, together with the local authorities, the Integrated Management Plans for Territorial Climate Change, as well as implement programs and projects for reducing GHG and adapting to climate change, integrating the strategic and priority actions into the territorial and environmental planning, budget, and financial instruments.

In the Colombian case, municipalities are not required to develop their own climate change adaptation plans (PAC). Law 1931 of 2018 states that each municipality must manage climate risk but does not explicitly state that it must have a PAC. However, the same law defines that municipalities must consult the “Integrated Territorial Climate Change Management Plan” (PIGCCT) of the corresponding departmental level, incorporate the guidelines defined as priorities within their local development instruments, and create specific programmes and projects.

Metropolitan scale

AMVA has different instruments that address the issue of climate change. However, as in the other referential cases handled, the metropolitan area has a specific plan that approaches this topic in greater depth, the *Action Plan for Climate Change and Variability in the Metropolitan Area of the Aburrá Valley 2019-2030* (PAC&VC). This plan is directly related to the *Comprehensive Plan for Air Quality Management* (PIGECA). It addresses short, medium, and long-term metropolitan strategies based on two thematic axes: (1) mitigation of greenhouse gas emissions and (2) adaptation to climate change. The plan was developed under the coordination of AMVA with the participation of the Universidad Nacional de Colombia (Medellin) and the collaboration of the Universidad Pontificia Bolivariana. The construction of the plan counted on the involvement of different sectors of society and experts on the subject.

The plan comprises mitigation measures, which were elaborated based on the GHG inventory developed by the Universidad Nacional de Colombia and Colombian commitments made in the Paris Agreement. It was established through an analytical methodology and organised into four super-criteria that aim to manage the prioritisation of measures, namely (1) protection of life, (2) basic needs, (3) Environment and ecosystem services, (4) Productivity. Governance and coexistence were considered a cross-cutting theme to all super-criteria (Figure 40).

Adaptation: Programmes prioritised according to supracriteria

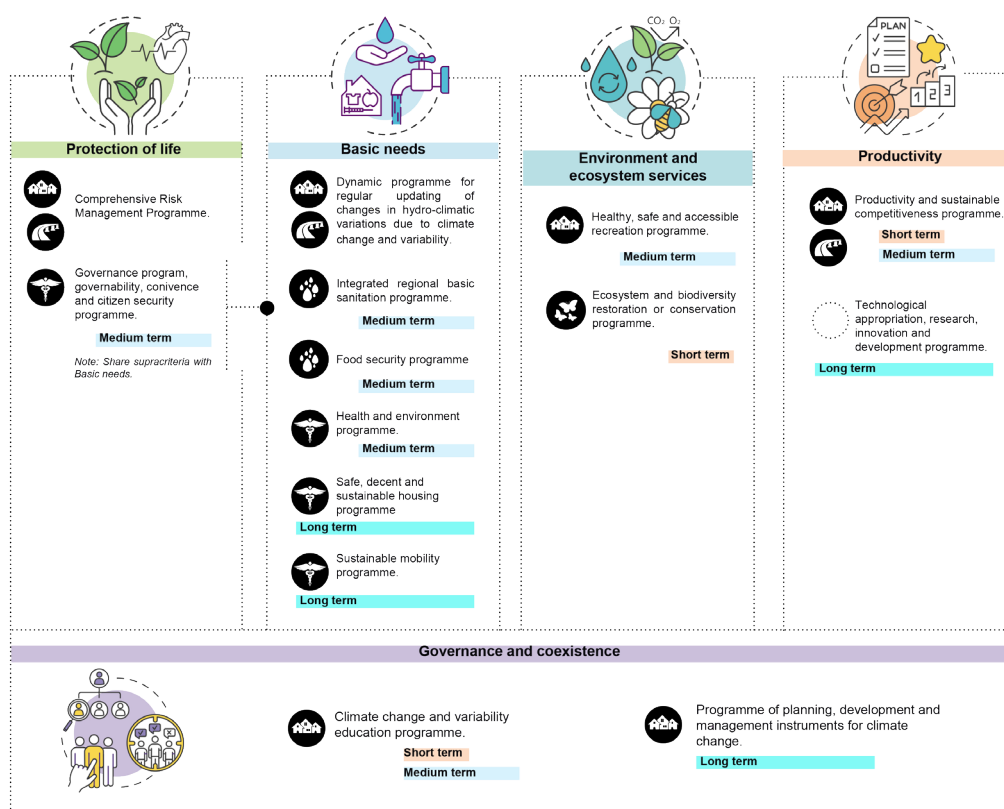


Figure 40: Prioritised adaptation measures according to super-criteria. Source: adapted from EAFIT and Área Metropolitana del Valle de Aburrá (2021)

Regarding mitigation, the GHG emissions inventory with the base year 2015 identified a significant contribution from the energy and transport sector (39%) and waste (22%). Therefore, the total emission reduction target for 2030 is 35% for the metropolitan territory, as illustrated in Figure 41. Mitigation measures are diverse and include the transportation sector, energy efficiency of buildings and infrastructures, solid waste management and valuation of green infrastructure (Table 13).

Projected GHG emission reduction percentage target by sector to 2030

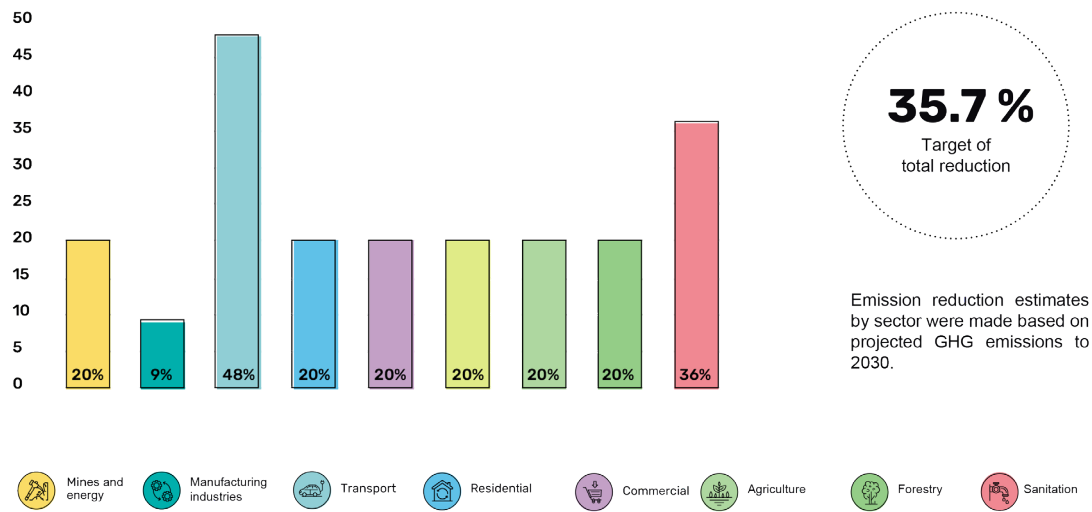


Figure 41: Mitigation target of GHG emissions by sector
 Source: adapted from EAFIT and Área Metropolitana del Valle de Aburrá (2021)

PRIORITISATION	MEASURES
1	Rural and urban forestry.
2	Livestock and pasture management.
3	Integral management of freight transport and dump trucks in the Aburrá Valley.
4	Improvement of the environmental and energy performance of the industrial sector in the Aburrá Valley.
5	Cwwonservation of existing carbon sinks.
6	Implement practices and technologies for energy efficiency in infrastructure and public buildings.
7	Implementation of clean technologies and improved industrial processes.
8	Decrease vehicular flow and congestion through adequate demand management.
9	Promote energy efficiency and renewable energy at residential and commercial levels.
10	Accelerated introduction of ultra-low emission and zero-emission vehicles in the public transport fleet.
11	Substitution of cleaner vehicle fuels.
12	Increased demand for ultra-low and zero emission vehicles in the private sector.
13	Design and implementation of a massive eco-efficient driving training programme.
14	Farmland management.
15	Infrastructure for sustainable and active mobility and for the expansion of the public transport system.
16	Promote schemes for the reduction, use and recovery of waste.

Table 13: Mitigation - Prioritisation of measures. Source: Área Metropolitana del Valle de Aburrá (2019), p.255

In order to achieve the climate goals of the region in a transversal manner, six strategic lines are proposed: (1) Education, training and public awareness; (2) Science, technology and innovation; (3) Governance and institutionalisation, (4) Land use and urban planning; (5) Financial and economic instruments and (6) Monitoring, evaluation and reporting (Table 14).

Regarding metropolitan planning, it is essential to highlight the Strategic Line of Land Use and Urban Planning, developed through the programme Planning, Development and Management Instruments for Adaptation to Climate Change. Its objective is to plan the territory considering the effects of climate change and its projections, and among the associated measures are (1) regulation of urban expansion, (2) Climate information system and (3) inclusion of climate change in planning instruments.

NAME OF THE METROPOLITAN AREA		ÁREA METROPOLITANA DEL VALLE DE ABURRÁ
Population		4 million inhabitants
Number of cities		10
Fringe characteristics		Areas of high slope with urban and rural characteristics occupied by low-income populations on the north-western and north-eastern slopes and higher-income populations in the south-eastern and south-western areas.
Main plan addressing climate change adaptation		Action Plan for climate change and variability of the Metropolitan Area of the Aburrá Valley 2019 -2030 (PAC&VC)
Main climate risks		<ul style="list-style-type: none"> - Systematic increase in temperature - Increase in the magnitude of storms or frequency of more severe storms - Increased duration and frequency of low rainfall periods - Increased duration and frequency of rainy periods - Social stressors: <ul style="list-style-type: none"> - Demographic growth - Governance
Transversal adaptation strategies	Education, training and public awareness	<ul style="list-style-type: none"> - Pedagogical strategies that enable training, education and awareness-raising about mitigation and adaptation actions - Formal, informal and non-formal education sector - Business sector and decision-makers
	Science, technology and innovation	<ul style="list-style-type: none"> - Strategic areas for research in the area of climate change, especially in the areas with the greatest contribution to GHG emissions
	Governance and institutionalisation	<ul style="list-style-type: none"> - Strengthen institutions and social fabric to achieve mitigation goals and increase metropolitan resilience
	Territorial planning	<ul style="list-style-type: none"> - Planning and developing interventions - Monitoring and support from public and private institutions - Improving climate resilience through territorial planning
	Financial and economic instruments	<ul style="list-style-type: none"> - Economic and financial instruments to support implementation - National and international funding sources
	Monitoring, evaluation and reporting	<ul style="list-style-type: none"> - Monitoring indicators

Table 14: General metropolitan characteristics, main climate risks and adaptation strategies in AMVA. Source: prepared by the author based on Salamanca e Bonilla (2021), Urban LEDS (<https://urban-leds.org/countries-cities/colombia/#aburra-valley>)

2.4.4 INNOVATIONS ON THE METROPOLITAN SCALE

BIO 2030 and the metropolitan green belt of the Aburrá Valley

One of the main strategic planning instruments that articulate the different sectoral plans of the metropolitan area and form a strategic development planning vision for AMVA is the BIO 2030. Although it predates the climate plan, it has several synergies with the PAC&VC guidelines. The preparation of the Plan was led by the Municipality of Medellín and the AMVA under the coordination of the Centro de Estudios Urbano Ambientales (URBAN) of the Universidad EAFIT. It was supported by local universities, APUR (Paris, France), and the Universidad Politecnica de Catalunya, forming an interdisciplinary team.

Until then, the metropolitan area had several sectoral plans but did not have a metropolitan master plan that integrated these different instruments and formed a strategic vision for the development of AMVA.

BIO2030 seeks to answer the significant challenges of the metropolitanisation phenomenon, overcome the existing administrative boundaries to guide the growth of the ten municipalities under a shared vision and contribute to the construction of consensus and inter-institutional coordination spaces.

The occupation model proposed is based on a polycentric and compact metropolis of medium density, avoiding urban sprawl and seeking energy efficiency. The plan identifies two metropolitan structuring systems to integrate the territory: (1) Environment, landscape and public space and (2) Mobility and transportation.

BIO 2030 articulates the metropolitan planning scale with the project scale by identifying three strategic areas of intervention: the River, the Hillside and the Plain, and proposing territorial scenarios and demonstration projects for these areas.

In the proposals, the river is a major metropolitan centre of activities and habitat and

the fringe areas are identified as strategic areas for interventions towards sustainable development. The plan recognises the dynamism of these areas and points out that by 2030 it is expected that 38% of AMVA’s population will live outside Medellin. Therefore, these are spaces destined to contain the growth of occupation on the slopes through the introduction of public uses, large-scale institutional spaces and the promotion of productive activities suitable to the conditions of the slopes. The proposal aims to preserve essential agricultural and natural ecosystems of significant environmental and landscape value.

Regarding the fringe areas, in line with the BIO 2030 proposals in the 2012-2015 administration, the Cinturón Verde Metropolitano del Valle de Aburrá was formulated in two contracts with the Universidad Nacional de Colombia and the Universidad Pontificia Bolivariana. This is a long-term strategic macro-project of collective interest, which aims to manage the urban-rural fringe towards the protection of areas that provide essential ecosystem services and the generation of public space aimed at increasing the

quality of life of the metropolitan inhabitant and the consolidation of a balanced and equitable territory.

As a result of the study, three areas of action were characterised for the entire metropolitan territory and that cover all the municipalities in the region: the “Outer Belt” which is intended for protection actions, ecological restoration, improvement of existing equipment and relocation, the “Ecological Connection Structure”, which is configured in a transition area with productive and recreational uses, and the “Urban-Rural Contact System”, in which the urban occupation is already consolidated and the strategies are focused on risk management, housing provision, public space and mobility (Figure 42).

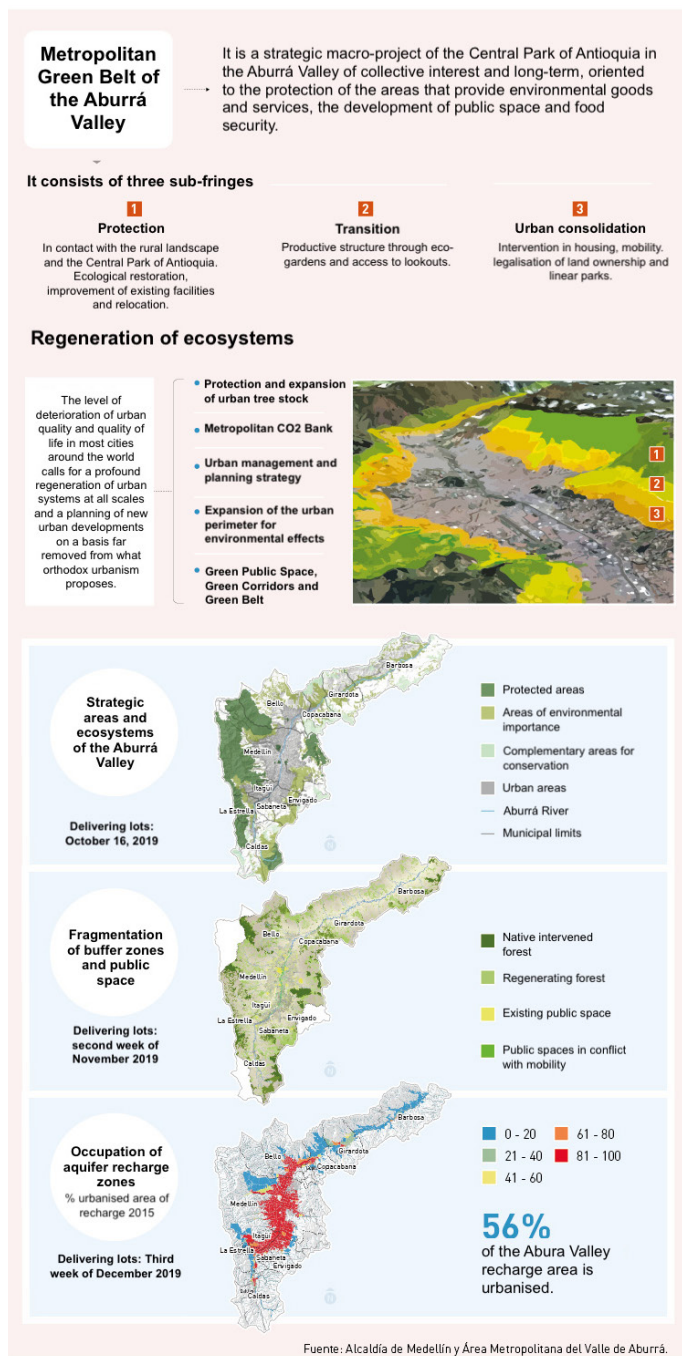


Figure 42: Metropolitan green belt of the Aburrá Valley
Source: adapted from: <https://www.metropol.gov.co/Paginas/Noticias/elmetropolitano-ambiental/parque-ambiental-cerro-de-las-tres-cruces.aspx>. Accessed on September 15, 2023.

2.4.5 FOCUS FRINGE AREA: JARDÍN CIRCUNVALAR DE MEDELLIN

Based on the Plan Bio 2030, Medellín’s Land Use Plan (POT) (2014-2027) was updated in 2014, establishing three Strategic Intervention Areas (AIE): the Rio Centro AIE, the Borde AIE (fringe) and the Transversalities AIE.

The Borde AIE (fringe) is divided into five macro-projects: (1) Borde Urbano Rural (BUR) Noroccidental, (2) BUR Suroccidental, (3) BUR San Antonio, (4) BUR Nororiental and (5) BUR Suroriental. These macro-projects contain the guidelines for the “Jardín Circunvalar de Medellín” project, which is part of the Metropolitan Green Belt.



Figure 43: Medellín’s strategic intervention areas and macro-projects. Available at: <https://www.medellin.gov.co/irj/portal/medellin?NavigationTarget=navurl://1835433ab6162f1d159791ea638561aa>. Accessed on September 15, 2023.

The macro-project areas were divided into 14 Masterplans, and on this more detailed scale, specific objectives and strategies were established for each sector (Figure 44). During this stage, local communities were actively involved through pedagogical models of consultation, dialogue, design, implementation, evaluation, and feedback. The municipal administration referred to this process as “Pedagogical Urbanism,” which will be explained in more detail below.

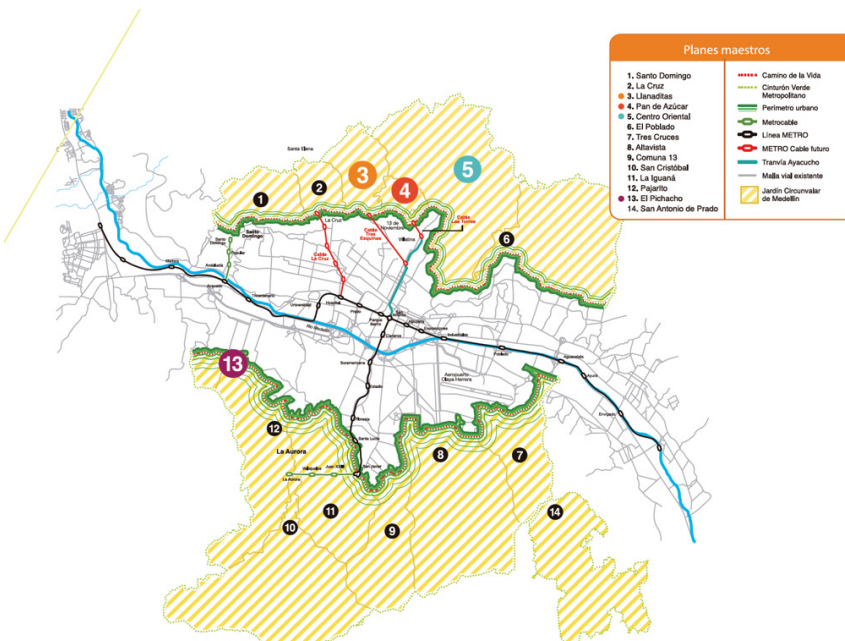


Figure 44: Jardim Circunvalar de Medellín’s Masterplans
Source: Alcaldía de Medellín and EDU (2015)

The Jardin Circunvalar Project in Medellín adopted a systemic intervention strategy in the territory. To this end, three strategic lines were fundamental: (1) sustainability and environmental recovery, (2) comprehensive habitat improvement for life, equity, and social cohesion and (3) pedagogical urbanism.

Among the 14 Materplans developed, Cerro Pan de Azúcar’s surroundings were selected as the project implementation’s pilot areas. Figure 45 illustrates the main strategies adopted in this area and demonstrates the systemic vision approach for its transformation. The control of urban sprawl and the valuation of the environmental and historical heritage are developed through ecological restoration, implementation of public facilities, community gardens, recreation areas and ecotourism; these uses are articulated with employment and income generation activities. In addition, actions are proposed aimed at risk management, ensuring decent and sustainable housing, and improving local urban mobility and its connections with the Medellín Valley through sustainable public transportation.



Figure 45: Cerro Pan de Azúcar’s Masterplan. Source: Alcaldía de Medellín and EDU (2015)

These actions are articulated to generate territorial transformation based on the five attributes of the Jardin Circunvalar de Medellín: (1) Integral sustainability of the territory, (2) Inclusive and structuring public space, (3) Control of urban expansion with an integral vision of development, (4) Connecting the territory with quality and (5) Decent, safe, sustainable, and accessible housing.

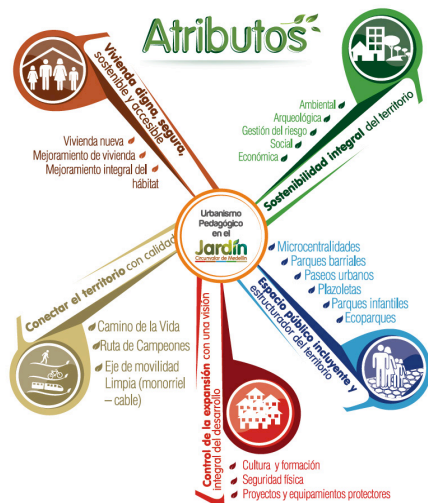


Figure 46: Five attributes of the Jardin Circunvalar de Medellín. Source: Alcaldía de Medellín and EDU (2015)

2.4.6 INNOVATIONS ON THE LOCAL SCALE

A systemic approach: environmental protection, sustainable neighbourhoods and urban mobility
 The metropolitan green belt and the Jardín Circunvalar de Medellín present innovative strategies for the transformation of fringe areas considering their complexities and pre-existences. Although the strategy extends to the 10 municipalities of the AMVA, the pilot projects implemented are concentrated in Medellín.

Based on previous experiences developed by the municipal administration, the Jardín Circunvalar project took on a systemic vision and incorporation of pre-existences. In this sense, based on the diagnosis and the participatory process, the interventions, which derive from general municipal and metropolitan planning strategies, are not only intended to protect the natural remnants, but to promote transformative actions through risk management, resettlement, improvements and provision of housing, public space, mobility, and income generation.

Regarding housing, one of the central problems of occupation in these areas, in the 14 Master Plans of the Jardín Circunvalar de Medellín 64 settlements were identified as needing complete transformation. Because of its resources, high levels of vulnerability and potential for expansion, the Cerro Pan de Azúcar area was prioritised for implementation of the pilot project.

As part of the Sustainable Neighbourhoods (Barrios Sostenibles) programme, the intervention is guided by two strategies. The first refers to the intervention in the consolidated areas, in which risk mitigation works, improvement of public space, sanitation and efficient infrastructure networks should be developed, in addition to the implementation of public facilities. The second refers to the new buildings constructed for housing provision and resettlement; these should be built based on bioclimatic principles of ventilation

and natural lighting, and with energy and water saving eco-technologies. The pilot project⁴⁶ arises from a cooperation agreement between Germany, Mexico and Colombia, and is led by the German Cooperation Agency - GIZ - with the support of the Ministry of Housing, City and Territory and the EDU (Alcaldía de Medellín and EDU, 2015).

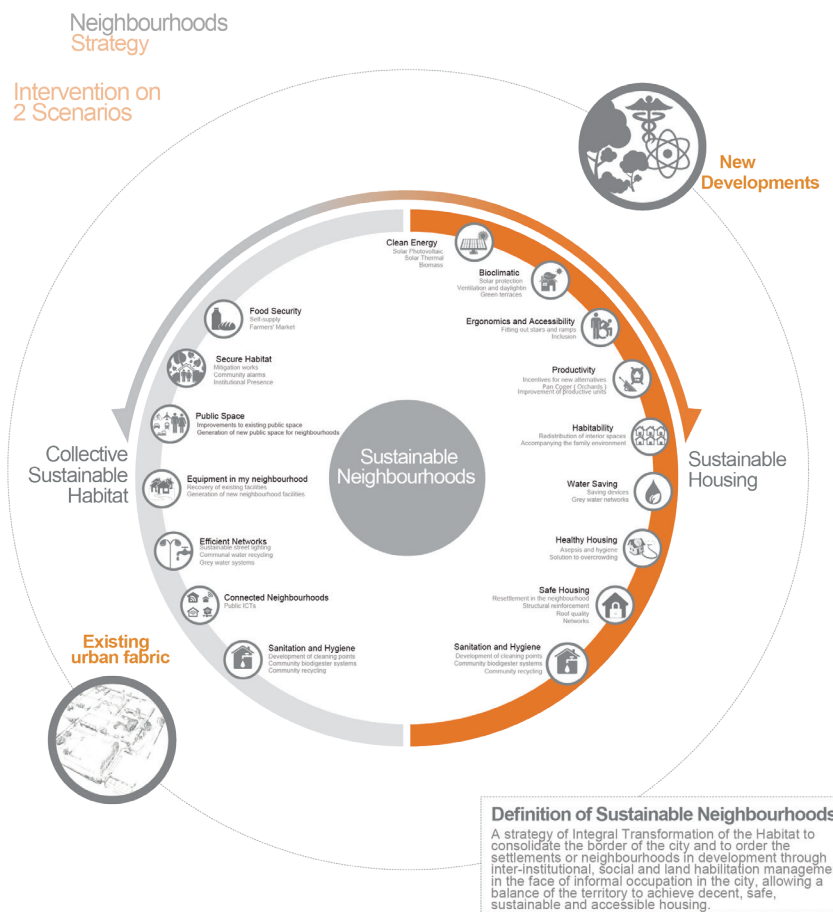


Figure 47: Sustainable neighbourhoods' strategy Source: adapted from Alcaldía de Medellín and EDU (2015)

46_ As part of Jardín Circunvalar, the pilot corresponds to 10 Trece de Noviembre neighbourhood homes.



Figure 48: Housing resettlement project (Before and after) - Poligono Trece de Noviembre. Source: Alcaldía de Medellín and EDU (2015)

Regarding public space, the strategy is to increase coverage and create a network of public spaces connected to each other and linked to housing, public facilities and mobility. Considering the territorial dynamics and their complexity, the public space is articulated with the objectives of risk mitigation, mobility enhancement, and preservation and restoration of the environmental and archaeological heritage of the upper slopes. Figure 49 and Figure 50, illustrate this relationship that combines green and gray infrastructure; the highest part of the slope is intended for ecological restoration and protection against erosion, followed by *Camino de la Vida* and *Ruta de Campeones*, which are intended for recreation, tourism and active mobility activities, and finally, the sustainable mobility systems such as the metroca- ble, monorail and underground.

Construction of structures that prevent and mitigate risks.

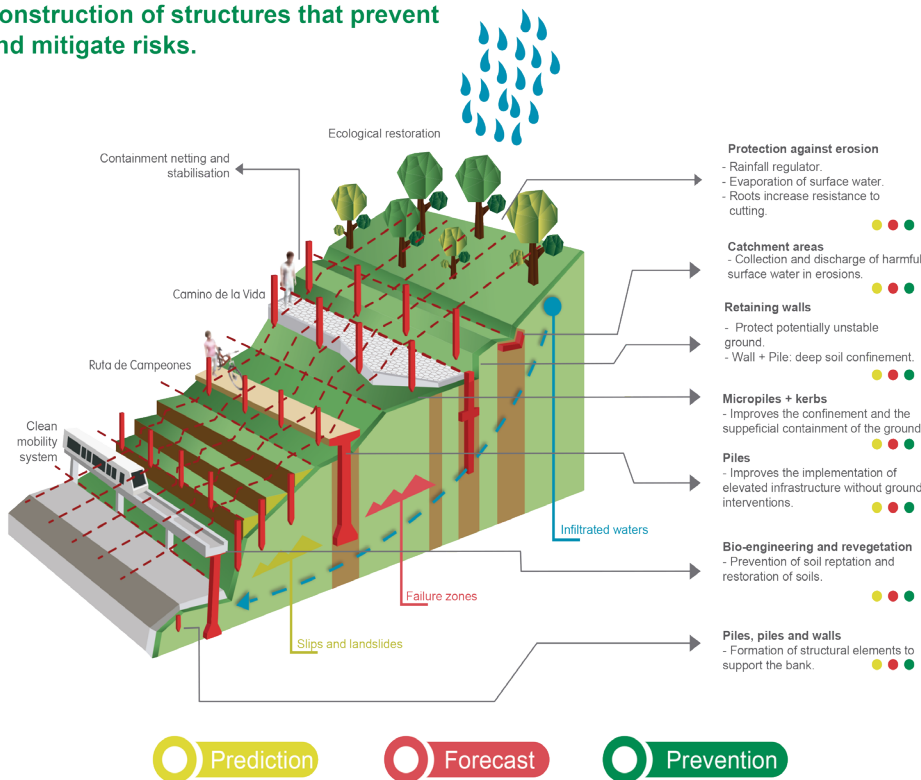


Figure 49: Construction of grey and green infrastructure for risk mitigation Source: adapted from Alcaldía de Medellín and EDU (2015)

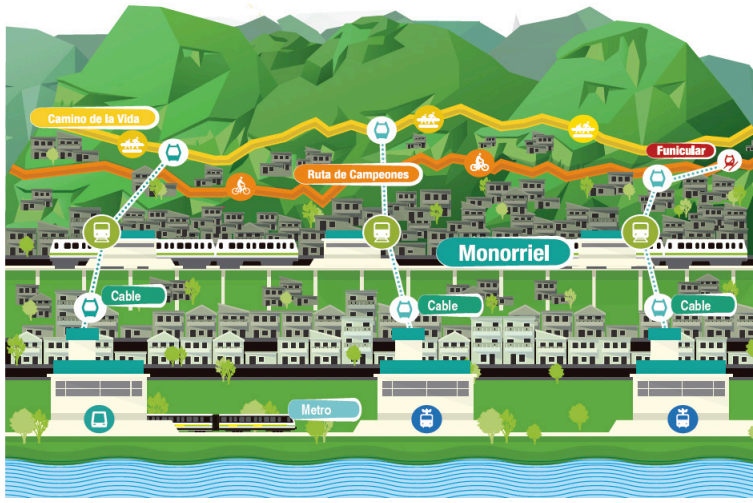


Figure 50: Schema of the Integral Connectivity Plan. Source: Alcaldía de Medellín and EDU (2015)

Institutional coordination, participation and socio-economic development: the Empresa de Desarrollo Urbano (EDU)

The Empresa de Desarrollo Urbano (EDU) is recognised as a key institution for several successful urban transformations in Medellín, such as Parques del Río, the comprehensive upgrading of the neighbourhoods Quebrada Juan Bobo and La Herrera, Integral Urban Projects (PUI) Nororiental and Comuna 13, the Articulated Life Units (UVAs), among others. Created in the 1990s, EDU applies land management instruments, acts as an urban and real estate renovator and operator, and designs and coordinates social management and execution of urban transformation projects. In this way, the company plays a role of intersectoral and inter-institutional coordination that allows the spatialisation of planning programmes and policies at the project scale. Due to its accumulated experience, EDU currently operates as a local, national and international construction company (EDU, Alcaldía de Medellín and BID, 2014).

In the case of Jardín Circunvalar, EDU has performed an important role in integral territorial transformation using the strategy of civic-pedagogical urbanism and articulating public and private actors for the development of the project, including NGOs, businesses, academia and public sectors. 39 partners and more than 2000 volunteers were mobilised (Alcaldía de Medellín and EDU, 2015).

The civic-pedagogical urbanism strategy used in the EDU management model is based on the active participation and learning of local actors and using educational and pedagogical tools for participation, evaluation and feedback, as illustrated in Figure 51.

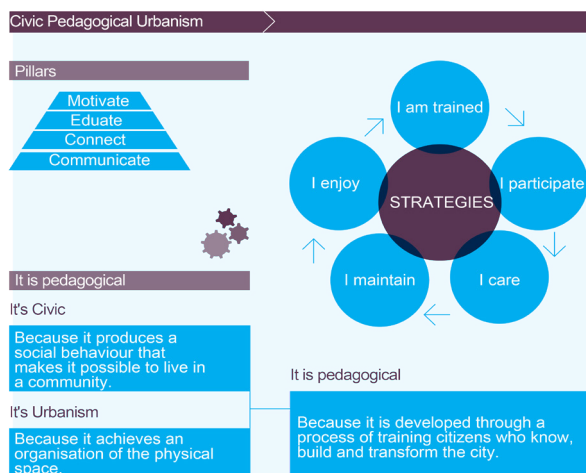


Figure 51: Civic-pedagogical urbanism model. Source: adapted from EDU, Alcaldía de Medellín and BID (2014, p. 64).

Following this management model, the local diagnosis was developed integrated, considering technical, social, environmental, economic and legal aspects. The formulation and execution stages were developed with intense local participation and training; the objective of this strategy is to empower citizens to know and transform their communities, collaborating for the sustainability of interventions in the process of co-responsibility (EDU, Alcaldía de Medellín and BID, 2014; Alcaldía de Medellín and EDU, 2015).



The program was coordinated by EDU and developed in partnership with the Pontificia Universidad Católica Bolivariana, Microempresas de Colombia and the Fundación Futuro para la Niñez. This action enabled the training of local leaders and entrepreneurs, which contributed to economic development and job creation. As a result, 476 social leaders and entrepreneurs were trained and certified by the School Renovando Ciudad para la Gente and 5,393 people received training in activities for the economic development (Alcaldía de Medellín and EDU, 2015).

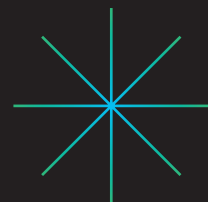
Regarding employment and income generation, 5,347 people from the sector were employed. The professional training covered different areas that contribute to constructing new dynamics and local businesses, such as ecotourism, gardening, agroecology, ecological restoration, food handling, crafts and construction. The professionals trained in civil construction were hired by the local authority and participated in the implementation of construction in the intervention area itself.

The areas of food production and tourism play an important role in local socio-economic development, besides contributing to containing urban sprawl. 22 agroecological vegetable gardens have been created, occupying an area of 31,000 m² and are cultivated by 350 families. Furthermore, 12 eco-parks have been built, integrating a system of public spaces, archaeological heritage, viewpoints and trails and attracting tourists to the region.

The cases discussed in this Chapter demonstrate the complexity of the issue, the limitations of plans and projects and the diverse range of strategies and governance structures. They illustrate that building cities and regions from a more resilient perspective implies dynamics of cooperation, participation and new spatial configurations that relate to the local and regional context. The next chapter summarises the lessons learnt, linking them to the theoretical discussions and forming the basis for the analytical framework and building recommendations for the case of the São Paulo Metropolitan Region (Juqueri-Cantareira sub-basin).

The construction of a method for analysing Urban and Regional Planning of the São Paulo Metropolitan fringe

3



The construction of a method for analysing Urban and Regional Planning of the São Paulo Metropolitan fringe

This chapter presents the construction of the analysis method applied to the case of the São Paulo Metropolitan Region. The objective is to combine theoretical discussions, elements, and lessons learnt from reference cases in order to create a comprehensive analytical framework that includes both urban dimensions and key resilience factors.

The chapter is divided into four parts. The first part provides a comprehensive overview of the lessons learnt from the reference cases, with the aim of extracting the key elements that will be incorporated into the analytical framework. The second part outlines the process of developing the general analytical framework by combining theory and the lessons learnt from the reference cases.

The third part describes how the framework was contextualized to the specific case of the Juqueri-Cantareira sub-basin in the São Paulo Metropolitan Region, emphasizing the primary territorial challenges. The section highlights the importance of flexibility in the general framework and the context for a territorial discussion.

Finally, the complementary methods to the documentary analysis are presented, such as semi-structured interviews with technicians and civil society actors, field visits, and spatial analyses of urban and regional planning instruments and the characterisation of the territory. A detailed list of the plans analysed, and the interviewees is provided.

Starting from a systemic perspective, the method sought to combine documentary analysis through the application of the framework, with spatial analysis, and to understand some of the nuances and limits of planning from the perspectives of those interviewed. In this sense, the research acknowledges that changing the planning perspective towards a more resilient and ecological pattern requires continuous cooperation among diverse scales and stakeholders and cannot be accomplished through one technical instrument. Rather, a systemic approach that takes into account multiple factors is essential.

3.1 LESSONS LEARNT FROM THE REFERENTIAL CASES

Integrating theoretical reflections with the analysis of reference cases poses challenges, given the limits encountered between theory and practical applications. At the same time,

the analysis of the cases enriches the discussions of the limits of planning on its different scales and the efforts to overcome them.

All cases present limitations and contradictions, such as discontinuity and limited application. However, it was possible to outline common general strategies, specifically in fringe areas, such as urban sprawl containment, since all cases exhibited a higher concentration of green spaces than central areas, the creation of new centralities to reduce travel distances, the establishment of new connections to promote sustainable and low-carbon mobility, and the preservation and improvement of green and blue infrastructure, as shown in Figure 53. In this sense, urban planning extends beyond the mere establishment of zoning laws. It involves the integration of numerous spatial scales and the translation of overarching guidelines into concrete action plans that identify strategic intervention zones and projects.

The main difference among the cases lies in their governance structure and how these general strategies are spatialised and adapted to the local context, as will be explored further. Nevertheless, the premise of territorial transformations is conceptually based on urban-environmental integration and sustainable transitions, despite the limitations in their implementation.

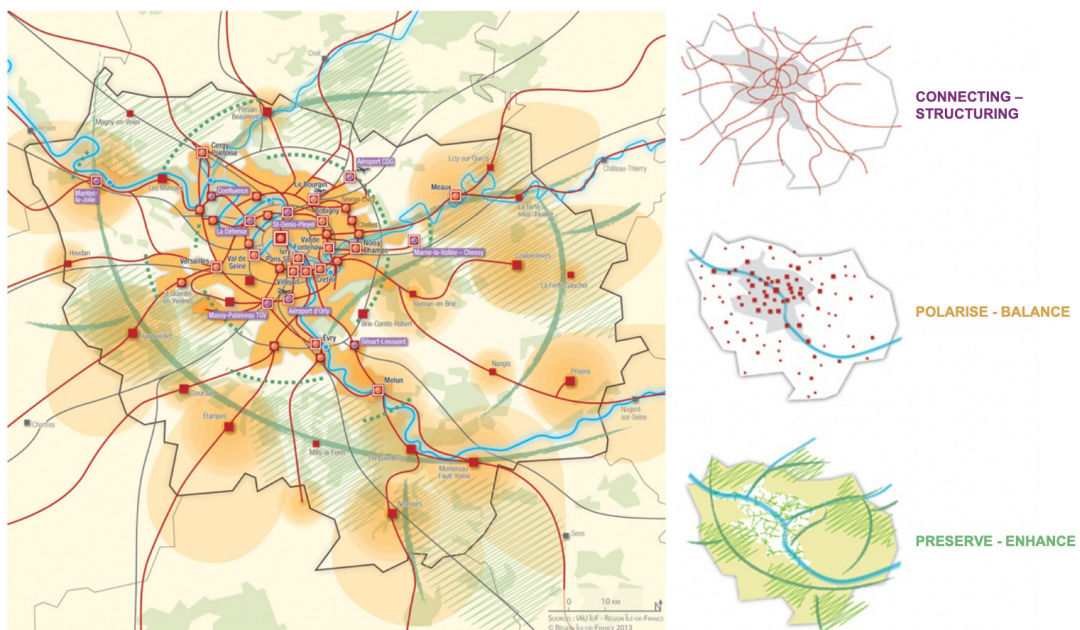


Figure 53 - Regional strategies of the Ile de France. Source: Adapted from Île de France (2013) p. 5

The fringe area studied in Barcelona concentrates large road infrastructures, industrial warehouses, and green spaces. In this context, after the rehabilitation of the Besòs River, the strategy was to redevelop part of the industrial warehouses and the public areas around them, bringing new dynamics and mixed uses - as the Ecodistrict in the former Mercedes Benz factory (Figure 54). On this local scale, the building is reused and in addition to the insertion of multiple uses, the principles of Barcelona's Superblock are applied, prioritising walkability and active mobility, greenery and the generation of clean local energy. At the same time, in a nearby area where the local characteristics are distinct and there are agricultural remnants, the strategy is to create an agroecology centre and promote the rehabilitation of the neighbourhood.



Figure 54 - La Mercedes Ecodistrict in Barcelona
 Source: available at: <https://lamercedes.barcelona/wp-content/uploads/2022/02/1-animacion-forma-min-scaled.jpg> Accessed on September 15, 2023.

In Paris, articulated with the Grand Paris Express project, the idea is to connect different remaining green areas in the currently fragmented territory through the Promenade des Hauteurs, activating new centralities along this route and redesigning the public space, giving more space to active mobility, green and blue infrastructure, and reinvention of the built stock (Figure 55).

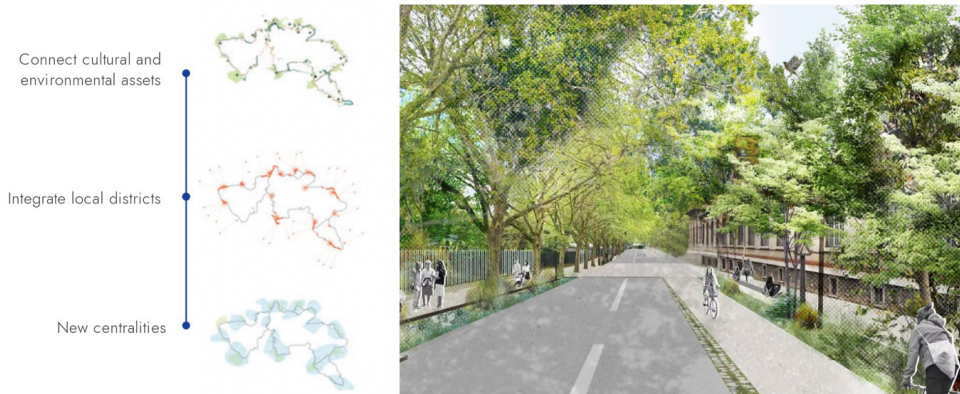


Figure 55 - Promenade Des Hauteurs and the Transformation of Streets and Public Spaces. Source: adapted from Est Ensemble⁴⁷ and Agence TER⁴⁸.

In Medellín, the idea was to articulate the environmental and social characteristics of the territory to create new dynamics to improve the local quality of life, promote risk management, and sustainable urban mobility with walking and cycling trails and cable cars integrated with the transport system (Figure 56).

PROYECTOS

PLANTAS ECONÓMICAS Y MINORILES: construcción de grupos de arbolado para la integración del distrito de la zona rural de la ciudad. El árbol como eje de cohesión y participación de las comunidades, se erige por parte de los habitantes.

PROYECTO URBANO: intervención de un espacio público en un barrio popular, en el que se genera un espacio público de calidad, con actividades deportivas, culturales, educativas, etc.

PROYECTO DE BARRIOS: intervención de un espacio público en un barrio popular, en el que se genera un espacio público de calidad, con actividades deportivas, culturales, educativas, etc.

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Figure 56 - Local projects in Jardín Circunvarlar - Medellín. Source: Alcaldía de Medellín and EDU (2015)

47_ Available at: https://www.est-ensemble.fr/sites/default/files/cartoguide_pdh_juin2020_leger.pdf
 48_ Available at: <https://agenceter.com/project/promenade-des-hauteurs/>

Furthermore, all cases showed concern for the equity issue, especially related to access to housing. In the case of Medellín, the study area was located on the fringe of the city and comprised of informal settlements with a socially vulnerable population. To address this issue, social housing units were constructed using more sustainable construction technologies. On the other hand, the focus of the European cases was primarily on promoting social cohesion, which involved the integration of different social classes within the same development through the provision of affordable housing units. This approach aimed to foster inclusive and cohesive communities while promoting social integration and reducing social inequality.

Regarding governance, the cases presented distinct configurations. The Greater Paris Metropolis case has a more organised and top-down structure, coordinated at the national, regional, inter-municipal, and municipal levels, integrated into different mandatory instruments at these different scales, such as SDRIF, ScoT, and PLU, and their respective responsible institutions.

While in the Barcelona Metropolitan Area, this structuring has a more bottom-up dynamic since Spain does not have the same coordination at the national level for metropolitan areas, and regional governments have greater autonomy. In this case, creating a metropolitan institution and inter-municipal consortia results from innovation and a culture of inter-municipal cooperation in an incremental process, which also presents challenges since adherence to some instruments is voluntary, such as local adaptation plans.

The Valle del Aburrá Metropolitan Area (Medellín) presents a mixture of these two dynamics since national legislation has instruments that regulate metropolitan areas. Still, there is little consistency in the coordination and structuring of these areas. AMVA presents some innovations in this context, being the country's oldest and best-structured metropolitan area. Medellín progresses by integrating the planning scales through the POT, Macroprojects, and Integrated Urban Projects.

Although there are these differences that are related to history and local context, as discussed in Chapter 2, the issue of articulation between the planning scales that results in the territorial transformation was a critical point, as well as the existence of different institutional spaces, focused on planning and participation also at different scales.

For example, in Barcelona and Medellín, the metropolitan institutions AMB and AMVA, and in Paris, the regional institution Ile de France, play an essential role in integrated planning and in the area of infrastructure, such as sustainable mobility in terms of mass transport, the introduction of a low carbon fleet, and clean energy, constantly relating to other scales. On the regional scale, efforts for closing the water, energy, and waste cycles prevail.

Regarding strategic planning and building bridges between the regional/metropolitan scale and the development of local projects with higher participation of the population, inter-municipal consortiums and companies/institutes with this competence have been essential such as Besòs Consortium and Barcelona Regional in Barcelona, Paris Region Institute and Est Ensemble in Paris, and the Urban Development Company (EDU) in Medellín.

The planning levels collaborate consistently, collaborating with one another, other planning levels, and the community. This diversity of planning and participation spaces has an intersectoral character. It is a facilitator for mobilising different types of stakeholders and knowledge that foster the strategies defined at supra-municipal scales in an incremental process of coordination and support.

An important point was the concern with the issue of ecological transition and the attraction of activities linked to a sustainable economy that generates local jobs and income. In European cases, this dynamic has been fostered by the European Union, focused on the transition to a green and circular economy. Therefore, there is a concern in both studied

metropolises, especially in Paris, regarding the attraction and creation of innovative companies in this sector. In the case of Medellín, the creation of local businesses was associated with tourism, sustainable agriculture, and professional training for local jobs in the analysed fringe area, while the AMVA adaptation plan has a broader strategy on attracting sustainable companies and industries.

The local projects, from all the articulation described above, seek from their contexts and local characteristics to create new local dynamics and better integration between the urban and the environment from the diversification of uses and local services, the transformation of the built stock from new parameters of energy efficiency and sustainability, promoting energy transition, sustainable mobility, and renaturalisation of the territory. In the European cases, these strategies were mainly related to reducing greenhouse gas emissions and carbon neutrality.

Figure 57 shows the relationship between the metropolitan, intermediate and local scales illustrating the main attributions highlighted at each of these scales and their interdependencies. The metropolitan and intermediate scales have a character more focused on coordination and support (technical and financial), consensus building and strategic visions for the territory. In addition, these scales concentrate on major common issues in the territory, such as transport, mobility and infrastructure. The local scale is the one that specialises territorial transformations through urban projects with greater participation of the population and integrating different strategies agreed at other scales.

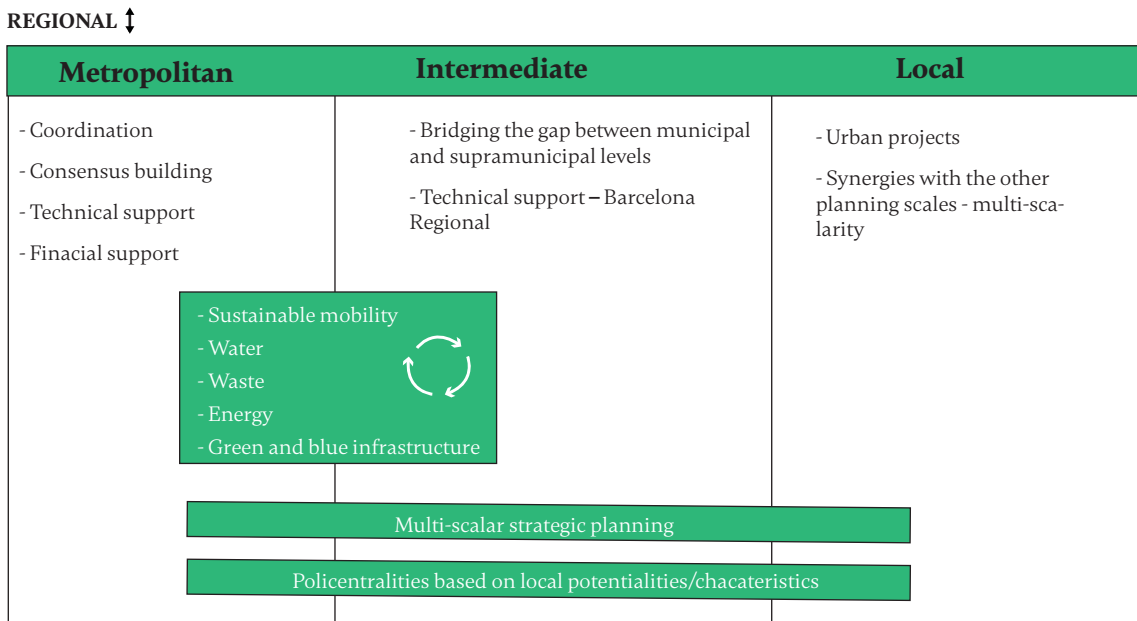


Figure 57 - Relationship between the metropolitan, intermediate and local scales. Source: prepared by the author.

	Barcelona Metropolitan Area	Greater Paris Metropolis	Metropolitan Area of the Aburrá Valley
Focus fringe area	Preserve green infrastructure. Create new centralities and urban-environmental dynamics. Equity.	New urban dynamics captured by the Grand Paris Express. Connecting natural and historical heritage. Equity.	Controlling urban sprawl. Tackling inequalities. Risk management. Housing and New Urban-Environmental Dynamics.
Governance	AMB as a key player for metropolitan planning, infrastructure and support, but on a voluntary basis in many topics. Besòs Consortium and Barcelona Regional as key players on the intermediate and local scale.	New governance structure concentrates planning at the intermediary scale. Strong multilevel coordination. Key players are Ile de France, IPR, and MGP.	AMVA is a key player in metropolitan planning and infrastructure. EDU as a key player for strategic and intersectorial planning.
Urban	Redevelopment of strategic areas. Sustainable mobility.	Redevelopment of strategic areas. Sustainable mobility.	Housing. Public space/facilities. Infrastructure. Sustainable mobility.
Ecological	Renaturalisation. Ecological corridor. Food / agriculture production.	Renaturalisation. Network of urban parks for ecological connectivity.	Restoration. Food / agriculture production. Tourism.
Socioeconomic	Equity. Professional qualification. Green jobs.	Equity. Professional qualification. Green jobs	Equity. Professional qualification.

Table 15 - Summary of the main outcomes of referential cases.. Source: prepared by the author.

3.2 BUILDING A GENERAL FRAMEWORK: COMBINING THEORY AND THE REFERENTIAL CASES LESSONS

In developing the analytical framework, key elements from the reference cases were considered, along with the arguments and theoretical concepts discussed in Chapter 1. The framework maintains the four analytical dimensions used in the referential case analysis, with the aim of establishing common elements and a certain degree of homogeneity. The definition of these dimensions is closely linked to the theoretical discussion, as they form part of a systemic understanding of urban systems and their relationship with the construction of resilient territories. The first step in constructing the framework involved defining the four dimensions within the context of metropolitan fringes, as indicated in (Table 16).

DIMENSIONS	DEFINITION
Governance	Refers to the process of decision making and the implementation of urban policies and programmes. As metropolitan fringes are made up of different municipalities, the governance system is composed of a complex variety of actors. Due to this complexity, governance must be based on the cooperation among different scales and stakeholders toward sustainable and resilient common future visions.
Ecological	Refers to green and blue infrastructure, which must be enhanced through uses that promote regenerative processes, ecological connectivity, and ecosystem services provision, such as climate regulation, water provision, and cultural services.
Urban	Refers to urban infrastructure and the built environment. The infrastructure must be regenerative and consider new climatic parameters closing the water, energy, waste, and food cycles at the local and regional level. The aim is to develop regenerative territories avoiding urban sprawl, reorganising the spaces already built, recovering abandoned areas, promoting the compaction of cities, and creating new centralities.
Socioeconomic	It encompasses issues such as equity, access to resources, job creation, and the provision of basic services such as housing and sanitation. This dimension also considers the effects of urbanisation on marginalised communities and seeks to ensure that the benefits of sustainable development are distributed fairly.

Table 16 - Definition of dimensions. Source: prepared by the author.

Additionally, the analytical framework was integrated with key resilience factors identified in reference cases and aligned with the existing literature. For instance, Suárez, Gómez-Bagetthun, and Onaindia (2019) highlighted diversity, modularity, duration of feedback, social cohesion, learning and innovation, and equity indicators as significant resilience factors. Similarly, Marta Berbés-Blázquez et al. (2021) emphasised diversity, functional redundancy, connectivity, slow variables, feedback, complex system

lens, learning, adaptive management and polycentric governance as crucial factors.

The authors demonstrate how sustainable transitions, and the construction of resilient urban environments are connected to complex and uncertain contexts that must be tied to flexibility and innovation, while not disregarding local contexts and inequalities present in territories. Diversity, for example, is central for these authors as it encompasses the variety, balance and disparity of different elements, emerges as a fundamental pillar. The expansion of this diversity can occur in different spheres, whether in the composition and interconnection of organisms in ecosystems or in the inclusion of diverse voices and ideas in social decision-making. This diversity is closely linked to modularity, which refers to the way in which the components of the system are interconnected. Systems with many small organisations working autonomously tend to be more resistant to shocks than those with just a few large organisations closely linked to each other. Functional redundancy, on the other hand, emphasises the importance of creating mechanisms that allow vital functions to continue, even when specific components fail, guaranteeing the system's continued operation.

In addition, socio-ecological resilience is inextricably linked to social cohesion, innovation, learning and equity. Social cohesion is essential because the collective response capacity of communities in the face of disruptions is crucial for recovery and adaptation. The systemic perspective, continuous learning, adaptive management, active participation and polycentric governance are essential approaches to tackling uncertainty and promoting effective and inclusive responses, taking into account the interconnectedness between social, ecological and technological systems. Together, these factors represent the complex network of elements that underpin socio-ecological resilience, emphasising the need for systemic and collaborative approaches to promote more robust and adaptable systems in an evolving world (Suárez *et al.*, 2016; Suárez, Gómez-Baggethun and Onaindia, 2019; Berbés-Blázquez *et al.*, 2021).

Considering this debate and that the scope of this research was not to select quantitative indicators, but rather key elements for analysing regional and urban plans, seven resilience factors were identified. These factors cut across the dimensions of the analytical framework, providing a comprehensive understanding of resilience in metropolitan and urban planning, as shown in Table 17.

Key Resilience Factors	Ecological	Urban	Socioeconomic	Governance
Diversity and redundancy	Land use diversity Food diversity Green infrastructure diversity	Diversity of land use Diversity of energy sources (renewable) Diversity of mobility modes favouring active mode	Business diversity Social cohesion	Diversity of institutional settings for planning and participation Mobilising different types of knowledge and actors
Managing Connectivity and Modularity	Ecological connectivity (green corridors, parks, green spaces etc.)	Urban connectivity (prioritise pedestrians, active mobility, and public transport) Density Mixed Uses Proximity - services	Polycentric economic development based on local potentialities and sustainability	Coordination and Support Strategic planning with a multiscalar perspective Polycentric Governance
Flexibility and Innovation	Foster innovation Professional training (education)	Pilot projects (testing)	Foster innovation	Participation of multiple stakeholders Incremental process Monitoring
Circularity and Climate Neutrality	Restoring and maintaining the water cycle Food and biomass production	Water, Waste and Energy Mobility Circular construction practices Self-sufficient buildings Re-development/adaptation	Circular - Low carbon economy	Coordination Technical support Financial support Participation Awareness
Culture	Integration of ecological and historical heritage	Enhancing the value of existing heritage Re-development	Foster creative industries	
Equity	Equitable distribution and access to ecological infrastructure	Housing Equitable distribution and access to facilities and services	Professional training (education) Employment opportunities	
Risk management	Nature based solutions (green and blue infrastructure)	Infrastructure (e.g. flooding) Housing Climate shelters	Participation Awareness and education	

Table 17 - Analytical framework integrating resilience factors. Source: prepared by the author.

Regarding the first resilience factor, diversity is connected to redundancy and is related to not depending on only one source or element. In the urban context, this essential element has different implications in each dimension, for example, diversity of actors and institutions, land use, modes of transportation, and energy, among others. At the same time, managing connectivity and modularity involves establishing cross-scale and multi-scale linkages between different components of urban systems, such as ecological and urban connectivity among different municipalities and polycentric governance and urban structures.

Flexibility and innovation are crucial for urban systems to adapt and respond to positive and negative feedback loops and foster creative solutions and transformative change in response to emerging challenges in metropolitan areas. In the referential cases, this factor was central in the participation of multiple actors and in the implementation of pilot projects and experiments for urban transformations.

Circularity and carbon neutrality were particularly important in the European cases and are part of the framework of sustainable transitions and climate goals. These strategies to achieve decarbonisation and regenerative processes emphasise sustainable mobility, energy efficiency, waste reduction, and integration of renewable energy sources.

Culture refers to strategies that promote local culture, creative industries, and social ties.

It highlights the importance of local characteristics and buildings, social cohesion, and community participation in the transformation of urban spaces. It is connected to equity, which addresses socioeconomic inequalities and aims to promote the inclusion of marginalised communities.

The last factor, Risk management, was particularly significant in the case of Medellín due to the socio-spatial inequalities in the territory. It refers to strategies that aim to diminish or reduce risks related to the impacts of climate change on the territory, such as landslides.

3.3 FRAMEWORK CONTEXTUALISATION TO SÃO PAULO METROPOLITAN REGION

The formulation of the general analytical framework (Table 17) was crucial for a comprehensive understanding of the theme, establishing an initial conceptual basis. However, due to its generic nature, which resulted from the systematisation and homogenisation of essential elements of the reference cases, it was necessary to contextualise the framework to the specific case of the Metropolitan Region of São Paulo, with particular emphasis on the empirical object of this research: the Juqueri-Cantareira sub-basin.

The contextualisation was fundamental to understanding the main peculiarities and challenges of the territory, considering its geographical location, socioeconomic and ecological characteristics, and the urban pressures present in the metropolitan region. This adaptation allowed for a more precise and relevant analysis of resilience factors, providing specific insights and identifying appropriate strategies to address the challenges faced by this territory.

By considering the particularities of the São Paulo Metropolitan Region and the object of study, this thesis sought to contribute to theoretical and practical knowledge in the field of urban resilience and sustainable transitions in metropolitan fringes, offering a contextualised and applicable approach to the specific issues faced by the Juqueri-Cantareira sub-basin and that can be transferred to other metropolitan fringe contexts considering the proper contextualisation.

The initial step in contextualising the framework involved understanding the Brazilian urban planning system and its integration with climate-related issues. This phase included a comprehensive review of relevant literature and public documents on the metropolitan and urban planning framework, specifically focussing on the climate issue. This provided an overview of the contextual setting for urban and climate policies in Brazil, emphasising the State of São Paulo and the São Paulo Metropolitan Region (RMSP).

In the second stage, a detailed analysis of the RMSP fringes was conducted, focussing on the Juqueri-Cantareira subbasin. This stage highlighted the critical urban, environmental, and social characteristics of the region. Fundamental demographic, environmental, urban, and socioeconomic data were collected, organised, and georeferenced (using QGIS). The primary sources of information were DataGeo, Census (2000/2010⁴⁹), Fundação Seade, EMPLASA, and SEEG⁵⁰.

After analysing the data and gaining a deeper understanding of the challenges of the territory, the general analytical framework (Table 17) was adapted to the empirical object of this thesis. This contextualisation was built on discussions held in Colloquia at Mackenzie Presbyterian University and Leibniz University Hannover and in supervision sessions with advisors Prof. Dr Angélica Benatti Alvim and Prof. Dipl.-Ing. Jörg Schröder, to identify the main issues and challenges of the territory. From these discussions, three categories were identified, namely:

49_ Due to the COVID-19 Pandemic, the 2020 Brazilian Census data collection was postponed to 2021. The final writing of the thesis was started in the first half of 2023 and the most recent Census results were not available. For this reason, the data used were those of the 2000-2010 Census and, when possible, complemented with data from Fundação Seade.

50_Greenhouse Gas Emissions and Removals Estimating System.

Urban dynamics: the area faces dynamics of urban sprawl and rapid urban population growth, a trend that is expected to persist until 2050. As a result of the sub-regions dependency on São Paulo

and other regional centres for employment opportunities, commuting is highly prevalent. This dependence also leads to significant car use due to inadequate public transport infrastructure (Emplasa, 2019).

Water and ecosystem services: The area under discussion is a fringe region that forms a crucial part of the water catchment zone in São Paulo State. It holds significant importance in ensuring the water security of the São Paulo metropolitan region. It plays a vital role in providing essential ecosystem services such as climate regulation, as per the studies conducted by São Paulo State (São Paulo (Estado). Secretaria de Infraestrutura e Meio Ambiente and Florestal., 2020).

Risks and vulnerabilities: the territory has two main evident risks, as will be presented in the contextualisation of the region, namely: (1) landslides and (2) floods. A third risk pointed out by the Brazilian Panel on Climate Change (2016) for the State of São Paulo and therefore applied to the region is the increase in temperature.

These three main points were correlated to the key factors and dimensions of resilience, forming a set of elements that guided the documentary analysis. These elements and dimensions were then coded in MAXQDA, assigning categories to the proposed analytical dimensions, as illustrated in Table 18.

Main Territorial Challenges	Main perceived resilience factors	Ecological	Urban	Socioeconomic	Governance
Urban Dynamics	<ul style="list-style-type: none"> - Diversity and redundancy - Managing Connectivity and Modularity - Flexibility and Innovation - Culture - Circularity and Carbon Neutrality 	<ul style="list-style-type: none"> - Environmental Protected Areas - Green leisure and recreational areas connecting strategic areas - Eco-tourism - Agroecological hub / Agriculture 	<ul style="list-style-type: none"> - Centralities - Avoid urban sprawl - Reorganising built-up areas - Mixed uses - Proximity - Spatial distribution of public facilities and services - Compactness - Zero/Low emissions zone - Connectivity and Accessibility - Energy-efficient Construction and Renovation - Diversity of mobility modes (low carbon) - Diversity of energy sources 	<ul style="list-style-type: none"> - Professional Qualification and Education - Employment and income generation connected to green and sustainable economy. - Affordable and social house 	
Water and Ecosystem Services	<ul style="list-style-type: none"> - Diversity and redundancy - Managing Connectivity and Modularity - Culture 	<ul style="list-style-type: none"> - Recovery of environmentally degraded areas - Ecological connectivity and urban greenery that articulate different scales - Environmental protection of riverbanks - Local food production Renaturalization / Restoration of Riverbanks - Protect green areas - Protect the spring areas - Rainwater Infiltration - Access to quality green spaces - Depollution of water bodies - Water reuse 	<ul style="list-style-type: none"> - Waste Management and Recycling - Sewage supply - Water supply 	<ul style="list-style-type: none"> - Environmental Education and Awareness - Foster creative industries in this area - Professional Qualification and Job Creation 	<ul style="list-style-type: none"> - Monitoring - Actors involved - Technical support - Financial support - Cooperation with other planning scales - Coordination and secretariats involved
Risks and vulnerabilities	<ul style="list-style-type: none"> - Managing Connectivity and Modularity - Equity - Risk management 	<ul style="list-style-type: none"> - Depollution of water bodies - Renaturalisation / protection of riverbanks - Afforestation - Wetlands - Multifunctional NbS (Parks, leisure, recreational and agricultural areas) 	<ul style="list-style-type: none"> - Prevent the occupation of risk areas - Urbanisation of Precarious Settlements - Resettlement of the population in risk areas - Adaptation of existing built-stock to estimated temperature - Adaptation of the Infrastructure Network to New Climate Projections 	<ul style="list-style-type: none"> - Participation and Awareness - Affordable and social housing 	

Table 18 - Analytical table containing the dimensions and elements used in the documentary analysis. Source: prepared by the author

This step was followed by the collection of planning documents on three scales: metropolitan, intermediate, and municipal, as illustrated in Table 19. The documents were obtained from official sources, such as municipalities and government agencies responsible for urban and climate planning. Qualitative documentary analysis was performed in the MAXQDA, considering the framework illustrated in Table 18, which offered advanced features for coding, categorising, and analysing textual data, allowing an in-depth exploration of the analysed documents.

SCALE	PLAN		LAW
Metropolitan	PDUI - São Paulo Metropolitan Region Integrated Development Plan		-
Intermediate	_51		-
Municipal	São Paulo (Perus, Jaraguá, Anhanguera)	Strategic Master Plan of the Municipality of São Paulo (2014)	Law No. 16.050/2014
		Climate Action Plan of the Municipality of São Paulo 2020-2050 (2021)	Decree N° 60.289/2021.
		Booklet of Proposals for the Regional Plans of the Sub-prefectures - Perus (2016) Perus Subprefecture Strategic Plan (2004) ⁵²	-
	Caieiras	Caieiras Municipal Master Plan (2012)	Law No. 4538/2012 ⁵³
	Franco da Rocha	Franco da Rocha Municipal Master Plan (2007, 2015)	Law No 618/2007 - amended by supplementary law n. 244/2015
	Francisco Morato	Francisco Morato Municipal Master Plan (2020)	Law No. 338/2020 amended by supplementary law n. 382/2022
		Francisco Morato's plan for adaptation and resilience to climate change (2022)	-
	Mairiporã	Mairiporã Municipal Master Plan (2021, 2022)	Law No 438/2021 - amended by supplementary law n. 455/2022
Cajamar	Cajamar Municipal Master Plan (2019)	Law n. 179/2019	

Table 19 - Documents analysed at metropolitan intermediate and municipal scales. Source: prepared by the author.

3.4 COMPLEMENTING THE ANALYSIS: ZONING MOSAIC, FIELD VISITS, AND INTER-VIEWS

As will be exposed in the next chapter, there are a number of weaknesses in regional and metropolitan planning in Brazil. In this context, the Metropolitan Integrated Development Plan of the São Paulo Metropolitan Region has not been approved, which means that it has no legal value. As a result, municipalities are not obliged to make their Master Plans compatible with it. This implies that each municipality has autonomy to define its urban planning strategies.

Nevertheless, in order to obtain a comprehensive overview of urban planning proposals at the regional level, a specific methodology was developed. This methodology consisted in the creation of a zoning mosaic that encompassed all the municipalities analysed (For more detail on the compatibilisation see Appendix C). For this, each municipality provided its zoning in open format, such as shapefile, dwg, or kml, with the exception of Caieiras and Francisco Morato, which provided it in pdf format.

From the information provided, QGIS software was used to process the data and create an integrated mosaic. A unified and simplified legend was assigned to this zoning to facilitate the understanding of the information.

51_ The only inter-municipal plan in the region is the Environmental Protection and Development Plan (PDPA) of APR-M-AJ. The plan was not included in the analysis as it covers only the section of the territory (the Springs protected area) primarily for diagnostic purposes.

52_ Although a booklet of proposals has been drawn up for the Perus Subprefecture Regional Plan, the document presents an extensive diagnosis of the Subprefecture and only a set of nine general guidelines. On the Subprefecture's website, the linked Regional Plan is from 2004.

53_ Only the Land Use and Occupation Law was revised in 2020 (Law 5392/2020).

By implementing this methodology, it became possible to gain a broader understanding of the spatial strategies employed in the study region. The zoning mosaic revealed the different approaches adopted by each municipality, highlighting areas of convergence and disagreement with the text of the Master Plans, as well as with the proposal of the metropolitan plan. This information is essential to understand the current scenario of the region in terms of urban planning.

Analysing the proposals of each municipality, taking into account the specificities of each area, allows a deeper understanding of the urban development strategies adopted. Through the zoning mosaic, it is possible to identify patterns, trends, and areas of conflict in the planning proposals.

This understanding is key to laying out recommendations and promoting coordination and collaboration between municipalities in the development of public policies and joint actions. In addition, the adopted regional approach emphasises the interdependence between municipalities and the importance of an integrated vision of urban planning.

To complement the documentary analysis and obtain a better understanding of the case study, individual and group field visits were carried out. One of these visits was developed under the research group “*Cities, Infrastructure, and Adaptation to Climate Change*”⁵⁴ in the “*International Workshop on Infrastructure, Resilience, and Adaptation of Cities*” and counted with researchers from different Brazilian and international universities, who could visit and discuss the territory.

These visits allowed a direct observation of the areas under study, providing a more concrete perspective and enriching the understanding of local dynamics, as well as the vision of other researchers on potentialities and challenges of the area in question.

Furthermore, semi-structured interviews were conducted with local stakeholders, such as technicians and secretaries from the municipalities and São Paulo State government, as well as civil society stakeholders (Table 20). These interviews were structured to gain additional information and perspectives on urban and climate policies, complementing the information obtained through the desk review. The identity of the people interviewed was preserved following the procedures approved by the Ethics Committee in the process 56852922.7.0000.0084.

54_ The research project “Cities Adaptation and Infrastructure to Climate Change - CIAM Clima” is led by Prof Dr Renato Anelli and is part of the research group “Contemporary Urbanism: networks, systems and processes” led by Prof Dr Angélica Benatti Alvim. The group includes Mackenzie Presbyterian University, the University of São Paulo, the Federal University of ABC, the Federal University of Rio Grande do Norte and São Judas University, as well as the German signatories of Klimapolis.

SCALE	INTERVIEWEE
Regional	- Director of the Department of Strategic Environmental Planning at the Secretariat of Environment, Infrastructure, and Logistics of the ESP
Regional	- Senior Researcher at the Centre for Geosciences, Risk Management, and Environmental Monitoring, participated in the Resilient Municipalities Programme
Metropolitan	- Former Urban Planning Secretary for the Municipality of São Paulo and participated in the development of PDUI-RMSP.
Inter-municipal	- Mayor of Francisco Morato, President of CIMBAJU and Vice-President of the SDGs of the National Front of Mayors
Inter-municipal	- Former Secretary for the Environment in the Caieiras Municipal Council, was part of CIMBAJU and the Instituto Ferrovia Parque.
Municipal - São Paulo	- Executive Secretary for Climate Change
Municipal - São Paulo	- Head of the office of the Secretariat of Green and Environment and participated in the development of PlanClima.
Municipal - São Paulo	- São Paulo City Councillor. Participated in the development of the Perus' Neighborhood Plan.
Municipal - Franco da Rocha	- Secretary of Licencing and Urban Planning - Deputy Secretary of Licencing and Urban Planning - Director of Urban Planning
Municipal - Mairiporã Intermunicipal - Sub-basin	- Environment Council of Mairiporã and Juqueri-Cantareira Sub-basin Council

Table 20 - Department and institution of technicians / professionals interviewed on the metropolitan, intermediate, and municipal scales. Source: prepared by the author.

During the interviews, scripts with semi-structured questions were used, allowing participants to express their opinions, knowledge, and experiences related to the topic under study. The interviews were recorded and then transcribed for analysis.

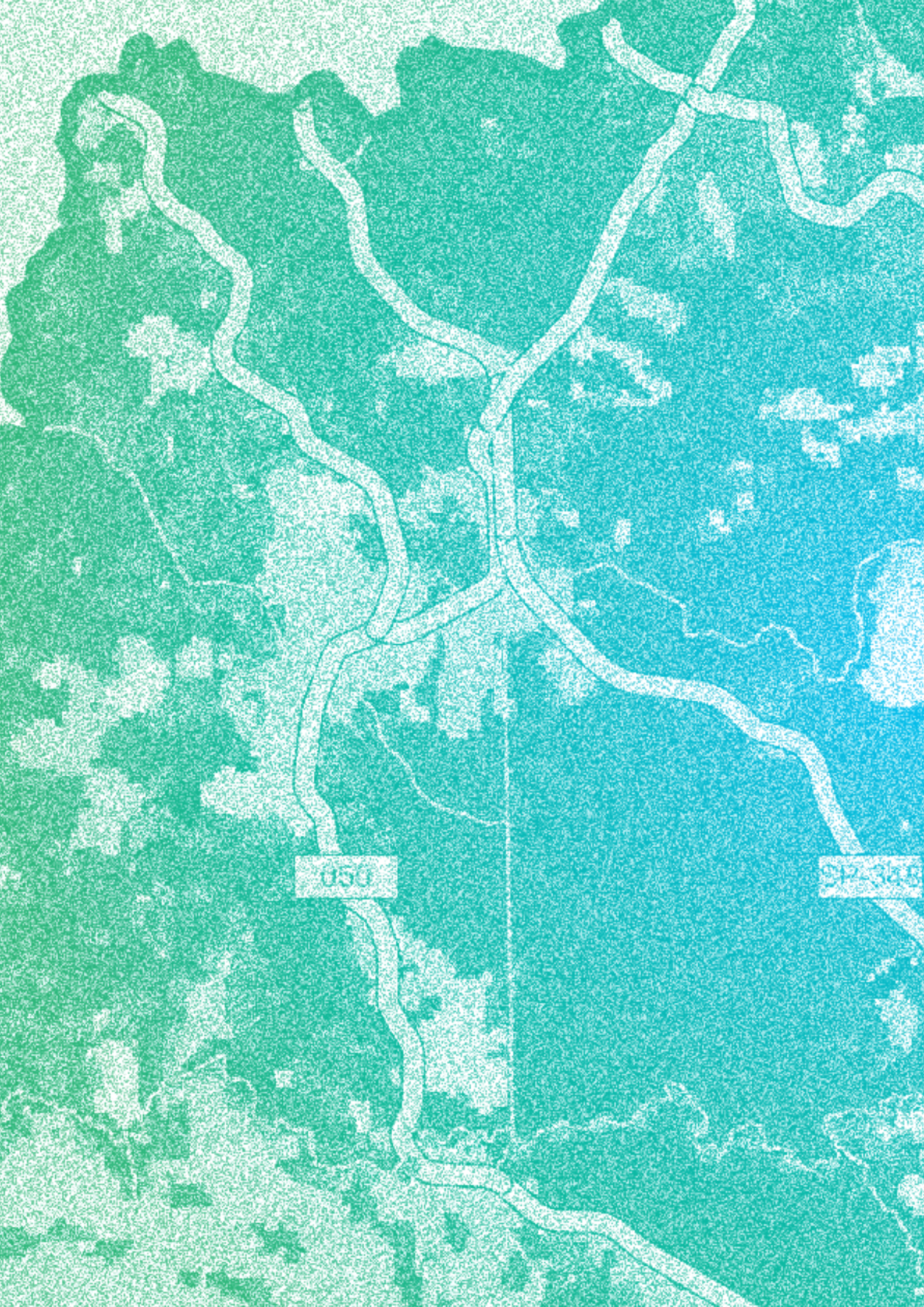
The interviews provided an opportunity to gain different perspectives and experiences related to urban and regional planning, as well as an overview of the different transformations of the territory and its respective planning policies over the years from the perspective of local actors. Technical experts and municipal secretaries shared their expertise and their views on the strategies adopted by municipalities. Civil society representatives made valuable contributions, bringing to light the concerns, needs, and expectations of the local population.

The semi-structured approach allowed for flexible interaction during the interviews, encouraging interviewees to express their opinions in an open manner. This exchange of information enriched the research process and contributed to a deeper understanding of urban planning policies and practises in the region.

By combining the analysis of planning documents, field visits, and semi-structured interviews, it was possible to obtain a multidimensional perspective of the urban planning proposals under analysis. This approach contributed to a comprehensive and in-depth approach to the analysis of urban and climate policies, trends, and challenges in this specific region.

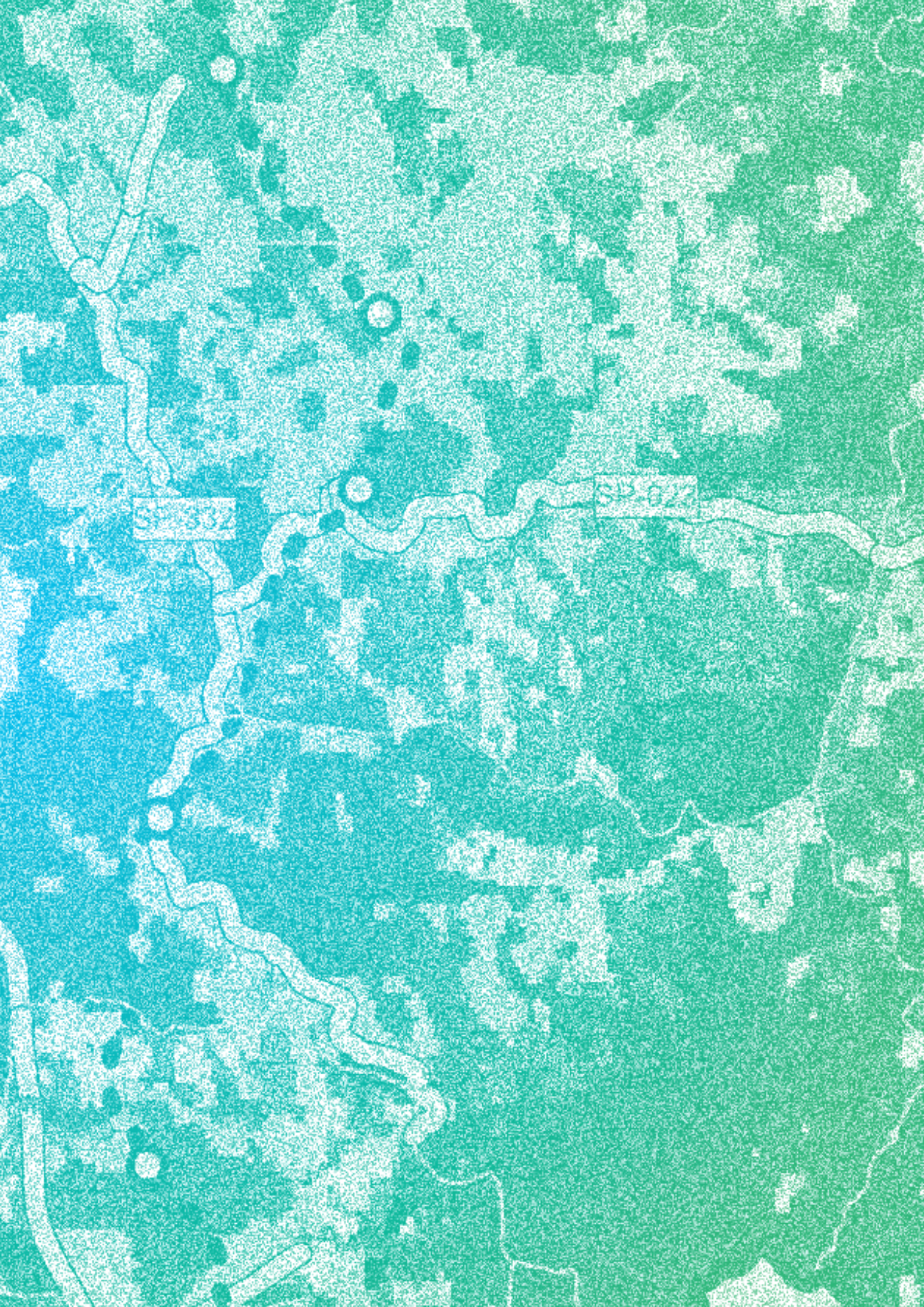
This combination relates to the theoretical and conceptual perspective addressed in the thesis, which understands that the construction of resilient cities and regions depends on a constant and incremental construction process that relates to different actors and scales and cannot be achieved only with the implementation of technical instruments, but from a combination and integration of a variety of factors which can be facilitated by integrated planning.

The next chapter presents the results and discussion of the application of the method to the case of the Juqueri-Cantareira sub-basin in the São Paulo Metropolitan Region.



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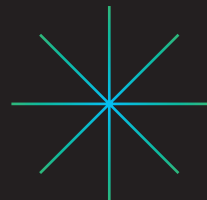


SP 82

SP 82

**The Fringes of São Paulo
Metropolitan Region: Critical
analysis and possible planning
pathways towards resilience**

4



The metropolitan fringes, as defined in the theoretical-conceptual framework of this research (Chapter 1), are generally characterised as complex territories made up of small and medium-sized districts and municipalities on the border of metropolitan areas.

In the context of the metropolitan fringes of the São Paulo Metropolitan Region (RMSP), the northern region, the area that corresponds to the Juqueri-Cantareira sub-basin, concentrates important natural remnants, environmental protection areas and Spring zones of regional interest. In contrast, as will be demonstrated, the region has experienced intense urban population growth in recent decades, combined with major infrastructure and logistics projects, generating urban pressure towards preserved areas.

Considering this background, this Chapter aims to present the results and discussions of the application of the method presented in the previous Chapter to the plans of a focus fringe area in the São Paulo Metropolitan Region to elaborate a set of recommendations for the urban and regional planning of its fringes that seek to promote resilience.

Firstly, a brief introduction is given, highlighting the way in which the issue of climate change has been addressed in urban policies in Brazil and the state of São Paulo. Secondly, the São Paulo Metropolitan Region is characterised in general, with a specific focus on the Juqueri-Cantareira sub-basin in order to provide a contextual background to the main social, economic, environmental and urban characteristics of the region.

In the third part, the results of applying the analytical framework are examined, and the discussion revolves around the region's three main territorial challenges: (1) urban dynamics, (2) water and ecosystem services and (3) risks and vulnerabilities.

Finally, the discussion that follows focuses on the significant advances, limitations and challenges found in the study, covering new governance arrangements, the articulation of the potential for resilient transformation at different scales, as well as the revision of urban and regional planning instruments, with the ultimate aim of contributing to the formulation of innovative plans and projects for metropolitan fringes.

4.1 URBAN AND CLIMATE POLICIES IN BRAZIL AND THE STATE OF SÃO PAULO

Brazil

During the past few decades, Brazil has played a significant role in climate and environmental discussions on the international stage. The country hosted the Rio 92 conference (United Nations Conference on Environment and Development), which was pivotal in creating guidelines and a global agenda to address climate change and global warming. During this conference, the United Nations Framework Convention on Climate Change (UNFCCC) was signed, with the commitment of most industrialised countries to implement its guidelines and stabilise their emissions of greenhouse gases (Martins and Ferreira, 2011). Brazil signed this agreement and subsequent environmental and climate agreements, such as the Kyoto Protocol and the Paris Agreement, committing to reduce its Greenhouse Gas emissions.

Since the redemocratisation and especially after the 1988 Brazilian Federal Constitution, a series of advances were instituted concerning urban and environmental policies. Such policies were recognised as innovative as they acknowledged in their narrative the scenario of environmental degradation and urban growth that was taking place in the national territory and established a series of instruments that sought to solve problems related to this scenario, proposing measures towards political-administrative decentralisation and the redemocratisation of society (Alvim, 2003).

The Federal Constitution has made progress in defining principles for urban and environmental policy, such as the mandatory use of master plans for cities with more than 20,000 inhabitants (Article 182) and the right to an ecologically balanced environment (Article 225), as well as the definition that states can create metropolitan regions, urban agglomerations, and micro-regions (Article 25), which lays some foundations for regionalisation. Nevertheless, as Alvim (2019) points out, there are still challenges in implementing and integrating the multiple scales of planning and urban and environmental instruments, which often have conflicting logics.

In terms of urban policy, the City Statute (Federal Law No. 10.257/2001) represented an important milestone in Brazilian urban policy, regulating constitutional articles and highlighting the role of municipalities in urban development and democratising urban governance, with the aim of achieving social justice and quality of life. The Metropolitan Statute (Federal Law No. 13.089/2015) represented a significant advance in the intergovernmental governance of metropolitan regions and urban agglomerations, establishing guidelines for the planning, management, and execution of functions of common interest. However, despite these advances, the Federal Constitution granted greater autonomy to municipalities while establishing shared competences between the Union, the States and the municipalities, creating complex coordination and negotiation situations that, even after the Metropolis Statute, did not evolve into a restructuring of governance and strengthening of planning institutions, with a municipalist vision of planning prevailing (Alvim, 2019).

Regarding Climate Change, for Barbi and Rei (2021), Brazil's climate change policies have undergone two main phases. The first phase started in 2000 when the federal government began discussing the basis for a climate policy through the Brazilian Climate Change Forum (FBMC). The second phase occurred in 2009, when the National Climate Change Policy (PNMC)⁵⁵ was approved, right after the 15th Conference of the Parties (COP). With this, Brazil adopted a voluntary target to reduce greenhouse gas emissions between 36.1% 38.9% of the total emissions projected for 2020.

Despite the commitment to reducing emissions stipulated in the PNMC, criticism has arisen due to the centralization of Brazilian climate governance at the federal level,

55_ Established by Law 12.187/2009 and Regulated by Decree 7.390/2010.

highlighting the need to include state and municipal governments in an integrated strategy. In this framework, the role of the urban dimension in this issue was unclear (Macedo, 2017; Sotto et al., 2019).

The PNMC culminated in the elaboration of the National Plan for Adaptation to Climate Change (PNA), published in 2016. The PNA established 11 sectoral and thematic strategies that are represented by the competent government agencies, which are: Agriculture, Biodiversity and ecosystems, Cities, Natural Disasters, Industry and Mining, Infrastructure (Energy, Transport, and Urban Mobility), People and Vulnerable Populations, Water Resources, Health, Food and Nutrition Security, and Coastal Zones.

Regarding urban planning, the primary strategy connected to the theme is “Cities”, although others have essential synergies. Specifically, the “Cities” strategy emphasises risk management. It suggests “no regrets” guidelines designed to reduce the vulnerability of Brazilian cities in light of their different scales and main challenges by considering the climate lens in urban planning and development (Brasil, 2016).

The document outlines the primary vulnerability of cities in Brazil. This vulnerability is driven by historical inequalities that worsen the situation for large and medium-sized municipalities. These factors include inadequate basic sanitation, the occupation of high-risk areas, and frequent flooding, as shown in Table 21. In general, medium and large cities have different levels of vulnerability across the country. These cities tend to be more compliant with planning instruments than small cities, but they have greater social inequalities, sanitation problems and populations at risk from floods and landslides. with planning instruments than small cities, but they have greater social inequalities, sanitation problems and populations at risk from floods and landslides.

SIZE	POP.	GEOGRAPHICAL LOCATION	MAIN VULNERABILITIES	EXPOSURES
Small	<50 thousand	Northern region, semi-arid, most of the Centre-West, North and Northeast MG, South BA, interior PR and South RS	Fewer resources for infrastructure and basic services. Development constraints and high socioeconomic vulnerability. Poverty Sanitation problems.	Mainly to droughts and floods. Eventually to flash floods. Water-borne diseases. High growth that may increase exposure to other hazards.
Medium	50 to 100 thousand	SP, RJ, Center-South of MG, West of PR, SC and RS, Northern portion of RS, great part of the coast that goes from RS to CE, axis between DF - Palmas (TO) - Belém (PA) - Manaus (AM). Scattered regions in MA, MT, and RO, some capitals and metropolitan regions.	Very variable. In general, they have more resources than small ones. The larger the municipality, the greater the adherence to urban planning instruments. Possible problems consist of drainage and sanitation.	Housing and economic activities in risk areas (floods and mass movements) that characterize different degrees of exposure, depending on the limitations of land use. Contagion of water-borne diseases and, depending on the case, respiratory diseases.
Large	100 to 500 thousand			
	500,000 to 1 million	Some capital cities and industrial and development hubs, mainly in the Southeast and South and Northeast.	Have more resources and capacity to deal with structural and basic service problems. Strong social inequality and consequent housing problems usually linked to sanitation problems. Inadequate drainage systems due to intensive sealing. Contamination of water resources.	High exposure to flash floods, mudslides and flooding; mass movements and water crises linked to urban supply. Respiratory diseases, thermal discomfort, worsening of health conditions and spread of some waterborne diseases
Metropolis	> 1 million	Capitals of SP, RJ, BA, CE, MG, AM, PR, PE, RS, PA, GO, MA and DF, and other two cities in the State of São Paulo		

Table 21 - Characterization of Brazilian municipalities regarding demographic aspects and urban risks in the context of climate change Source: Adapted from the document “Strategies for Cities” of the PNA (Brasil, 2016)

Although there is mention of the need for joint actions between different federative entities, the PNA reinforces the municipal scale in the implementation of adaptation actions, following the Brazilian federative model and referring to the application of already existing instruments, such as the City Statute (Law No. 10.257/2001), and the Metropolis Statute (Law No. 13.089/2015) (Table 22). The first instrument focuses on municipal Master Plans and brings guidelines for the democratic management of cities and social participation in the formulation of urban policies, while the second establishes procedures for the organisation, planning, and management of metropolitan regions in the country, seeking to promote integration and cooperation among the municipalities that make up the metropolitan regions.

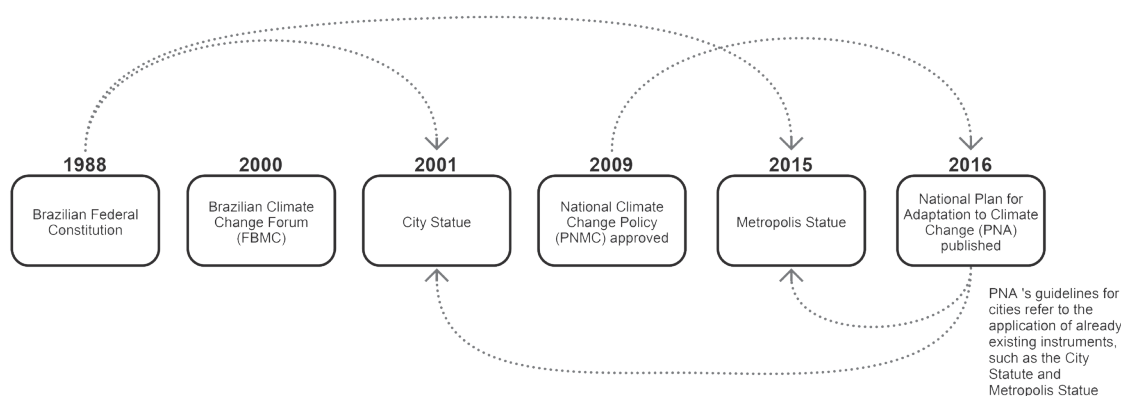


Figure 58 - Milestones of urban and climate policies in Brazil. Source: prepared by the author.

Both instruments have guidelines with synergies to the framework of sustainable cities, such as environmental recovery and preservation, right to housing, and the creation of Special Social Interest Zones (ZEIS), public transport, and sustainable mobility, among others.

Nevertheless, as discussed by Klug, Marengo, and Luedemann (2016) in the context of City Statutes and climate change, the implementation of these guidelines can assist in reducing vulnerability, local governments have acted timidly, although several initiatives have been undertaken. Accordingly, Sotto et al. (2019) state that the Brazilian Federal Government does not monitor local climate actions and has not yet developed precise instruments that outline how climate action is integrated into urban policy.

In this sense, the PNA's strategies are generic in that they refer to existing urban instruments and are not articulated with improvements in the articulation of inter-federative bodies, despite there being a mention in guideline 1. Similarly, several guidelines, such as incorporating climate adaptation considerations into urban rehabilitation and development (guidelines 2, 3 and 4), strengthening urban planning processes to mitigate natural disasters (guideline 5) and improving sanitation and waste management systems (guidelines 7, 8, 9 and 10), although crucial and valuable for urban development, are not reflected in a paradigm shift in planning. In this sense, the PNA's strategies are generic in that they refer to existing urban instruments and are not articulated with improvements in the articulation of inter-federative bodies, despite there being a mention in guideline 1. Similarly, several guidelines, such as incorporating climate adaptation considerations into urban rehabilitation and development (guidelines 2, 3 and 4), strengthening urban planning processes to mitigate natural disasters (guideline 5) and improving sanitation and waste management systems (guidelines 7, 8, 9 and 10), although crucial and valuable for urban development, are not reflected in a paradigm shift in planning

1. Promote federal coordination among the three spheres of government with the aim of cooperative action in reducing vulnerability to climate change through interfederative planning and management.
2. Consider climate change adaptation in the promotion of the rehabilitation of consolidated, degraded and infrastructure installed urban areas.
3. Consider climate change adaptation in the promotion of urbanisation of precarious settlements
4. Consider climate change adaptation in the production of social housing at scale
5. Strengthen urban expansion planning processes in order to prevent the occurrence of natural disasters and the emergence of risks
6. Strengthen actions related to hillside containment works and the preparation of the Municipal Risk Reduction Plan (PMRR), increasing the number of municipalities that benefit from it.
7. Consider adaptation to climate change in the implementation of the National Sanitation Plan;
8. Strengthen sustainable urban drainage actions to reduce flooding. Such sustainable drainage actions should observe, wherever possible, ecosystem-based adaptation (EbA) principles;
9. Support the implementation and improvement of water supply and sanitary sewage systems. Facilitate multiple uses of water, stimulating efficient use of energy, with the use of biogas resulting from the treatment of solid urban waste and sewage and other renewable energies;
10. Support actions to improve urban cleaning and solid waste management systems;
11. Support the management and dissemination of information related to climate change, which may subsidise the development of diagnosis and the development of adaptation strategies in synergy with urban planning;
12. Support the development of studies on the impacts of climate change in different cities;
13. To support the formation and training of human resources and the dissemination of technological resources for the use and management of information, with the aim of applying established strategies and methodologies;
14. Consider climate change adaptation in the improvement of urban planning models;
15. Support the coordination of initiatives for the review of technical standards and the regulation of building and urban planning parameters so that they can foster resilient solutions in the construction of buildings and urban infrastructure.

Table 22 - Priority guidelines for promoting adaptation under the PNA "Cities" strategy Source: prepared by the author based on information from the PNA - Cities Strategy (Brasil, 2016).

Therefore, in the context of urban and metropolitan planning, the PNA is a very limited instrument for identifying pathways for the necessary transformations that urban areas must undergo to become more resilient, particularly from an ecological urban perspective.

The integration of urban and climate policies remains a challenge at the Brazilian level, despite the advances achieved over the last decade since the federal constitution. In some cases, municipalities have taken voluntary action in collaboration with transnational networks, such as ICLEI (Barbi and Rei, 2021); however, a joint effort is necessary to ensure effective integration and strengthening of Brazil's climate and environmental policies, including the transformation of urban areas, not solely risk management, in a coordinated and multiscale manner.

State of São Paulo

The complexity of the climate issue requires the construction of coordinated actions encompassing different scales and actors. In addition to the commitments of nation-states to combat climate change, non-state actors⁵⁶, such as companies, civil society organisations, and subnational governments, have been recognised as key actors since the Paris Agreement. The agreement encouraged nation-states to cooperate with non-state actors to strengthen mitigation and adaptation actions, highlighting the role of cities and local efforts in tackling climate change (Macedo, De and Jacobi, 2019).

56_ Or non-Party actors.

In the Brazilian context, the weakening of climate and environmental policies at the federal level, has placed a significant protagonist on local and regional governments. In this sense, the State of São Paulo plays a substantial role in the regional sphere by having important climate and urban instruments, although there are implementation and governance challenges, as will be exposed further.

The State of São Paulo, located in the Southeast region, is the most populous in Brazil, with 44,420,459 inhabitants⁵⁷, distributed across 645 municipalities. According to the Brazilian Panel on Climate Change, the main climate risks in the southeaster region of Brazil are related to the increase in temperature (between 2.5° and 3°C for the end of the 21st century), greater frequency of occurrence of hot days and reduction of the occurrence of cold nights, the occurrence of heat waves and urban heat islands and increase in rainfall of 25% to 30% by the end of the century (PBMC, 2016).

Within the scope of climate policies, the State of São Paulo has the State Policy on Climate Change (PEMC) implemented in 2009. This policy establishes guidelines and targets for the reduction of greenhouse gas emissions, as well as the promotion of adaptation actions. Regarding urban planning, the PEMC deals with the discipline of land use in Section IX. This includes preventing disorderly urban development, encouraging sustainable transportation options, establishing polycentralities throughout the state to reduce transportation needs, and safeguarding and restoring vegetation.

The focus of the PEMC was the reduction of 20% of CO₂ emissions by 2020 over the base year of 2005. However, according to a report prepared by the State Government, in 2020, São Paulo's net emissions were only reduced by 2.1% and gross emissions by 0.8%. It is worth highlighting that the Energy sector had an increase of 24.3% and the Waste sector of 14.3%. (São Paulo (Estado), 2022a).

More than a decade after the approval of the PEMC and the finding of little progress, especially regarding emissions, São Paulo has developed instruments and programs to address the issue. In 2019, the Resilient Municipalities of São Paulo Program (PMPR) was launched (Decree No. 64,659/2019) within the scope of ProAdapta⁵⁸. The PMPR counted the participation of 12 municipalities that received training and developed their respective climate adaptation and resilience strategies, including Francisco Morato, part of the territory analysed in the thesis (São Paulo (Estado), 2021).

In 2021 the State joined the UN/UNFCCC's Race to Zero and Race to Resilience campaigns through Decree 65.881/2021. In 2022, it launched the final version of the Climate Action Plan - Net Zero 2050, which has the ambitious goal of achieving carbon neutrality in the State by 2050 (São Paulo (Estado), 2022b).

In addition to specific climate change policies, the State of São Paulo has a recently approved territorial instrument with a climate lens in its analyses and guidelines, the Ecological Economic Zoning (ZEE) (State Decree No. 67.430/2022). The ZEE is a territorial instrument that seeks to reconcile economic development with environmental preservation, considering an analysis of the characteristics and potential of each administrative region of the State and climate scenarios to guide the occupation and use of the territory sustainably. Among the ZEE products is the ZEE Network, which consists of a platform of georeferenced data of the State of São Paulo that are publicly accessible and may be used by the municipalities to prepare their respective local policies.

Although instruments have advanced, there is a lack of coordination concerning the

57_ According to data from the IBGE 2022 census available at: <https://censo2022.ibge.gov.br/panorama/>. Accessed on: August 31, 2023.

58_ ProAdapta is a cooperation programme between the Brazilian Government (MMA) and the German Cooperation for Sustainable Development (GIZ) to strengthen the climate resilience of Brazil through the effective implementation of the National Climate Change Adaptation Agenda.

articulation between Brazil's climate and urban agendas. First and foremost, the 1988 Federal Constitution established different competencies for each federative entity, with the Union being responsible for matters of general interest, the States for issues of regional interest, and municipalities for matters of local concern. The design established in the Brazilian Federal Constitution provided a political-administrative decentralisation that expanded the competence of municipalities, giving them greater political, fiscal and financial autonomy (Alvim, 2019).

In the scope of Urban Policy, this decentralisation culminated in new challenges and municipal responsibilities, such as the obligation to institute Master Plans for municipalities with more than 20,000 inhabitants. However, despite the decentralisation, the Constitution defines some issues as joint competence of the federative entities (Union, States, Federal District and Municipalities), among them the protection of the environment.

Due to this governance design, even though no clear guidelines exist regarding the obligation to implement specific instruments for adaptation and resilience, this competence falls to the municipalities. Other instruments are also subject to this logic, as demonstrated by the discussion about the PNA.

In contrast, climate issues in metropolitan areas require a multi-scale approach because the environmental elements and urban dynamics transcend the political and administrative boundaries of the municipalities, demanding regional cooperation and management. As far as the Brazilian case is concerned, this issue remains uncompleted. Despite the advances in the regulation of Urban Policy through the City Statute (Federal Law n. 10.257/2001), the establishment of the Ministry of Cities (2003) and the Metropolis Statute (Federal Law n. 13.089/2015), little progress has been made so far in integrating the urban and environmental agendas effectively.

In the State of São Paulo, the establishment of the São Paulo State Water Resources Policy (Law No. 7.663/1991) and the State Law for the Protection and Recovery of Springs (Law No. 9.866/1997) brought about an innovative model for environmental planning and management in the State of São Paulo, considering watersheds as hydric management units and requiring the drafting of specific laws for regionally important water source areas. This initiative was another important step in the search for solutions that take into account both urban and environmental needs (Alvim, 2003; Alvim, Bruna and Kato, 2008; Alvim, Marques and Alves, 2018).

As discussed in the following sections, in the Juqueri-Cantareira sub-basin, this legislation plays an important role in limiting urban sprawl and protecting the environment in the eastern vector of the territory, where the Alto Juquery Riverbank Preservation and Recovery Area (APRM-AJ) is located. The approval of the specific laws required municipalities in the riverbank preservation areas to make their master plans compatible with the guidelines set out in the law and in the new environmental zoning for each sub-basin.

However, this process has not been accompanied by a gradual strengthening of planning institutions, and a municipalist and sectoral vision has prevailed, with intense conflicts between economic development, urban development and environmental protection and restoration.

The lack of integration and effective cooperation between the different levels of government, especially in the metropolitan context, hinders the implementation of urban and climate policies in an efficient and coordinated way. In the case of São Paulo State, a clear gap in metropolitan governance has been aggravated in recent years, for instance, with the extinction of the State Metropolitan Planning Company (EMPLASA)⁵⁹ in 2019, as will be further detailed in the next session.

59_ Law No. 17.056, of 05 June 2019.

4.2 SÃO PAULO METROPOLITAN REGION: CONTEXT AND PLANNING VISIONS FOR THE FRINGES

4.2.1 CONTEXT AND GENERAL INFORMATION

São Paulo Metropolitan Region (RMSP) is one of the largest urban agglomerations in the world, reaching 21,252,384 inhabitants⁶⁰ in 2021, distributed in 39 municipalities. Population Projection⁶¹ indicates that this urban population tends to grow even more in the following years, especially in the fringes of its territory, in areas that often coincide with environmental interest and/or protection areas. This metropolitan region has significant economic importance at the Federal and State levels since its Gross Domestic Product (GDP) corresponds to 18% of the Brazilian GDP and 54% of the State GDP (Table 23).

	São Paulo Metropolitan Region
Population	21,252,384 inhabitants (*)
Number of municipalities	39 municipalities
% of country's and state's population	10.47% of Brazil's population 47% of São Paulo's (State) population
Area	7,946 km ² (*)
% of natural land	44,76% (**)
% of country's GDP	18% of Brazil's GDP (**)
% of the state's GDP	54% of São Paulo's (State) GDP (**)
Is the Metropolitan area institutionalised by law?	Yes. Established by Federal Complementary Law n. 14 of 8 June 1973, regulated by State Complementary Law n. 94 of 29 May 1974, and reorganised by State Complementary Law n. 1,139 of 16 June 2011.
Has it an administrative and technical body?	No.
Institution name/foundation date	-
Metropolitan fringes characteristics	The Mário Covas Ring Road, as well as the environmental protected areas and springs, are crucial elements that structure the fringe areas of the RMSP. These areas have a significant portion of the metropolis' vulnerable population and complex, interdependent dynamics with the city center of São Paulo. There are several regional centers, such as ABC Paulista (southern sub-region), Guarulhos (eastern sub-region), and Osasco and Barueri (southwestern sub-region).
Focus area	Name: Juqueri-Cantareira sub-basin (northern region) Municipalities: São Paulo (districts of Anhanguera, Jaraguá and Perus), Caieiras, Cajamar, Franco da Rocha, Francisco Morato, and Mairiporã Population: 1.001.743 inhabitants (*) Area: 848.71 km ²

Table 23 - General characteristics of São Paulo Metropolitan Region. Source: prepared by the author based on Fundação Seade - Perfil dos Municípios Paulistas (2021). Available at: <https://perfil.seade.gov.br/#> (*), Emplasa (2019) (**), Mapbiomas (2021) – Percentage of forest land cover in RMSP (**).

Created in 1973, still in the context of the military regime, and reorganised by Complementary Law No. 1,139 of June 16, 2011, the region is inserted in a complex governance setting. It is home to the Alto Tietê Hydrographic Basin (BAT)⁶², a hydric-environmental unit that corresponds to the Water Resources Management Unit - 06 (UGRHI-06), one of the 22 hydrographic basins established by the State of São Paulo. The BAT territory practically coincides with the metropolitan territory, involving 34 out of the 39 municipalities in the RMSP; hence the name “Metropolitan São Paulo Basin” (Alvim, 2003), as shown in Figure 59.

60_ According to data from the IBGE 2022 census available at: <https://censo2022.ibge.gov.br/panorama/>. Accessed on: August 31, 2023.

61_ Projections - SEADE Foundation. Information on Municipalities of the State of São Paulo. Available at <<http://www.imp.seade.gov.br/frontend/#/tabelas>>. Accessed June 2018.

62_ The BAT covers an area of 5,985 km² and is composed of the following sub-basins: (1) Alto Tietê-Cabeceiras, (2) Billings-Tamanduatei, (3) Cotia-Guarapiranga, (4) Juqueri-Cantareira, (5) Penha-Pinheiros and (6) Pinheiros-Pirapora.

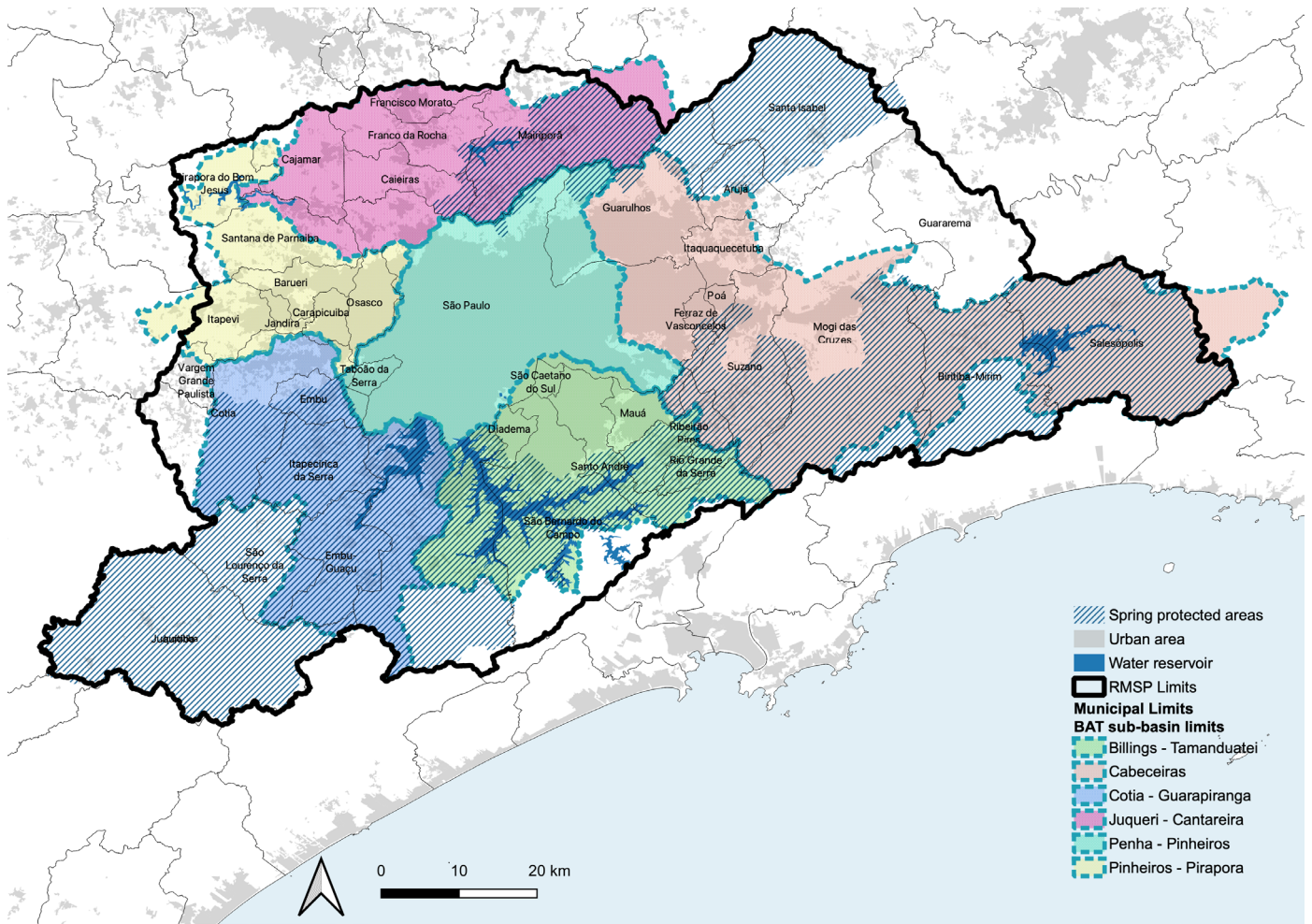


Figure 59 - Limit of the Metropolitan Region of São Paulo and its municipalities overlapping with the limit of the Upper Tietê Basin (BAT-UGRHI-06) and its division into sub-basins. Source: Prepared by the author based on geo-referenced data from IBGE (2010, 2022) and DataGeo Portal - São Paulo State Secretariat for the Environment. Projection: SIRGAS 2000.

In the São Paulo Metropolitan Region (SPMR), the phenomenon of intense population growth occurred mainly between 1960 and the end of the 1980s (Figure 60), especially due to the Brazilian rural exodus and interstate migration in search of job opportunities (Pasternak, 2017). This timeframe coincides with the period of intensified peri-urbanisation in Brazil and spatial segregation between the central areas and the peripheries discussed by Coy *et al.* (2018).

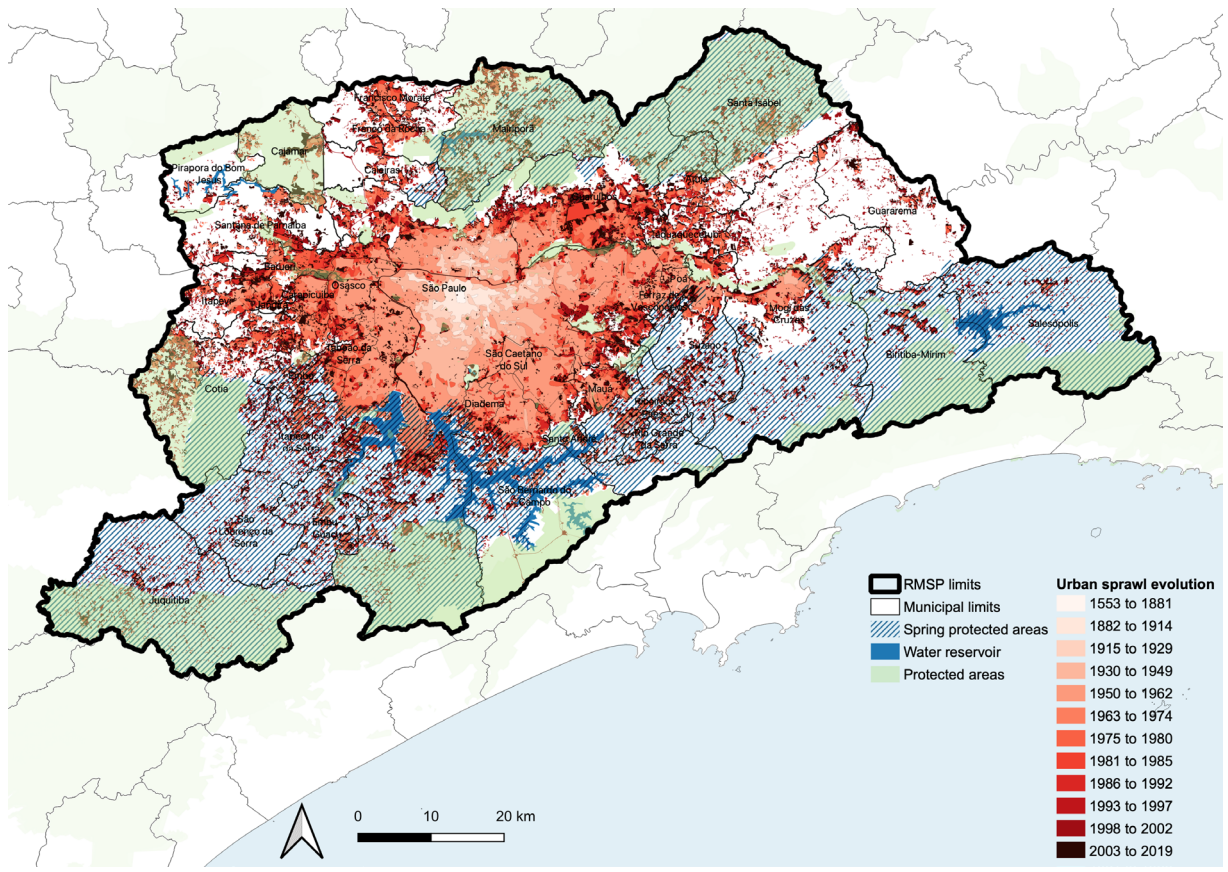


Figure 60 - São Paulo Metropolitan Region urban sprawl evolution versus environmental protected areas.

Source: Prepared by the author based on geo-referenced data from EMLASA (2010), IBGE (2010, 2019) and DataGeo Portal - São Paulo State Secretariat for the Environment. Projection: SIRGAS 2000.

Although the overall demographic growth rates of RMSP declined in the following decades due to the relocation of industries to the state of São Paulo countryside and the economic crisis (Cunha *et al.*, 2013), there is intense population growth in medium-sized and small towns on the 'fringes' of the metropolis, which Da Cunha (2016) describes as a phenomenon of dispersed urbanisation and regionalisation of everyday life, as opposed to the idea of 'demetropolisation' or 'metropolitan deconcentration'.

Unlike the interstate migration between the 1960s and 1980s, the recent increase of the urban population in the peripheral cities of the RMSP comes mainly from an intra-metropolitan migration⁶³. However, there is still a strong dependency of the peripheral municipalities on São Paulo (Capital city) and other regional sub-centres, such as Guarulhos, Osasco, and the ABC Paulista (Santo André, São Bernardo do Campo and São Caetano do Sul), as mainly employment opportunities are concentrated in those areas. The northern subregion, which forms part of the empirical object of this thesis, has the lowest percentage of employments of the entire metropolitan region, a fact that reinforces its dependence on neighbouring municipalities (Figure 61 and Figure 62).

63_ Da Cunha (2016) highlights from data of the last demographic census (2010) that there is a reduction in the overall demographic growth of the RMSP compared to previous censuses. However, there is a change in the growth pattern, the peripheral cities have the highest rates of population growth, but this increase comes mainly from an intrametropolitan migration and no longer mainly from interstate migration. Still, according to the author about 50 thousand people/year migrate to the most peripheral regions within the region.

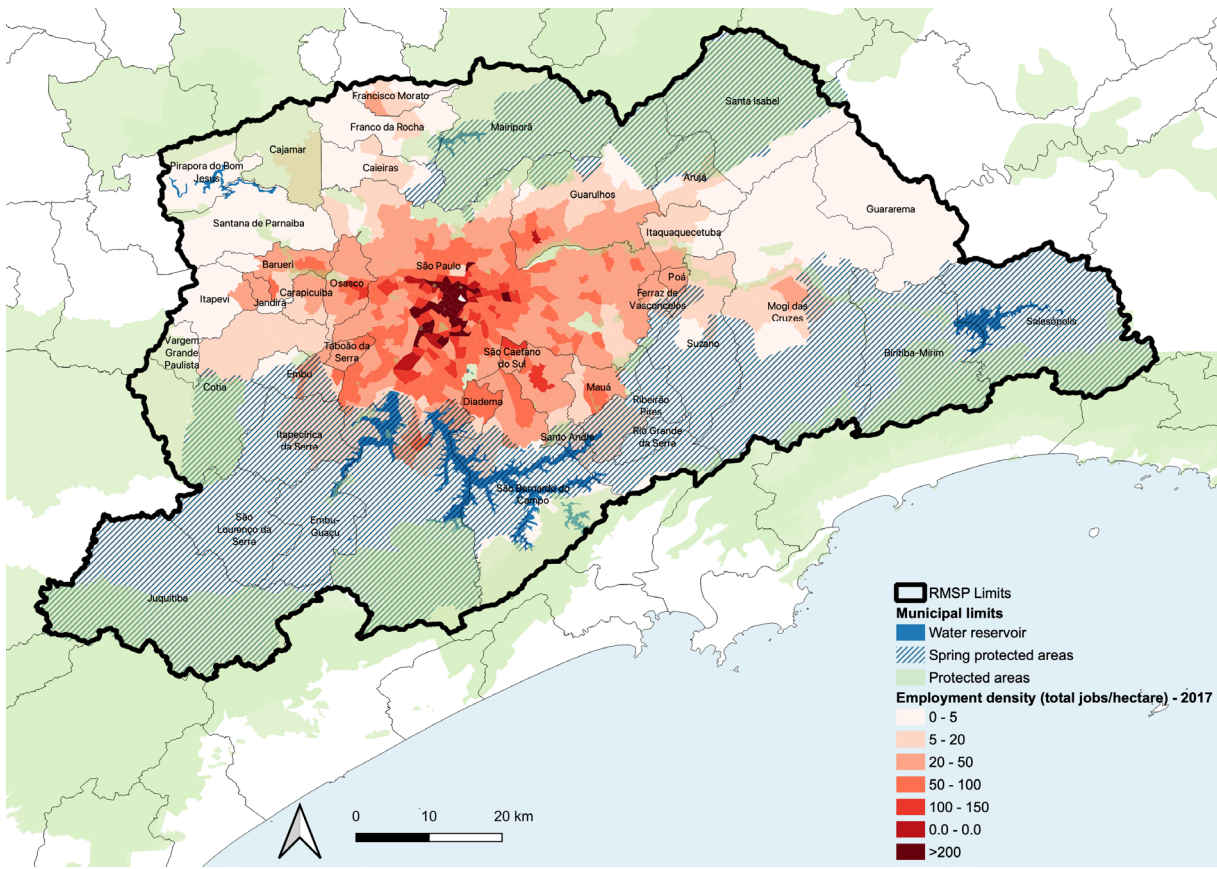


Figure 61 - Employment density and environmental protected areas in São Paulo Metropolitan Region.
 Source: Prepared by the author based on georeferenced data from IBGE (2010), DataGeo Portal - São Paulo State Secretariat for the Environment and Pesquisa Origem e Destino - Metrô SP (2018). Projection: SIRGAS 2000.

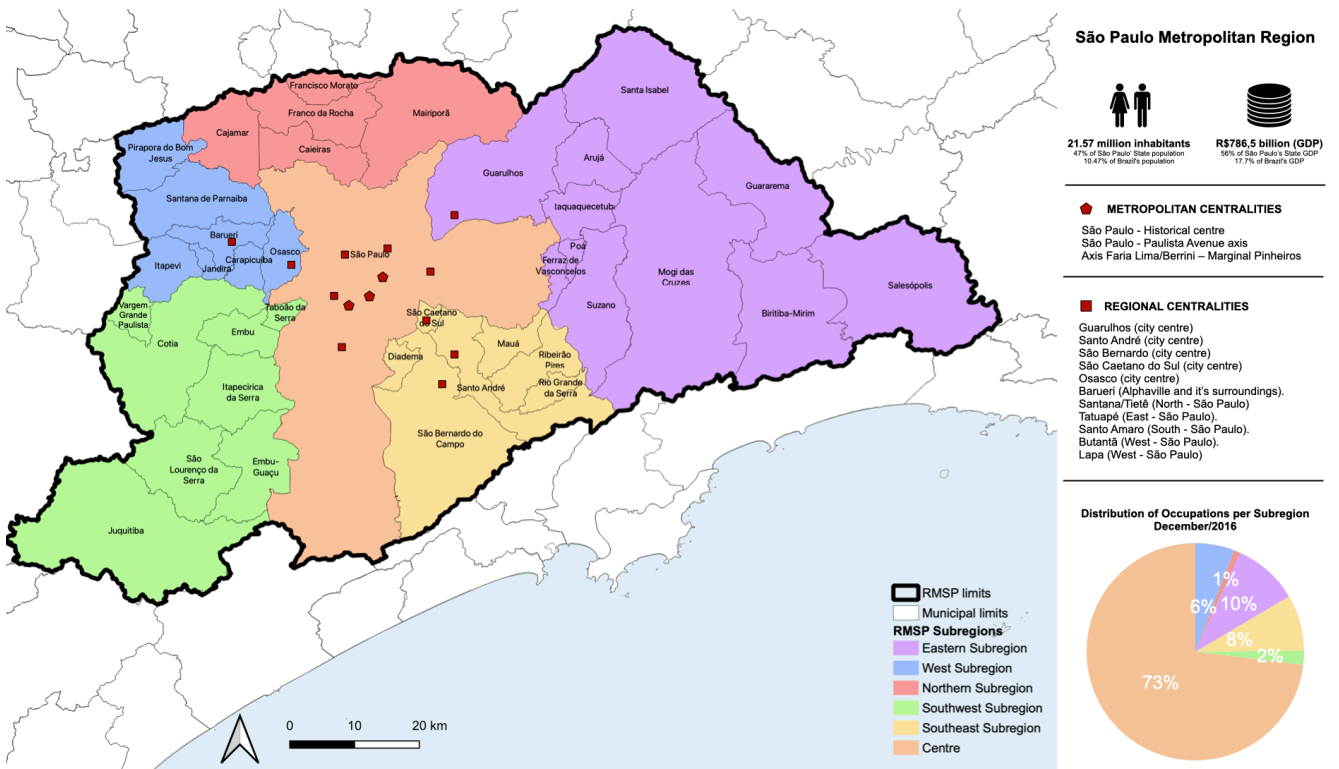


Figure 62 - São Paulo Metropolitan Region's subregions, metropolitan and regional centralities.
 Source: Prepared by the author based on data from IBGE (2010) and PDUI (2019). Projection: SIRGAS 2000.

Data and projections from the SEADE Foundation indicate that this phenomenon of higher demographic growth in cities located on the fringes of the metropolis in relation to São Paulo Capital will continue in the coming decades, especially in the northern sub-region (Table 24 and Figure 63).

SUBREGION	AGGR 2000/2010	AGGR 2010/2020	AGGR 2030/2030	AGGR 2030/2040	AGGR 2040/2050
North	2,01%	1,54%	1,04%	0,65%	0,42%
East	1,51%	1,12%	0,84%	0,46%	0,21%
Southeast	0,8%	0,52%	0,25%	0,02%	-0,26%
Southwest	1,575%	1,165%	0,81%	0,505%	0,24%
West	1,69%	1,34%	0,98%	0,56%	0,22%
São Paulo	0,76%	0,54%	0,31%	0,09%	-0,12%

Table 24 - Annual Geometric Growth Rate (AGGR) by sub-region of the São Paulo Metropolitan Region from 2000 to 2050

Source: Prepared by the author based on data from SEADE Foundation (2021). Available at: <https://repositorio.seade.gov.br/dataset/populacao-crescimento-populacional-por-municipio>. Accessed on: 17 November 2021.

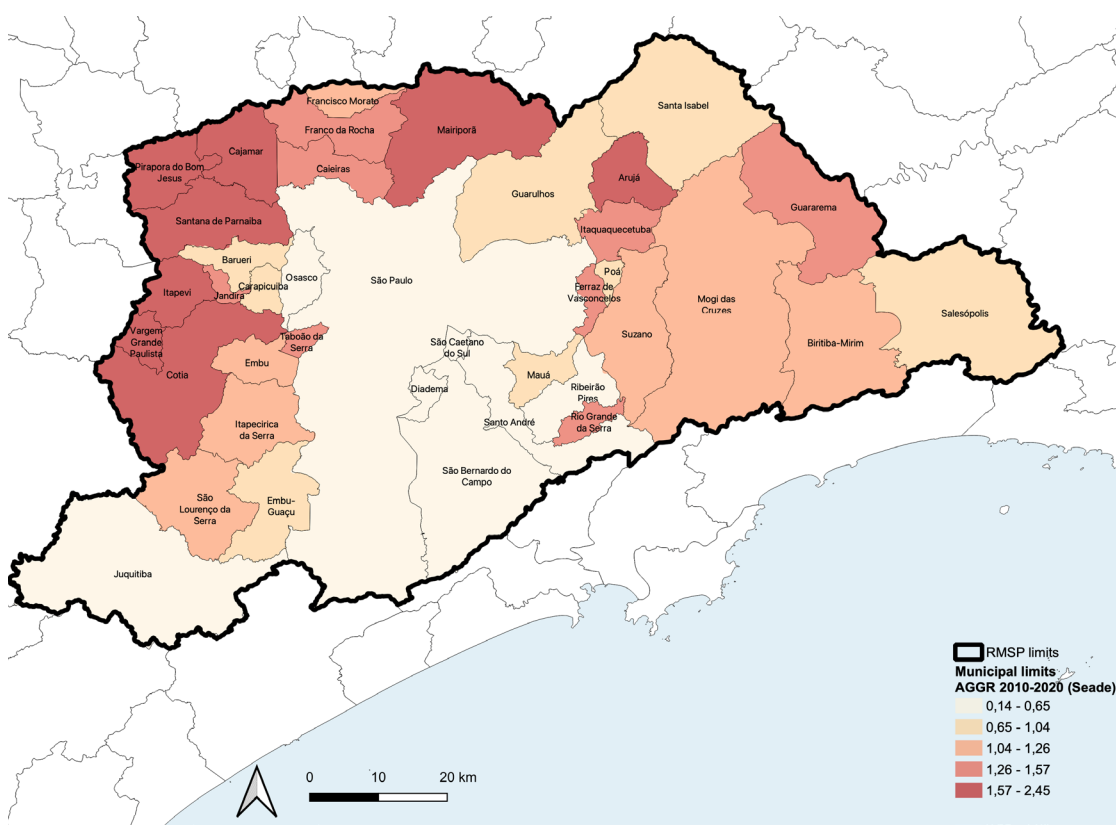


Figure 63 - Geometric Rate of Annual Growth of the Municipalities of RMSP - 2010-2020
Data source: SEADE Foundation (2021).

Despite this change in pattern, in general, the studies developed on the process of development and occupation of Brazilian metropolitan regions have a greater focus on large urban areas, their dynamics, uses and complexities. Few discussions are held on the fringe areas of the metropolises in an approach that considers the diversity and potentialities of these spaces.

Besides the academic debate, in the Brazilian case, there is a lack of regional planning and tools aimed at the fringes with a mixture of urban, rural, and environmental traits. This absence, as Travassos et al. (2021) have highlighted, results in an institutional gap that undermines the protection of ecosystem services. These areas are frequently considered as land reserves for urban expansion rather than an object of innovation for thinking about an urban planning and development model that renews and reinvents its occupied urban areas and utilises the remaining natural and protected areas with sustainable activities that combine social and economic development with environmental protection.

4.2.2 SÃO PAULO METROPOLITAN REGION INTEGRATED DEVELOPMENT PLAN (PDUI-RMSP)

Although it is the biggest metropolitan area in Brazil, RMSP has no specific agency or institution responsible for integrated planning and governance. At present, there is only a metropolitan council⁶⁴ in place. This gap exists due to the Brazilian interfederative model and insufficient attention given to metropolitan policy and structuring processes, which has resulted in a lack of prioritisation for implementation across different federative levels despite the institutionalisation (D’Almeida and Franco, 2018).

The Metropolis Statute determines that the development of an Integrated Urban Development Plan (PDUI) is mandatory for all metropolitan regions in the country. This plan must be approved by state law. In the original text, the governor who did not comply with this requirement within three years would be punished for administrative improbity. Furthermore, the same penalty would apply to the mayor who failed to adopt the necessary measures to ensure the compatibility of the municipal master plan with the PDUI within three years of its approval. However, in 2018, on the revision of the Metropolis Statute, article 21, which dealt with this issue, was revoked by Law no. 13,683/2018, weakening the process of elaboration and approval of PDUIs.

In the case of RMSP, the drafting process of the PDUI took place between 2015 and 2018, resulting in the preparation of a final document in 2019 that, although forwarded to the State Legislative Assembly, has not been approved at the time of writing this thesis, and therefore has no legal force.

D’Almeida and Franco (2018) indicate that the Public Functions of Common Interest (FPICs) guided the development process of the PDUI in RMSP. Although there is no clear definition of FPICs, it was determined at the time that they would address the main structural issues of the metropolitan region: Economic, Social and Territorial Development; Housing and Social Vulnerability; Environment, Sanitation and Water Resources; Mobility, Transportation and Logistics.

In this context, the authors state that discussions about an interfederal governance structure for implementing the plan emerged in this scenario to prevent the PDUI from becoming another merely bureaucratic plan, discursive and ineffective in promoting urban transformation. These discussions aimed at understanding PDUI as an essential part of an integrated and multi-scale planning system, as demonstrated in the following diagram (Figure 64).

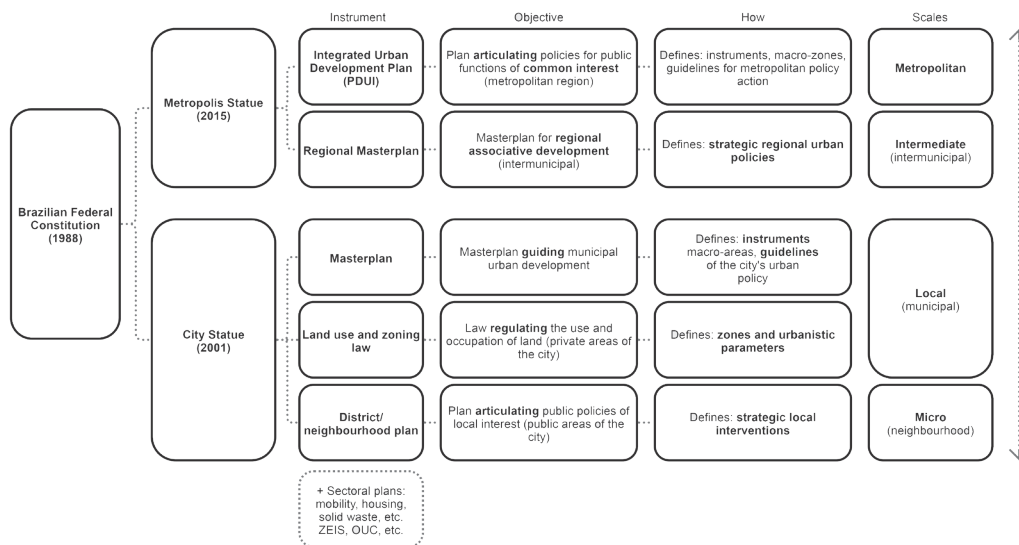


Figure 64 - Brazilian urban planning system Source: Adapted from Consórcio Intermunicipal Grande ABC, Prefeitura Municipal de São Paulo e Prefeitura Municipal de Guarulhos (2016)

64_ The Metropolitan Region Development Council of São Paulo (CDRMSP).

Although significant efforts were made, interviews and empirical analysis revealed that after the final document of the PDUI was completed, discussions about the metropolitan issue were halted, and the public planning company, EEMPLASA, was dissolved. Consequently, the result was a technical document lacking legal authority and operational capacity, falling short of the original proposal.

However, upon analysing the PDUI document regarding climate issues, it was noted that the plan addressed the topic in a broad sense. The plan mentioned incentives for adaptation in accordance with PNA, incorporating renewable energy into the metropolitan region’s energy matrix and considering climate studies and scenarios for risk management.

The “Environment, Sanitation, and Water Resources” section proposes the implementation of a Metropolitan Plan to address climate change. This plan would include several actions such as compiling an inventory of greenhouse gas emissions, implementing mitigation programs, educating the public about climate change, promoting energy efficiency and sustainable urban mobility, reducing socio-environmental vulnerability and risk management, conducting studies on the impacts of climate change on municipalities, and formulating climate protection policies for cities in watersheds.

Concerning the fringe areas, the PDUI recognises the importance of these areas for the sustainability of the metropolis on account of their natural remnants and protected areas, especially the springs of regional interest. The approach proposed in the plan’s guidelines and in the macro-zoning is based on principles similar to those of the Master Plans analysed in the reference cases, i.e., to avoid the expansion of the urban area towards protected areas and/or natural remnants, the densification of consolidated urban areas articulated with the creation of polycentralities that reduce displacement and balance the distribution of social facilities and labour supply (Figure 65).

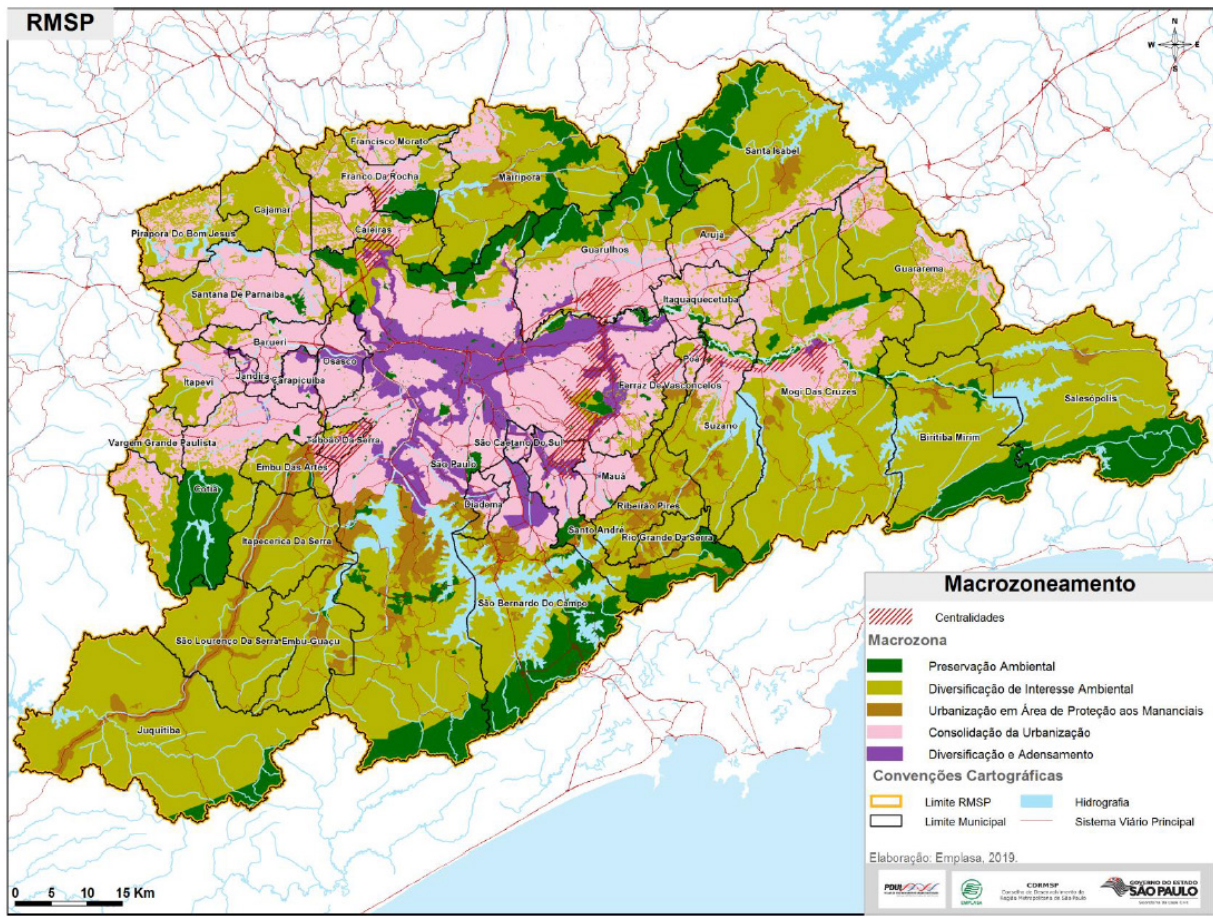


Figure 65 - PDUI Macro-zoning. Source: PDUI RMSP (2019, p. 47)

The Macro-zoning delineates most of these fringe areas as Macrozones of environmental interest diversification (Figure 65). The PDUI recommends promoting environmental recovery, low-density urbanisation, and sustainable use in these areas, as well as maintaining and increasing rural activities and using environmental compensation instruments, such as Payment for Environmental Services (PSA).

In the plan’s guidelines and macro-zoning, it is proposed to establish new centralities within the metropolitan territory’s urbanised zones and to densify these areas while containing urban sprawl.

Although the overall strategy is aligned with the reference cases, it is important to note that there are no clear strategic visions or projects for the fringes. As a result, only the environmental value of these areas is recognised without necessarily pointing out pathways for their development, nor what type of centralities should be encouraged, or how these relate to the physical characteristics and support of each subregion. This more detailed breakdown could be developed subsequently if the entire governance process envisaged at the beginning had been implemented.

4.3 FOCUS FRINGE AREA: THE JUQUERI-CANTAREIRA SUB-BASIN

4.3.1 CONTEXT

The empirical object of this thesis, the Juqueri-Cantareira sub-basin, is a hydric sub-region that composes the Upper Tietê Hydrographic Basin (UGRHI-6) and is inserted in the northern portion of the RMSP, involving part of the municipality of São Paulo, especially the districts Anhanguera, Jaraguá and Perus; and smaller municipalities: Caieiras, Cajamar, Franco da Rocha, Francisco Morato and Mairiporã (Figure 66).

This sub-basin is located in an area of reasonably rugged topography that is accompanied by important natural remnants on a metropolitan scale, such as Serra da Cantareira State Park, Itapetinga State Park, Itaberaba State Park, Juquery State Park, Jaraguá State Park, Cajamar Environmental Preservation Area, Cantareira Environmental Preservation Area, and Anhanguera Municipal Park, which are part of the São Paulo Green Belt Biosphere Reserve (IPT, 2008).

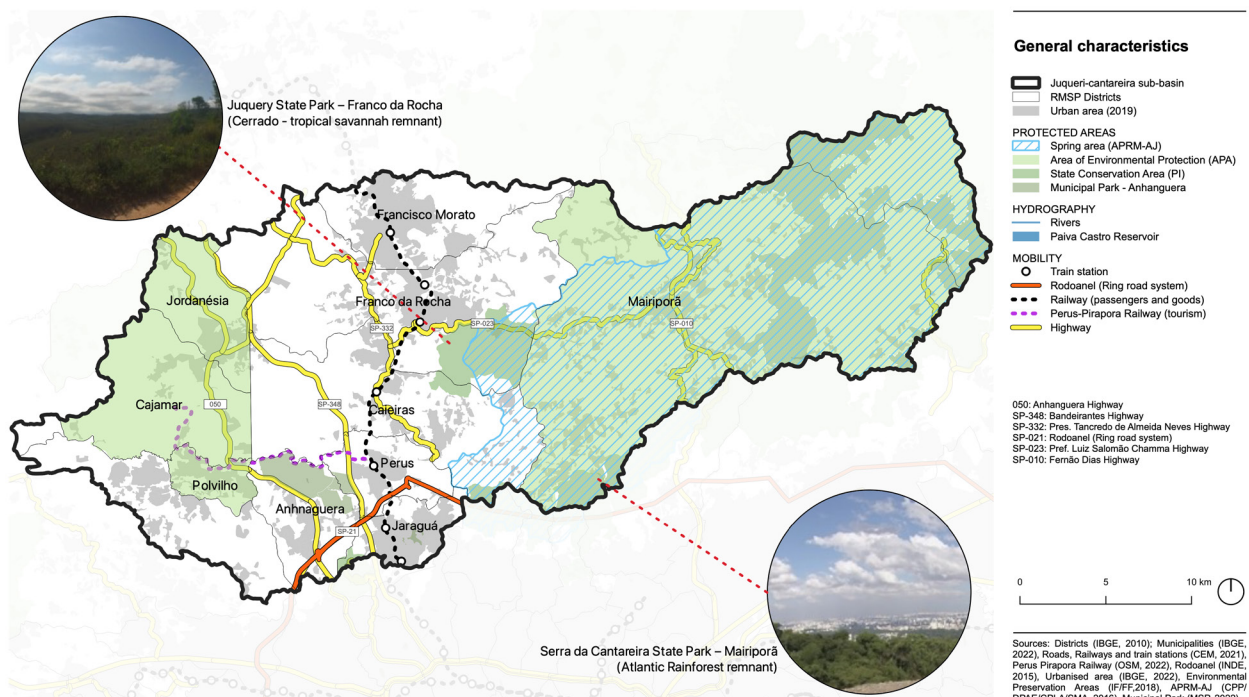


Figure 66 - Juqueri-Cantareira Sub-basin – general characteristics. Prepared by the author.

The rugged topography and railway system of the former São Paulo Railway Company, connecting the state's hinterland to the Port of Santos, gave rise to early urban settlements near the railway stops in the valley floors in the twentieth century. With the growth of urbanisation, newer areas have developed primarily on the slopes, especially the most vulnerable. The following maps illustrate the urban expansion process between 1990 and 2021 based on Mapbiomas data.

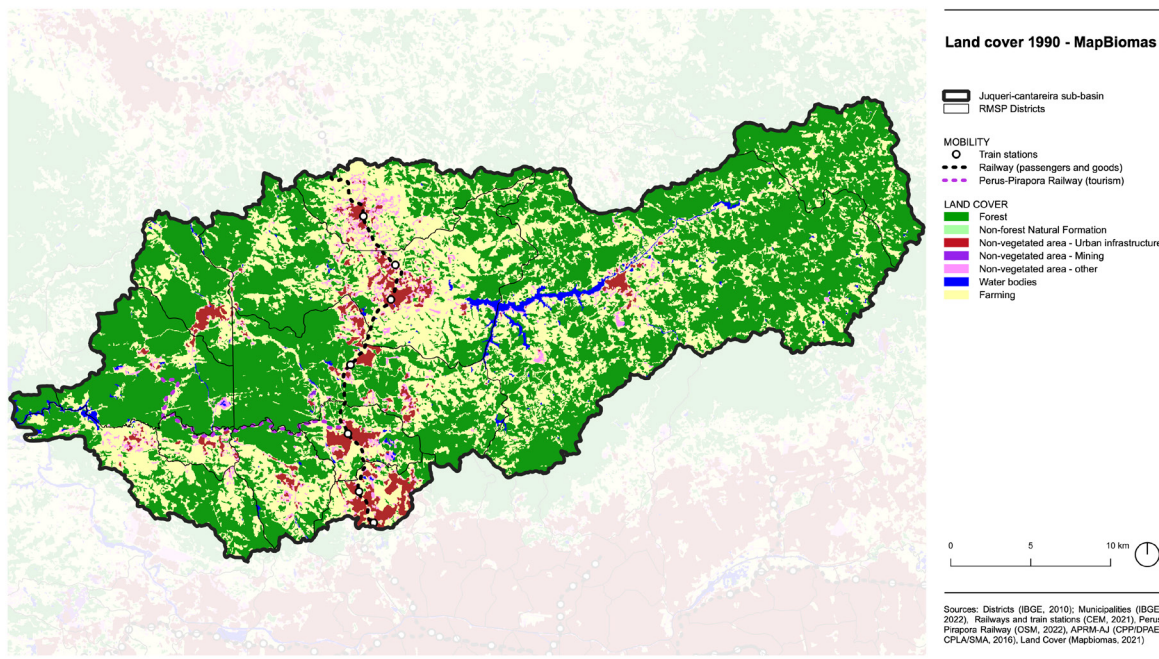


Figure 67 - Juqueri-Cantareira sub-basin Land cover in 1990. Prepared by the author.

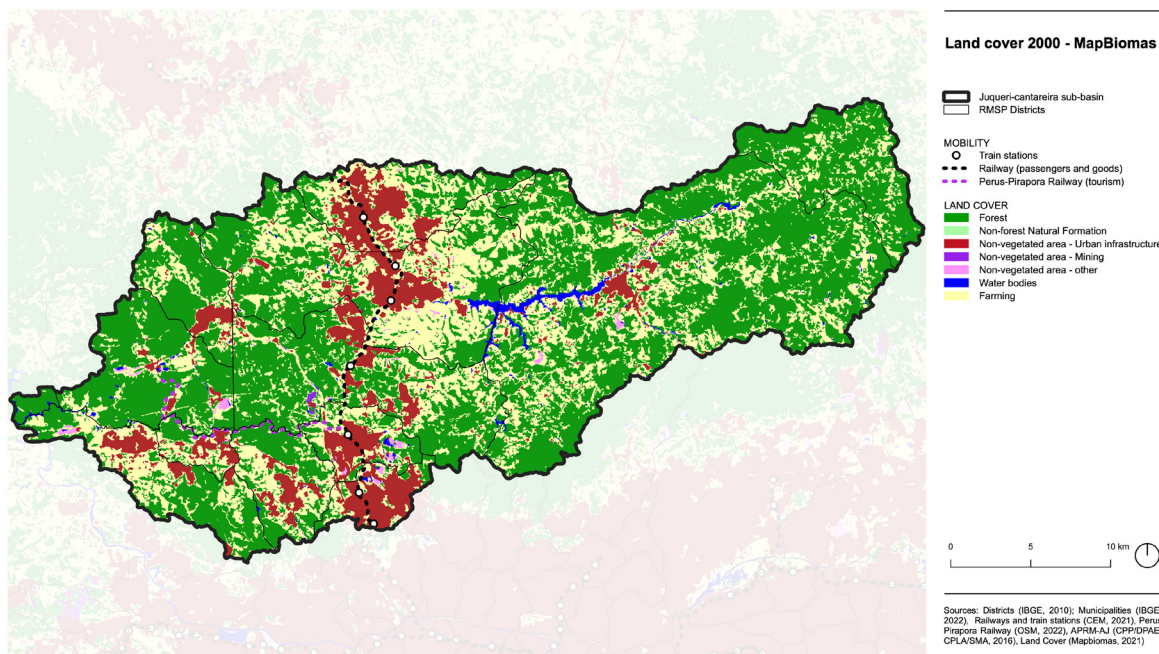


Figure 68 - Juqueri-Cantareira sub-basin Land cover in 2000. Prepared by the author.

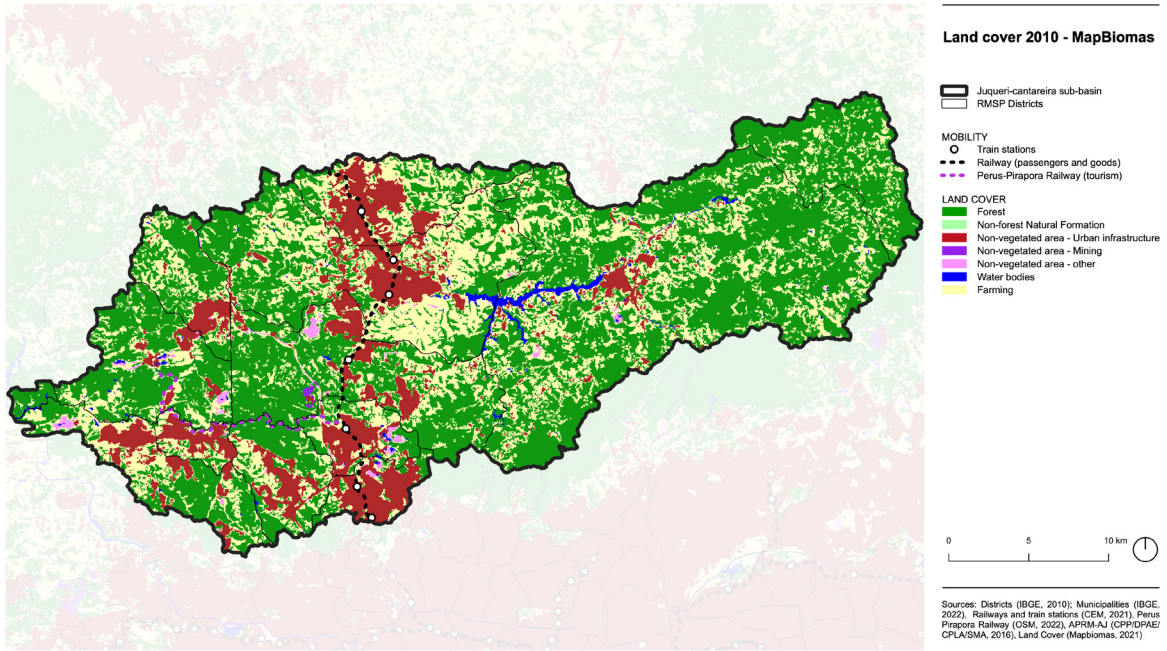


Figure 69 - Juqueri-Cantareira sub-basin Land cover in 2010. Prepared by the author.

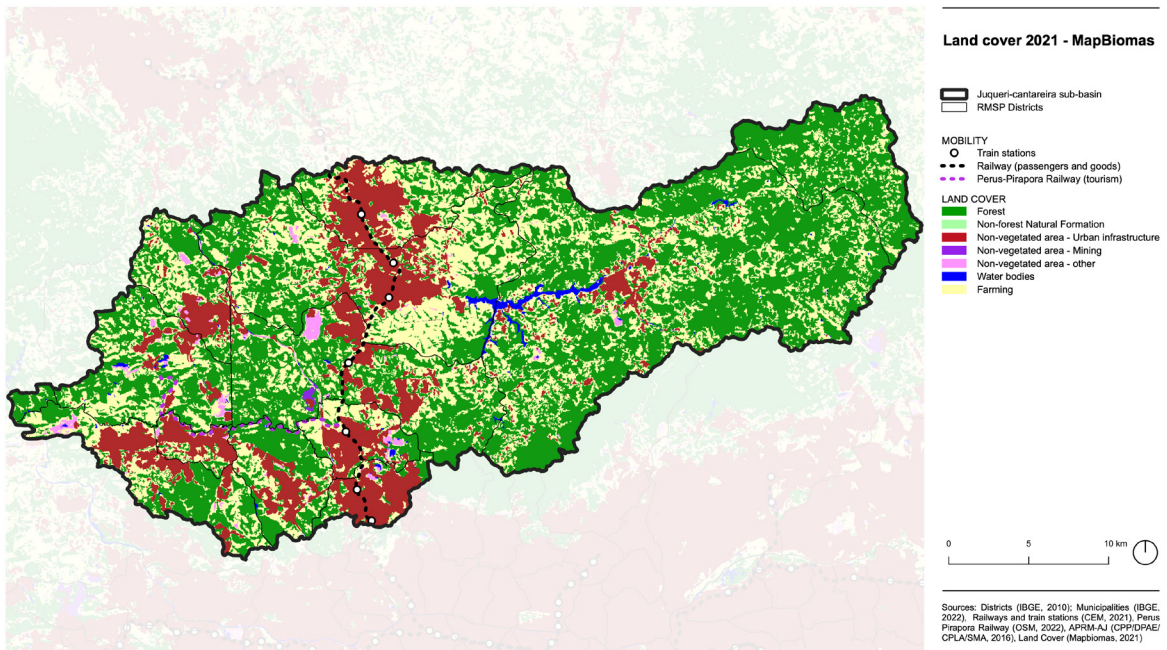


Figure 70 - Juqueri-Cantareira sub-basin Land cover in 2021. Prepared by the author.

Part of the buildings that were established in the early urban settlements hold considerable historical significance. The following map (Figure 71) illustrates the assets protected by the Council for the Defense of Historical, Archaeological, Artistic and Tourist Heritage (CONDEPHAAT). These assets, together with a group of buildings protected by IPHAN and by the Municipal Council for the Preservation of the Historical, Cultural and Environmental Heritage of the City of São Paulo (CONPRESP), make up a large collection that expresses a part of the history of the municipalities that make up the Juqueri-Cantareira sub-basin, as well as that of the State and the Metropolitan Region of São Paulo. Many of them are related to the railway or to the period of industrial development of the municipalities, such as the train stations, the Perus-Pirapora railway, the former Companhia Brasileira de Cimento Portland, the Companhia Melhoramentos and the Juquery Hospital Complex.

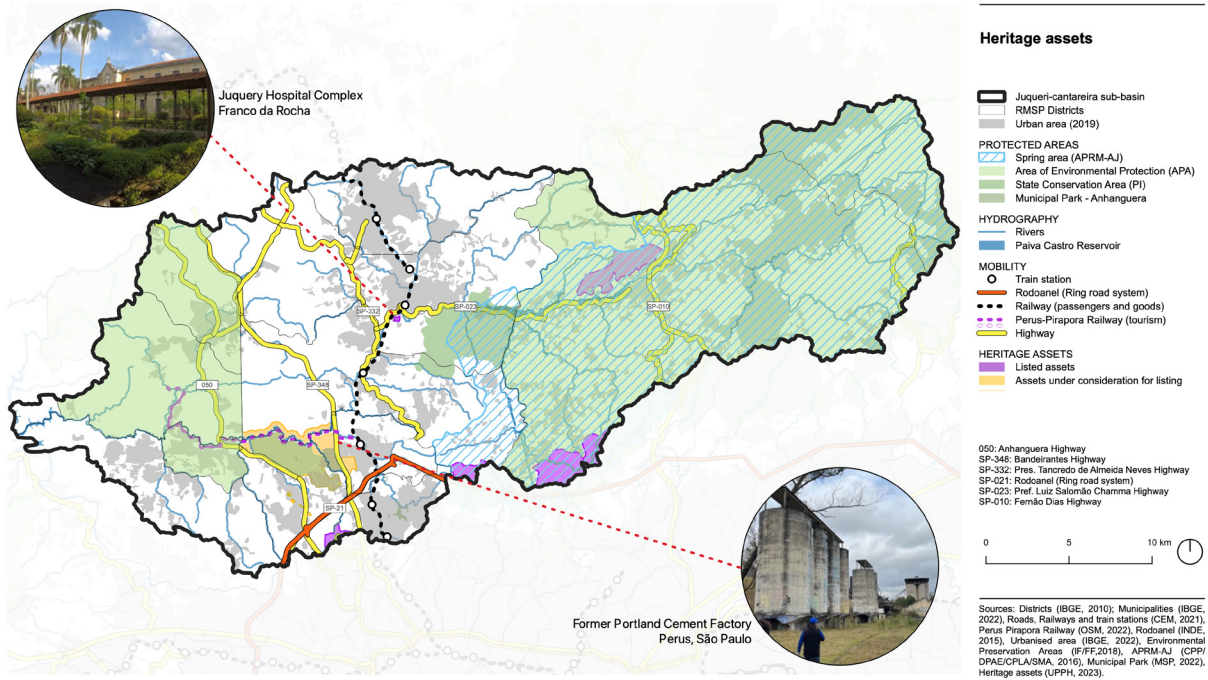


Figure 71 - Juqueri-Cantareira Sub-Basin: APRM-AJ, properties under protection by CONDEPHAAT and preservation areas. Prepared by the author.

The sub-basin is home to 1,001,743 inhabitants⁶⁵. Except Cajamar, which has 78,786 residents, most municipalities are medium-sized, with more than 100,000 residents. The districts of São Paulo stand out by having similar populations to the neighbouring cities. Jaraguá (SP) stands out with the largest population of the sub-basin, 214,796 inhabitants.

The gross density of the region is low due to the amount of unoccupied or sparsely populated areas. Most of the urban areas have densities that do not exceed 200 inhabitants per hectare. The densest areas are mainly located in the districts belonging to the municipality of São Paulo (Anhanguera, Perus and Jaraguá), and in the peripheries of the municipalities of Franco da Rocha, Francisco Morato and Caieiras (Figure 72).

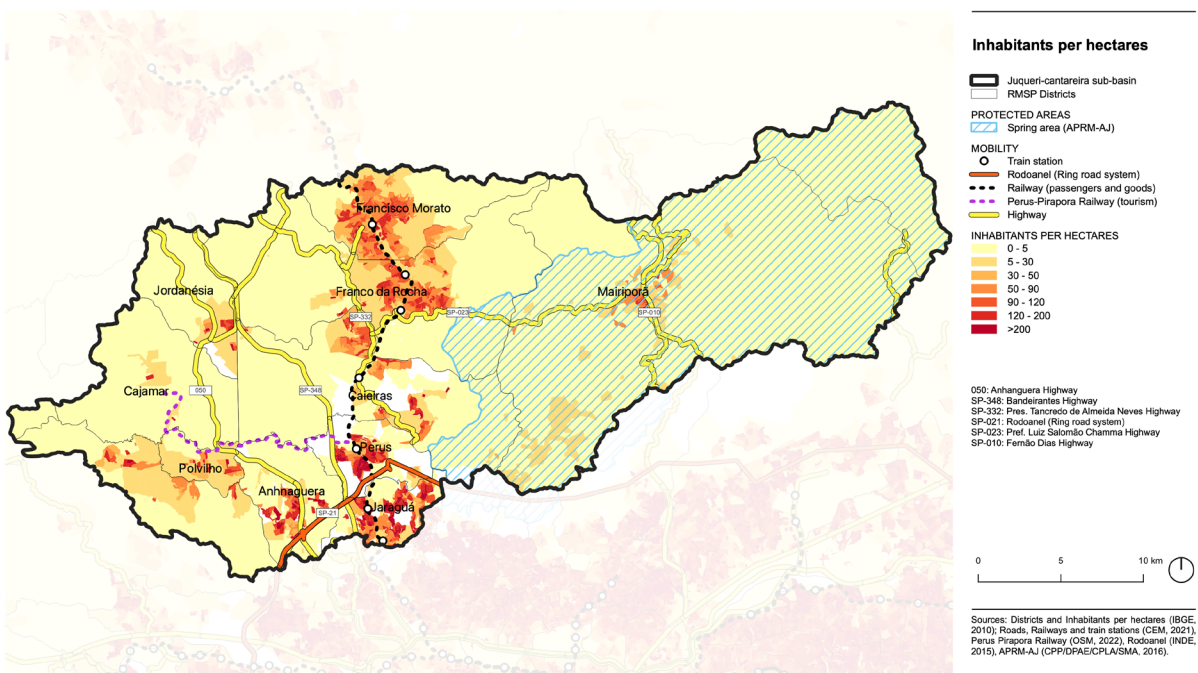


Figure 72 – Juqueri-Cantareira sub-basin – Density (Inhabitants per hectares). Prepared by the author.

65_ According to data from the Perfil dos Municípios Paulistas (2021), prepared by the Seade foundation. Available at: <https://perfil.seade.gov.br/#>. Accessed on: June 5, 23. The total sum of the population of the districts and municipalities that make up the sub-basin were considered.

In terms of settlement typologies, Figure 73, based on data from the World Urban Database and Access Portal Tools (WUDAPT) Project (Demuzere, Kittner and Bechtel, 2021), shows the predominance of open lowrise and compact lowrise Local Climate Zones (LCZ) in urbanised areas, given that verticalisation is a recent phenomenon in the region. In many areas, single-family residential use predominates.

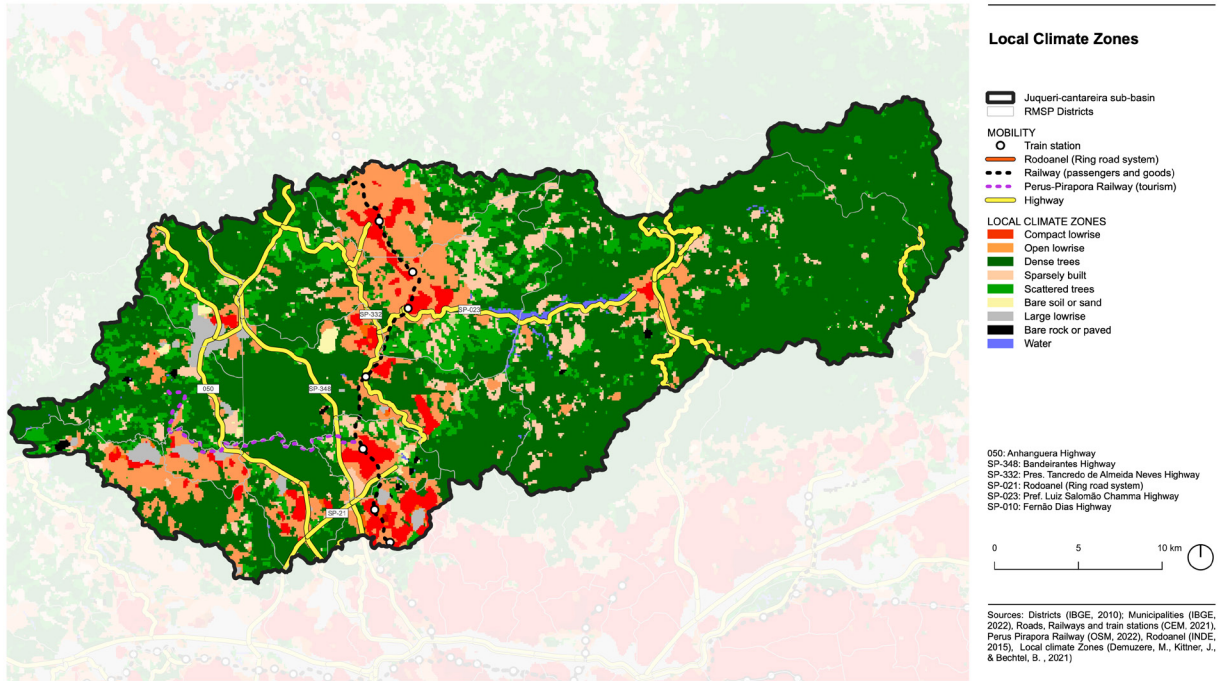


Figure 73 - Juqueri-Cantareira sub-basin - Local Climate Zones. Prepared by the author.



Figure 74 - Local Climate Zones - Built and land cover types. Source: Demuzere et al. (2021)

Regarding the Annual Geometric Growth Rates (AGGR), it is worth noting that the average population growth rate in the Juqueri-Cantareira sub-basin between 2000 and 2010 was 2.60% per year, while the average for the municipality of São Paulo in the same period was 0.76% per year and the metropolitan region 0.97% per year, indicating a population migration movement to the region. The municipalities of Mairiporã and Cajamar (especially Polvilho district) stand out with high rates, besides the districts of Jaraguá and Anhanguera, located in the extreme north of the municipality of São Paulo (Figure 75).

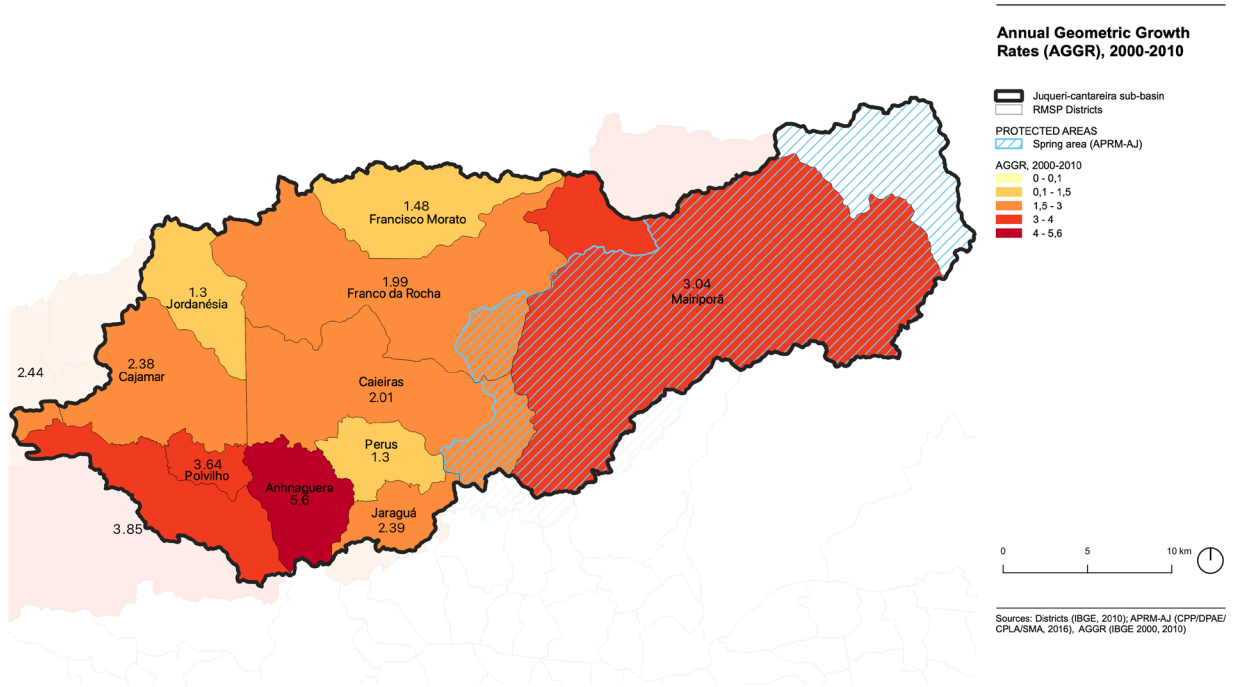


Figure 75 – Juqueri-Cantareira sub-basin - Annual Geometric Growth Rates (AGGR), 2000-2010. Prepared by the author.

In general, the region’s municipalities have an economy linked to the service sector and present a growing number of areas destined for industry and logistics located along the road axes that connect São Paulo to the Jundiaí and Campinas (Anhanguera and Bandeirantes highways). Due to the rugged configuration and the presence of forests and natural reserves, urban occupation is rarefied and located along the main transport axes - railways and highways (Alvim, Marques and Alves, 2018). Notably, virtually all districts of the Juqueri-Cantareira sub-basin have a rural population, especially Mairiporã, where the Paiva Castro reservoir is located, with the largest rural population in this region.

MUNICIPALITY	SÃO PAULO	CAIEIRAS	FRANCO DA ROCHA	FRANCISCO MORATO	MAIRIPORÃ	CAJAMAR
Area	São Paulo: 1,521.11 km ² Perus: 25,5 km ² Anhanguera: 33,42 km ² Jaraguá: 28,59 km ²	97.64 Km ²	132,775 Km ² .	49 Km ²	320,70 Km ²	131,39 Km ² .
Population	São Paulo: 11,914,851 Perus subprefecture: 90,110 (Perus), 86,020 (Anhanguera) and 214,796 (Jaraguá)	101,748 inhabitants (*)	153,903 inhabitants (*)	176,346 inhabitants (*)	100,034 inhabitants (*)	78,786 inhabitants (*)
Geometric Annual Growth Rate of Population - 2010-2021	São Paulo: 0,53% by year Perus: 1,08% by year Anhanguera: 2,50% by year Jaraguá: 1,39% by year	1,50% by year	1,45% by year	1,22% by year	1,97% by year	1,91% by year
Level of Urbanisation	São Paulo: 99,10%.	98,31%	92,13%	99,80%	92,54%	98,86%
Demographic density	São Paulo: 7833,00 inhabitants/km ²	1042,07 inhabitants/km ²	1159,08 inhabitants/km ²	3598,90 inhabitants/km ²	311,92 inhabitants/km ²	599,63 inhabitants/km ²
Population under 15 years old	São Paulo: 18,93% Perus: 22,48% Anhanguera: 20,25% Jaraguá: 20,99%.	19,52%	20,75%	22,70%	18,52%	21,96%
Population aged 60 and over	São Paulo: 16,04% Perus: 11,02% Anhanguera: 9,12% Jaraguá: 11,91%.	12,50%	11,54%	11,10%	13,81%	10,30%
Waste Collection - Level of Service - Demographic Census 2010	São Paulo: 99,81%.	99,87%	98,75%	97,94%	96,71%	99,17%
Water Supply - Level of Service - Demographic Census 2010	São Paulo: 99,32%.	97,40%	96,92%	95,96%	75,00%	92,58%
Sewage - Level of Service - Demographic Census 2010	São Paulo: 92,26%.	86,50%	69,17%	50,01%	38,12%	71,71%
Main economic activities:	São Paulo: Services (90.11%), and industrial activities (9.88%) (**)	Services (60.35%), and industrial activities (39.59%) (**)	Services (68.91%), and industrial activities (30.98%) (**)	Services (92.29%), and industrial activities (7.68%) (**)	Services (78.33%), and industrial activities (21.62%) (**)	Services (83.88%), and industrial activities (16.11%) (**)
Municipal GDP	São Paulo: R\$714,683,362.46 (**)	R\$3,556,312.29 (**)	R\$2,995,316.15 (**)	R\$ 1,517,245.40 (**)	R\$ 1,748,553.22 (**)	R\$16,970,110.95 (**)
Per capita GDP	São Paulo: R\$60,805.18 (**)	R\$ 36,376.87 (**)	R\$ 20,221.41 (**)	R\$ 8,915.06 (**)	R\$18,382.22 (**)	R\$226,539.99 (**)
Master Plan	Strategic Master Plan - PDE (Law 16.050/14) and Zoning (Law 16.402/2016) Sub-municipality Strategic Regional Plan - Perus (2004)	Supplementary Law No. 4538/2012 and Zoning Amendment in 2020	Complementary Law No. 244/2015 (Amendment of the Participatory Master Plan - Law No. 618/2007)		Supplementary Law No. 438 of 24 September 2021 (modifications in the Supplementary Law No. 455/2022)	Supplementary Act Number 179 of 2019
Climate adaptation plan	Climate Action Plan of the Municipality of São Paulo 2020-2050 (2021)	-	-	Francisco Morato's Plan of adaptation and resilience to climate change (2022)	-	-

Table 25 - General data and characteristics of the municipalities and districts of the Juqueri-Cantareira sub-basin Sources: Fundação Seade - Perfil dos Municípios Paulistas, 2021(*) ; IBGE data from 2018, apud in Seade, Perfil dos Municípios Paulistas, 2021 (**).

Most families in the sub-basin territory have an average monthly income between “less than one minimum wage” and “two minimum wages”. Figure 76 shows the social inequalities present in the region. Only in a small portion of the territory is the average monthly income above 10 minimum wages. These areas correspond to high-standard gated communities in Santana de Parnaíba (near Alphaville); Caieiras; and Mairiporã. The homogeneity concerning income in the municipalities of Franco da Rocha and Francisco Morato calls attention: they present a meager monthly income in all their territory, reflecting this area’s social vulnerability.

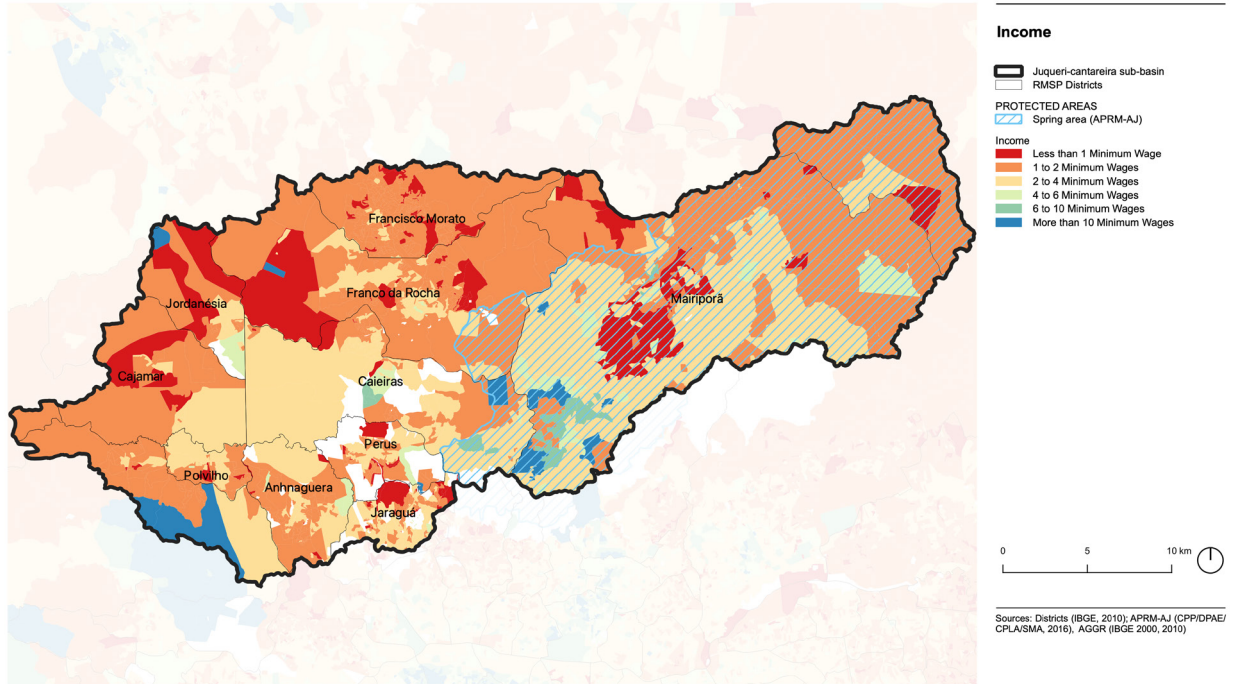


Figure 76 – Juqueri-Cantareira Sub-basin - Average monthly nominal income of people responsible for household, 2010. Prepared by the author. Note: Minimum wage of the State of São Paulo in 2010 was 510BRL

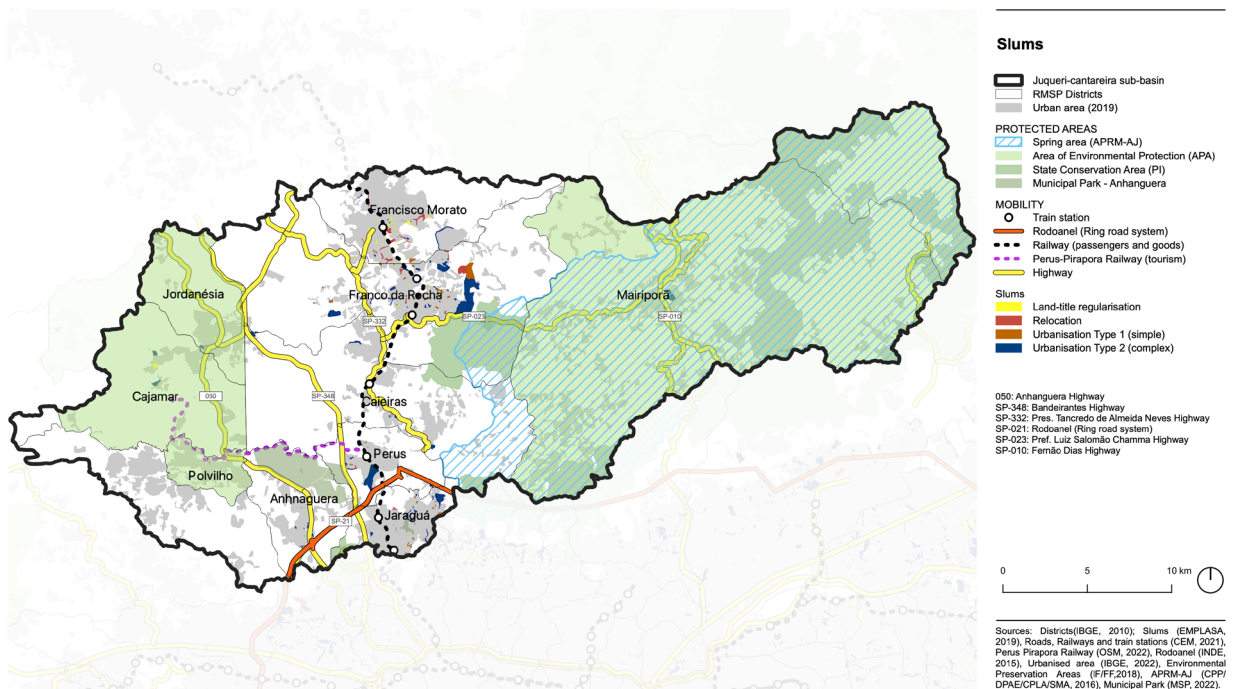


Figure 77 – Juqueri-Cantareira sub-basin - Slums. Prepared by the author.

The Slums have been increasing in the region, especially in the municipalities of Franco da Rocha and Francisco Morato and in the districts of Perus, Anhanguera and Jaraguá (Figure 77). In Francisco Morato, slums that are assigned as object of relocation predominate, followed by those that can be regularised, while in Franco da Rocha and districts of São Paulo, those that can be urbanised, at different levels of complexity, predominate⁶⁶.

Georeferenced data from the São Paulo Social Vulnerability Index (IPVS) specialised in Figure 78, shows the social vulnerability of the municipalities and districts that comprise the region. The areas of vulnerability degrees 6 and 7, that is, areas with high vulnerability, correspond to the peripheries of Mairiporã, Franco da Rocha and Francisco Morato. The regions corresponding to degree 1, with very low vulnerability, are the same ones that coincide with high-standard gated communities and present a high monthly income.

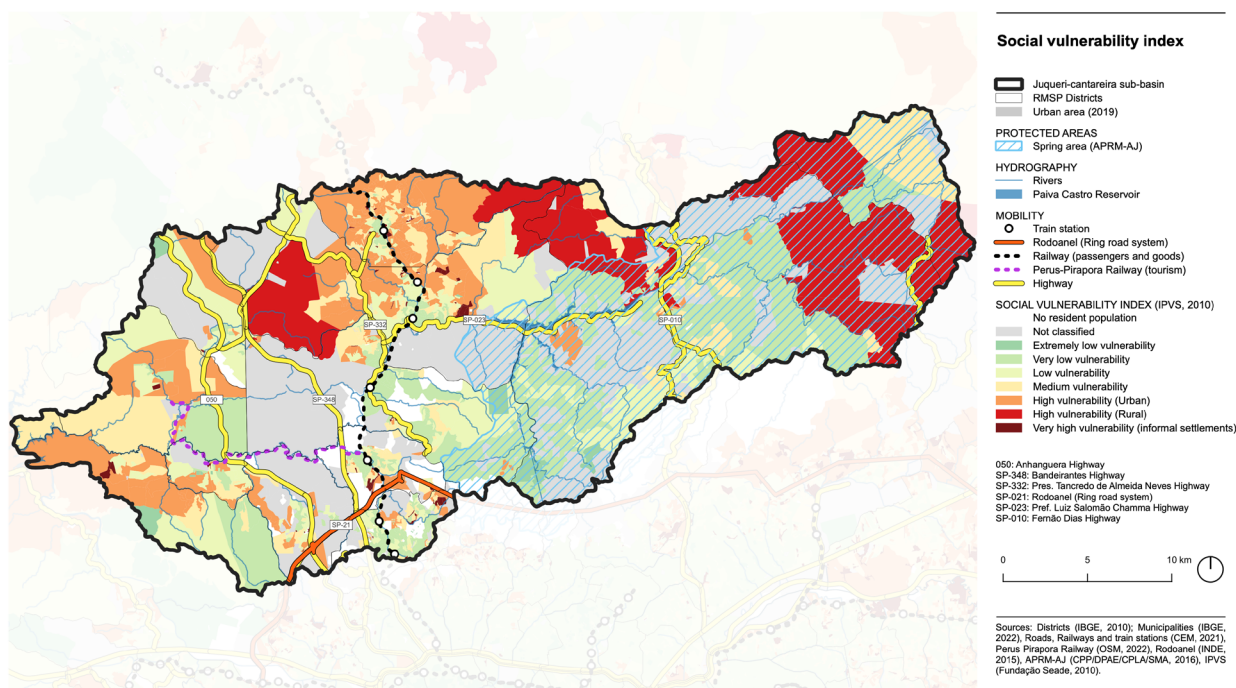


Figure 78 - Juqueri Sub-basin - Paulista Social Vulnerability Index, 2010. Prepared by the author.

The districts in the municipality of São Paulo present a medium-high degree of vulnerability, with some foci of high vulnerability. Notably, degree 7 (high vulnerability) corresponds only to rural areas. According to the IPVS methodology, the entire municipality of São Paulo is considered urban, including the mentioned districts. Generally, since most of their territory is subject to medium and high levels of vulnerability, Francisco Morato, Franco da Rocha and Cajamar represent the most vulnerable municipalities in the subbasin.

Regarding the regional planning instruments that influence the area, the focus of the analysis was placed on the PDUI. While it lacks legal enforcement, as explained in the previous session, it stands as the sole urban metropolitan plan currently in existence. Other sectorial plans, such as those pertaining to drainage, basin management, and transportation, were not incorporated into the analysis. However, it is important to note significant initiatives outlined in these sectorial plans, including noteworthy projects like Rodoanel Norte, Ferroanel, and the associated logistics platforms.

66_ The data used was provided by EMPLASA and used a methodology developed by the State Housing Secretariat and the Housing and Urban Development Company (CDHU) in partnership with the municipalities and indicates different types of slums. For more information, see technical note at: <https://www.cdhu.sp.gov.br/documents/20143/37003/4-Nota-Tecnica-Mapeamento.pdf/8cd7cd38-7892-27f5-098b-398adc0e279f>

At the intermediate scale, there is no regional plan prepared by the Juquery Basin Intermunicipal Consortium (CIMBAJU), the existing regional plan is the PDPA which comprises the Protection and Recovery Area of Alto Juquery Springs (APRM-AJ) partially covering the territory of Mairiporã (80%), Caieiras (20%) and Franco da Rocha (5%). Finally, all municipalities in the region have approved municipal Master Plans, however, only São Paulo and Francisco Morato have a Climate Change Adaptation Plan.

It is important to highlight that the emission profile of the region’s municipalities. São Paulo, due to its scale and concentration of activities, is the municipality with the highest volume of emissions, 13 times higher than the second highest emitting municipality, Cajamar. Caieiras has negative emissions in the waste sector due to the thermoelectric plant powered by landfill biogas located in the municipality (Figure 79).

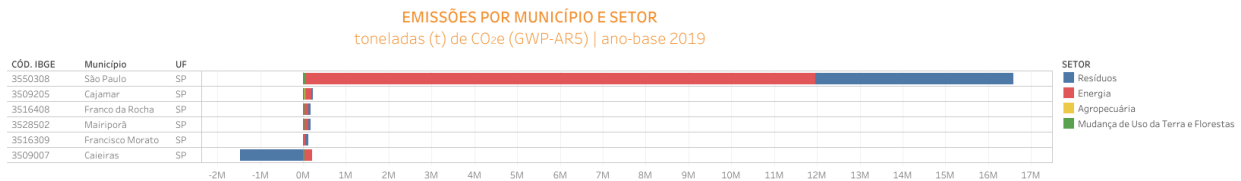


Figure 79 - Emissions by municipality and sector. Data source: SEEG, 2021. Available at: <https://plataforma.seeg.eco.br/cities/statistics>. Accessed on: August 31, 2023.

In percentage terms, all municipalities have a large part of their emissions coming from the Energy sector⁶⁷ and Solid Waste. Mairiporã, Cajamar, Caieiras and Franco da Rocha have a considerable portion of emissions from changes in land use, due to the territorial dynamics and urban expansion that will be explored further on (Figure 80).

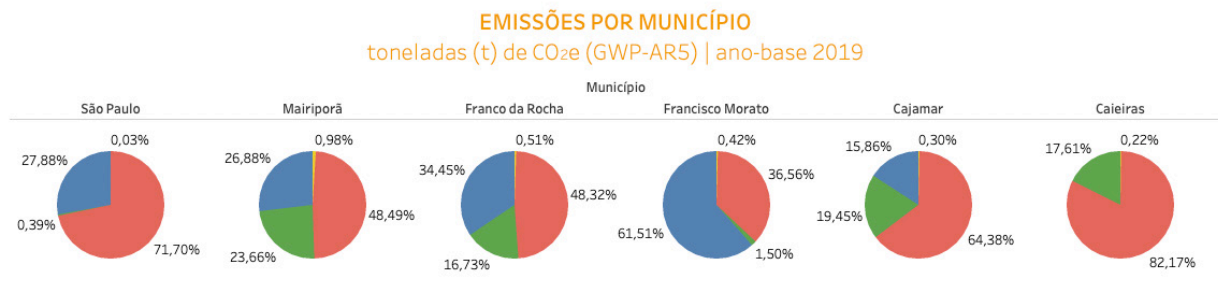


Figure 80 - Percentage of emissions by municipality and sector. Data source: SEEG, 2021. Available at: <https://plataforma.seeg.eco.br/cities/statistics>. Accessed on: August 31, 2023.

The synthesis of some data, despite not exhausting the complexity of its challenges and trends, allows pointing out the central issues that should be addressed in an articulated manner by the set of territorial planning instruments proposed, having as perspective the resilience and transformation of the territory. The next session sought to present the results of the analysis of the plans articulated in the semi-structured interviews organised in three topics: (1) Urban dynamics, (2) Water and ecosystem services and, (3) Risks and vulnerabilities.

4.3.2 RESULTS AND DISCUSSION ON URBAN DYNAMICS

Regarding urban dynamics, and in light of the discussion presented in previous chapters on the necessity of transforming urban planning towards a more resilient and regenerative

67_ Emissions resulting from the combustion of fossil fuels, such as those used in transportation and industrial processes.

model, the scientific literature and reference cases have identified various strategies. Among these strategies is creating multi-polar regions that aim to reduce long distances and car dependency, providing new urban dynamics in fringes.

As addressed in the referential cases, these multipolar regions should be guided by sustainability, resilience, and ecological and equitable transition principles. Thus, the aim is to avoid the expansion of urban space, promote the reorganisation and renovation of the already built areas, and introduce concepts of proximity, such as the idea of the 15-minute city, urban densification, sustainable transport, and active mobility, in detriment of the individual motorised vehicle.

Table 26 summarises the documentary analysis of the plans, focusing on the issue of incentivised urban dynamics. It is important to highlight that currently, in the region, only the cities of São Paulo and Francisco Morato have a Climate Change Adaptation Plan in force. Besides, concerning Master Plans, the issue of climate change is only explicitly addressed in São Paulo's Master Plan and in PDUI RMSP.

	SUMMARY OF DOCUMENTAL ANALYSIS
São Paulo Metropolitan Region	The PDUI stimulates new urban dynamics by envisaging the creation of a multipolar metropolis, creating new centralities and compacting consolidated urban areas, reducing home-work distances. It proposes prioritising multimodal public transport, encouraging the integration of individual and public transport and stimulating active modes (walking and cycling), as well as fare integration. It mentions the climate issue of increasing the share of renewable sources in the metropolis' energy matrix. It mentions strengthening the innovation environment as a factor in economic development and encouraging the green economy.
São Paulo	Both the PDE and PlanClima establish guidelines aimed at compactness, proximity, and a multipolar city, connected by different modes of sustainable transport. PlanClima goes further by proposing more specific targets and the <i>Zero Emission Zone</i> on the perimeter of the first Ring Road (Minianel Viário). In terms of economic dynamism, PlanClima focuses more on attracting companies and generating sustainable jobs and a green economy. The PDE focuses on the sustainable economy in agriculture and eco-tourism in peri-urban areas. In Perus, at the subprefecture level, the focus of attracting economic activities is on tourism, requalification of the territory and attracting industrial warehouses to the Anhanguera Road axis. There are conflicts between economic development and environmental issues on a local scale, despite the various instruments.
Caieiras	The master plan lacks incentives for creating a polycentric city, densification, diversity of uses, and compactness in the central area. Instead of mixed-use zones, there are commercial corridors along the main avenues and predominantly residential areas in the centre and on the outskirts. Most high-density residential areas are on the outskirts, while the central area is mostly geared towards medium- and low-density residential use. Although the urban sprawl is said to be contained, the western vector is an object of urban expansion in zoning. The urban mobility guidelines tend to duplicate or build new roads and encourage motorised transport, despite a vision of public transport development. Economic development focuses on attracting industries, with mention of green entrepreneurship and tourism.
Franco da Rocha	The plan proposes mixed-use and urban void utilization in the central area. Public facilities and green spaces are encouraged to have a better distribution. However, zoning leads to industrial sprawl in the northwest, which is based on a system of motorised and individual mobility. This is related to income generation and socio-economic dimension. The eastern vector towards the water source area is intended for urban containment and low density. There are family farming areas. To broaden the municipal self-sufficiency base, the plan focuses on attracting industries, and technology firms, and expanding vocational education through technical schools, colleges, and universities.
Francisco Morato	The Master Plan of Francisco Morato adopts the UN 2030 Agenda for Sustainable Development but lacks specific guidelines for sustainable mobility and urban requalification. Most of the municipality's territory is already occupied and infrastructure improvements are mentioned in a generic way. The western part is for industrial activities and the eastern part is for environmental protection, rural activities, and low-density farms. The city's climate change plan focuses on risks, with little mention of promoting new urban dynamics, only decent housing and reducing polluting vehicles through awareness campaigns and mobility plans.
Mairiporã	The Master Plan aims to create new urban dynamics by consolidating existing and new centralities, encouraging mixed uses, active facades, and wider sidewalks, stimulating small centralities, reducing commuting, and avoiding urban sprawl. The Plan also proposes a System of Protected Areas, Open Spaces, and Green Areas, prioritizing active modes of transport and collective public transport, and focusing on the development of ecological tourism for sustainable economic activities.
Cajamar	The Master Plan aims to consolidate municipal centrality, create new centralities and public spaces, and encourage urban redevelopment and population densification in areas with existing infrastructure. Compatible diversification of uses is also prioritised to reduce commuting and balance employment distribution. Urban mobility, cycle lanes and pedestrian safety are mentioned, but individual motorised transport is still encouraged by the focus on expanding the road system. The Anhanguera Road is for industrial and logistical use, while rural activities and tourism (adventure, eco-tourism, rural and industrial tourism) are promoted for socio-economic development.

Table 26 - Summary of documental analysis on urban dynamic. Source: prepared by the author.

The analysis identified a series of contradictions in the metropolitan and urban planning documents, the municipal Master Plans' guidelines, and their spatialisation in the zoning. For example, in all Master Plans of the region, there is the discourse of containment of urban sprawl and the search for a balanced distribution of equipment in the territory to promote multipolarity and valorisation of public and active transport to the detriment of individual motorised vehicles. However, contradictions are observed between the discourse of the plans and the (non) spatialisation of this discourse in the Land use and occupation laws (zoning).

As Figure 80 indicates, the zoning system promotes urban expansion, encourages dependence on cars, and attracts industrial activities. This reinforces the concept of a fragmented city that is constantly expanding to accommodate economic activities, the circulation of goods, consumption, and accumulation.

The region's western vector stands out in this regard. On the map with MapBiomass data (Figure 81), one notices a series of natural remnants in this portion of the territory that also comprise the Cajamar Environmental Preservation Area (APA Cajamar⁶⁸). On the other hand, in the zoning mosaic these areas are destined for urban expansion. Following Cajamar's economic development model, focused on logistics and industrial activities along highways, Caieiras and Franco da Rocha allocate large areas along the Bandeirantes highway to industrial activities. Indeed, spatial analysis shows that a number of logistics and industrial warehouses have been built in the region.

In the case of Caieiras, part of this large area in the western sector, which comprised the former Melhoramentos Papéis Industry, is destined for medium and high-density residential urbanisation. It is important to highlight that part of these areas are considered unsuitable for urbanization due to their high slopes, as pointed out in the Metropolitan Chamber's document on urban environmental risk management of PDUI RMSP⁶⁹ presented to support the Macro-zoning development.

In the specific context of the municipality of São Paulo, a relatively more appropriate approach to this issue is observed since the industrial axis is located along the Anhanguera highway and the PIU (Urban Intervention Project) of the New São Paulo Warehouse (NESP), along the Bandeirantes highway.

Unlike Franco da Rocha and Caieiras, these industrial axes do not occupy the territory in a sprawling manner. Still, they are organised in the form of corridors and combined with environmental preservation areas.

Nevertheless, the general municipal strategy is quite different from that proposed in the PDUI. The PDUI (Figure 65) proposes protecting and recovering areas with natural remnants and protected areas and the densification of consolidated urban areas in a strategy more aligned with the one established by the referential cases. Still, as discussed in the previous section, there are no clear criteria on how these new centralities would be articulated to the existing physical support and infrastructures.

Beyond the Macro-zoning, when analysing the PDUI guidelines for the northern region, it is evident that the main focus is on transport and mobility. The guidelines propose mo-

68_ The Cajamar Environmental Preservation Area (APA Cajamar) was established by State Law No. 4,055/1984. This APA is a Sustainable Use Conservation Unit; it contains an area of approximately 13,400 hectares and shelters remnants of the Atlantic Forest. According to the Secretary for the Environment of the Government of the State of São Paulo, it protects areas of the Serra do Japi and the Serra dos Cristais, as well as watersheds. State Law 4.055/1984, which declares the creation of this area, prohibits the installation of potentially polluting activities in the region. However, the amount of industries, mining areas and logistics centres inserted in this APA is a factor that calls attention, besides the urban stain, which has spread in the municipal territory. Such aspects of urban occupation go against the principles established in this conservation unit.

69_ Available at: https://rmsp.pdui.sp.gov.br/wp-content/uploads/rmsp_biblioteca_001_apresentacoes.pdf. Accessed on 07 June 23.

dernisation and restructuring of existing roads, the creation of inter-municipal cycle paths connecting the region’s municipalities, and the implementation of a Light Rail Vehicle (LRV) for urban and tourist transport purposes. Additionally, the proposal includes setting up the North/North-West Dry Port, aimed at strengthening the infrastructural and logistical role in the region.

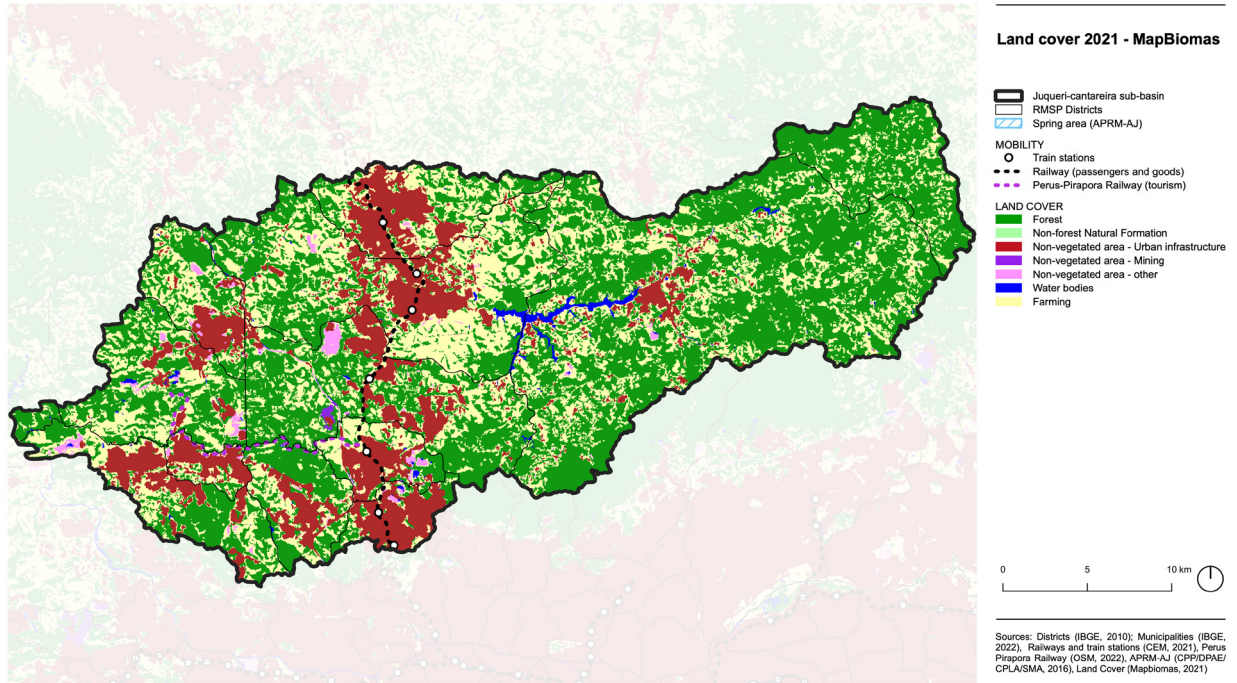


Figure 81 - Juqueri-Cantareira sub-basin Land cover in 2021. Prepared by the author.

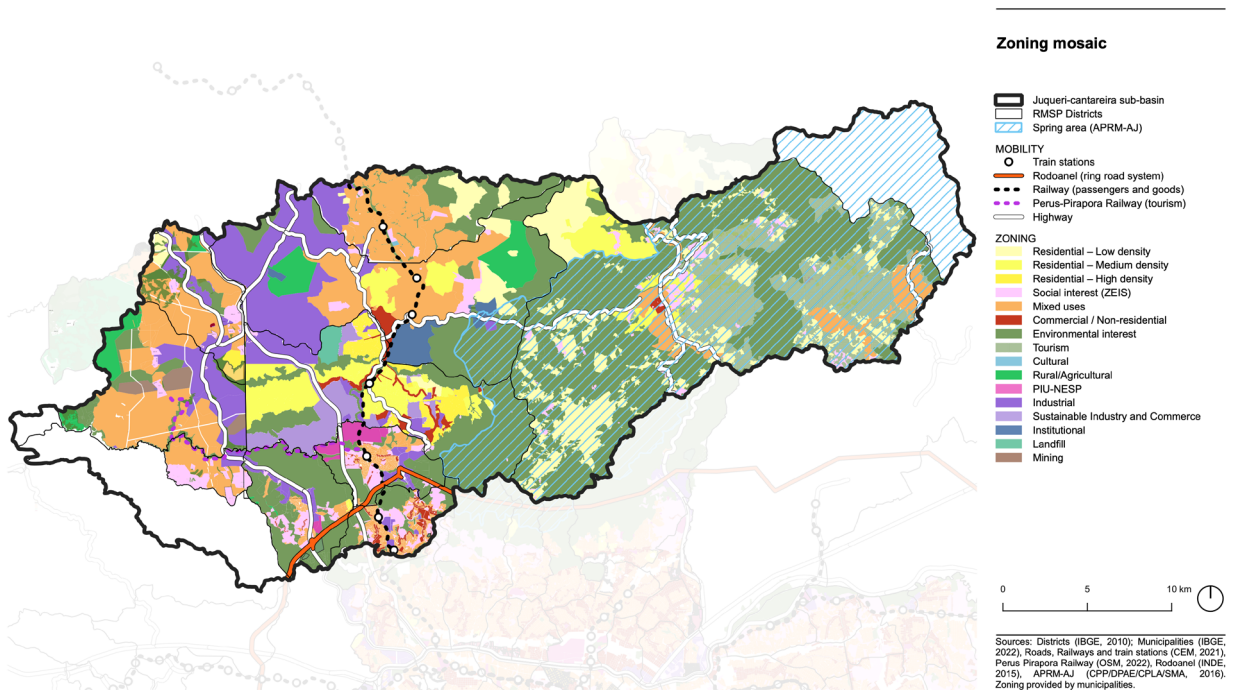


Figure 82 - Juqueri-Cantareira sub-basin municipal zoning mosaic. Prepared by the author.

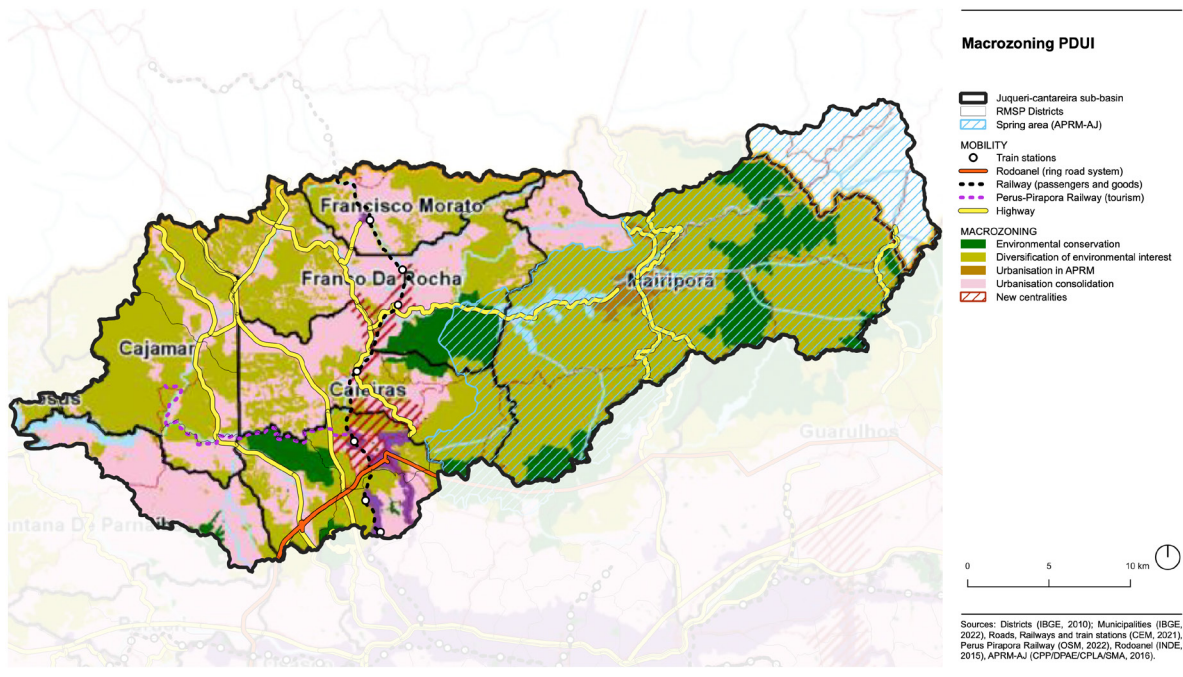


Figure 83 - Juqueri-Cantareira sub-basin PDUI Macro-zoning. Prepared by the author.

Besides some advances, this result demonstrates that the city planning of the region is far from the compact city concept that integrates environmental concerns and is much closer to the paradigm of a sprawling and fragmented city. São Paulo and Mairiporã were the municipalities that presented the best results in the analysis of urban dynamics. Among the strategies employed are the creation of new centralities, densification, and the introduction of proximity principles.

Still, it is necessary to reflect on how this densification has been or will be done and how it articulates with the local physical support and infrastructure or its need for renovation. For example, in the municipality of São Paulo, there is an ongoing debate about the implementation of the master plan as the verticalisation of the city progresses without the necessary urban renewal actions in the surrounding areas in terms of greening, walkability, public transport and density.

In this sense, taking the case of São Paulo as an example, Anelli (2020) stresses the significance of the Urban Transformation Structuring Axes (EETU) as a crucial element of the PDE which contributes to decrease the need for daily commuting between home and work, limits the horizontal expansion of the urban area, and prioritizes high and medium-capacity public transport. However, the author highlights certain limitations, for instance, managing river basins and coordination between municipal bodies, especially in combating flooding, are major challenges. The lack of collaboration between organizations such as the Municipal Secretariat for Urban Infrastructure and Works (SIURB) and the Municipal Secretariat for Urban Development (SMDU) reduces the effectiveness of drainage and flood prevention strategies. Moreover, the mismatch between macro-drainage plans and local reality affects the proper application of PDE guidelines in district plans (*Planos Regionais*), compromising the adaptation of measures to the specific conditions of watersheds and risk areas. The author also emphasizes that the challenges faced are often due to coordination and management rather than purely technical limitations.

In the same perspective, in Franco da Rocha the area designated in the PDUI as a new centrality and addressed in the Municipal Master Plan as an area of mixed-use and more densely settled already faces serious flooding problems (Figure 84). While

it is crucial to increase the population density of these regions, achieving this goal requires a comprehensive approach that involves upgrading the existing infrastructure and public spaces.

CURRENT SCENARIO

The central area of Franco da Rocha municipality is characterized by a compact and extensively paved urbanization with low-rise buildings. However, a substantial portion of the city center is situated within a high-risk flood zone, leading to recurrent flood incidents. The high susceptibility to floods poses significant challenges to the local community and infrastructure, impacting not only residents but also businesses and public services located in the affected areas.

PLANNING SCENARIO

The municipal planning of Franco da Rocha proposes mixed-use development in the central area, including the reuse of the institutional zone that encompasses the historic building of the former Juquery Hospital Complex. Additionally, the Metropolitan Plan suggests establishing a new centrality within the same central area. However, the development of a new centrality in the central area must prioritize an integrated approach that incorporates flood management strategies.

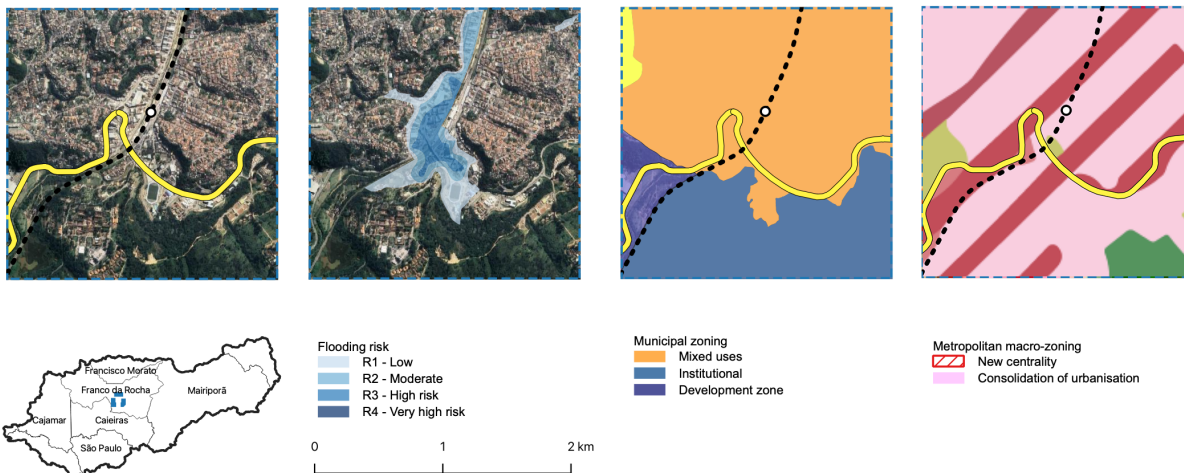


Figure 84 - Current scenario and planning scenario for Franco da Rocha in the municipal and metropolitan instruments. Prepared by the author.

São Paulo’s PlanClima, in turn, presents a series of guidelines that in terms of urban development concern environmental protection, mixed uses, encouraging sustainable mobility (active mobility, public transport and low carbon), the use of renewable energies and changes in the construction sector with a view to energy efficiency. The plan itself, when discussing potential scenarios for reducing GHG emissions, points to the challenges in implementing an ambitious emissions reduction scenario. As Table 27 illustrates, substantial changes would be needed in the energy, construction, transport and mobility and waste sectors, which would involve changes across several sectors.

	PREMISES	WHAT IS WITHIN REACH OF THE CITY?	WHAT ELSE SHOULD HAPPEN?
Energy	<ul style="list-style-type: none"> 86% of the national electricity matrix is renewable (hydro, solar, wind and biomass); 13% of residential buildings equipped with photovoltaic distributed generation systems; 24% of commercial buildings equipped with distributed photovoltaic generation systems. 	The city does not have competence over the energy issue, and is only responsible for actions to raise awareness and publicise the energy consumption of energy consumption of buildings. It can mobilise efforts to review the existing regulatory framework.	The installed capacity for wind power generation should double in relation to 2017 and solar energy should represent 3% of the national electric matrix until 2029, according to the Ten-Year Energy Expansion Plan 2029 of EPE. Revision of the compensation model for the use of the distribution network, so as not to reduce the attractiveness of distributed generation and not to burden other consumers.
Buildings	<ul style="list-style-type: none"> 41.2 per cent of residential buildings and 12.4 per cent of commercial buildings with solar water heating; 60 per cent of existing residential buildings equipped with high-efficiency cooling and ventilation systems; 80 per cent of all commercial buildings equipped with high-efficiency cooling and ventilation systems. 	The city can stimulate changes by regulating energy efficiency criteria in buildings as well as by adopting sustainable technologies and building standards in its buildings.	The adoption of high efficiency standards by the industry for air conditioning equipment, according to Decree 234/2020 of the National Metrology Institute (INMETRO), is an example of progress in the search for greater efficiency of the products available in the market.
Mobility and transport	<ul style="list-style-type: none"> 8% of all journeys in the city made by bicycle; 100 per cent of the municipal bus fleet using zero-emission technology; 51% reduction in journeys made by individual car as the main mode compared to OD 2017; 90% reduction in fossil-fuelled passenger vehicles; 49% of the passenger vehicle fleet powered by zero-emission technology.. 	The city should invest in infrastructure for active mobility and accessibility. Replacing the municipal bus fleet progressively by clean alternatives. The feasibility of Zero Emission Zones and logistics terminals to encourage the adoption of zero emission vehicles.	The metro expansion will attract more passengers to public transport. The vehicle fleets in the city should stabilize until 2025. The progressive introduction of hybrid and electric vehicles will reduce automotive gasoline consumption in the city.
Waste and liquid effluents	<ul style="list-style-type: none"> Recycling of 48% of all paper waste generated in the city; Recycling 43% of all plastic waste generated in the city; Diversion of 66% of all food waste destined for landfill treatment. 	The city must build until 2030 two eco-parks, universalize selective collection and double the number of registered cooperatives. All pruning waste should be composted or treated by biodigestion.	The recovery of recycled waste by industry is expected to increase. A dramatic reduction in single-use plastic is expected from city regulation. Initiatives for on-site composting in households and commercial buildings.

Table 27 - Actions needed to realise PlanClima SP's Ambitious Scenario by 2050. Source: adapted from São Paulo PlanClima (2021)

Despite the intricacy of the circumstances, and while São Paulo’s Master Plan is the most in line with the analytical framework’s scope when compared to other plans, PlanClima’s analysis indicates that the projected trend scenario for greenhouse gas (GHG) emissions in the city of São Paulo is on the rise. As a result, a series of transformations will need to take place to attain the carbon neutrality goal outlined in the plan by 2050 (Figure 85).

Figura 16: Potencial de redução de emissões de GEE do Cenário Ambicioso em comparação ao Cenário Tendencial (tCO2e/ano).

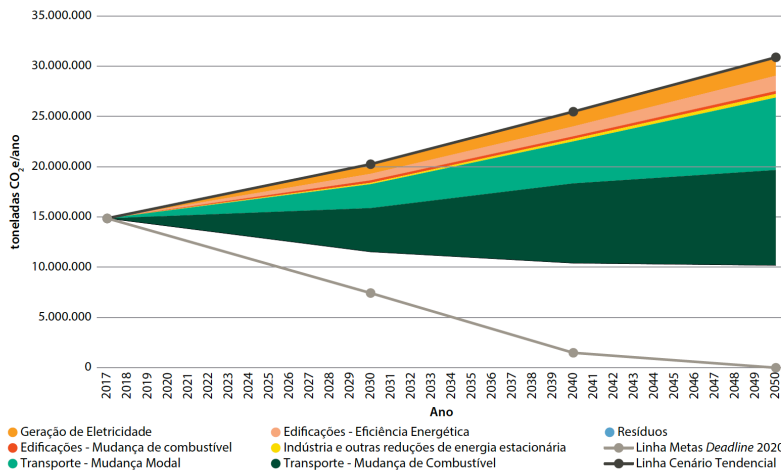


Figure 85 - Potential GHG emission reduction of the Ambitious Scenario compared to the Trend Scenario (tCO2e/year) Source: São Paulo PlanClima (2021)

The current situation shows that the region is still far from becoming resilient to the challenges of climate change with the current tools and governance structure in place. It is crucial to implement a significant transformation in the way these cities are planned and built. Based on this finding, there should be a more comprehensive and strategic approach to urban planning, taking into consideration the need to reduce greenhouse gas emissions, adapt to existing impacts, and promote transformations within the built environment that might change the trend of carbon dependency and promote regenerative development.

Establishing a planning process based on an integrated vision inevitably implies a complex socio-cultural movement involving multiple actors. It is necessary to face the region's problems and to value its environmental and urban potentialities and the local communities, incorporating the ecological transition in the territorial management from a systemic vision of integrated planning between the urban and the environmental and between the municipal and the regional scales.

Despite Brazil having signed the Paris Agreement and the State and the city of São Paulo having a climate action plan aiming to achieve carbon neutrality by 2050, none of the master's plans analysed effectively addressed this issue. Although some plans mention energy efficiency in buildings, only São Paulo's PlanClima explicitly establishes the goal of carbon neutrality. It is crucial that Master Plans are updated and include clear targets, with a territorial approach, to ensure sustainable urban development in line with international commitments.

4.3.3 RESULTS AND DISCUSSION ON WATER AND ECOSYSTEM SERVICES

As pointed out in a previous studies, (Marques, 2019; Marques and Alvim, 2021) urbanization, and environment in the context of metropolitan fringes. The focus of study is the Juqueri-Cantareira sub-basin, a strategic territory for the ecosystemic balance of the São Paulo Metropolitan Region (SPMR) the environmental issue has still been addressed in a sectorial way in the region's Master Plans. Despite that, there are some advances, both in legislation and in implementing certain guidelines.

	SUMMARY OF DOCUMENTAL ANALYSIS
São Paulo Metropolitan Region	The PDUI recognises the importance of green spaces, food production and the provision of ecosystem services. It provides for the creation of Macrozones of Environmental Interest and a system of Metropolitan Green Areas. The plan prioritises environmental and basic sanitation actions in critical sub-basins for water quality in the Areas for the Protection and Recovery of Springs (APRM). It mentions the strengthening of food production activities, community-based tourism and the green economy, and the creation of instruments for remuneration and financial compensation for water-producing protected areas.
São Paulo	Both PDE and PlanClima prioritise the preservation of natural areas, particularly in peri-urban regions. PlanClima focuses on conserving areas that provide ecosystem services and promoting nature-based solutions, while PDE emphasises the sustainable development of rural areas. The Perus sub-prefecture recognises the economic and social importance of these areas and proposes ecotourism and agricultural activities, as well as linking existing and planned parks. However, there are spatial conflicts with infrastructure and logistics projects.
Caieiras	The Master Plan focuses on containing urban sprawl in the eastern part of the territory, which is an Environmental Protection and Water Resources Macrozone (MPARH). The plan aims to articulate green areas and environmental protection through a system of parks that would be linked with other municipalities in the basin. The western vector of the municipality is intended for urban expansion, with incentives to attract non-polluting industries and promote green entrepreneurship and tourism. The plan also encourages sustainable economic and agricultural activities in the MPARH.
Franco da Rocha	The Master Plan proposes guidelines to promote and expand municipal green areas, as well as recover degraded areas and integrate them with environmental sanitation. The plan also includes an integrated system of greenways, parks, and leisure facilities to promote ecological connectivity. It designates two Macrozones of Environmental Interest and a Rural Macrozone in the eastern part of the region to contain urban sprawl, while the West Portion has a family farming zone but also plans for urban expansion with industries and warehouses.
Francisco Morato	The Master Plan aims to create environmental protection areas, particularly around the railway and in the eastern part of the municipality, with low-density residential areas. Francisco Morato's Municipal Plan for Adaptation and Resilience to Climate Change aims to increase green spaces and afforestation, recover springs and forests, and protect vegetation to minimise the effects of heat islands and reduce the risk of flooding and landslides. It also encourages family farmers to protect water resources through sustainable economic opportunities such as agroforestry and permaculture.
Mairiporã	Mairiporã has a large area of springs of regional interest, and the Municipal Master Plan is advanced in terms of environmental protection and recovery. It proposes a system of protected areas, open spaces and green areas to create ecological corridors and conserve areas that provide ecosystem services. Among the instruments proposed are the Payment for Environmental Services (Municipal PSA) and the Green IPTU, which offer tax benefits to those who take measures to protect the environment. Ecotourism is encouraged to generate employment and income.
Cajamar	The Master Plan outlines guidelines for ecosystem services, including a green space system, increasing green space per capita, riverbank protection, water pollution control, restoration of degraded areas, afforestation and environmental sanitation programmes. It also promotes self-sustaining practices and technologies, such as wastewater treatment and rainwater harvesting, while maintaining and expanding the planting of street trees to create green corridors linking squares, parks and areas of regional and local environmental importance. The plan also aims to strengthen the tourism sector by exploiting the territory's potential.

Table 28 - Summary of documental analysis on Water and Ecosystem Services Source: prepared by the author.

Table 28 summarises the documentary analysis of the plans focusing on the “Water and Ecosystem Services” dimension. Regarding the issue of water and ecosystem services, it is important to highlight the matter of multiscalarity and the contradictions and convergences between the different planning documents. In this sense, the importance of the state government's role in environmental protection must be considered. The Juqueri-Cantareira sub-basin is a prime example of the relevance of the environmental dimension, with its numerous protected areas and natural remnants. One key finding is the significant impact of the law on the preservation of springs in containing urban sprawl in the region.

The spatial analysis elaborated from the mosaic of zoning (Figure 82) and Mapbiomas data (Figure 81) shows that the areas protected by state legislation play an important role in this sense. The Master Plans are compatible with the specific law of APRM-AJ and therefore treat the whole eastern sector as an area of preservation and/or environmental recovery and urban sprawl containment. These areas were delimited by the State government, by the Secretary of Environment, which indicates an important advance regarding environmental protection.

In this context, several challenges exist between the prevailing economic development model and the need for environmental protection. For instance, during the interviews, it was revealed that Mairiporã, the municipality with the largest portion of the Spring area (80% of the territory), has not yet determined a viable pathway for its own sustainable development.

Municipalities commonly view protected areas as obstacles to municipal “development” because they do not receive any economic compensation for maintaining these areas. Moreover, the present “development” model heavily relies on an extractivist and industrial approach.

Currently, municipal policies have not been effectively incorporated into the emerging paradigm of sustainable and ecological transitions, which has been developed over the past few decades within the framework of addressing climate change. This issue extends beyond the municipalities of this particular region and is closely linked to the earlier discussion in this chapter concerning the lack of coordination between federal, state, and municipal policies regarding ecological transition. As a result, there is a notable lack of alignment and coherence in this regard.

During the interviews, a key individual from Mairiporã, who has actively participated in social and environmental movements in the region since the 1980s, emphasised that these movements have long been exploring alternative approaches and strategies for environmental preservation, for example, those related to the green economy. However, the interviewee expressed concern about lacking a clear vision and sufficient framework to implement policies in this direction within the Juqueri-Cantareira sub-basin effectively. Certain State government policies, such as the Ecological-Economic Zoning and the recently introduced Climate Action Plan, have the potential to guide in this regard if they are properly coordinated with the municipalities in the region.

This difficulty in implementing policies incorporating the issue of nature and the green economy is one of the major contradictions of Brazilian policies. Several studies indicate how Brazil has the potential to implement these agendas through Nature-based Solutions or Ecosystem-based Adaptation because of its rich biodiversity (Scarano, 2017; Marques *et al.*, 2021; Torres *et al.*, 2023).

However, according to Torres *et al.* (2023), who specifically examine the concept of Nature-based Solutions (NbS), it is important to note that although the concept is gaining attention in the environmental policy agenda of Brazilian cities, it is still in its early stages and is not explicitly incorporated into policy and territorial planning instruments, such as the Master Plans.

Furthermore, considering the significant socioeconomic disparities present in Brazil, these instruments must be integrated with efforts to address social inequalities. The authors also argue that to effectively tackle the challenges of environmental injustice arising from the implementation of NbS, several key aspects need to be addressed. These encompass broader issues such as the institutional framework and funding models at the macro level, planning and governance approaches, legal techniques and instruments, participatory planning processes, and the establishment of multi-stakeholder governance mechanisms.

Despite this, one notices that there is an advance in the attempt to incorporate instruments that seek to somehow reconcile environmental preservation and/or recovery and economic development, both at the metropolitan and municipal scale. For instance, the PDUI-RMSP designates the importance of natural remnants and protected areas in this region and cites the introduction of compensatory and financial instruments such as Payment for Environmental Services (PSA)^{70 71}. This instrument is also mentioned in Mairiporã’s master plan, although

70_ This instrument is part of the Municipal Plan for the Conservation and Recovery of Areas Providing Environmental Services (PMSA) approved by means of CADES Resolution 202/19, and provides for the remuneration of rural producers when they prove the adoption of good agricultural practices (organic agriculture and/or agroecological transition) or even carry out actions to recover forest remnants, springs and riparian forests (SÃO PAULO (city), 2020).

71_ The PDUI proposes the implementation of a Metropolitan Payment for Environmental Services (PSA) programme, which aims to reward, financially or otherwise, the owners or holders of areas with ecosystems that play a fundamental role in the maintenance, restoration or recovery of ecosystem services. Actions eligible for compensation include the conservation of remnant forests, the restoration of springs, riparian forests and permanent conservation areas, and the conversion of family farms to organic practices in accordance with current legislation. This programme should be coordinated with related state and municipal initiatives to promote the enhancement and conservation of ecosystem services in the metropolitan region.

it has not been implemented so far, and in São Paulo's master plan.

In the case of São Paulo, PSA is in a more advanced implementation stage. The instrument was articulated to the *Connect the Dots Project (Projeto Ligue os Pontos)*, a project designed with principles of circular economy and value chain within the scope of the Municipal Secretariat of Urbanism and Licensing, which seeks to promote sustainable development and new urban-rural dynamics in peri-urban areas of São Paulo, focusing on social participation and the creation of new local dynamics that provided the generation of new local businesses focused on agro-ecological agriculture, ecotourism and environmental education (Abreu, Franco and Mori, 2016; Municipality of São Paulo / Prefeitura de São Paulo, 2016; Marques et al., 2023).

Although all the Master Plans acknowledge the significance of environmental tourism as a potential sector for socio-economic development, except for Francisco Morato, there is currently no coordinated effort to implement it as a comprehensive territorial project. In this context, local policies like the Connect the Dots Project could be a replicable model for other areas within the São Paulo metropolitan region. By engaging local stakeholders and fostering environmental preservation and restoration, these initiatives aim to establish new policies for territorial development. They also offer potential pathways to reconcile these development goals, particularly through eco-tourism and food production.

To date, the actions of *Connect the Dots Project* have been concentrated in the South Zone of São Paulo and, therefore, not in the districts covered in this study. In Perus, there is an area of Special Environmental Protection Zone (ZEPAM), where the Perus-Pirapora Railway (Figure 87) and the Former Portland Cement Plant (Figure 88) are located, but which still does not have a local project in execution, although there is activity from local groups that develop actions focused on tourism, environmental education, and cultural activities⁷².

In the area susceptible to flooding shown in Figure 86, a linear park (Parque Linear Ribeirão Perus) was proposed in 2008 by the São Paulo City Council with the aim of containing the problem of flooding in the neighbourhood. However, the park's proposal met with strong resistance from the local population, highlighting conflicts and limits of planning and urban interventions in the territory (Bezerra, 2016).

72_ Justiniano (2022) shows a series of existing conflicts in the districts of Jaraguá, Perus and Ananhanguera between verticalisation, road infrastructure works (Rodoanel Norte) and the New São Paulo Warehouse Project (PIU-NESP). At the same time, the author presents the potential of the territory and the construction of the Territory of Interest of Culture and Landscape Jaraguá, Perus and Anhanguera (TICP JPA) as a bottom-up response to this process of transformation of the territory.

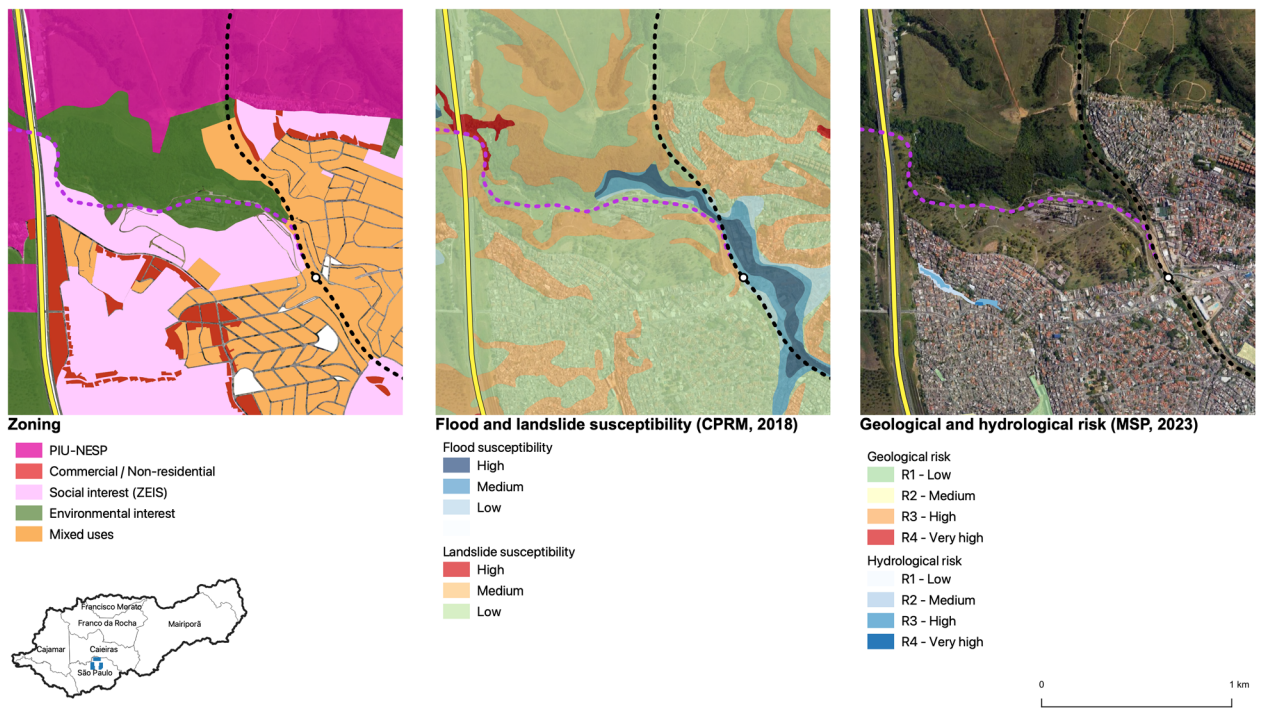


Figure 86 - Area around Perus station: zoning, susceptibility and risks to landsliding and flooding. Prepared by the author.



Figure 87 - Field visit with CIAM-Clima researchers to the Perus-Pirapora Railway. Source: author's own collection.



Figure 88 - Field visit with CIAM-Clima researchers to the former Cement Factory. Source: author's own collection

On the other hand, the natural remnants or large green areas that are located in the eastern vector and that are not objects of areas protected by law, or in which a more flexible legislation such as the Environmental Protection Areas (APA) applies, are objects of urban sprawl in the municipal planning, even in areas with high declivity and unsuitable for ur-

banisation according to the geotechnical chart, as in the case of Franco da Rocha and Caieiras (Figure 89), as explored in the discussion on urban dynamics.

CURRENT SCENARIO

The non-urbanized area comprises a range of natural remnants and eucalyptus plantations, which have been established by the paper factory in Caieiras. It is characterised by its sloping terrain, with a significant portion being susceptible to landslides. This susceptibility warrants careful attention and proper management strategies to mitigate potential risks.

PLANNING SCENARIO

The municipal planning envisages a spreading vector, primarily focusing on industrial and low-density residential use (in Caieiras). In contrast, the metropolitan planning, which currently lacks legal force, proposes the preservation and/or sustainable uses for the majority of the area, suggesting predominantly urbanizing along the highway axis.

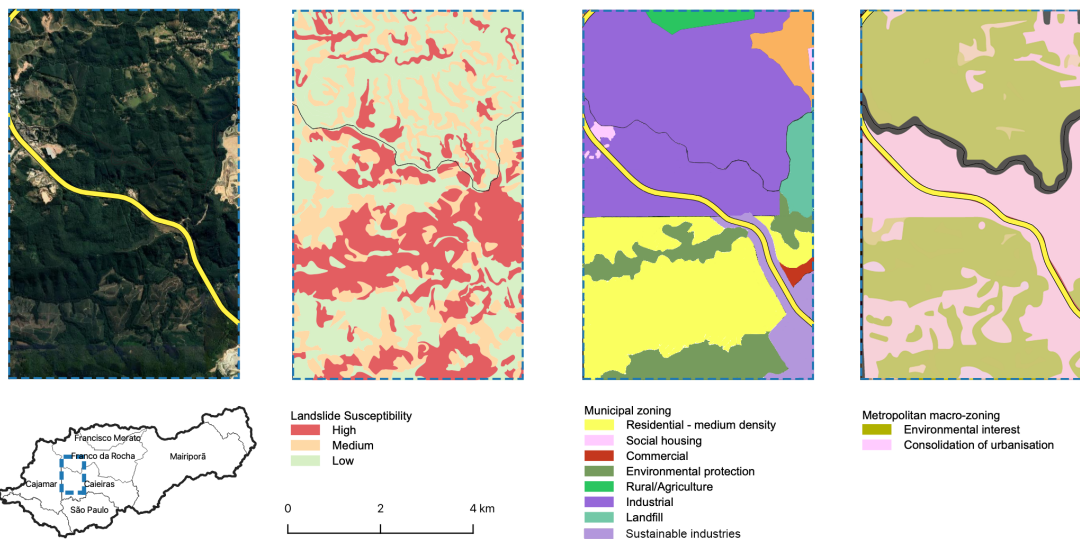


Figure 89 - Current scenario and planning scenario for Caieiras and Franco da Rocha’s eastern vector in the municipal and metropolitan instruments. Source: Prepared by the author.

It is important to emphasise that several studies show a strong association between urban expansion and the suppression of vegetation, resulting in an increase in the occurrence of extreme climatic events, such as intense rainfall and heat islands (Ferraz Young, 2013; Lima and Magaña Rueda, 2018; Bender, Freitas and Machado, 2019; Ferreira, 2019; Machado et al., 2021; Lima, De, Fonseca-Salazar and Campo, 2023). Therefore, in addition to the risks inherent in municipal planning targeting areas with high susceptibility to landslides for urban expansion, it is imperative to consider the impacts that the suppression of vegetation will possibly have on both the sub-basin in question and the São Paulo Metropolitan Region.

In a different approach to the master plans, the PDUI proposal recognises that the metropolitan fringe provides important ecosystem services (Figure 90)⁷³. These areas are largely delineated as ‘Macrozones of Diversification of Environmental Interest’, with the aim of reconciling the conservation of socio-environmental assets with the development of diversified urban, rural and economic activities. In this sense, the guidelines for this macrozone would include the maintenance of ecosystem services, the rehabilitation of degraded areas, sustainable use, low urban density policies and urban qualification, the promotion of environmental compensation instruments and the maintenance of protected areas.

73_ In 2018, as part of the preparation of the PDUI-RMSP, the São Paulo City Green Belt Biosphere Reserve (RBCV) held a workshop with experts to spatialise the region’s ecosystem services. Figure 90, published in the book “Ecosystem Services and Human Wellbeing in the São Paulo City Green Belt Biosphere Reserve”, summarises the intrinsic capacity of the reserve’s ecosystems to provide ecosystem services. It shows that the northern region of the RMSP contains areas of very high capacity, especially in the eastern vector of the territory (APRM-AJ), and of high and medium capacity in the western vector, where natural remnants are concentrated in Perus, Caieiras, Cajamar and Franco da Rocha.

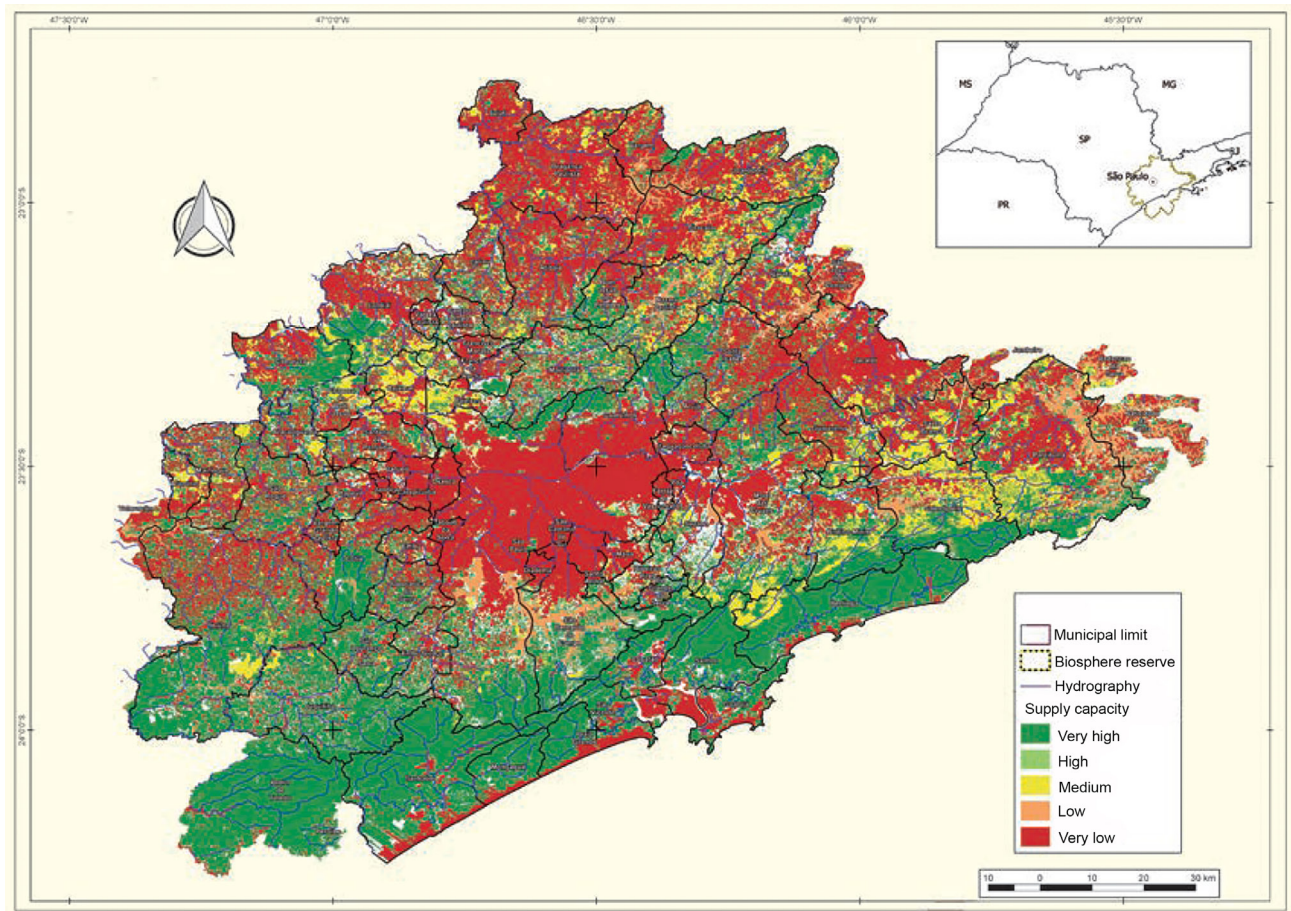


Figure 90 - Capacity to provide ecosystem services in the RBCV. Source: Victor; Furlan; Nalon; Iembo (2019) apud in São Paulo (Estado). Secretaria de Infraestrutura e Meio Ambiente (2020).

At the municipal scale, it is relevant to highlight that all the Master Plans analysed address, in some way, the environmental dimension and propose common strategies. These strategies include the creation of a municipal system of green areas, the protection of permanent protection areas (APPs), the implementation of street afforestation, the recovery of degraded areas, the clean-up of rivers and streams, and the improvement of environmental sanitation. Some plans also mention the need to prepare a basin-wide environmental sanitation plan, that is, in collaboration with other municipalities, recognising that this is a problem that affects more than one municipality and that it must be addressed jointly.

As reported in the interviews, the issue of green area systems was incorporated into the Master Plans, mainly due to the actions of CIMBAJU (Inter-Municipal Consortium of Municipalities of the Juqueri Basin) and socio-environmental movements in the region. This progress can be observed in the establishment of linear parks along the railway line in several stretches (Figure 91). In an interview conducted in the municipality of Franco da Rocha, it was highlighted that, besides the park already implemented, more park stretches are being planned that will connect the municipalities of Franco da Rocha and Mairiporã.



Figure 91 - Caieiras municipal EcoPark. In the background, an area earmarked for urban expansion by the municipal plan. Source: author's own collection.

It is important to highlight that the Master Plans address the environmental dimension, in line with the guidelines established by the City Statute. However, with the exception of São Paulo's Climate Change Adaptation Plan, there is no direct correlation between the incorporation of nature benefits in addressing climate issues in urban planning. Specifically, the implementation of Nature-based Solutions for heat island reduction, carbon sequestration and other measures is still not widely contemplated in the region's urban planning.

4.3.4 RESULTS AND DISCUSSION ON RISKS AND VULNERABILITIES

The Master Plans and the PDUI mainly address risk issues related to the structural problems present in Brazilian cities due to a long history of social inequalities and neglect. The general strategies adopted focus on mitigating the risk of landslides and flooding in urban areas, with special reference to precarious settlements. Table 29 summarises the documentary analysis of the plans, outlining the "Risks and Vulnerabilities" dimension and highlighting the approach adopted by each municipality to deal with the issue

	SUMMARY OF DOCUMENTAL ANALYSIS
São Paulo Metropolitan Region	The PDUI aims to preserve the environment, limit urban sprawl in flood and landslide prone areas, urbanise precarious settlements, promote social housing in areas with infrastructure, and create a risk communication and education programme. It also provides for the drafting, implementation and monitoring of the Metropolitan Environmental Risk Management Plan and proposes mechanisms for representation through Environmental Risk Management Working Groups to discuss, plan and implement the Plan's actions.
São Paulo	The plans propose solutions such as urbanisation of precarious settlements, land regularisation and resettlement of populations in risk areas. PlanClima mentions the use of NbS, while PDE mentions urban interventions in valley bottoms, sanitation, drainage, creation of linear parks and urbanisation of slums. In the sub-prefecture of Perus, there are several social housing areas and, although the SbN concept is not included in the text, it is proposed to extend green areas and create multifunctional linear parks along several streams and rivers to solve flooding problems.
Caieiras	The main strategies are to prevent the occupation of new risk areas and to provide housing alternatives for low-income families. All the social housing areas are located on the outskirts of the municipality, although the text mentions guaranteeing decent housing in central areas with infrastructure. The plan mentions the promotion of an integrated system of permanent monitoring of the Paiva Castro reservoir, together with SABESP ⁷⁴ , to prevent the effects of flooding.
Franco da Rocha	The master plan addresses the recurrent flooding in Franco da Rocha. The strategies proposed include the creation of a network of linear parks and green corridors, the preparation of a municipal plan for flood prevention, and the implementation of macro-drainage studies. The focus is on precarious settlements, with guidelines for resettlement and access to adequate housing. Private sector participation and government support programmes are also mentioned.
Francisco Morato	The Master Plan provides general guidelines for risk management, including the creation of a flood buffer zone and a community risk reduction plan. It also creates social housing zones and emphasises the development of a Municipal Housing and Land Regularisation Plan that diagnoses precarious settlements. Francisco Morato's Municipal Plan for Adaptation and Resilience to Climate Change aims to reduce risk and vulnerability. It includes community training and mentions the creation of a project database to facilitate participation in tenders for works in high risk areas (R3 and R4).
Mairiporã	The Master Plan proposes to prevent the occupation of high-risk areas, to preserve and restore vegetated areas, and to protect the soil from landslides and erosion. The Municipal Social Housing Policy should be integrated with the Environment and Sanitation Policy in order to prevent new illegal settlements in environmentally sensitive areas and to rehabilitate risk areas and environmental protection areas, especially those with dwellings that cannot be formalised or urbanised. The Urban and Periurban Intervention Areas for the Rehabilitation of Areas of Geotechnical, Flood or Other Risks (AIUPRR), established by law, are designed to identify areas that require action to eliminate, correct or manage risks.
Cajamar	The Master Plan Sets proposes the creation of emergency committees for risk situations, with special representatives for transport, civil defence and public security. It also proposes public awareness campaigns and community participation in the planning, implementation and operation of flood control measures. In addition, the plan proposes general guidelines to prevent the occupation of risk areas, to maintain and restore vegetated areas, and to protect the soil from erosion and landslides. It proposes social housing initiatives such as land regularisation and urbanisation of precarious settlements, as well as various related programmes in partnership with other federal agencies.

Table 29 - Summary of documental analysis on Risks and Vulnerabilities. Source: prepared by the author.

In general, the strategies presented in the plans are quite homogeneous and are aimed at avoiding the occupation of unsuitable areas, the relocation of the population in risk areas, the urbanisation of precarious settlements and Land tenure regularisation. Besides, the construction of social housing in Social Interest Zones (ZEIS) is also proposed. Caieiras draws attention because no ZEIS is located in a central area, only in the peripheral zones of the municipality, which contradicts the text of the master plan itself, which mentions access to decent housing in central areas with infrastructure.

However, despite this set of general strategies, or intentions, presented in the Master Plans, there are few examples of local projects that materialise these guidelines. In the case of Franco da Rocha, for instance, a city with a recurrent history of flooding, some measures foreseen in the Master Plan to mitigate these events were implemented, such as the Benedito Bueno de Moraes Municipal Park (Figure 92).



Figure 92 - Municipal Park Benedito Bueno de Moraes in Franco da Rocha. Source: author's own collection.



Figure 93 - Infrastructure works to reduce flooding along the Juqueri River around the Baltazar Fidelis train station in Franco da Rocha. Source: author's own collection

Despite efforts to address the issue of recurrent floods in the municipality, the existing works have proven insufficient (Moreira, 2018). Consequently, additional infrastructure projects, including polders and drainage ponds, have been proposed in the region with investments from the State Government (Figure 93 and Figure 94).

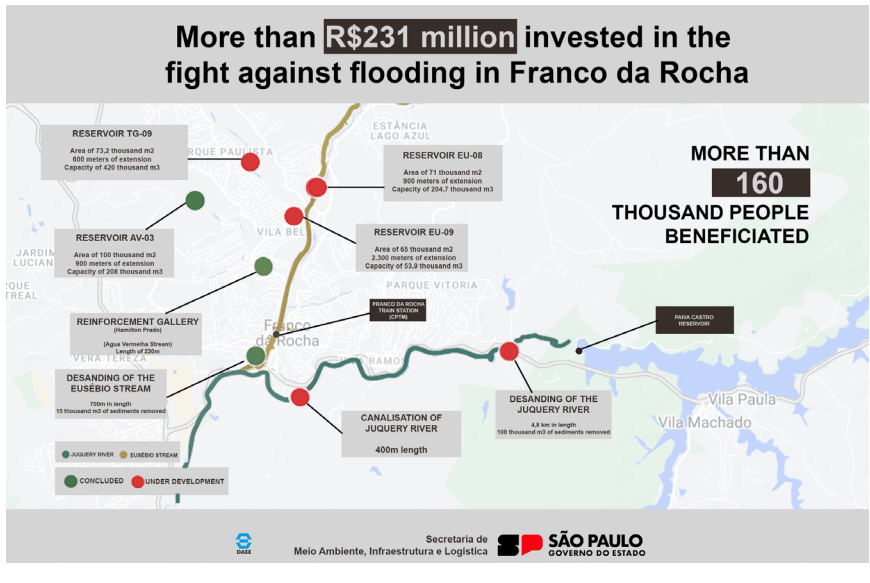


Figure 94 - São Paulo State Government projects on anti-flooding infrastructure in the city of Franco da Rocha. Adapted from: <https://www.saopaulo.sp.gov.br/spnoticias/governo-de-sp-inaugura-ete-inicia-construcao-de-piscinao-em-franco-da-rocha/>. Accessed on 12th June 2023.

Although these projects can play a fundamental role in flood control, they are often not integrated into the overall planning of the city. In general, they are implemented on a sectoral basis, without considering the connections with local territorial development, such as possible integration with green areas, public spaces or a sustainable drainage system, or even how infrastructure projects can be integrated into the existing proposal to densify the central area, since it suffers recurrently from flooding. Figure 95 shows an example of this, as the central area of Franco da Rocha is intended for densification and mixed use but is an area prone to flooding. From an urban point of view, the densification strategy is appropriate as it is an important centre with access to public transport. However, this densification must be considered in an integrated way with the climate issue, both in terms of infrastructure renovation and the introduction of new urban dynamics, for example in terms of afforestation and mobility.

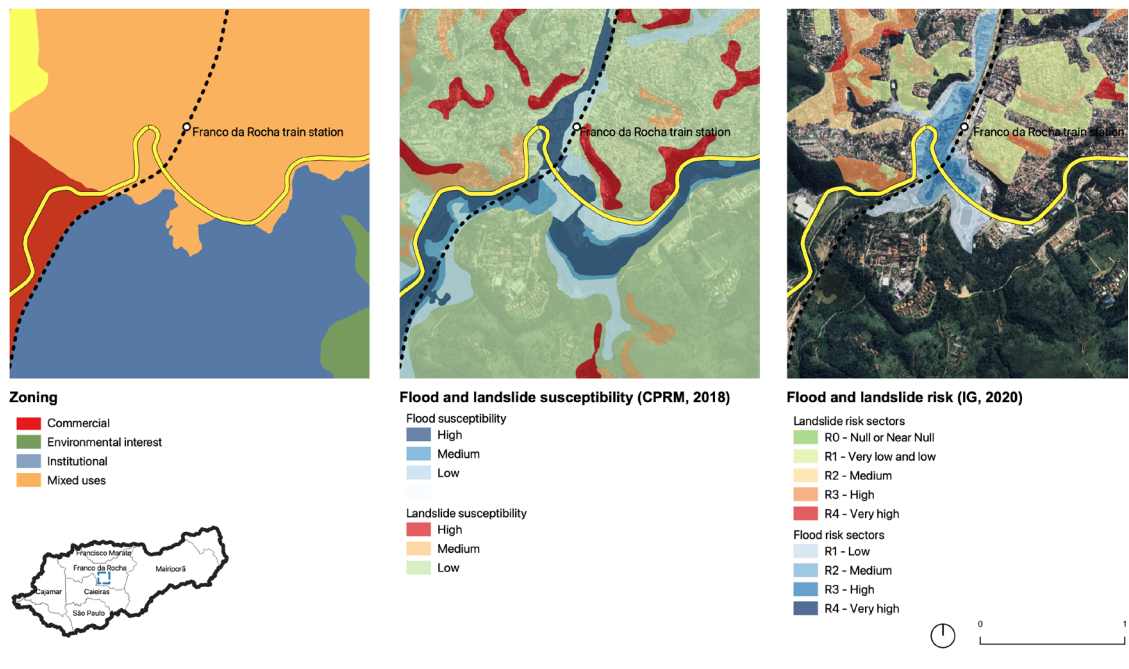


Figure 95 - Central area of Franco da Rocha, zoning, susceptibility and risk of flooding and landslides. Prepared by the author.

São Paulo and Francisco Morato, the only municipalities in the region with an Adaptation plan, stand out for presenting a series of risk management instruments highlighted in the interviews.

The municipality of São Paulo has established an Executive Secretariat for Climate Change to coordinate and provide a comprehensive approach to implementing the municipal PlanClima. Within this framework, the Secretariat has initiated a specific plan focused on risk management called the Preventive Plan for Summer Rains (*Plano Preventivo de Chuva de Verão*). This plan operates in collaboration with the Government of the State of São Paulo and aims to develop warning systems to prevent human losses. Similarly, Francisco Morato has taken steps to address risks through a lens of social innovation. This includes initiatives such as participatory mapping of high-risk areas in collaboration with civil defence authorities and the development of comprehensive plans like the Contingency Plan (PLANCON) and the Municipal Risk Reduction Plan (PMRR).

The two municipalities are part of ICLEI, and São Paulo is also part of C40, which are transnational networks that face this issue of tackling climate change. It is crucial to note that risk management is especially vital in Brazil, given the large number of individuals residing in precarious or high-risk areas.

At this point, it is also important to highlight the role of other planning levels, such as the Metropolitan Thematic Chamber for the Management of Environmental Risks linked to the Urban Development Council of the Metropolitan Region of São Paulo. This Thematic Chamber played an important role in the elaboration process of the PDUI aligned with the guidelines and strategies of the National Policy for Protection and Civil Defense (PNPDEC), proposing the general bases for the elaboration, implementation and monitoring of the Metropolitan Plan for Environmental Risk Management in an interfederative perspective (Moreira, 2018).

The PDUI advances in relation to the Master Plans, but it has no legal force. As mentioned earlier, municipal instruments are promoting urban expansion in areas that have high slopes and are deemed unsuitable for occupation, as highlighted in the Metropolitan Chamber's document on urban environmental risk management.

In addition, the São Paulo State government has played an important role in mapping the risk areas and providing crucial data for municipal governments. As discussed in Chapter 1, one of the great difficulties of medium and small municipalities is in institutional capacity and also in the availability of data for understanding local risks. In this sense, the government of the State of São Paulo and the Geological Institute elaborated a study on the risk areas of the metropolitan region of São Paulo⁷⁵ with data that may serve to elaborate public policies at the municipal level to face this issue. Furthermore, the Ecological Economic Zoning (ZEE) provides a series of projection data and climate scenarios available through the ZEE network that can also contribute to municipal planning.

It is crucial to emphasise that while data plays a fundamental role in developing effective public policies, the mere presence of data does not guarantee their implementation in the planning process, particularly in the context of local projects. Despite the State government's efforts to make data available and the significant involvement of civil defence at the municipal and state levels in risk management, there is still a lack of an effective territorial and integrated perspective.

Based on the discussions so far, it can be inferred that the policies action concerning climate change in these urban areas have mainly been approached from a risk management perspective, with more emphasis on Civil Defence than on urban planning and necessary

75. More information available at: <https://www.infraestruturameioambiente.sp.gov.br/2020/12/governo-de-sao-paulo-finaliza-mapeamento-de-riscos-em-38-municipios-da-regiao-metropolitana-do-estado/>. Accessed on 12 June 23

ecological transitions. The adoption of a broader perspective, such as resilience, which is explored in this thesis, is not yet adequately incorporated into the Brazilian public policy framework.

4.4 ADVANCES, LIMITS, AND CHALLENGES

The issue of climate change imposes the need for profound transformations in the way cities are planned and designed. Due to its inter and transdisciplinary nature, this issue must be addressed at different scales and in a cross-cutting manner during the planning process. It is essential to incorporate the issue of climate change into urban and regional master plans, as well as to spacialise it in local projects.

In the context of the São Paulo Metropolitan Region, where there is a long history of social inequalities and spatial fragmentation, it is necessary to adopt a flexible and innovative approach in planning institutions in order to promote cooperation and support the municipalities in this process. This implies the creation of new forms of governance and the diversification of spaces dedicated to planning and social participation.

As previously mentioned, despite the progress made in Brazil through the implementation of the City and Metropolis Statutes, the issue of urban development, particularly at the regional and metropolitan level, remains inadequately addressed in the country. This reflects a significant governance challenge which is exacerbated against a backdrop of weakened planning and participation mechanisms.

Taking the Sao Paulo Metropolitan Region as a case in point, despite the establishment of the Metropolis Statute and the development of the PDUI, the plan has not been officially enacted into law, and no institution dedicated to the integrated planning of the region has been established.

Notably, RMSP represents the largest metropolitan area in the country, boasting significant economic influence with a contribution of over 18% to the national GDP and 54% to the state GDP. Consequently, the absence of a clear governance process raises questions about the feasibility of achieving integrated management for this territory. Moreover, the lack of discussions regarding a strategic project that defines the creation and purpose of new poles hinders the establishment of a multi-polar region.

The analysis of the plans and semi-structured interviews revealed the strategic relevance of the fringes of the São Paulo Metropolitan Region for the metropolis, specifically for the State Government, in terms of water production and distribution through the creation of the spring's areas of regional interest. Consequently, the importance of the environmental safeguard of these areas and its fundamental role in the containment of urban expansion in areas of environmental relevance is acknowledged. Although there are criticisms and challenges regarding the Springs Law, it has played an important role in the metropolis from an environmental perspective.

However, the existing gap in a propositional agenda, strategic projects and innovative modalities of employment and income generation that contribute to the ecological transition is still a challenge.

The Master Plans highlight inter-municipal cooperation for urban and ecological connectivity and provide some general guidelines for environmental recovery, protection, and urbanisation of slums. However, upon spatialisation of the zoning, a series of contradictions between the discourse and its territorialisation were observed. Currently, planning documents, especially municipal ones, continue to emphasise the perspective of a fragmented, dispersed and carbon-dependent city (Figure 96). The generic guidelines for prioritising public transport and active mobility over individual motorised transport also conflicted with the majority of the guidelines aimed at building, widening and duplicating highways. These

inconsistencies need to be addressed in order to ensure effective implementation of the Master Plans and to achieve a resilient urban development.

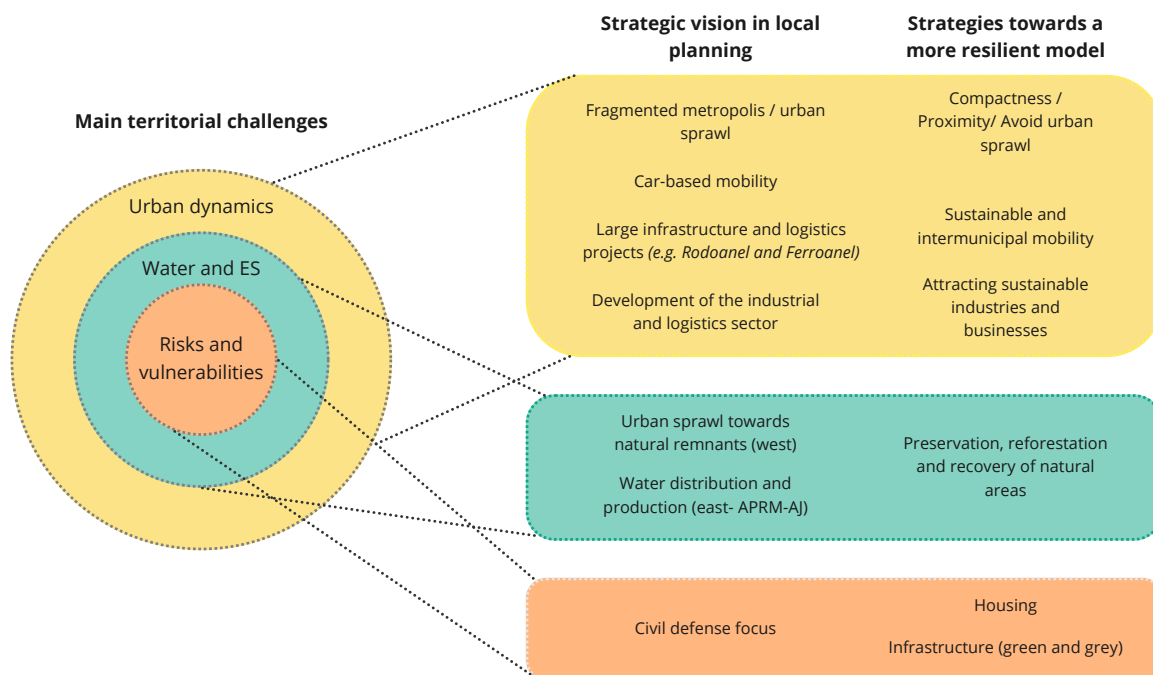


Figure 96 - Diagram illustrating the relationship between main territorial challenges, strategic visions of planning documents and strategies towards a more resilient model. Source: prepared by the author

In addition, regional planning documents for the region also include a second strategy focused on large infrastructure and logistics projects. Examples of such projects include the Rodoanel (ring road) and the Ferroanel (ring railway), along with logistics platforms.

In this regard, regional planning treats the analysed fringe area as strategic for the circulation of people and goods and the distribution and production of water, but not based on its potential and opening up new possibilities for development.

These two regional agendas - environmental protection and major logistics infrastructure projects - are somewhat contradictory since there is a lack of integration between these two perspectives in local territorial projects that work in the public interest and improve the environmental and urban conditions of the population, especially in the face of climate challenges that are intertwined with the existing problems in these territories.

In order to advance in this area, it is necessary that the region adopts a multi-scale planning approach and execute local strategic projects that materialise the necessary transformations towards a resilient territory. The commitment of the State of São Paulo to achieve carbon neutrality by 2050 is contradictory in the absence of an appropriate territorial approach and the effective provision of technical and financial support to make such a transition possible, especially in metropolitan regions. Since some central topics, such as decarbonisation, energy transition, adaptation of infrastructure and building stock to new climate conditions, have not been mentioned in municipal planning legislation, apart from São Paulo's Plan Clima.

Although technological development plays a crucial role in this process, this thesis argues for a territorial approach. Such an approach implies the consideration of the cha-

racteristics and potentialities of each territory, taking into account the territorial, socio-economic and environmental dimensions. Thus, it becomes necessary to integrate strategic urban planning in a broad and comprehensive perspective, aiming to foster resilience and sustainability at multiple scales.

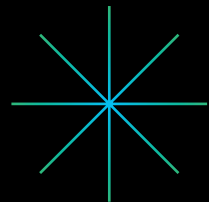
As an example, it is possible to observe the practical application of this approach in the referential cases discussed in Chapter 2, in which the local strategic projects, in cooperation with the communities, make effective the objectives and guidelines established in other planning spheres, transforming existing urban fabrics to promote the urban-environmental balance of neighbourhoods, social cohesion and improved quality of urban environments. This conception transcends the traditional logic of zoning, adopting a strategic and propositional posture that considers the needs and aspirations of the inhabitants of these metropolitan areas.

In parallel, common large-scale challenges such as transport and infrastructure are addressed at the metropolitan or regional scale, as in the Paris Region, in which transport is thought out in a regional manner, integrating different cities by means of a low-carbon fleet. And the Barcelona Metropolitan Area, which has planned the management of the water cycle, the proximity of food production, and a future energy model more focused on renewable energies.

It is of utmost importance to overcome the current logic of urban fragmentation and carbon dependency by adopting a territorial approach that encompasses integrative policies and projects for resilience in metropolitan fringes. To this end, the implementation of multi-scale planning, local strategic projects and a sustainable development model that takes into account the specificities of each region and promotes active participation of the communities involved is necessary.

Conclusions

5



5.1 OVERALL CONCLUSIONS

This research investigated the importance of articulating planning scales and actors and prioritising territorial transformation strategies within metropolitan fringes to enhance resilience amidst the challenges posed by climate change. It advocates for a more flexible and adaptative territorial governance model that breaks down and articulates multiple scales in large metropolitan regions and underscores the strategic significance of the metropolitan fringes in this process, emphasising the imperative of not overlooking their potential in climate resilience efforts.

Chapter 1 presented the theoretical perspective of the research, briefly introduced the problem of climate change, its causes and effects on urban areas, and showed how cities are part of the climate crisis problem due to the number of emissions that come from urban areas and the natural resources they demand. Therefore, among the responses to this current crisis, the need to build a new urban planning paradigm, based on ecological and regenerative principles, is put into perspective.

Thus, the concept of socio-ecological resilience is discussed, which focuses on the capacity of a complex socio-ecological system to adapt and transform in response to disturbances. In the context of urban planning, building resilient urban environments involves transforming urban systems into a (re)connection between human needs and the capacity of the biosphere (Folke *et al.*, 2011). This perspective challenges the traditional planning paradigm, which is based on the idea of stability and predictability (Heymans *et al.*, 2019).

In this context, responding to the first specific research objective, the role of metropolitan fringes in this process of transformation and the paradigm shift was discussed. Based on the definition of metropolitan fringes as complex areas composed of small and medium-sized districts and municipalities on the border of metropolitan areas with urban, environmental and rural characteristics, the importance of the dynamics present in these areas, such as urban population growth, their environmental and territorial characteristics, and the multiple scales that relate to these complex territories, open up possibilities for new paths of planning and governance and place these areas in a strategic position for building resilience through planning.

Therefore, given the need to promote the transition to a

more ecological and equitable urban development model, where it is necessary to integrate nature and the city in order to both reduce extreme temperatures and contribute to improving drainage and achieving carbon sequestration, to reverse the inefficient pattern of urban sprawl in order to reduce car dependency and promote multimodal regional and local accessibility, this debate must go beyond the central areas of large urban centres to include the peripheral areas and beyond.

To gain a better understanding of how metropolitan areas around the world are addressing this issue in fringe areas, Chapter 2 presented the analysis and lessons learnt from three reference cases of the metropolitan areas of Barcelona, Paris, and Medellín. The analysis of the cases demonstrates the complexity of urban and regional planning and the diversity of possible institutional arrangements. For instance, the Greater Paris Metropolis has a more top-down structure, while the Barcelona Metropolitan Area has a bottom-up dynamic, and the Valle del Aburrá Metropolitan Area in Medellín presents a mixture of these two dynamics. The coordination and structuring of these areas vary, with each presenting its own challenges and innovations.

Despite historical and local contextual differences, the critical point in achieving territorial transformation lies in the articulation between planning scales and the existence of diverse institutional spaces focused on planning and participation at various scales, from regional to local. For instance, in Barcelona, Medellín, and Paris, the regional institutions such as AMB, AMVA, and Ile de France, respectively, have an important role in integrated planning and infrastructure development. They focus on sustainable mobility with mass transport, low carbon fleet, and clean energy in coordination with other scales. These institutions also work towards closing the water, energy, and waste cycles at the regional level.

Inter-municipal consortiums and companies/institutes have been essential in bridging the gap between regional/metropolitan scale and local projects, with a higher participation of the population. For instance, Besòs Consortium and Barcelona Regional in Barcelona, Paris Region Institute and Est Ensemble in Paris, and the Urban Development Company (EDU) in Medellín.

The planning levels collaborate consistently, working together with other planning levels and the community. This diversity of planning and participation spaces is intersectoral, mobilising different types of stakeholders and knowledge to foster strategies defined at supra-municipal scales in an incremental process of coordination and support.

Regarding the spatial policies, although the principles and strategies present a number of similarities, such as avoiding urban sprawl, reducing displacement (proximity and mixed uses), promoting low-carbon urban mobility and renewing urban infrastructure, the spatialisation of these strategies takes place in different ways and depends on contextualisation both in spatial, institutional and social terms. For instance, in Barcelona, the Besòs River was rehabilitated into a public park which solved flooding issues. Further, industrial warehouses were redeveloped to create sustainable neighbourhoods with the Barcelona superblock strategy, and development is planned for a remnant of agricultural land to convert the area into an agroecology hub. In Paris, connected to the Grand Paris Express, the Promenade des Hauteurs connects green areas, redesigns public spaces to prioritize active mobility, green and blue infrastructure, and reinvents the built stock. In Medellín, natural remnants were protected and restored alongside infrastructure solutions against landslides, sustainable mobility modes, and social housing built with sustainable construction technologies.

All cases showed a concern for equity, ecological transition, and the attraction of activities linked to a sustainable economy connected to their contexts. In the case of Europe, this dynamic has been promoted by the European Union with a focus on the transition to a green and circular economy. Thus, in the two research metropolises, particularly Paris,

there is concern about the attraction and creation of innovative enterprises in this sector. In the case of Medellín, the establishment of local employment was linked to tourism, sustainable agriculture, and professional training for local jobs in the areas examined, while the AMVA adaptation plan had a broader strategy to attract sustainable enterprises and industries.

The cases demonstrated the importance of context, multiscale, strategic planning and the diversity of institutions and actors for the effectiveness of planning that is not immune to contradictions and limits, such as discontinuity and extensive processes. To shed light on the possibilities for the empirical object of this thesis, it was essential to understand the spatial strategies and the breakdown and articulation of scales in the reference cases, configuring essential elements for the analytical framework. This is particularly relevant as the planning levels and instruments in São Paulo Metropolitan Region are established by law, but there is a lack of coordination and responsible institutions among them.

Chapter 3 presented the method used to analyse a fringe area of the São Paulo Metropolitan Region (the Juqueri-Cantareira sub-basin). The first part of the chapter described the efforts undertaken to build a framework for analysing urban and regional plans, connecting the theoretical principles presented in the first chapter, the lessons learnt in the reference cases, and the importance of contextualising the framework. Then, the methods that complement the analysis of the application of the framework are presented, which was the spatial analysis made from the mosaic of local zoning, field visits and interviews.

All this methodological effort demonstrates the complexity of the subject from the perspective of planning - without exhausting it - and points to the construction of methods that seek to integrate multiple scales and new planning principles. Meeting the general objective of the research, which is to contribute to the formulation of public policies and academic discussions based on a territorial approach to building resilience, discussing the planning pathways towards resilience in metropolitan fringes and approaching these areas as strategic for the implementation of resilience strategies based on elements extracted from the literature review and the analysis of reference cases. During this process, two crucial points emerged: the need to integrate multiple scales, ranging from regional to local, and the significance of considering the context to spatially implement strategies and address local challenges effectively.

Chapter 4 presents the results of the application of the method in the Juqueri-Cantareira sub-basin and the critical analysis that resulted from this application. The results support the research hypothesis and show the existence of critical gaps in the articulation between planning scales and resilience strategies and the absence of a territorial approach in the analysed metropolitan fringe. It was concluded that the region's master plans have not yet significantly integrated the climate issue into their strategies and continue to affirm the urban expansion model towards natural remnants, spatial fragmentation and car dependency. Despite this general pattern, there are some advances in the text of the plans, mainly deriving from the City Statute, concerning urban-environmental integration, social interest zones and the prioritisation of public transport, although these elements are more present in the discourse of the plan than spatialised in zoning or urban projects. São Paulo and Francisco Morato were the only municipalities to have an adaptation plan, which, despite the progress made, is still disconnected from the territorial issue, with actions focused on risk management through civil defence.

In addition, there are important gaps in planning that go beyond the study region and relate to the implementation of the Brazilian planning system. Although this system provides instruments at the metropolitan, intermunicipal, municipal and local levels, there is a weakening of the regional level with the modification of the Metropolis Statute in 2018 and the

disappearance of EMPLASA in 2019, and little experience at the local level (neighbourhood plans and urban projects) in the study region

These gaps in Brazilian urban and regional planning need to be corrected in order to tackle the problem of climate change from a territorial approach that integrates the existing challenges. Thus, the defence of the thesis is reiterated, arguing the need to articulate planning scales and prioritise sustainable development in metropolitan fringe areas as crucial factors in increasing the resilience of these territories in the face of climate change.

For example, given that the fringe area studied currently reveals regional instruments aimed at tackling the problem of climate change and guaranteeing environmental protection, there is a prevailing logic of economic and urban development focused on urban sprawl and large logistics and water distribution infrastructures without an articulation of new territorial development dynamics aimed at sustainability and resilience that take into account environmental, social and urban characteristics. Furthermore, there is a lack of institutions at different levels responsible for this articulation and territorial development.

Considering that the São Paulo Metropolitan Region already has sub-divisions such as sub-regions and sub-basins that essentially coincide territorially, it is important to think about strengthening and institutionalising these sub-regions in the form of regional and metropolitan agencies to promote strategic planning and articulate the different scales with intersectoral perspective and social participation.

To this end, a new governance model for urban and regional planning is essential in the context of metropolitan regions to rethink their development model. This model must focus on breaking down and articulating different planning scales, while promoting inter-municipal cooperation to develop urban strategies and interventions based on local specificities, without ignoring regional implications. This approach requires a feedback loop from the regional to the local, where plans and projects are developed taking into account the unique local context and communities, ultimately leading to a new territorial dynamic based on a resilient and regenerative paradigm.

5.2 RECOMMENDATIONS: DIFFERENT PLANNING SCALES AND APPROACHES TOWARDS A MORE RESILIENT MODEL

At the national level, Brazil has had important advances in terms of urban policies following the 1988 Federal Constitution, such as the City Statute (2001) and the Metropolis Statute (2015). However, these instruments have not been incrementally implemented or improved sufficiently to integrate the three central challenges worked on in this thesis: the regional/metropolitan issue, the articulation of multiple scales, and the climate challenges.

The National Adaptation Plan (PNA), in the context of urban and metropolitan planning, has been a limited instrument to identify the pathways for the necessary transformations that urban areas must undergo to become more resilient. Integration of urban and climate policies remains a challenge (Klug, Marengo and Luedemann, 2016; Sotto et al., 2019; Barbi and Rei, 2021). In some cases, municipalities have adopted voluntary actions, mostly in collaboration with transnational networks (Macedo, 2017), such as São Paulo and Francisco Morato in the scope of this research; however, a joint effort is needed to ensure effective articulation and the strengthening of climate and environmental policies in Brazil, including the transformation of urban areas that surpasses risk management alone.

In the context of the Juqueri-cantareira sub-basin, several impasses and conflicts between regional and local urban and climate instruments were identified. On the one hand, the São Paulo State Government has appeared as an important stakeholder in terms of the

production and availability of spatial and climate data (e.g. DataGeo, ZEE Network and risk mapping in the RMSP) and public policies and programmes aimed at planning and adaptation (e.g. PEMEC, Resilient São Paulo Municipalities Programme, Net Zero). However, there is a lack of articulation for this to become an effective territorial transformation, which as presented in this thesis depends on multiscale coordination.

In this sense, there is a contradiction since planning structures have been weakened, for example, with the extinction of EMPLASA in 2019 and the immobilisation of the PDUI-RMSP process, which was finalised as a bill in 2019, but has not yet been approved in the State Legislative Assembly.

Another important point regarding the state government is its ambiguous approach towards the Juqueri-cantareira sub-basin. The São Paulo State approaches the analysed metropolitan fringe as strategic for water distribution/production and logistics. This leads to policies on environmental protection, especially in the spring's areas, and the implementation of large transport/logistics infrastructure projects, but without necessarily proposing counterparts and territorial development.

In the environmental protection areas, new perspectives and new strategies are needed since the municipalities do not receive economic compensation for environmental preservation and see these areas as “impediments to municipal development”. For these and other reasons, the integration of climate and urban policies depends on interfederative actions and policies, so that there is a paradigm shift and that the extractive vision of vast urban expansion and carbon dependence is not one that guides the development of Brazilian cities.

As a result, the general picture of the master plans of the analysed region focuses on urban expansion towards natural remnants, spatial fragmentation, and car dependence, which contrasts specific advances such as the implementation of parks along the railway and does not systematically address the problem of territorial occupation (housing, proximity, compactness, and integration with nature), infrastructure renewal, and mobility systems.

In the context of the São Paulo Metropolitan Region, where there is a long history of social inequalities and spatial fragmentation, it is necessary to adopt a flexible and innovative approach in planning institutions to promote cooperation and support municipalities in this process. This implies the creation of new forms of governance and the diversification of spaces dedicated to planning and social participation at different urban scales (metropolitan, intermediate, municipal and local), as summarised in Table 30.

SCALE	RECOMMENDATIONS	
Metropolitan Scale		Equity / Urban dynamics / Water and ecosystem services / Risks and vulnerabilities
- Coordination and consensus building - regional visions	Establish effective coordination between municipalities for regional objectives.	
- Technical and financial support	Create fund to support sustainable projects.	
- Provision of integrated data	Develop platform with climate and territorial information and studies to guide regional development.	
- Infrastructure renewal	Invest in green, blue and grey infrastructure.	
- Sustainable mobility system	Develop low-carbon public transport and active mobility.	
- Monitoring	Monitoring and evaluation by sub-region.	
Intermediate Scale (Intermunicipal)		
- Coordination and consensus building	Create forum for integrated strategies.	
- Interdisciplinary technical support	Establish interdisciplinary teams to support strategic planning and urban projects.	
- Bridging local and supra-municipal scales	Facilitate cooperation between different scales.	
- Ecological and urban connectivity	Ecological connectivity in the basin and urban integration, prioritising the use of nature-based solutions such as green corridors integrated into the mobility system.	
Municipal Scale		
- Review of planning instruments	Review local planning instruments considering the climate issue and the ecological transition. Urban-environmental integration (nature-based solutions) Controlling urban sprawl Thinking about densification in already urbanised areas Urbanisation of precarious settlements	
- Articulation with other scales	Collaboration between municipal, inter-municipal and metropolitan levels.	
Local Scale		
- Integrative urban projects	Going beyond zoning and proposing urban projects that integrate local needs and the climate issue from the four dimensions explored in this work: governance, urban, ecological and socio-economic.	
- Participation and awareness	Involve community in co-creating and raising awareness about the need for interventions.	

Table 30 - Summary of recommendations by planning scale. Source: prepared by the author.

At the metropolitan/regional scale, it is recommended to create an institution that works on coordination and consensus building among municipalities, technical and financial support for the preparation of plans and projects, provision of climate and territorial data and studies to guide regional development, and the renewal of urban and mobility infrastructure in view of the new climate parameters and decarbonisation.

Given the territorial scale involved, the creation of a metropolitan agency and the strengthening of existing inter-municipal consortia and committees, such as the watershed committee, is recommended to facilitate the development of a sort of regional agency able to offer technical and, in some cases, financial support to municipalities for the development of strategic visions in territorial planning, thus addressing the climate issue as a cross-cutting dimension. These instances can act as catalysts for integrated governance, enabling a more efficient and cooperative management of the Metropolitan Region, as well as an interdisciplinary and intersectoral approach.

The Master Plans of the study region indicate some issues that should be addressed at the sub-basin level, involving all the municipalities of the Intermunicipal Consortium of the Juquery Basin (CIMBAJU), such as drainage and environmental sanitation, mobility, solid waste, ecological tourism, and food production. However, political-administrative decentralisation has expanded the powers of the municipalities, and given the current challenges, it is necessary to foster inter-municipal cooperation and spaces for participation. In this sense, by redesigning governance considering multiple planning scales, the inter-municipal bodies would serve as a bridge between the supra-municipal and the local levels, and the

local projects would integrate different knowledge to face the challenge of integrating resilience as transformation, as illustrated in Figure 97.

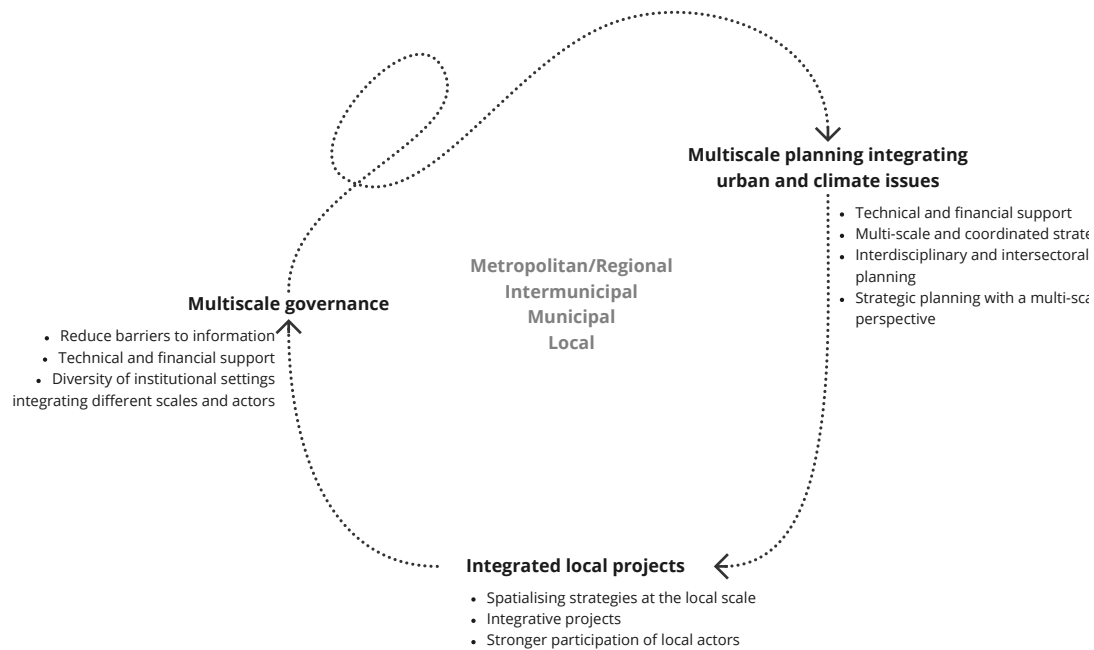


Figure 97 - Diagram illustrating multiple planning scales and their articulations. Source: prepared by the author

The reconfiguration of the governance structure and the establishment of institutions dedicated to articulating planning at different levels represent an important basis for implementing the guidelines outlined in the subsequent segment. It is important to emphasise that this redesign of governance must be adaptable, based on the public interest, and create conditions for the development of policies, plans and projects that combine urban and climate policies from an ecological perspective and involve different stakeholders.

Due to the scale of the São Paulo Metropolitan Region, the intermediate (inter-municipal) scale should be strengthened. It currently exists in the form of inter-municipal consortia and basin committees, but it is advocated here that this scale be better institutionalised along the lines of regional offices with interdisciplinary teams that act as a bridge between the local and supra-municipal scales and offer technical support for strategic planning and project development, prioritising inter-municipal urban and environmental integration. Strengthening this scale is important given the difficulty for municipalities to maintain interdisciplinary and highly qualified teams.

Creating regional institutions at different levels is necessary to address uneven adaptive capacity among municipalities, equalise planning resources, and establish regional networks for effective and long-term local actions. Concentrating the instruments only at the municipal level has limitations regarding the high costs of plan development and vulnerability analysis, limited access to data and information, lack of technical expertise, and political leadership (Dinshaw, Lane and Elias-Trostmann, 2017; Shi, 2019).

The municipal scale should review local planning instruments considering new climate parameters, the need to reduce emissions and effective integration with nature, public interest, and the three main territorial challenges discussed in Chapter 4: urban dynamics, water and ecosystem services, and risks and vulnerabilities. Efforts should

be made to communicate potential pathways towards ecological perspectives while considering the pros, cons, and uncertainties along with civil participation.

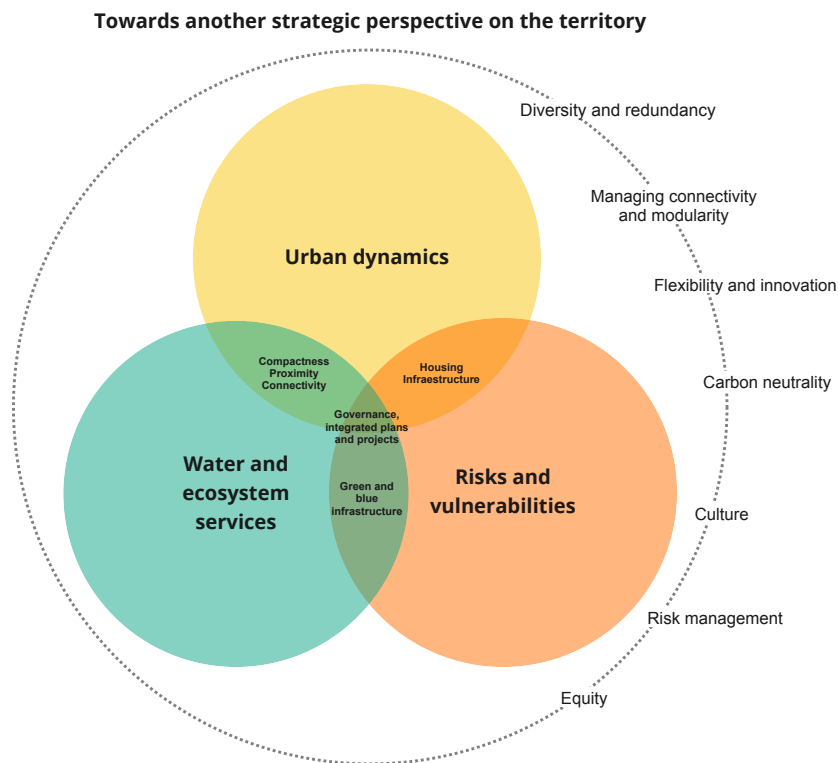


Figure 98 - Diagram illustrating another strategic perspective on the territory Source: prepared by the author

This inter-scalar dialogue and articulation must go beyond zoning and planning laws and unfold in integrative projects that articulates local needs and the climate issue. This scale, closer to local communities, should involve the participation of multiple actors in a process of co-creation and awareness of the need for interventions and the transformation of cities towards this new paradigm. As Heymans et al. (2019) point out, there are no universal solutions; different approaches and context-specific solutions should be considered, and plans and projects should be viewed as opportunities to promote cross-disciplinary integration and knowledge sharing among stakeholders.

Bringing the fringes into this debate means recognising the strategic importance of these areas and providing new development pathways for them. It is part of a larger discussion on sustainable transitions involving multiple disciplines and rethinking economic and urban development on a more regenerative and inclusive basis. Integrating planning scales and prioritising sustainable development in these areas is crucial as this encompasses important natural remnants and environmental protection zones that offer essential ecosystem services and offer opportunities for innovative infrastructure and built environment transformations.

The challenges facing these scenarios are immense, as they involve the restructuring of urban and regional planning and, at the same time, substantial socio-cultural changes, in addition to the profound inequalities of Brazilian cities. Therefore, the issue of equity must permeate all planning, since there is an important part of the population that is even more vulnerable to extreme events because they live in areas with a lack of infrastructure, which must be prioritised (Lemos, 2022).

In the context of Brazil, addressing the climate issue from a territorial perspective and encompassing transformations becomes essential. Currently, the existing urban climate policies focus predominantly on risk management, neglecting the dimension of territorial transformation needed to address climate challenges in an integrated manner.

To effectively address this complex issue, it is essential to promote the integration of different scales and actors, allowing for a comprehensive approach that takes into account the particularities of each region and collaboration between public and private sectors, local communities and non-governmental organisations. Only through this integrated approach will it be possible to achieve significant progress in building resilience in the face of the challenges faced by the country.

5.3 TRANSFERABILITY: CONTRIBUTIONS TO URBAN AND REGIONAL PLANNING AND OTHER AREAS OF KNOWLEDGE

At the beginning of the development of this research, the focus was on the metropolitan and regional scale and the role of ecosystem services played by natural remnants and protected areas in metropolitan fringe areas. As the research evolved, the results revealed two central transferability aspects in urban and regional planning: the issue of articulating different planning scales and the importance of context. In other words, the “solution” to the climate issue does not lie in a single instrument or scale of planning but in its articulations, which are strongly linked to the territorial, social and political context. These two main findings must permeate any transferability of the research.

With that said, in the area of urban and regional planning, the research contributes to the debates about transforming cities and regions towards resilient and ecological principles. By adopting a systemic perspective, the questions, insights, and discussions approached in the thesis are part of a broader debate on rethinking pathways of our development model, which acknowledge that our current mainstream model contributes to carbon dependency and consequently worsens the climate crisis.

A substantial part of the discussions about climate change and adaptation in Brazil is concentrated on infrastructure and housing provision, as a significant part of the population lives in precarious settlements and risk areas. As the case of Medellín illustrated and can be further developed, the urbanisation of these areas can go beyond housing provision and combine socio-economic development with a more ecological perspective, quality of life and innovative sustainable mobility modes.

As illustrated in the case of the São Paulo Metropolitan Region, the fringe areas and the metropolitan peripheries have been side-lined in proposals for sustainable development. Although there are some initiatives in São Paulo (capital city), such as the Connect the Dots Project and urbanisation of precarious settlements, these initiatives are primarily focused on the southern part of the municipality and lack a metropolitan scale and strategy.

In this respect, the discussion of metropolitan fringes as strategic areas for intervention and the examples and ideas discussed in this thesis can be valuable as starting points for discussions and proposals in other fringe areas of São Paulo Metropolitan Region, as well as other metropolitan fringes and peripheries in the Global South and beyond.

Focusing on transformative pathways and interconnecting multiple scales that unfold in territorial projects can guide cities in the transition to more resilient development. Bringing this discussion to the planning of metropolitan regions means understanding that these regions have been growing in population because they offer important economic, social, and cultural advantages for their populations, as engines of innovation. On the other hand, it also means recognising that many aspects of this fruitful model have to be reconsidered as there is a need to decarbonise different sectors such as economy, transport and building, and distri-

bute the benefits of this development more equitably.

A global metropolis such as São Paulo must think and develop pathways to address this transformation and include socially vulnerable populations in this transition. In the process of economic and urban growth of the São Paulo Metropolitan Region, many people were excluded from the benefits of the so-called formal city, and this population must be included in this city transformation.

In this sense, it is necessary to rethink large metropolitan regions and global cities. In this debate, the metropolitan fringes and peripheries of these large metropolises must be considered in regard to their deficiencies as well as their potential so that the inclusion of these territories and their inhabitants are part of this transition and to avoid a concentration of debates and actions only in the central areas of the capital.

This discussion is part of the debate on how to think about large metropolitan regions in a context of climate and urban crises. This work is not intended to provide all the answers, but to make a contribution from the perspective of urban and regional planning and by placing the metropolitan fringes at the centre of this debate.

The fact is that these regions need to be re-imagined based on new principles. With the COVID-19 pandemic and the advance of technologies, much has been thought about the possibility of teleworking and a possible migration of people who benefit from this modality to the countryside or smaller cities, with a higher quality of life and close to the capitals, on the fringes of the metropolises. Although this is still speculation, the fact is that these cities have grown in population in many contexts and it is necessary to think collectively about what model of cities we want, how to include different social groups, and how to reconcile conflicting visions in a new agenda.

Although the specific challenges and characteristics of metropolitan fringes may vary between regions, the underlying principles of resilience from the perspective of this work can be adapted to suit different urban environments. Furthermore, the contextualisation step detailed in Chapter 3 demonstrates the flexibility of the overall framework and provides insights into how it can be applied in other contexts.

Moreover, the feedback loop between empirical findings and theoretical frameworks constitutes an important aspect of transferability. The empirical observations of planning strategies obtained in the selected reference cases reverberate to contribute to the ongoing evolution of theoretical paradigms in the field of urban planning. Consequently, the transferability of this research lies not only in its practical implications but also in its potential to contribute to theoretical discussions in urban and regional planning, as well as its necessary transformations towards more sustainable and resilient models.

Due to the complexity of the topic, the implications of this study go beyond the scope of urban planning, permeating different disciplines as studies from different fields have been utilised in the construction of this research. The insights from this research have the potential to intersect with disciplines such as environmental science, ecology, landscape, public policy and geography, fostering a cross-fertilisation of ideas that transcend conventional disciplinary boundaries. The synthesis of planning principles articulated with resilience strategies resonates with broader sustainability discourses, where the search for a more regenerative model and the balance between human activities and natural resources remains a key concern.

5.4 LIMITATIONS OF THE RESEARCH AND AVENUES FOR FURTHER DEVELOPMENT

This qualitative research relies on theoretical reflections and practical examples, which has some limitations. The research design was cross-cutting in the sense that it adopted a systemic view and integrated different scales. By seeking to identify pathways towards resilience,

understanding urban systems as complex systems composed of multiple interdependent elements necessarily implied selectivity in the aspects addressed and in the stakeholders that were interviewed. Thus, the nuances of each dimension addressed were not fully explored.

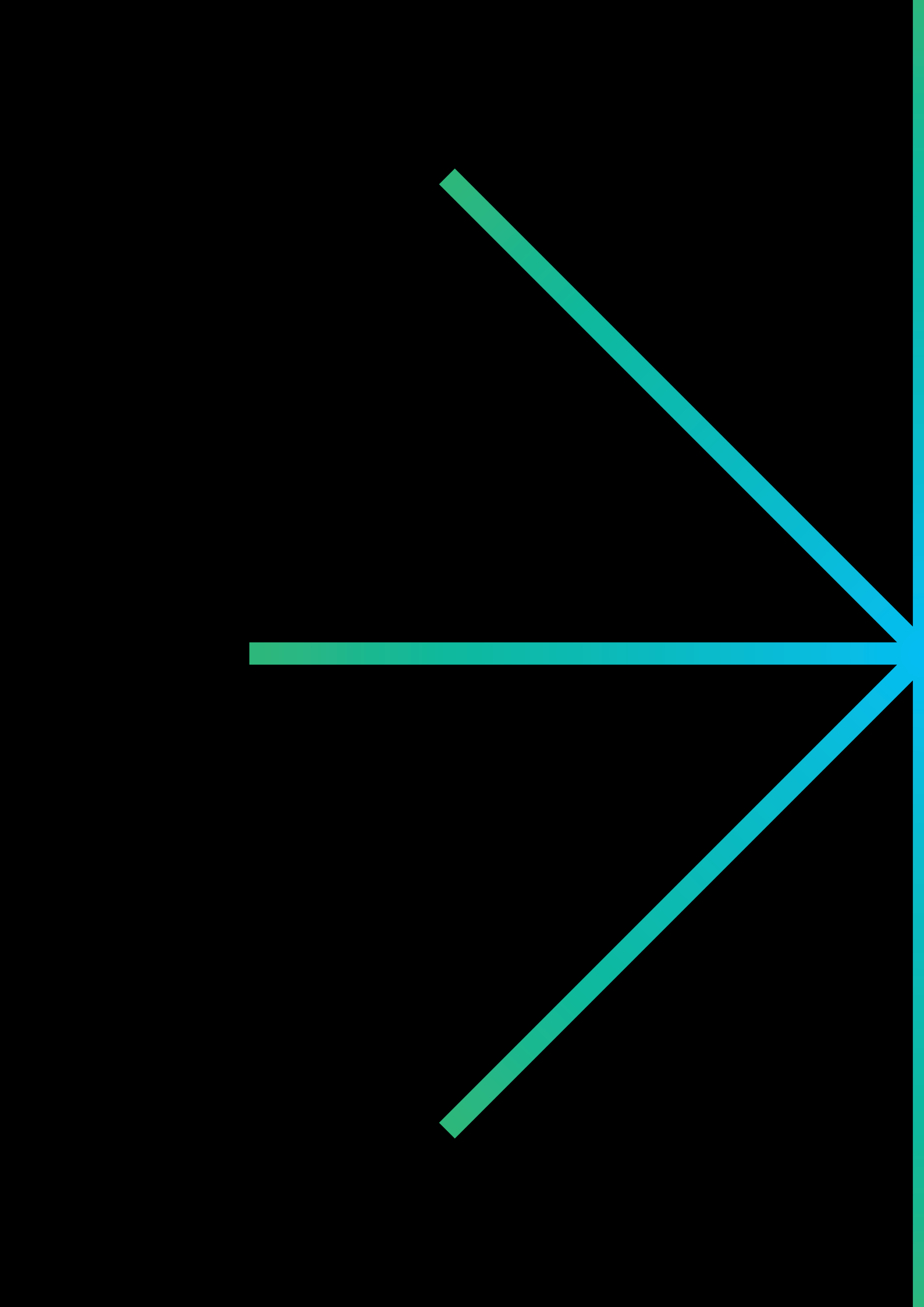
Second, the scope of the reference cases remained limited to a select number of case studies. The depth of analysis in these cases may therefore restrict the generalisability of findings to a broader spectrum of fringe metropolitan contexts. Expanding the empirical base through a wider selection of cases could increase the understanding of fringe dynamics and improve the research findings, which was not possible due to a time issue.

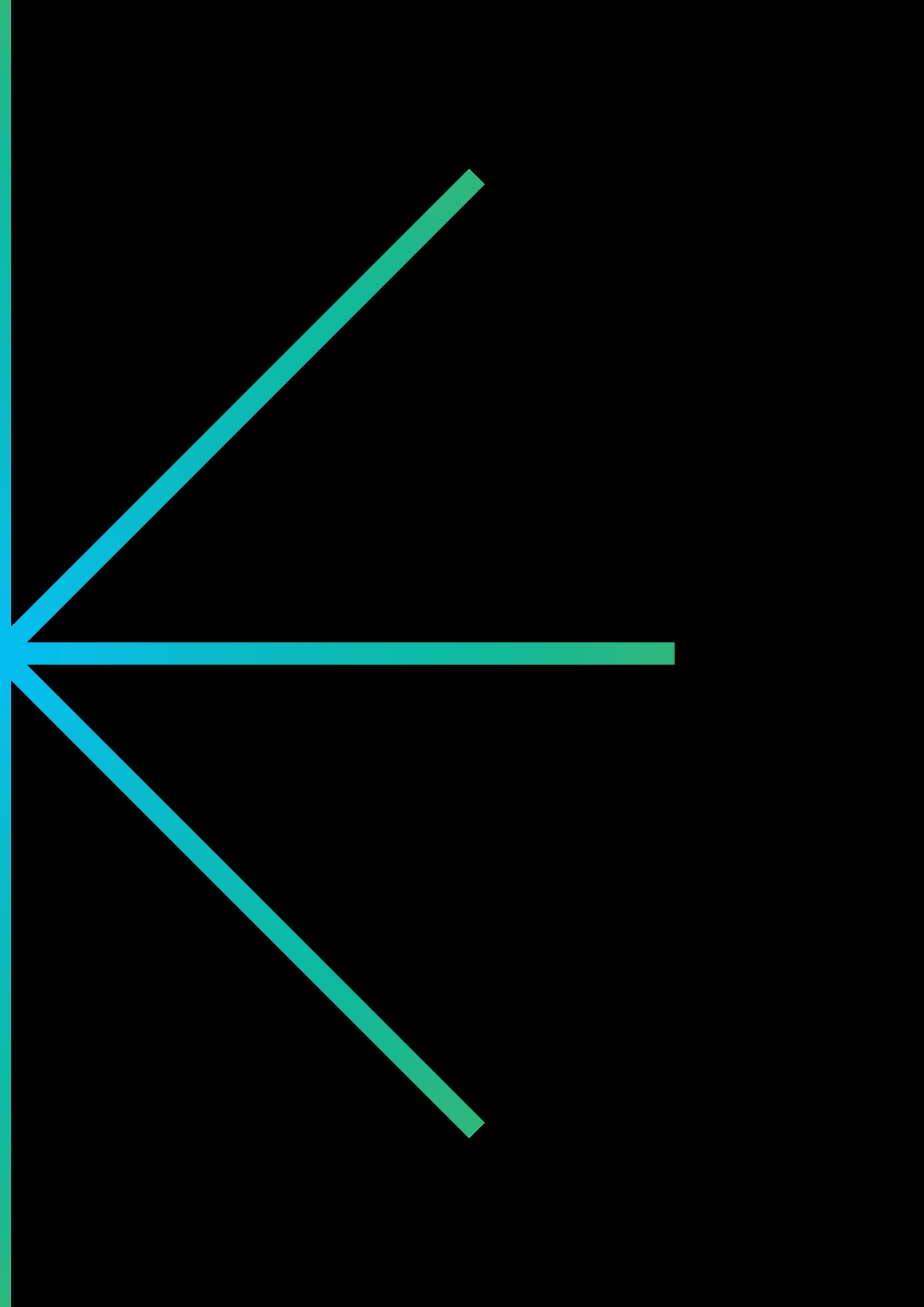
Thirdly, the characterisation of the sub-basin analysed was based on data from the 2010 census, which also represents an important limitation. As explained earlier, this was due to the postponement of the 2020 census in light of the COVID-19 pandemic, which was not released in time to be incorporated into this analysis. The lack of more recent data may affect the accuracy of this characterisation, since socio-economic conditions may have evolved since then. In addition, the analysis of the plans covered the period up to 2022 and changes in government policies and initiatives implemented after the transition of the Federal and State government were not incorporated into this study.

In this sense, more research is needed to address the analysed region, as well as other fringe areas. Some primary possible avenues for further research development are: investigating the environmental and climate impacts of urban expansion indicated in the Master Plans, urban design typologies for densification of already urbanised areas, nature-based solutions and parameters for infrastructure renewal, new pathways for sustainable economic development, decarbonisation, and financing models for urban interventions and planning institutions.

In addition, dealing with the climate issue presupposes dealing with the uncertainty of different trajectories that lie on our horizon, depending on the choices and transitions that will be taken forward. In this sense, research is needed at different levels to address these different trajectories related, for example, to extreme weather events scenarios and their multiple implications, especially in precarious settlements.

Several transformations related to this topic are needed, which makes the range of future research quite broad. Without pretending to exhaust the complexity of the topic and recognising that the issue addressed here is part of a challenge that must be faced in an inter- and transdisciplinary way, it is hoped that this research will open the way for new investigations on the fringes of the Metropolitan Region of São Paulo and other regions around the world.





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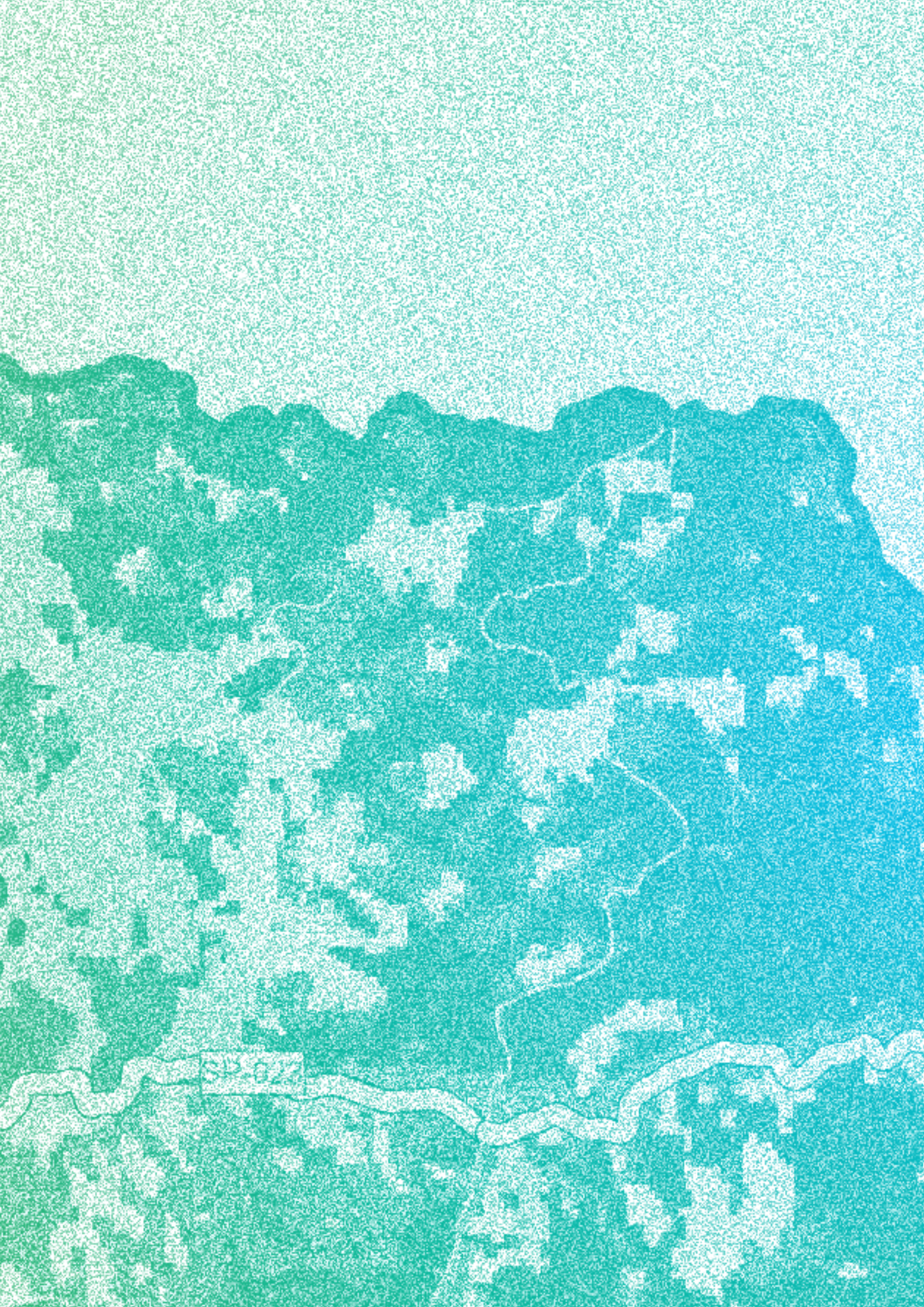
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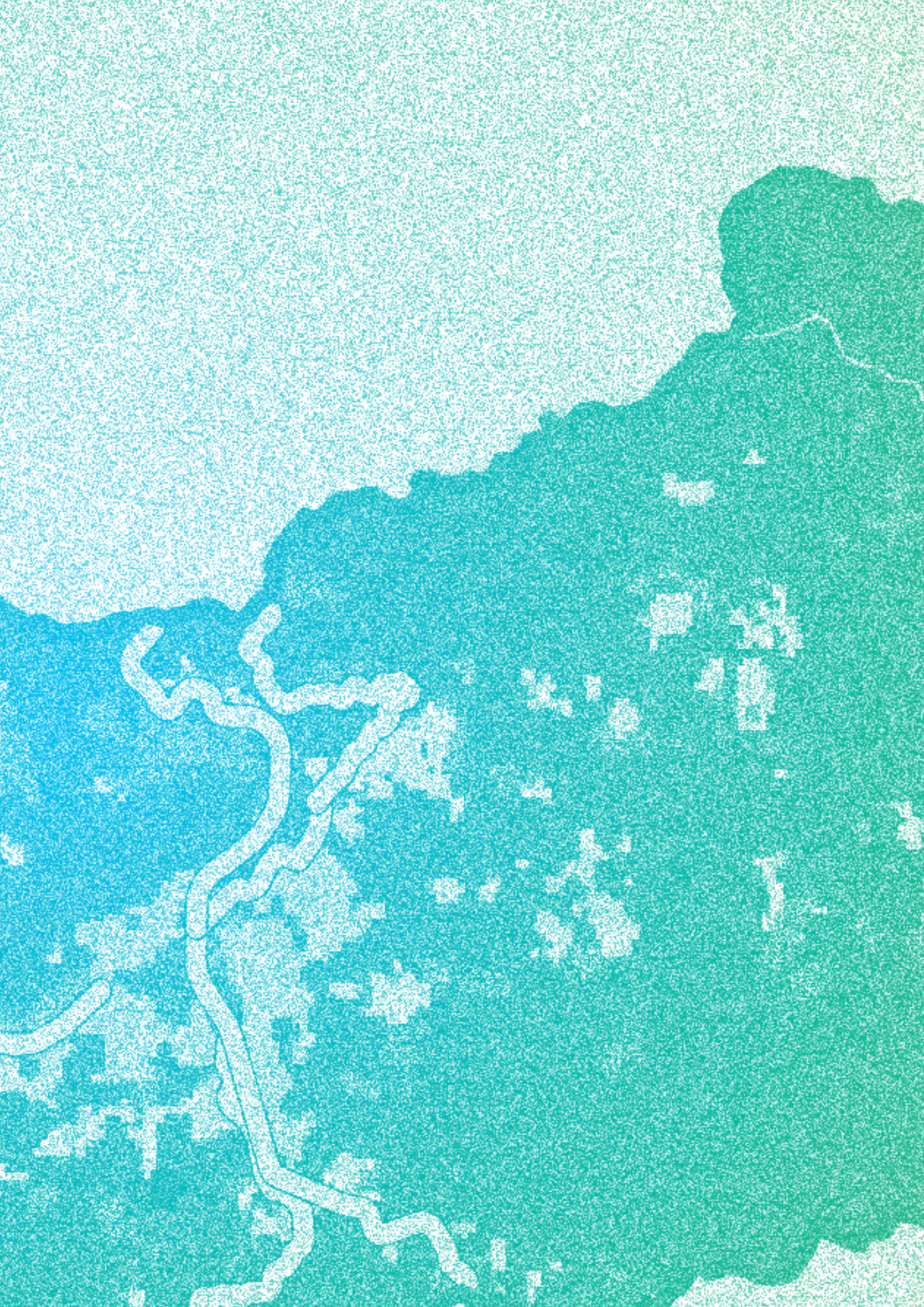
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Appendix

Appendix A – Informed Consent Form – TCLE

EXPLANATIONS

This is an invitation to participate in the research *“Planning paths for resilience through the integration of urban systems and ecosystems in metropolitan fringes: the case of São Paulo Metropolitan Region, Brazil”* - which has the responsible researcher ANGÉLICA TANUS BENATTI ALVIM and the DAAD and CAPES-PROEX doctoral scholar researcher ANDRESA LEDO MARQUES as conductors - through the activity of semi-structured interviews with professionals working at different levels of urban planning in the metropolitan regions of Barcelona, Paris and São Paulo.

The interviews are part of the methodology of a doctoral research project in progress in the Graduate Program in Architecture and Urbanism (PPGAU) of Mackenzie Presbyterian University and Leibniz Universität Hannover under the provisory title: *“Planning paths for resilience through the integration of urban systems and ecosystems in metropolitan fringes: the case of São Paulo Metropolitan Region, Brazil”*. The research is funded by Deutscher Akademischer Austauschdienst (DAAD) and the Programa de Excelência Acadêmica da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES-PROEX).

The aim of the interviews is to collect information and perspectives from professionals working in different positions and scales in urban planning in the analysed Metropolitan Regions (Barcelona, Paris, Medellín, and São Paulo) seeking to understand the main (1) political-administrative processes and structure, (2) guidelines, and (3) strategies of metropolitan planning for resilience that seek to integrate urban systems and ecosystems. To this end, professionals were chosen who perform management and/or coordination functions of public policies and projects in the field of urban planning that contribute to metropolitan resilience in a context of climate change. The analysis of the metropolitan adaptation plans of Barcelona and Paris serves as a basis for the formulation of a methodology for the evaluation of metropolitan fringes which will be contextualized and applied to the case of the Metropolitan Region of São Paulo. Thus, the activity of semi-structured interviews with professionals working in different levels of urban planning in these regions represents an important methodological step for a deeper understanding of the plans as well as for analysis and propositions for the case of São Paulo Metropolitan Region.

A question guide was prepared with the intention of guiding the interview and at the same time avoid excessive redundancies and any uneasiness to the interviewee. The interviews present “minimal risks” for the interviewee, as he/she will be in a safe environment of his/her choice, so as not to cause any type of inconvenience, nor possible risks related to the participant’s safety. The interview will last around 60 minutes.

You have the right to refuse to participate or to withdraw your consent at any stage of the research, without any harm to your person. If you decide to participate, the results will only be published in congresses or scientific publications and in the conclusions of the researcher’s doctorate, currently in progress. This data will be stored by the researcher responsible for this research in a safe place for a period of 5 years. To this end, you must sign the informed consent form.

This document has been printed in two copies, one of which will remain with you and the other with the researcher **ANDRESA LEDO MARQUES**.

Access to the research information will be made available after the final presentation of the doctoral thesis, according to the adoption of the information contained in the interviews offered to the researcher. The availability will be made through the dissemination of the publication channels and the institution’s thesis repository.

At any time during the entire research period, you may ask questions or report any unforeseen circumstances by contacting the researcher **ANDRESA LEDO MARQUES**, by phone – +49 176 82280939 –, or e-mail – andresa.ledo@hotmail.com, and with the Professor Dr. Angélica Tanus Benatti Alvim, by phone – +55 (11) 996567560-, or e-mail - angelica.alvim@mackenzie.br.

If you have any questions about the ethics of this research, you may contact the Committee on Ethics in Re-

search (CEP) of Mackenzie Presbyterian University, which is an “interdisciplinary collegiate, with a public mission, of a consultative, deliberative and educational nature, created to defend the interests of research participants in their integrity and dignity, and to contribute to the development of research within ethical standards”, located at Rua da Consolação, 896, Edifício João Calvino, 4.º andar, sala 400. Contact by phone +55 (11) 2766-7615, and e-mail cep@mackenzie.br. The opening hours of CEP are Mondays and Wednesdays from 15:00 to 18:00, and Tuesdays and Thursdays from 09:30 to 12:30 (no service on Fridays).

Free and Informed Consent

After having been clarified about the objectives, importance and the way the data will be collected in this research, besides knowing the risks, discomforts and benefits that it will bring to me and being aware of all my rights, I agree to participate in the Research “***Planning paths for resilience through the integration of urban systems and ecosystems in metropolitan fringes: the case of São Paulo Metropolitan Region, Brazil***” through the activity of semi-structured interviews with professionals who act in different levels of urban planning in the metropolitan regions of Barcelona, Paris and São Paulo, and authorize the disclosure of the information provided by me in congresses, scientific publications and in the results of the Research that will be presented to the Graduate Program in Architecture and Urbanism (PPGAU) of Mackenzie Presbyterian University for obtaining the title of Doctor in Architecture and Urbanism to ANDRESA LEDO MARQUES.

_____, _____ 2022.

Research participant’s signature: _____

Statement of the responsible researcher

As the researcher responsible for the research “***Planning paths for resilience through the integration of urban systems and ecosystems in metropolitan fringes: the case of São Paulo Metropolitan Region, Brazil***”, I declare that I take full responsibility to faithfully comply with the procedures methodologically and rights that have been clarified and ensured to the participant of this study. I also declare to be aware that in the inobservance of the commitment assumed herein I will be infringing the Federal Rules of Ethics, which regulate the research involving the human being.

_____, _____ 2022.

Name of the responsible researcher: _____

(011) 996567560, angelica.alvim@mackenzie.br . Rua Itambé, 185A, Edifício Professor Cristiano Stokler das Neves, Prédio 9, sala da diretoria, Higienópolis, São Paulo - SP, 01239-001. Contact by phone +55 (11) 21148383.

Responsible Researcher’s Signature: _____

Appendix B – Semi-structured Interview Roadmap

Metropolitan scale

- (1) Is the Metropolitan Region institutionalised by law? What is its governance model/structure?
- (2) Does the Metropolitan Region have an urban planning agency or body? What are its competences and how do they differ from or complement those of other levels?
- (3) What are the main metropolitan instruments related to adaptation and resilience to climate change? How are they articulated at different levels?
- (4) How do these instruments relate to urban policies?
- (5) How do municipalities adhere to the instruments and guidelines of metropolitan policy?
- (6) What are the main supports offered to metropolitan municipalities in terms of adaptation and resilience to climate change?
- (7) What are the main climate risks and the main strategies for the fringe areas?
- (8) What is the contribution of the metropolitan scale to the articulation of other planning scales?

Intermediate scale (focus fringe area)

- (1) What is the political-administrative configuration of the intermediate scale (e.g. consortium, agreement, committee, etc.)? What is its governance model/structure?
- (2) With regard to urban planning, what are its competences and how do they diverge from or complement the competences of other scales?
- (3) What are the main climate risks and what are the main instruments related to adaptation and resilience to climate change?
- (4) How do these instruments relate to urban policies? Is there any support from other planning levels? Who is responsible for drawing up projects?
- (5) How do municipalities adhere to the proposed instruments and guidelines?
- (6) What are the main strategies and projects related to adaptation and resilience to climate change?
- (7) What are the criteria for prioritising projects? Who are the main players involved?
- (8) How is monitoring carried out?

Municipal scale (focus fringe area)

- (1) Regarding urban planning, what are the municipal competences and how do they diverge from or complement the competences of other scales?
- (2) What are the main municipal instruments related to adaptation and resilience to climate change? How do they articulate with other planning scales?
- (3) How do these instruments relate to urban policies? Is there any support from other planning levels? Who is responsible for drawing up projects?
- (4) How do municipalities adhere to the instruments and guidelines proposed by other planning levels?
- (5) What are the main strategies and projects related to adaptation and resilience to climate change?
- (6) What are the criteria for prioritising projects? Who are the main players involved?
- (7) What are the main challenges in implementing urban projects?
- (8) How is monitoring carried out?

Project/intervention scale (focus fringe area)

- (1) What are the main objectives and guidelines of the urban project?
- (2) How do these objectives and guidelines contribute to and/or articulate with adaptation and resilience to climate change?
- (3) How does the project articulate with other planning scales?
- (4) Who were the main actors in drawing up the project? Who was responsible for drawing it up?
- (5) Where did the financial resources come from?
- (6) Who are the main beneficiaries?

Appendix C – Compatibility and simplification of municipal zoning

MUNICIPALITY	ORIGINAL ZONE LEGEND	ZONE LEGEND ATTRIBUTED
São Paulo (<i>Perus, Jaraguá, Anhanguera</i>)	ZPR - Predominantly Residential Zone	Residential – Low density
	ZER - Exclusively Residential Zone	
	ZM - Mixed Zone	Mixed uses
	ZEU - Urban Transformation Structuring Axis Zone	
	ZC - Centrality Zone	Commercial / Non-residential
	ZEIS - Special Social Interest Zone	Social interest
	ZEPAM - Special Environmental Protection Zone	Environmental interest
	ZEP - Special Preservation Zone	
	ZPDS - Zone of Preservation and Sustainable Development	
	ZPI - Predominantly Industrial Area	Industrial
ZOE - Special Occupation Zone	PIU-NESP	
Caieiras	ZPR 3 - Predominantly Low-Density Residential Zone	Residential – Low density
	ZPR 2 - Predominantly Medium Density Residential Zone	Residential – Medium density
	ZEIM - Special Metropolitan Interest Zone	
	ZPR 1 - Predominantly High-Density Residential Zone;	Residential – High density
	CCS - Commercial and Services Corridor	Comercial
	ZUD - Zone of Diversified Use	
	ZEIS - Special Social Interest Zone	Social interest
	ZEPARH - Special Environmental Protection and Water Resources Zone	Environmental interest
	ZEUC - Special Conservation Unit Zone	
	ZUPI 1 - Predominantly Industrial Use Zone	Industrial
	ZICS - Industrial and Sustainable Trade Zone	Sustainable Industry and Commerce
	ZESA - Special Environmental Sanitation Zone	Landfill
Franco da Rocha	ZCC - Condominium and Farming Area	Residential – Low density
	ZPR - Predominantly Residential Zone	Residential – Medium density
	ZD - Development Zone	Comercial
	ZM - Mixed Zone	Mixed uses
	ZEIS - Special Social Interest Zone	Social interest
	ZAF - Family Agriculture Zone	Rural / Agricultural
	ZUR - Rural Use Zone	
	ZIA - Environmental Interest Zone	Environmental interest
	ZIN - Institutional Area	Institutional
Francisco Morato	AUD - Area of Differentiated Urbanization	Residential – Low density
	CAED - Corridor of Diversified Economic Activities	Comercial
	ZEUC - Controlled Urban Expansion	Mixed uses
	ZQU - Urban Qualification	
	ZVC - Downtown Upgrading	
	ZEIS - Special Social Interest Zone	Social interest
	ZAC - Flood Damping	Environmental interest
	ZECP - Special Area of Permanent Preservation	
	ZEPP - Special Area of Permanent Preservation	
	ZERA - Special Environmental Recovery Area	
	ZI - Industrial Area	Industrial
	ZUD - Diversified Use Zone	
	ZPRb - Area of Predominated Use	Cultural interest

Continue

Francisco Morato	AUD - Area of Differentiated Urbanization	Residential – Low density
	CAED - Corridor of Diversified Economic Activities	Comercial
	ZEUC - Controlled Urban Expansion	Mixed uses
	ZQU - Urban Qualification	
	ZVC - Downtown Upgrading	
	ZEIS - Special Social Interest Zone	Social interest
	ZAC - Flood Damping	Environmental interest
	ZECP - Special Area of Permanent Preservation	
	ZEPP - Special Area of Permanent Preservation	
	ZERA - Special Environmental Recovery Area	
	ZI - Industrial Area	Industrial
	ZUD - Diversified Use Zone	
	ZPRb - Area of Predominated Use	Cultural interest
	Mairiporã	ZPRb - Predominantly Low-Density Residential Use Zone
ZPRm - Predominantly Residential Use Zone with Medium Density		Residential – Medium density
ZPRa - Predominantly Residential Use Zone with High Density		Residential – High density
ZUDEM - Zone of Diversified Uses in Springs		Comercial
ZC - Centrality Zone		Mixed uses
ZAC - Zone of Densification and Connection		
ZEDEC - Special Zone for the Development of Economic and Cultural Activities		
ZEIS - Special Social Interest Zone		Social interest
ZATE - Environmental Area for Ecological Tourism		Tourism
ZAPP - Environmental Area for Landscape Preservation		Environmental interest
ZPA - Environmental Protection Area		
Cajamar	ZER 1 - Exclusively Low-Density Residential Area	Residential – Low density
	ZER 2 - Exclusively Medium Density Residential Area	Residential – Medium density
	ZER 3 - Exclusively High-Density Residential Zone	Residential – High density
	ZUI - Intelligent Urban Area	Mixed uses
	ZMU - Mixed Urban Area	
	ZEIS - Special Social Interest Zone	Social interest
	Rural Zone	Rural / Agricultural
	ZIA - Zone of Environmental Interest	Environmental interest
	ZAE 1 - Special Environmental Protection Area	
	ZAE 2 - Environmental Special Zone of Springs	
	ZMI - Mining Zone	Mining
	ZUPI - Predominantly Industrial Area	Industrial
	Cultural Zone	Cultural interest

Appendix D – Summary of the analytical framework applied to the selected plans

Plan	Integrated Urban Development Plan of the São Paulo Metropolitan Region (PDUI-RMSP). Available at: https://rmsp.pdui.sp.gov.br/wp-content/uploads/rmsp_docs_pdui_0016_cader-no_final_de_propostas.pdf (Accessed on September 21, 2023).
Year	2019
Law	The plan has yet to be passed into the realm of law.
Political-administrative limit	São Paulo Metropolitan Region

URBAN DYNAMICS		
	Elements	Summary of coded segments
Ecological	Environmental Protected Areas	Protect and conserve environmental protection areas, permanent protection areas and water sources.
	Green leisure and recreational areas - ecological connectivity	Setting up a metropolitan system of green and protected areas, connecting existing green areas in the metropolis or expanding areas of environmental interest. Encourage the creation and strengthen the management of parks and green areas, promoting an increase in supply and improved accessibility to leisure, recreation and education facilities.
	Eco-tourism	Develop tourism activities in the RMSP. Community-based ecotourism and the management of small forest resources. Promote ecotourism activities, scientific research, recreation, leisure and activities associated with environmental education.
	Agroecology / Agriculture	Develop a plan to support and encourage agricultural and farming activities that promote food and environmental security, as well as sustainable development, including urban and peri-urban agriculture.
Urban	Centralities	Structuring a metropolitan network of urban centralities that induces the decentralisation of employment, commerce and services, both public and private, reducing dependence on the expanded centre of the city of São Paulo. Strengthen the System of Centralities in the Diversification and Densification Macrozone.
	Avoid urban sprawl	Mediate the conflicting interests between urban expansion, environmental preservation and economic development. Contain the expansion of urban areas over conservation units and protected areas, especially those protecting water sources and sustainable agricultural production.
	Reorganising built-up areas	Prioritise densification in areas with urban infrastructure and increase access to basic sanitation networks in poor areas. Enabling land-use planning for the development of a compact, less unequal, non-fragmented and more socially integrated metropolis. Control the process of urban densification so as not to overload local infrastructure and service systems. Complement investments in infrastructure and equipment where necessary.
	Proximity - Spatial distribution of public facilities and services	Promote occupation, densification and mixed use, through urban planning instruments, in the areas served by the medium and high-capacity transport network. Promote the transformation and diversification of urban uses.
	Compactness	Intensify urban densification and contain peripheral urban sprawl, with a view to reducing pressure on environmentally fragile areas and rural areas.
	Zero/Low emissions zone	-
	Connectivity and Accessibility	Promoting perimeter links that connect centralities, centres and hubs of economic activity. Implement municipal and inter-municipal public transport services as an integrated network and promote fare integration of services. Increase accessibility by public transport in areas with high population density or in those where densification will be promoted. Several of the guidelines for the northern region are related to transport and mobility, both the upgrading and creation of roads and the implementation of cycle paths and trams.
	Energy-efficient Construction and Renovation	-
	Diversity of mobility modes (low carbon)	Prioritise public transport, encourage the integration of individual and public transport and stimulate active modes (walking and cycling). Implementation of the urban-tourist Light Rail Vehicle (LRV) on the Caieiras-Barueri (urban) / Pirapora do Bom Jesus (tourist) sections, Construction of the Nova Tenente Marques, integrated into the Revitalisation Project for the former Perus-Pirapora Railway, with the creation of a LRV (Cajamar - São Paulo - CPTM Perus) and Creation of a bus corridor between the Terra Preta/ Mairiporã district and Franco da Rocha/Francisco Morato. Creation of a (direct) bus line between the cities of Cajamar (Polo Industrial) and Francisco Morato.
	Diversity of energy sources	Contribute to mitigating and adapting to climate change by increasing the share of renewable sources in the metropolis' energy matrix.

Continue

Socioeconomic	Professional Qualification and Education	Strengthening the innovation environment as a factor in economic development and the continuous improvement of professional qualifications.
	Employment and income generation connected to green and sustainable economy.	Strengthening metropolitan competitive advantages. Improve productive activities in line with the new paradigms of sustainability, technological progress and social justice. Encouraging the development of the green economy and labour markets based on the sustainable use and recovery of the environment.
	Affordable and social house	Promote social housing in areas with infrastructure and reduced environmental risk.

WATER AND ECOSYSTEM SERVICES		
	Elements	Summary of coded segments
Ecological	Recovery of environmentally degraded areas	Promote the environmental recovery of degraded areas, especially in the Environmental Protection Macrozone. Develop environmental recovery actions in areas located in valley bottoms and drainage headwaters.
	Ecological connectivity and urban greenery that articulate different scales	Setting up a metropolitan system of green and protected areas, connecting existing green areas in the metropolis or expanding areas of environmental interest. Expand and upgrade public spaces, green and permeable areas.
	Environmental protection of riverbanks	Preserving, conserving and restoring Permanent Preservation Areas (PPAs) and other protected areas, adequately linking the water network, remaining vegetation and the built environment.
	Local food production	Promote the implementation of multifunctional agricultural landscapes, making production systems vectors for environmental conservation. Develop a plan to support and encourage agricultural and farming activities that promote food and environmental security, as well as sustainable development, including urban and peri-urban agriculture.
	Renaturalisation / Restoration of River-banks	Preserving, conserving and restoring Permanent Preservation Areas (PPAs) and other protected areas, adequately linking the water network, remaining vegetation and the built environment.
	Protect green areas	Protect and conserve environmental protection areas, permanent protection areas and water sources.
	Protect the spring areas	Protecting areas of environmental interest, guaranteeing the maintenance of biodiversity and the availability and quality of water resources.
	Rainwater Infiltration	Maintenance and conservation of rural roads, ensuring adequate rainwater drainage and soil permeability. Creation and implementation of a system for registering areas of regional interest for recovery and implementation of non-structural measures, integrated with the system of green areas and protected areas, aimed, among other things, at increasing soil permeability.
	Access to quality green spaces	Encourage the creation and strengthen the management of parks and green areas, promoting an increase in supply and improved accessibility to public leisure, recreation and education facilities.
	Depollution of water bodies	-
	Water reuse	Encouraging the reuse and rational use of water through environmental education, communication, awareness-raising and social mobilisation.
Urban	Waste Management and Recycling	Encourage regional solutions for the treatment of solid waste and the environmentally appropriate final disposal of waste.
	Sewage supply	Prioritise, in environmental sanitation actions, the critical sub-basins with regard to water quality in the Areas for the Protection and Recovery of Springs (APRM). Ensuring planning, shared management, social control and decentralised implementation models in the universalisation of basic sanitation.
	Water supply	
Socioeconomic	Environmental Education and Awareness	Promote environmental education activities, especially in the Macro Area of Environmental Interest. Formulating programmes to raise awareness and provide information about climate change.
	Foster creative industries in this area	Encouraging the development of the green economy and labour markets based on the sustainable use and recovery of the environment. Develop tourism activities in the RMSA.
	Professional Qualification and Job Creation	Promote instruments for the socio-economic sustainability of environmental assets, including, among others, remuneration and financial compensation for protected areas that produce water.

RISKS AND VULNERABILITIES		
	Elements	Summary of coded segments
Ecological	Depollution of water bodies	
	Renaturalisation / protection of riverbanks	Preserving, conserving and restoring Permanent Preservation Areas (PPAs) and other protected areas, adequately linking the water network, remaining vegetation and the built environment.
	Afforestation	
	Wetlands	
	Multifunctional NbS (Parks, leisure, recreational and agricultural areas)	There is no mention of nature-based solutions, only the implementation of a Metropolitan Green Area System.
Urban	Prevent the occupation of risk areas	Restrict the expansion of occupation in accordance with risk mapping and areas susceptible to the occurrence of major landslides, sudden floods or related geological or hydrological processes, and follow the recommendations of geotechnical maps of suitability for urbanisation.
	Manage occupied risk areas	Promote urban regeneration and environmental recovery in areas of vulnerability and risk through integrated action in environmental risk management, strengthening prevention in areas susceptible to disasters. Implementation and coordination of risk management and natural disaster prevention policies. Inter-federative coordination to reduce socio-environmental vulnerability and disaster risk management.
	Urbanisation of Precarious Settlements	Implementation and coordination of policies for the qualification and requalification of urban spaces, with the aim of promoting the urbanisation and land regularisation of precarious settlements, providing them with services, equipment and urban infrastructure, and guaranteeing the recovery of urban and environmental quality.
	Resettlement of the population in risk areas	Reducing the occupation of areas with geological-geotechnical risks, flooding and contaminated soils, including prioritising the territories of water sources, accompanied by the prevention of the emergence of new situations of vulnerability and a resettlement policy. housing.
	Adaptation of existing built-stock to estimated temperature	-
	Adaptation of the Infrastructure Network to New Climate Projections	There is no mention of adapting urban infrastructure to the new climate conditions, only the provision of infrastructure, such as macro-drainage solutions, combining structural and non-structural measures.
Socioeconomic	Participation and Awareness	Create a Risk Communication and Education Programme for the training and technical capacity building of human resources from city halls, education systems, civil society in general and other related bodies.
	Affordable and social housing	Promote social housing in areas with infrastructure and reduced environmental risk.
Governance	Monitoring	Metropolitan Planning and Management System Thematic Chamber for Plan Management Creation of a metropolitan data and information system for the planning and territorial management of the RMSP, as well as for permanent monitoring of the implementation of the goals, projects and actions of the PDUI-RMSP.
	Actors involved	Civil society, public managers, organisations and universities.
	Technical support	Develop regional support for housing and regional information systems on georeferenced platforms, capable of integrating dispersed data in a standardised way and contributing to the coordination and prioritisation of actions.
	Financial support	Improve the governance structure and inter-federative funding mechanisms. Expand the sources of contributions to the RMSP Development Fund, including sources earmarked for the high-capacity public transport network.
	Cooperation with other planning scales	Inter-federative and inter-municipal co-operation is constantly mentioned.
	Coordination and secretariats involved	Coordination: EMPLASA (PDUI-RMSP) Intersectoral

Plan	Strategic Masterplan for the Municipality of São Paulo. Available at: https://gestaourbana.prefeitura.sp.gov.br/wp-content/uploads/2015/01/Plano-Diretor-Estrat%C3%A9gico-Lei-n%C2%BA-16.050-de-31-de-julho-de-2014-Texto-da-lei-ilustrado.pdf . (Accessed on September 21, 2023).
Year	2014
Law	Law 16.050/2014
Political-administrative limit	São Paulo (Municipality)

URBAN DYNAMICS		
	Elements	Summary of coded segments
Ecological	Environmental Protected Areas	It reinserts rural areas in the municipality and creates the Environmental Protection and Recovery Macrozone and Environmental Zones, such as the Special Environmental Protection Zone (ZEPAM), the Preservation and Sustainable Development Zones (ZPDS) and the Special Preservation Zone (ZEP).
	Green leisure and recreational areas - ecological connectivity	Increasing the number of parks in the city: 167 proposed parks, added to the 105 that already exist. Creation of a system of protected areas, green areas and open spaces. Articulation of pedestrian and cycle paths, preferably in valley bottoms, significant green areas, open spaces and urban and linear parks;
	Eco-tourism	The PDE recognises the need for new dynamics in the city's peri-urban areas as well as the environmental importance of these areas. For this reason, it re-establishes municipal rural areas based on a multifunctional concept, in which these areas contribute to environmental preservation, food production, ecotourism and environmental education.
	Agroecology / Agriculture	
Urban	Centralities	Qualifying existing centralities and stimulating the creation of new centralities by increasing the supply of shops, services and jobs, especially in the Urban Vulnerability Reduction Macro Area and the Vulnerability Reduction and Environmental Recovery Macro Area.
	Avoid urban sprawl	Containment of urban sprawl over areas of environmental interest and the protection and recovery of water sources and areas of sustainable agricultural production.
	Reorganising built-up areas	Expand the network of urban and social facilities: education, health, sports, culture, social assistance and food security. Encourage non-residential uses in the Urban Transformation Structuring Axes and neighbourhood centralities, to create jobs and reduce the distance between home and work.
	Proximity - Spatial distribution of public facilities and services	
	Compactness	Promote densification of housing and urban activities along the public transport system.
	Zero/Low emissions zone	-
	Connectivity and Accessibility	Increasing and qualifying the supply of different public transport systems, linking them to non-motorised modes of transport and promoting improvements in the urban and environmental quality of the surroundings. Discourage the use of individual motorised transport.
	Energy-efficient Construction and Renovation	Use of renewable energies, energy efficiency and energy cogeneration Create, by specific law, tax and urban planning incentives for sustainable construction, including the renovation of existing buildings.
	Diversity of mobility modes (low carbon)	Improving and complementing the urban mobility system, with integration between public transport, road, cycle, waterway and pedestrian circulation systems, providing it with suitable conditions for universal accessibility and appropriate signposting. Encourage the use of electric or hydrogen-powered vehicles to reduce GHG emissions.
Diversity of energy sources	Promoting energy efficiency programmes, energy cogeneration and renewable energies in buildings, public lighting and transport.	
Socioeconomic	Professional Qualification and Education	
	Employment and income generation connected to green and sustainable economy.	Leveraging the creative capacity, scientific and technological knowledge and innovation that exist in the municipality to generate high value-added and environmentally sustainable economic activities. Creative Economy Hubs in the Territories of Interest for Culture and Landscape (there is one in the study region: TICP Jaraguá/Perus). Implementation of the New São Paulo Warehouse (NESP) and industrial and logistics corridor.
	Affordable and social house	Encouraging the provision of social housing for the low and middle-income population in order to bring housing closer to employment.

WATER AND ECOSYSTEM SERVICES		
	Elements	Summary of coded segments
Ecological	Recovery of environmentally degraded areas	Restoring the quality of existing environmental systems, especially rivers, streams and vegetated areas, linking them appropriately with urban systems.
	Ecological connectivity and urban greenery that articulate different scales	It reinserts rural areas in the municipality and creates the Environmental Protection and Recovery Macrozone and Environmental Zones, such as the Special Environmental Protection Zone (ZEPAM) and the Special Preservation Zone (ZEP). Increases the number of parks in the city: 167 proposed parks, added to the 105 that already exist.
	Environmental protection of riverbanks	
	Local food production	Stimulating family, urban and peri-urban agriculture, encouraging organic farming and reducing the use of pesticides.
	Renaturalisation / Restoration of Riverbanks	Urban interventions in valley bottoms, combining sanitation, drainage, linear parks and slum upgrading (valley bottom recovery programme).
	Protect green areas	Protection of environmental protection areas and water sources. Creation of the Environmental Protection and Recovery Macrozone and Environmental Zones, such as the Special Environmental Protection Zone (ZEPAM) and the Special Preservation Zone (ZEP).
	Protect the spring areas	
	Rainwater Infiltration	Expansion of permeable areas along valley bottoms and drainage headwaters, significant green areas and afforestation, especially in the Urban Structuring and Qualification Macrozone.
	Access to quality green spaces	Increasing the number of parks in the city: 167 proposed parks, added to the 105 that already exist. Improve the ratio of green areas per inhabitant of the municipality. Creation of a system of protected areas, green areas and open spaces.
	Depollution of water bodies	Urban interventions in valley bottoms, combining sanitation, drainage, linear parks and slum upgrading (valley bottom recovery programme).
	Water reuse	
Urban	Waste Management and Recycling	Selective collection of solid waste and local processing of organic waste. Waste drop-off points obliged to reverse logistics. Setting up Ecoparks (one is planned in Perus).
	Sewage supply	Universalisation of the Environmental Sanitation System, which comprises water supply, sewage, drainage and integrated solid waste management systems. Eliminate the discharge of sewage into watercourses and the drainage and rainwater collection system, contributing to the recovery of rivers, streams and reservoirs.
	Water supply	
Socioeconomic	Environmental Education and Awareness	Encourage the adoption of habits, customs and practices aimed at protecting environmental resources. Encourage environmental education activities, with an emphasis on solid waste management.
	Foster creative industries in this area	Promotion of economic activities compatible with sustainable development. Sustainable rural economic development centre. Promoting sustainable development in rural areas by supporting family farming, especially organic farming, and sustainable tourism, especially community-based tourism.
	Professional Qualification and Job Creation	Poles of sustainable rural development: promoting economic activities and creating jobs in rural areas.

RISKS AND VULNERABILITIES		
	Elements	Summary of coded segments
Ecological	Depollution of water bodies	Urban interventions in valley bottoms, combining sanitation, drainage, linear parks and slum upgrading (valley bottom recovery programme).
	Renaturalisation / protection of riverbanks	
	Afforestation	
	Wetlands	
	Multifunctional NbS (Parks, leisure, recreational and agricultural areas)	Nature-based solutions are not mentioned, but the expansion of permeable areas along valley bottoms and drainage headwaters, significant green areas and afforestation are mentioned, especially in the Urban Structuring and Qualification Macrozone.
Urban	Prevent the occupation of risk areas	Preventing the formation of new risk areas by means of urbanisation and building guidelines that are compatible with the potential and restrictions of the physical environment.
	Manage occupied risk areas	Elimination and reduction of situations of urban vulnerability that expose various social groups, especially those on low incomes, to situations of risk, danger and threat. Contribute to minimising the effects of heat islands and soil sealing.
	Urbanisation of Precarious Settlements	Promoting the urbanisation and land regularisation of precarious and irregular settlements occupied by the low-income population with adequate provision of urban services, facilities and infrastructure.
	Resettlement of the population in risk areas	Construction of Social Interest Housing for the resettlement of people living in risk areas, permanent preservation areas, when there is no other alternative, and those living in precarious settlements in the Environmental Protection Macrozone.
	Adaptation of existing built-stock to estimated temperature	Contribute to minimising the effects of heat islands and soil sealing.
	Adaptation of the Infrastructure Network to New Climate Projections	

Continue

Socioeconomic	Participation and Awareness	Adopt participatory instruments throughout the development cycle of risk reduction programmes and actions. Protecting the population in risk areas by preparing for disasters. Disseminate information on risk areas and the occurrence of extreme events. Participatory monitoring of areas susceptible to disasters and risks involving residents and community leaders, including the structuring of Civil Defence Centres (NUDEC).
	Affordable and social housing	Urbanisation of precarious settlements and land regularisation. Encouraging the provision of social housing for the low and middle-income population in order to bring housing closer to employment.
Governance	Monitoring	The plan provides for monitoring and follow-up through the regulation of the PDE Monitoring System.
	Actors involved	Civil society, public managers, organisations and universities.
	Technical support	Develop regional support for housing and regional information systems on georeferenced platforms, capable of integrating dispersed data in a standardised way and contributing to the coordination and prioritisation of actions.
	Financial support	Urban Development Fund (FUNDURB) - Intended for investment in urban improvements of a distributive nature, such as Social Interest Housing, Social Facilities, Cultural Heritage, Green Areas, Environmental Conservation Units, Public Spaces, Neighbourhood Plans, Collective Public Transport, Cycling System and Pedestrian Circulation System.
	Cooperation with other planning scales	Articulation between municipal, state and federal bodies and organisations to guarantee urban and environmental conservation, preservation and recovery, including integrated territorial monitoring. Articulation, within the framework of the River Basin Committees, of joint conservation, recovery and environmental inspection actions between the municipalities of the Metropolitan Region and the State Environment Secretariat. Articulate, together with the municipalities of the São Paulo Metropolitan Region, integrated policies for the reduction and eradication of risks in areas close to or located on the inter-municipal boundaries. Promote the exchange of municipal, state and federal information on risks.
	Coordination and secretariats involved	Ensure that the sectoral plans set out in the Strategic Masterplan are articulated in a transversal and intersectoral manner.

Plan	Climate Action Plan for the Municipality of São Paulo 2020-2050. https://www.prefeitura.sp.gov.br/cidade/secretarias/upload/governo/secretaria_executiva_de_mudancas_climaticas/arquivos/planclimasp/PlanClimaSP_BaixaResolucao.pdf . Accessed: 4 oct. 2022.
Year	2021
Law	Decree No. 60.289 of 3 June 2021. Available at: https://legislacao.prefeitura.sp.gov.br/leis/decreto-60289-de-3-de-junho-de-2021
Political-administrative limit	São Paulo (Municipality)

URBAN DYNAMICS		
	Elements	Summary of coded segments
Ecological	Environmental Protected Areas	Strengthen the means and instruments for conserving biodiversity, natural capital and ecosystem and environmental services. Conservation and Recovery of the Atlantic Forest.
	Green leisure and recreational areas - ecological connectivity	Connect parks, squares and other green areas by planting native tree species that are attractive to wildlife species that provide pollination and seed dispersal services.
	Eco-tourism	Ecological/rural tourism (Sampa+Rural Platform)
	Agroecology / Agriculture	To strengthen environmentally and socially sustainable economic activities in the rural areas of the municipality of São Paulo, especially local, family and organic food production.
Urban	Centralities	Making the Urban Structuring Axes viable, avoiding urban sprawl and promoting densification in areas close to the transport offer and bringing work and housing closer together. Encouraging the reduction of home-work distances in order to minimise the demand for transport services.
	Avoid urban sprawl	
	Reorganising built-up areas	
	Proximity - Spatial distribution of public facilities and services	
	Compactness	
	Zero/Low emissions zone	To legally establish and signpost a Zero Emission Zone in the Municipality of São Paulo. Establish a Zero Emission Zone on the perimeter of the Minianel Viário
	Connectivity and Accessibility	
	Energy-efficient Construction and Renovation	Include energy efficiency criteria in buildings in the Building and Construction Code. Expand energy efficiency renovations and improvements to the city's entire building portfolio.
	Diversity of mobility modes (low carbon)	Promoting active mobility and zero emissions Encouraging the use of bicycles as a common means of transport, through the expansion of infrastructure and awareness-raising and communication strategies Upgrading public road spaces to favour walkability. 100% of municipal buses with zero emissions (Law 16.802/2018)
Diversity of energy sources	Mobilise efforts to promote the production and distribution of energy from renewable sources and distributed generation, as well as improving the energy efficiency of equipment.	
Socioeconomic	Professional Qualification and Education	Technical training for farmers and the strengthening of value chains.
	Employment and income generation connected to green and sustainable economy.	To mobilise efforts to promote socio-economic development and improve the quality of life in the Municipality of São Paulo from the perspective of a circular economy and zero carbon. Organic and agro-ecological agriculture in rural areas, through technical training for farmers and the strengthening of value chains.
	Affordable and social house	To promote the construction of social housing under improved standards of natural ventilation and lighting in the Municipality of São Paulo.

WATER AND ECOSYSTEM SERVICES		
	Elements	Summary of coded segments
Ecological	Recovery of environmentally degraded areas	Implementation of the Municipal Plan for the Conservation and Recovery of Areas that Provide Environmental Services.
	Ecological connectivity and urban greenery that articulate different scales	Identify potential and priority public places with a vocation for nature-based solutions (SbN) projects and incorporate them into the programme. these practices in public drainage works.
	Environmental protection of riverbanks	Protect and requalify springs and watercourses.
	Local food production	Promoting organic and agroecological agriculture in rural areas.
	Renaturalisation / Restoration of Riverbanks	Protect and requalify springs and watercourses.
	Protect green areas	Strengthen the means and instruments for conserving biodiversity, natural capital and ecosystem and environmental services. Conservation and Recovery of the Atlantic Forest.
	Protect the spring areas	
	Rainwater Infiltration	Increase the permeable area of new and existing public facilities and spaces.
	Access to quality green spaces	
	Depollution of water bodies	Cleaning up streams - Clean Stream Programme.
	Water reuse	Increasing the implementation of the Municipal Programme for the Conservation and Rational Use of Reuse Water in Buildings.

Urban	Waste Management and Recycling	Universalise coverage of the selective dry waste collection service. Maximise composting processes. Setting up Ecoparks ⁷⁴ (one is planned in Perus).
	Sewage supply	Universalisation of sewage treatment.
	Water supply	
Socioeconomic	Environmental Education and Awareness	Preparation and implementation of the Municipal Environmental Education Programme, including climate change.
	Foster creative industries in this area	Organic and agro-ecological agriculture in rural areas, through technical training for farmers and the strengthening of value chains. Community-based entrepreneurship and co-operatives.
	Professional Qualification and Job Creation	

RISKS AND VULNERABILITIES		
	Elements	Summary of coded segments
Ecological	Depollution of water bodies	Follow up on the Clean Stream Programme.
	Renaturalisation / protection of riverbanks	Draw up a plan for the protection and requalification of springs and watercourses.
	Afforestation	Promote the planting of native trees that are resilient to climate change in order to protect biodiversity and improve thermal comfort in the city. Increase the provision of ecosystem services by afforestation, such as thermal comfort, increased air humidity, protection of fauna, etc.
	Wetlands	
	Multifunctional NbS (Parks, leisure, recreational and agricultural areas)	Identify potential and priority public places with a vocation for nature-based solutions (SbN) projects and incorporate them into the programme. these practices in public drainage works.
Urban	Prevent the occupation of risk areas	Map critical flood zones, taking into account the occurrence of extreme climatic events and with a view to incorporating them into the Land Use and Occupation Law.
	Manage occupied risk areas	Strengthen the governance of the Municipal Civil Defence System for intersectoral and transversal management of risk and disaster reduction.
	Urbanisation of Precarious Settlements	Urbanisation of precarious settlements, housing provision and similar adopt proposals with increased soil permeability and green areas capable of reducing environmental modification or predation.
	Resettlement of the population in risk areas	
	Adaptation of existing built-stock to estimated temperature	Expand energy efficiency renovations and improvements to the city's entire building portfolio.
	Adaptation of the Infrastructure Network to New Climate Projections	Evaluate the current infrastructure and make it more suitable and resilient. Use of nature-based solutions (NBS) associated with grey infrastructure considering future climate-related uncertainties.
Socioeconomic	Participation and Awareness	Improve protocols for the preventive shutdown of the mobility system, including alerts in the event of extreme weather events. Ongoing training in climate change for the following audiences. Disseminating information, offering free courses and publicising activities and initiatives in the field of climate change, etc. Preparation and implementation of the Municipal Environmental Education Programme, including climate change. Green and Healthy Environments Programme (PAVS).
	Affordable and social housing	Increasing housing provision for the low-income population.

Continue

⁷⁴An ecopark is a site for the mechanical and biological treatment of solid urban waste, integrating different technologies for the segregation and treatment of the various fractions contained in the waste. This treatment aims to maximise the recovery of dry and organic waste and reduce the volume of waste to be disposed of in landfill sites, using technologies for generating energy, composting, recovering recyclables, properly disposing of waste and other treatments on the market.

Governance	Monitoring	PlanClima SP Monitoring, Evaluation and Reporting System (MAR PlanClima SP System). The revision of PlanClima SP must be carried out in the first year of each elected government, associated with the Multi-Year Plan and the Targets Programme.
	Actors involved	The Executive Secretariat for Climate Change (SECLima) has councils and collegiate bodies with the participation of different actors, such as the Climate Change and Ecoeconomics Committee, COMFROTA-SP, the SECLIMA Consultative Committee and the Intersecretarial Working Group.
	Technical support	-
	Financial support	-
	Cooperation with other planning scales	Cooperation with other planning levels takes place on specific issues, such as the Integrated Water Defence Operation (OIDA), which has a partnership with the São Paulo state government, aimed at monitoring the region's water sources, integrated inspection and containment of irregular occupations.
	Coordination and secretariats involved	The Executive Secretariat for Climate Change (SECLima) coordinates the plan transversally with the other secretariats. With regard to risks, SECLima is coordinating the implementation of the Summer Rains Prevention Plan, which involves various municipal departments working on the monitoring and warning system for floods and landslides in the municipality.

Plan	Strategic Masterplan for the Municipality of São Paulo Strategic Regional Plan for Perus. Available at: https://www.prefeitura.sp.gov.br/cidade/secretarias/upload/Perus_completo.pdf (Accessed on September 7, 2023). Notebook of Proposals for the Regional Plans of the Sub-prefectures - Perus. Available at: https://gestaourbana.prefeitura.sp.gov.br/wp-content/uploads/2016/03/QA-PR.pdf (Accessed on September 7, 2023).
Year	2004 / 2016
Law	-
Political-administrative limit	Perus Subprefecture

URBAN DYNAMICS		
	Elements	Summary of coded segments
Ecological	Environmental Protected Areas	Ensuring the permanence and preservation of natural and cultural heritage, especially the Cement Factory complex and Anhanguera Park. Recover and preserve areas with remaining Atlantic Forest vegetation, in accordance with the PMMA.
	Green leisure and recreational areas - ecological connectivity	Promote connections between existing and proposed parks (Existing: Pq. Anhanguera, Pq. Jaraguá, Cantareira, Pinheirinho d'Água - Proposed: Pq. Linear Ribeirão Perus, Pq. Aterro Bandeirantes, Luta dos Queixadas, Pq. Cavas de Ouro). Expansion of green areas and implementation of multifunctional linear parks along the Perus Stream, Areião Stream, Santa Fé Stream, Juquery-Pinheirinho River (connecting with other municipalities) and Itaim Stream. Implementation of the park along the Mário Covas Metropolitan Ring Road.
	Eco-tourism	Environmental tourism activities at the Perus Portland Cement Factory, which is part of the restoration of the Perus-Pirapora Railway.
	Agroecology / Agriculture	Create incentives to maintain non-predatory rural activities such as high value-added agriculture, fish farming, among others. Encouraging sustainable development and income generation through family and organic farming.
Urban	Centralities	Centralities in the central area of Perus, on Avenida Doutor Sylvio de Campos, on Avenida Fiorelli Peccicacco (Perus District). Centralities in Coronel José Gladiador, Virgínia Castiglione and Leopoldo de Passos Lima Streets (Perus District).
	Avoid urban sprawl	Preventing the advance of urbanisation in unsuitable and environmentally protected areas.
	Reorganising built-up areas	
	Proximity - Spatial distribution of public facilities and services	Creation of the Perus Cultural Corridor comprising leisure, tourism and cultural activities developed in different interconnected spaces: CEU Perus, Inácia Dias Square, Perus Portland Cement Factory.
	Compactness	
	Zero/Low emissions zone	-
	Connectivity and Accessibility	Implementation of the Perus and Anhanguera terminals and bus corridors Improve regional accessibility by making full use of the Bandeirantes and Anhanguera motorways and the Mário Covas Metropolitan Ring Road. Make it possible to link the Perus and Anhanguera districts by connecting them to the Minianel Viário. Various directives aimed at widening streets, avenues and roads.
	Energy-efficient Construction and Renovation	-
	Diversity of mobility modes (low carbon)	Encouraging walkability and the implementation of cycle paths.
	Diversity of energy sources	-
Socioeconomic	Professional Qualification and Education	Education, training and training of local labour for tourism-related services.
	Employment and income generation connected to green and sustainable economy.	Environmental tourism activities at the Perus Portland Cement Factory, which is part of the restoration of the Perus-Pirapora Railway. Encouraging the establishment of industries, logistics and commercial centres in the intra-urban voids in the Urban and Environmental Control and Qualification Macro Area Implement the Perus-Jaraguá Territory of Interest for Culture and Landscape.
	Affordable and social house	Provide alternative housing for the residents of the workers' village. Land regularisation and urbanisation of areas occupied by low-income populations where it is appropriate for them to remain, including the implementation of infrastructure in irregular allotments and slums. Expanding the supply of housing for low-income families, ensuring their participation in the Municipal Housing Plan.

WATER AND ECOSYSTEM SERVICES		
	Elements	Summary of coded segments
Ecological	Recovery of environmentally degraded areas	Recover and preserve areas with remaining Atlantic Forest vegetation, in accordance with the PMMA. Preserving environmental conditions and restoring what has been damaged.
	Ecological connectivity and urban greenery that articulate different scales	Implement a system of public parks. Promote connections between existing and proposed parks (Existing: Pq. Anhanguera, Pq. Jaraguá, Cantareira, Pinheirinho d'Água - Proposed: Pq. Linear Ribeirão Perus, Pq. Aterro Bandeirantes, Luta dos Queixadas, Pq. Cavas de Ouro).
	Environmental protection of riverbanks	Implementation of multifunctional linear parks along the Perus Stream and Areião Stream.
	Local food production	Encouraging sustainable development and income generation through family and organic farming.
	Renaturalisation / Restoration of Riverbanks	Recover degraded areas and restore riparian forest where possible.
	Protect green areas	Ensuring the permanence and preservation of natural and cultural heritage, especially the Cement Factory complex and Anhanguera Park. Recover and preserve areas with remaining Atlantic Forest vegetation, in accordance with the PMMA.
	Protect the spring areas	-
	Rainwater Infiltration	Definition of pavements with a reduction in impermeable area.
	Access to quality green spaces	Expansion of green areas and implementation of multifunctional linear parks along the Perus Stream, Areião Stream, Santa Fé Stream, Juquery-Pinheirinho River (connecting with other municipalities) and Itaim Stream.
	Depollution of water bodies	-
	Water reuse	-
Urban	Waste Management and Recycling	Improve rubbish collection and implement selective collection.
	Sewage supply	Implement sanitary sewage systems throughout the urbanised area; Implement sewage treatment plants. Supervising and monitoring the discharge of sewage into inappropriate places, including drainage systems.
	Water supply	Completing the basic infrastructure, especially the water, sewage, drainage and public lighting networks.
Socioeconomic	Environmental Education and Awareness	Promoting public awareness through environmental education programmes.
	Foster creative industries in this area	Implement the Perus-Jaraguá Territory of Interest for Culture and Landscape. Environmental tourism activities at the Perus Portland Cement Factory, which is part of the restoration of the Perus-Pirapora Railway and other areas of interest in the region, such as Anhanfuera Park. Promote the development of a centre for tourist activities.
	Professional Qualification and Job Creation	Training and professional qualification for tourism activities. Implementation of vocational courses.

RISKS AND VULNERABILITIES		
	Elements	Summary of coded segments
Ecological	Depollution of water bodies	-
	Renaturalisation / protection of riverbanks	Recover degraded areas and restore riparian forest where possible.
	Afforestation	Promote the afforestation and upgrading of pavements to include part of the permeable area.
	Wetlands	-
	Multifunctional NbS (Parks, leisure, recreational and agricultural areas)	Although the concept of SbN is not included in the text, it is proposed to expand green areas and create multifunctional linear parks along the Perus Stream, Areião Stream, Santa Fé Stream, Juquery-Pinheirinho River (connecting with other municipalities) and Itaim Stream, helping to solve flooding problems.
Urban	Prevent the occupation of risk areas	Monitoring and controlling occupation in inappropriate places, especially environmental preservation areas, and on common property. Supervising and controlling clandestine and irregular occupation processes.
	Manage occupied risk areas	Promote the control of flood-prone areas.
	Urbanisation of Precarious Settlements	Land regularisation and urbanisation of areas occupied by low-income populations where it is appropriate for them to remain.
	Resettlement of the population in risk areas	Removal and consequent relocation of families living in an area of geotechnical risk and in unhealthy conditions.
	Adaptation of existing built-stock to estimated temperature	-
	Adaptation of the Infrastructure Network to New Climate Projections	-
Socioeconomic	Participation and Awareness	Promoting public awareness through environmental education programmes.
	Affordable and social housing	Special Zones of Social Interest.

Plan	Caieiras Municipal Master Plan Available at: https://www.caieiras.sp.gov.br/secretarias/downloads/PlanoDiretorMunicipal/Lei-4538-PlanoDiretor.pdf . (Accessed on September 7, 2023).
Year	2012 (Only the Land Use and Occupation Law was revised in 2020 - Law 5392/2020)
Law	Supplementary Law no. 4538/2012
Political-administrative limit	Caieiras

URBAN DYNAMICS		
	Elements	Summary of coded segments
Ecological	Environmental Protected Areas	Special Zones for Environmental Protection and Water Resources - Environmental protection especially aimed at the part of the municipality that coincides with the APRM-AJ and the APP areas along the streams.
	Green leisure and recreational areas - ecological connectivity	To provide continuity in the municipality's green areas, enhancing and preserving the urban landscape and minimising negative anthropic action on the environment. Creation of a system of parks and green areas linked to a system of cycle paths. This system connects public transport facilities.
	Eco-tourism	Encouraging and structuring tourism as a driver of development and job and income generation in the municipality. Using sustainable tourism as a development alternative for the Environmental Protection and Water Resources Macrozone (MPARH).
	Agroecology / Agriculture	Make efforts to provide rural landowners in MPARH areas with access to federal and state government information, instruments and programmes on the sustainable economic use of soil and natural resources. Indication of areas with a vocation for economic and agricultural activities with sustainable use of the soil and natural resources.
Urban	Centralities	-
	Avoid urban sprawl	Contain and monitor the spread of urban occupation - in the eastern region of Caieiras, guaranteeing the protection of water sources and the maintenance of an ecological corridor between the areas of the Cantareira and Juquery State Parks. Controlling and directing the vectors of urban expansion, avoiding the sprawl of urban centres and encouraging the occupation of the large voids between consolidated urban centres.
	Reorganising built-up areas	Adapt densification to the carrying capacity of the physical environment, maximising the use of areas well provided with infrastructure and avoiding overloading installed networks.
	Proximity - Spatial distribution of public facilities and services	Promote small commercial and service centres close to areas of predominantly residential use. Ensuring the availability of public facilities and services distributed equally across the territory, allowing access to education, health, culture, sport and leisure and social assistance.
	Compactness	Promote densification of the urbanised areas closest to the consolidated nuclei and the central area.
	Zero/Low emissions zone	-
	Connectivity and Accessibility	Reducing congestion in saturated areas in terms of vehicle traffic, such as: creating and widening motorways and avenues. Provide road access in areas destined for industrial use. Structuring the intercity transport network in order to improve passenger service and drawing up, through CIMBAJU, a specific study and plan to define the best intercity bus routes. Prioritise public transport over individual transport and invest in the integration of transport modes. Improving local public transport services, reducing the intervals between bus journeys and the range of routes served. Implement a cycle path and cycle lane system, connecting the linear parks proposed in the Parks and Green Corridors System.
	Energy-efficient Construction and Renovation	-
	Diversity of mobility modes (low carbon)	Cycle path and cycle lane system, connecting linear parks, the main residential areas and public transport facilities.
	Diversity of energy sources	-
Socioeconomic	Professional Qualification and Education	
	Employment and income generation connected to green and sustainable economy.	Stimulating local economic development, facilitating the generation of local jobs and income in a socially and environmentally sustainable manner. To create favourable urban conditions for the installation of new industries in areas intended primarily for industrial use and to meet the expansion demands of existing ones. Creation of an Incentivised Industrial District in Caieiras. Creation of a business incubator, through partnerships with SEBRAE or FINEP, to stimulate entrepreneurship and the generation of technological products with high added value.
	Affordable and social house	Guarantee the universal right to decent housing by democratising access to land and quality public services. Reversing the process of socio-spatial segregation in the city by offering areas for housing production aimed at lower-income social segments, including in central areas, and by urbanising and regularising the land tenure of areas occupied by low-income populations, with a view to the social inclusion of their inhabitants (however, the ZEIS are only located in peripheral areas).

WATER AND ECOSYSTEM SERVICES		
	Elements	Summary of coded segments
Ecological	Recovery of environmentally degraded areas	To endeavour to protect, preserve, recover and conserve the environment and water resources in the municipality.
	Ecological connectivity and urban greenery that articulate different scales	To provide continuity in the municipality's green areas, enhancing and preserving the urban landscape and minimising negative anthropic action on the environment. Implement a system of parks and green corridors.
	Environmental protection of riverbanks	To provide continuity in the municipality's green areas, enhancing and preserving the urban landscape and minimising negative anthropic action on the environment. Special Zones for Environmental Protection and Water Resources - Environmental protection especially aimed at the part of the municipality that coincides with the APRM-AJ and the APP areas along the streams.
	Local food production	Indication of areas with a vocation for economic and agricultural activities with sustainable use of the soil and natural resources. Encourage residents, when zoning allows, to exercise sustainable land use in agricultural activities.
	Renaturalisation / Restoration of Riverbanks	Use the work of Caieiras' representatives on the CBH-AT to collaborate in the implementation of water resource recovery projects in the municipality. Use the CBH-AT and the Metropolitan Development Council as a forum for discussing regional counterparts and prospecting for resources to finance projects for high-impact state and federal structuring projects.
	Protect green areas	Special Zones for Environmental Protection and Water Resources - Environmental protection especially aimed at the part of the municipality that coincides with the APRM-AJ and the APP areas along the streams.
	Protect the spring areas	Contain and monitor the spread of urban occupation in the eastern region of Caieiras, guaranteeing the protection of water sources and the maintenance of an ecological corridor between the areas of the Cantareira and Juquery State Parks.
	Rainwater Infiltration	Use parks from the green areas system as integral elements of the urban drainage system.
	Access to quality green spaces	Continuously expand the Caieiras Parks and Green Areas System by indicating the location of green areas in the approval guidelines for new housing developments, so that the new green areas integrate the existing system by connecting with parks, APA, APP, APM, UC and fragments of native forest in the surrounding area.
	Depollution of water bodies	Raising the quality of the urban environment by protecting the natural and built environments, restoring sensitive areas and preventing buffering and pollution of streams.
Water reuse	-	
Urban	Waste Management and Recycling	Create and implement specific programmes for environmental education for adults and the elderly: Philosophy of the 3 (three) R's - Reduce, Recycle, Reuse, articulating such actions with the Selective Collection Programme. The Special Environmental Sanitation Zone (ZESA) is characterised by a specific area earmarked for solid waste disposal activities in the form of a private sanitary landfill.
	Sewage supply	Draw up a Municipal Basic Sanitation Plan, providing solutions for the universalisation of sanitary sewage collection, treatment and disposal, in order to eliminate this source of river pollution. Implementation of at least two sewage treatment plants.
	Water supply	Installation of a water supply network in the Santa Inês region.
Socioeconomic	Environmental Education and Awareness	Contribute to the construction and dissemination of municipal memory and identity, through the protection of cultural heritage, utilising it as a means of sustainable development. Implement environmental education programmes in the municipality.
	Foster creative industries in this area	Stimulating local economic development, facilitating the generation of local jobs and income in a socially and environmentally sustainable manner. Create mechanisms, legal instruments and strategies for public-private partnerships and forms of environmental compensation in the municipality.
	Professional Qualification and Job Creation	To develop, with the support of the multidisciplinary group mentioned above and in conjunction with the Municipal Secretariat for Economic Development and Employment and the Regional Education Directorate, the feasibility and alternatives for implementing a programme for young environmental agents or similar, aimed at secondary school students, including a citizenship approach, critical education and eco-entrepreneurship. Encouraging and structuring tourism as a driver of development and job and income generation in the municipality. To support landowners located in the MPARH who are interested in setting up tourism-related businesses.

Risks and vulnerabilities		
	Elements	Summary of coded segments
Ecological	Depollution of water bodies	Raising the quality of the urban environment by protecting the natural and built environments, restoring sensitive areas and preventing buffering and pollution of streams.
	Renaturalisation / protection of riverbanks	Use the work of Caieiras' representatives on the CBH-AT to collaborate in the implementation of water resource recovery projects in the municipality.
	Afforestation	Strengthen existing urban afforestation programmes in the municipality.
	Wetlands	-
	Multifunctional NbS (Parks, leisure, recreational and agricultural areas)	Use parks from the green areas system as integral elements of the urban drainage system. Preparation of a Municipal Urban Drainage Plan, considering the potential use of the Parks and Green Areas System as an element of Urban Drainage.
Urban	Prevent the occupation of risk areas	Intensify inspection activities to inhibit irregular occupations in risk areas at the start of occupations. Inhibit new allotments in areas of Conservation Units, APPs, hilltops and regions with steep slopes, such as Serra das Laranjeiras.
	Manage occupied risk areas	Map areas at risk of landslides, landslides and floods in Caieiras. Identify and present alternatives to the urban occupations that currently exist in risk areas.
	Urbanisation of Precarious Settlements	Guarantee the urban and land requalification of existing precarious and irregular settlements that are not identified as risk areas.
	Resettlement of the population in risk areas	Guarantee housing alternatives for the resettlement of low-income families living in areas unsuitable for residential use, or removed from risk areas, areas protected by specific environmental legislation or resulting from environmental recovery programmes and urban interventions.
	Adaptation of existing built-stock to estimated temperature	-
	Adaptation of the Infrastructure Network to New Climate Projections	-
Socioeconomic	Participation and Awareness	Provide the region with an integrated permanent monitoring system for the Paiva Castro reservoir, to prevent the impact of floods by working with SABESP to implement a permanent monitoring system for the Paiva Castro reservoir. Formation of COMDEC - Municipal Civil Defence Coordination and structuring of Civil Defence activities in the municipality.
	Affordable and social housing	Reversing the process of socio-spatial segregation in the city by offering areas for housing production aimed at lower-income social segments, including in central areas, and by urbanising and regularising land in areas occupied by low-income populations, with a view to the social inclusion of their inhabitants. Ensure free technical support, urban planning and legal advice for individual or collective initiatives by the low-income population to produce or improve their housing.

Governance	Monitoring	The guidelines for Integrated and Participatory Planning and Management of Urban Policy include guaranteeing transparency and democracy in urban planning, with a focus on creating instruments for public participation, an Integrated Municipal Information System and articulation between urban management and other municipal departments, with a view to establishing priorities and meeting deadlines in urban policies and plans.
	Actors involved	Encouraging partnerships between the public and private sectors. Social participation - municipal councils and involvement of the local population in the development of urban projects for neighbourhood squares.
	Technical support	-
	Financial support	The Municipal Urban Development Fund, whose resources will be used to carry out urban interventions, urban infrastructure, construction of public facilities, parks and squares in the Urban Consolidation Macrozone, as well as collaborating in the expropriation or acquisition of areas of environmental, urban and landscape interest in the municipality. Make efforts to raise funds from federal and state programmes to make the actions indicated in this master plan viable.
	Cooperation with other planning scales	Creation of a new body (autarchy or institute) to manage and plan urban development and housing. Integrating local and regional planning through co-operation and coordination with the other municipalities in CIMBAJU and the region. Negotiations and compensation for projects affecting the municipality, such as the High Speed Train. Joint action by the Cimbaju municipalities in favour of infrastructure projects that are relevant to all municipalities, in negotiating counterparts to state and federal structuring projects that affect the region.
	Coordination and secretariats involved	Support and collaborate with the other levels of the municipal administration in the implementation and management of the strategic actions defined in this Master Plan

Plan	Franco da Rocha Municipal Master Plan. Available at: https://www.francoarocha.sp.gov.br/franco/servico/leipdf/7081 and https://www.francoarocha.sp.gov.br/franco/servico/leipdf/7270 . (Accessed on September 7, 2023).
Year	2007 / 2015
Law	Law n. 618/2007 - amended by supplementary law n. 244/2015
Political-administrative limit	Franco da Rocha

URBAN DYNAMICS		
	Elements	Summary of coded segments
Ecological	Environmental Protected Areas	Preserving vegetation, expanding green areas and preserving existing ones.
	Green leisure and recreational areas - ecological connectivity	Implementation of a Municipal Green Areas System consisting of public squares, existing and proposed parks. Integrated system of greenways, linear parks, valley bottom parks and public leisure facilities.
	Eco-tourism	Support eco-tourism as a strategy in environmental education programmes, through specific publications and agreements with environmental preservation associations.
	Agroecology / Agriculture	Making rural activities compatible with urban activities and environmentally fragile areas. Providing information on the municipality's urban and rural reality to support the implementation of new economic activities.
Urban	Centralities	
	Avoid urban sprawl	Limiting and concentrating the urbanisation process within the current urban perimeter defined in this Master Plan law, preventing the horizontal expansion of the urban area with the creation of new urban voids.
	Reorganising built-up areas	Promoting the appropriate use of urban voids, underutilised or idle buildings or land.
	Diversity of land use - mixed uses	Orderly spatial distribution of the population and economic activities in order to avoid and correct the distortions of the municipality's growth and its negative effects on the environment.
	Proximity - Spatial distribution of public facilities and services	Promote the distribution of land uses and occupation intensities in a balanced way in relation to the available infrastructure, transport and the environment, in order to avoid idleness and overloading of collective investments. Create specific conditions for metropolitan and collector roads that enable the selective coexistence of diversified commercial and service uses with residential use, guaranteeing urban regeneration.
	Compactness	Encouraging the decentralisation of employment sources and population densification in the regions with the highest labour supply index or those that will become a supply index.
	Zero/Low emissions zone	-
	Connectivity and Accessibility	Promoting conditions of accessibility for citizens to essential goods and services, work, housing and leisure. promote regional integration. Improve pedestrian connectivity between the two sides of the railway line. Promote the construction of new railway stations in the central area, in Baltazar Fidélis, in Paradinha, in the northern region and in the Juquery Complex.
	Energy-efficient Construction and Renovation	Saving energy and increasing the energy efficiency of public buildings. Require the implementation of energy efficiency methods and techniques in public and private buildings, including through building legislation.
	Diversity of mobility modes (low carbon)	Implement adequate infrastructure for cyclists and pedestrians. Give priority to public transport over individual transport. Promote accessibility through an integrated network of motor vehicle lanes, cycle paths and pedestrian routes, with safety, autonomy and comfort, especially for people with special mobility difficulties. Demand improvements in public transport through the maximum reduction in pollutant emissions, setting targets for the gradual substitution of alternative fuels with low pollutant emissions.
Diversity of energy sources	Proper treatment of solid waste, using methane gas emissions to generate energy.	
Socioeconomic	Professional Qualification and Education	To petition the state government for the establishment of a university campus for the development of studies, research and training of human resources in areas of interest to municipal development. Expanding access to vocational education through technical schools and technology colleges. Promoting programmes to train young people for the job market, especially in technological training. To encourage research and technological development geared towards the rational use of natural resources.
	Employment and income generation connected to green and sustainable economy.	Expansion of the municipality's economic self-sufficiency base, supporting the generation of employment, work and income for the local population and integration and complementarity between urban and rural activities with a view to socio-economic development. Supporting the establishment of technological innovation parks, focused on industry and the provision of services, the development of support programmes for micro and small businesses and cooperatives. Supporting the creation of small businesses, whether family or corporate, to absorb unemployed and unskilled workers from the city. Installation of areas with the presence of institutions and companies focused on technological innovation; provision of areas for the construction of new "industrial plants" and the installation of commercial companies aimed at serving the municipal population. Insert culture into the economic process as an instrument for generating and distributing income.
	Affordable and social house	Use of urban voids with public infrastructure for housing programmes. Ensure access to decent housing by expanding the supply of housing for low-income groups. Discipline the subdivision, use and occupation of land in order to increase the supply of housing for the lowest-income population; To implement a housing policy with the aim of ensuring universal access to decent housing served by basic urban infrastructure for residents, with priority for the low-income population, including through re-urbanisation and land regularisation.

WATER AND ECOSYSTEM SERVICES		
	Elements	Summary of coded segments
Ecological	Recovery of environmentally degraded areas	Recovery of environmentally degraded areas. The promotion of an ecologically balanced environment with the preservation and restoration of ecosystems and biodiversity for current and future generations. Implement the Environmental Recovery Programme for Water Resource Basins by setting up linear parks, valley bottom parks and greenways with the participation of landowners, residents, users, entrepreneurs and investors in general, with a view to improving the environmental quality of the municipality.
	Ecological connectivity and urban greenery that articulate different scales	Implementation of a Municipal Green Areas System consisting of public squares, existing and proposed parks. Increasing the quantity and improving the quality of green areas, their access and distribution throughout the city's neighbourhoods. Promoting the afforestation of pavements and the central medians of public roads, connecting these green paths to the Green Areas System, prioritising the characteristics and needs of native vegetation and its contribution to the good quality of the urban biome.
	Environmental protection of riverbanks	Create a network of linear parks and green corridors to protect valley bottoms, setting up buffer zones to safeguard the integrity of watercourse preservation areas. Protecting watercourses, water sources, Permanent Preservation Areas (PPAs) and riparian forests. Implement a programme for the recovery and preservation of protective vegetation in the headwaters, springs and structural watercourses and their tributaries that make up the micro-basins. Prevent the suppression of vegetation in permanent preservation areas.
	Local food production	Creation of the Family Agriculture Zone (ZAF) in which sustainable agricultural uses, non-impacting rural family activities, residential and local commerce are permitted. provide information on the municipality's urban and rural reality to support the implementation of new economic activities.
	Renaturalisation / Restoration of Riverbanks	Implement the Environmental Recovery Programme for Water Resource Basins by setting up linear parks, valley bottom parks and greenways with the participation of landowners, residents, users, entrepreneurs and investors in general, with a view to improving the environmental quality of the municipality.
	Protect green areas	Protect green areas, public squares and other public facilities with large vegetation. Preserving vegetation, expanding green areas and preserving existing ones.
	Protect the spring areas	Ensure the improvement of the urban landscape, the preservation of natural resources and, in particular, the water supply sources of the Municipality and the Metropolitan Region of Greater São Paulo. Protecting watercourses, water sources, Permanent Preservation Areas (PPAs) and riparian forests.
	Rainwater Infiltration	The Executive will encourage and demand the reservation of minimum areas of permeability of urban soil, with a view to absorbing rainwater, recharging the water table and preventing and reducing the effects of floods and inundations.
	Access to quality green spaces	Revitalising squares, gardens and green areas, improving public lighting and street furniture, in partnership with the private sector. Increasing the quantity and improving the quality of green areas, their access and distribution throughout the city's neighbourhoods.
	Depollution of water bodies	The municipal plan for preventing and combating flooding should contain guidelines and targets for reducing pollution of watercourses.
Water reuse	Formulate and initiate the implementation of an environmental sanitation policy through integrated environmental management of drinking water supply, sewage collection and treatment, rainwater drainage systems, solid waste management, water reuse and land use and occupation.	
Urban	Waste Management and Recycling	Proper treatment of solid waste, using methane gas emissions to generate energy. Draw up an Integrated Solid Waste Management Plan that provides for the reduction of generation, segregation, packaging, storage, collection, selective collection, recycling, transport, treatment and final disposal, as well as the elimination of risks and the protection of health and the environment.
	Sewage supply	Formulate and initiate the implementation of an environmental sanitation policy through integrated environmental management of drinking water supply, sewage collection and treatment, rainwater drainage systems, solid waste management, water reuse and land use and occupation.
	Water supply	
Socioeconomic	Environmental Education and Awareness	Promote environmental education at all levels of education and public awareness of environmental preservation. Promote and encourage afforestation in public and private schools and other institutional spaces, using pedagogical and participatory approaches. Implement educational programmes capable of developing critical awareness among the population of socio-environmental issues related to urban and rural green areas. Implement educational programmes capable of making the population aware of the diverse perceptions of the landscape in its biophysical, spatial, morphological, cultural, social, aesthetic-sensory and symbolic aspects. Ensuring that urban watercourses are visible to the population, preventing the channelling of streams and, where necessary, creating low-impact structures capable of allowing people to cross rivers and streams in the city.
	Foster creative industries in this area	Insert culture into the economic process as an instrument for generating and distributing income. Supporting the creation of small businesses, whether family or corporate, to absorb unemployed and unskilled workers from the city.
	Professional Qualification and Job Creation	Set up a labour qualification, training and retraining programme, including in collaboration, by means of an agreement, with apprenticeship services linked to trade associations. To petition the state government for the establishment of a university campus for the development of studies, research and training of human resources in areas of interest to municipal development.

RISKS AND VULNERABILITIES		
	Elements	Summary of coded segments
Ecological	Depollution of water bodies	The municipal plan for preventing and combating flooding should contain guidelines and targets for reducing pollution of watercourses.
	Renaturalisation / protection of riverbanks	Implement the Environmental Recovery Programme for Water Resource Basins by setting up linear parks, valley bottom parks and greenways with the participation of landowners, residents, users, entrepreneurs and investors in general, with a view to improving the environmental quality of the municipality.
	Afforestation	Promoting the afforestation of pavements and the central medians of public roads, connecting these green paths to the Green Areas System, prioritising the characteristics and needs of native vegetation and its contribution to the good quality of the urban biome.
	Wetlands	-
	Multifunctional Nbs (Parks, leisure, recreational and agricultural areas)	Implementation of a Municipal Green Areas System consisting of public squares, existing and proposed parks. Integrated system of greenways, linear parks, valley bottom parks and public leisure facilities - EPLs.
Urban	Prevent the occupation of risk areas	Improve the systems for monitoring and controlling land occupation in the municipality, in order to prevent the appearance of irregular allotments and punish those responsible.
	Manage occupied risk areas	Providing technical and legal advice and support for the self-construction of housing for the low-income population, including the supply of standard building projects. It mentions the provision of macro-drainage studies to indicate rainwater containment works in order to avoid and reduce the effects of flooding in urbanised areas.
	Urbanisation of Precarious Settlements	Reurbanisation and land regularisation of irregular occupations carried out by the low-income population through the implementation of basic urban infrastructure, green areas and other public and community facilities.
	Resettlement of the population in risk areas	Develop and implement resettlement programmes for the population living in areas where there is a risk to life or health.
	Adaptation of existing built-stock to estimated temperature	-
	Adaptation of the Infrastructure Network to New Climate Projections	-
Socioeconomic	Participation and Awareness	Ensuring that urban watercourses are visible to the population, preventing the channelling of streams and, where necessary, creating low-impact structures capable of allowing people to cross rivers and streams in the city. Implement educational programmes in public and public schools and institute campaigns to raise public awareness of the conservation and rational use of the municipality's water resources.
	Affordable and social housing	Housing policy must prioritise the population with the lowest incomes or those living in areas of greatest risk. Ensure access to decent housing by expanding the supply of housing for low-income groups, with the participation of the public and private sectors. Discipline the subdivision, use and occupation of land in order to increase the supply of housing for the lowest-income population. To implement housing policy with the aim of ensuring universal access to decent housing served by basic urban infrastructure for residents, with priority for the low-income population, including through re-urbanisation and land regularisation.
Governance	Monitoring	-
	Actors involved	Encouraging partnerships between the public and private sectors. Social participation - municipal councils.
	Technical support	The Municipal Urban Development Fund will be used for housing programmes, public transport, urban infrastructure, green areas, historical and environmental protection, including land regularisation and property acquisition.
	Financial support	
	Cooperation with other planning scales	The municipal planning process must also take into account the regional public interests contained in national, regional and state plans for land use planning and economic and social development, especially the metropolitan plan and the Alto Tietê river basin plan. To petition the state government for the establishment of a university campus for the development of studies, research and training of human resources in areas of interest to municipal development. Propose actions to the State Government to make better use of the Juquery Park area. Promote regional integration. The Municipal Executive will promote joint actions with the State Government so that the rail passenger transport system, operated by CPTM, increases the quality and supply of this transport, linking the municipality to neighbouring municipalities and the capital. The establishment of partnerships with the Government of the State of São Paulo, research institutions and civil society to carry out an inventory of the architectural heritage of the Juquery Complex.
	Coordination and secretariats involved	-

Plan	Francisco Morato Municipal Master Plan. Available at: https://www.legislacaodigital.com.br/FranciscoMorato-SP/LeisComplementares/338 and https://www.franciscomorato.sp.gov.br/arquivos/planos_municipais/plano_diretor.pdf (Accessed on September 11, 2023).
Year	2020/2022
Law	Law No. 338/2020 amended by supplementary law n. 382/2022
Political-administrative limit	Francisco Morato

URBAN DYNAMICS		
	Elements	Summary of coded segments
Ecological	Environmental Protected Areas	Raising the quality of the urban environment by preserving natural resources and protecting historical, artistic, cultural, urban, archaeological and landscape heritage. The Special Permanent Conservation Zone - ZECP, or Legal Reserve, is characterised by being the area located in the rural zone, necessary for the sustainable use of natural resources, the conservation and rehabilitation of ecological processes, the conservation of biodiversity and the shelter and protection of native fauna and flora. A flexible system or set of planned guidelines for the management and sustainable use of natural resources, at an optimum level of yield and preservation of biological diversity.
	Green leisure and recreational areas - ecological connectivity	Provide adequate standards of air, water and soil quality, use of open and green spaces, circulation and housing in areas free of waste, visual and noise pollution.
	Eco-tourism	
	Agroecology / Agriculture	Combating socio-spatial exclusion in the municipality and the rural exodus, promoting quality of life in the countryside and the development of small and medium-sized agriculture.
Urban	Centralities	The creation of the Downtown Enhancement Area aims to encourage and enhance specialised and diversified commerce and services, as well as improving the road system. The Diversified Economic Activities Corridor is intended for the establishment of regional commercial and service enterprises, as well as the installation or expansion of small-scale industries. The Controlled Urban Expansion Area is intended for the expansion of urbanisation in a planned and controlled manner, with guaranteed implementation of sanitation infrastructure.
	Avoid urban sprawl	The creation of the Special Permanent Conservation Zone - ZECP, or Legal Reserve, is characterised by the fact that it is an area located in the countryside that is necessary for the sustainable use of natural resources, the conservation and rehabilitation of ecological processes, the conservation of biodiversity and the shelter and protection of native fauna and flora.
	Reorganising built-up areas	Creation of the Urban Qualification Area, characterised by the fact that it is already occupied, requiring the qualification of infrastructure, services and urban facilities. Encourage the spatial distribution of the population and economic activities in a way that is compatible with the environment, urban services, infrastructure and facilities.
	Diversity of land use - mixed uses	The Diversified Use Zone will allow the activities contemplated in the industrial zones and those permitted in the social interest zones. In this zone, activities involving solid, liquid and gaseous waste and emissions must be subject to the application of appropriate control and treatment methods, under the terms of current legislation.
	Proximity - Spatial distribution of public facilities and services	Promote the integration of uses, with the diversification and mixing of compatible activities, in order to optimise the use of installed capacity, balance the distribution of labour supply and reduce costs and commuting.
	Compactness	-
	Zero/Low emissions zone	-
	Connectivity and Accessibility	Draw up the Municipal Urban Mobility Plan.
	Energy-efficient Construction and Renovation	To help reduce energy consumption and improve environmental quality by establishing urban planning parameters that minimise drainage problems and improve the conditions for lighting, aeration, sunlight, ventilation of buildings and infiltration of water into the soil.
		Diversity of mobility modes (low carbon)
	Diversity of energy sources	-
Socioeconomic	Professional Qualification and Education	
	Employment and income generation connected to green and sustainable economy.	-
	Affordable and social house	Creation of Special Zones of Social Interest (ZEIS), which are characterised by allowing buildings for low-income housing. Draw up the Municipal Housing and Land Regularisation Plan, which should include a diagnosis of precarious settlements.

WATER AND ECOSYSTEM SERVICES		
	Elements	Summary of coded segments
Ecological	Recovery of environmentally degraded areas	Creation of Special Environmental Recovery Zones (ZERAs).
	Ecological connectivity and urban greenery that articulate different scales	-
	Environmental protection of riverbanks	Creation of the Special Permanent Preservation Zone - ZEPP, characterised by an area protected under the terms of articles 2 and 3 of Law 4.771, whether or not covered by native vegetation, with the environmental function of preserving water resources, the landscape, geological stability, biodiversity, the gene flow of fauna and flora, protecting the soil and ensuring the well-being of human populations.
	Local food production	Combating socio-spatial exclusion in the municipality and the rural exodus, promoting quality of life in the countryside and the development of small and medium-sized agriculture.
	Renaturalisation / Restoration of Riverbanks	Creation of the Special Permanent Preservation Zone - ZEPP, characterised by an area protected under the terms of articles 2 and 3 of Law 4.771, whether or not covered by native vegetation, with the environmental function of preserving water resources, the landscape, geological stability, biodiversity, the gene flow of fauna and flora, protecting the soil and ensuring the well-being of human populations.
	Protect green areas	
	Protect the spring areas	
	Rainwater Infiltration	
	Access to quality green spaces	-
	Depollution of water bodies	-
Water reuse	-	
Urban	Waste Management and Recycling	Draw up the Municipal Environment Plan, which should include, among other things, the Municipal Plan for Basic Sanitation, Macro and Micro Drainage and the Municipal Solid Waste Plan.
	Sewage supply	
	Water supply	
Socioeconomic	Environmental Education and Awareness	-
	Foster creative industries in this area	-
	Professional Qualification and Job Creation	-

RISKS AND VULNERABILITIES		
	Elements	Summary of coded segments
Ecological	Depollution of water bodies	-
	Renaturalisation / protection of riverbanks	Creation of the Special Permanent Preservation Zone - ZEPP, characterised by an area protected under the terms of articles 2 and 3 of Law 4.771, whether or not covered by native vegetation, with the environmental function of preserving water resources, the landscape, geological stability, biodiversity, the gene flow of fauna and flora, protecting the soil and ensuring the well-being of human populations.
	Afforestation	-
	Wetlands	-
	Multifunctional NbS (Parks, leisure, recreational and agricultural areas)	-
Urban	Prevent the occupation of risk areas	-
	Manage occupied risk areas	Creation of the Flood Buffer Zone is intended to contain rainwater to prevent flooding. Draw up the Municipal Risk Reduction Plan, which should include the Municipal Contingency Plan.
	Urbanisation of Precarious Settlements	
	Resettlement of the population in risk areas	-
	Adaptation of existing built-stock to estimated temperature	-
	Adaptation of the Infrastructure Network to New Climate Projections	-
Socioeconomic	Participation and Awareness	
	Affordable and social housing	Draw up the Municipal Housing and Land Regularisation Plan, which should include a diagnosis of precarious settlements. Creation of Special Zones of Social Interest (ZEIS), which are characterised by allowing buildings for low-income housing.

Plan	Francisco Morato Climate Adaptation and Resilience Plan. Available at: https://smastr20.blob.core.windows.net/download/VERSÃO%20FINAL%20-%20Plano%20de%20Adaptação%20e%20Resiliência%20Climática%20de%20Francisco%20Morato.pdf (Accessed on September 11, 2023).
Year	2022
Law	-
Political-administrative limit	Francisco Morato

URBAN DYNAMICS		
	Elements	Summary of coded segments
Ecological	Environmental Protected Areas	Increase urban afforestation and in conservation areas.
	Green leisure and recreational areas - ecological connectivity	Expand green areas and urban afforestation.
	Eco-tourism	-
	Agroecology / Agriculture	Growing a collective garden. Encourage the activities of family farmers to protect water resources, fostering sustainable economic opportunities such as agroforestry and permaculture. Promote sustainable family farming, protecting ecosystem services and thus improving quality of life.
Urban	Centralities	-
	Avoid urban sprawl	-
	Reorganising built-up areas	-
	Diversity of land use - mixed uses	-
	Proximity - Spatial distribution of public facilities and services	-
	Compactness	-
	Zero/Low emissions zone	-
	Connectivity and Accessibility	Improving air quality and reducing the number of polluting vehicles through traffic awareness campaigns and the Municipal Urban Mobility Plan.
	Energy-efficient Construction and Renovation	-
	Diversity of mobility modes (low carbon)	-
	Diversity of energy sources	Expand the pilot solar energy project at the Vereador Heitor Hartmann Municipal School
Socioeconomic	Professional Qualification and Education	-
	Employment and income generation connected to green and sustainable economy.	Encouraging scientific, technological and innovation development for sustainable management and generating employment and income, through partnerships with higher and technical education units and other partners.
	Affordable and social house	Ensuring decent housing through municipal housing and land regularisation programmes.

WATER AND ECOSYSTEM SERVICES		
	Elements	Summary of coded segments
Ecological	Recovery of environmentally degraded areas	Improving the municipality's urban green infrastructure (restoring springs and riparian forests, reducing the risks of flooding and drainage systems, reducing the risks of landslides, undermining and silting, implementing measures to protect and restore fragments of vegetation and forests.
	Ecological connectivity and urban greenery that articulate different scales	Expand green areas and urban afforestation.
	Environmental protection of riverbanks	Recover springs and riparian forest. Target: Recover 20 per cent of riparian forests and springs by 2030.
	Local food production	Growing a collective garden. Encourage the activities of family farmers to protect water resources, fostering sustainable economic opportunities such as agroforestry and permaculture. Promote sustainable family farming, protecting ecosystem services and thus improving quality of life.
	Renaturalisation / Restoration of Riverbanks	Recover springs and riparian forest. Target: Recover 20 per cent of riparian forests and springs by 2030.
	Protect green areas	Improving the municipality's urban green infrastructure (restoring springs and riparian forests, reducing the risks of flooding and drainage systems, reducing the risks of landslides, undermining and silting, implementing measures to protect and restore fragments of vegetation and forests.
	Protect the spring areas	
	Rainwater Infiltration	
	Access to quality green spaces	-
	Depollution of water bodies	Periodic cleaning of the Tapera Grande pool 03. Stream desilting and gallery cleaning. Intensify the cleaning of galleries and manholes.
	Water reuse	Create a rainwater harvesting system for homes and businesses.

Continue

Urban	Waste Management and Recycling	Awareness-raising and monitoring campaign at critical waste disposal points. Collection and disposal of solid waste. Community rubbish bin. Implement selective waste collectors. Updating a specific law on the correct disposal of solid waste. Create an Integrated Solid Waste Management Programme. Indicate the environmentally correct ways of handling, in the stages of generation, packaging, transport, transshipment, treatment, recycling, destination and final disposal. Gradually increase the percentage of waste reused to 70 per cent.
	Sewage supply	Increasing water security (water and sewage) by implementing sanitation and complying with the Municipal Basic Sanitation Plan.
	Water supply	
Socioeconomic	Environmental Education and Awareness	Intersectoral partnership to implement environmental education. Environmental education campaign in public and private schools. Create a Municipal Environmental Education Programme.
	Foster creative industries in this area	-
	Professional Qualification and Job Creation	-

RISKS AND VULNERABILITIES

	Elements	Summary of coded segments
Ecological	Depollution of water bodies	-
	Renaturalisation / protection of riverbanks	Recover springs and riparian forest. Target: Recover 20 per cent of riparian forests and springs by 2030.
	Afforestation	Expand green areas and urban afforestation. Minimise the effects of heatwaves with the Adopt a Square programme, which involves the restoration, preservation and conservation of public spaces, with a view to urban afforestation. Creation of a municipal urban afforestation plan. Increasing urban afforestation and afforestation in conservation areas, such as environmental actions like campaigns to distribute seedlings for planting and intensifying tree planting in less wooded areas. Planting project in areas at risk of landslides.
	Wetlands	Create rain gardens.
	Multifunctional NbS (Parks, leisure, recreational and agricultural areas)	Planting project in areas at risk of landslides.
Urban	Prevent the occupation of risk areas	Planting project in areas at risk of landslides. Implement a programme to combat the worsening risk levels in the areas listed in the Municipal Risk Reduction Plan and to prevent the emergence of new areas. Action Plan for monitoring municipal areas to prevent occupation in areas closed by Civil Defence. Prevent the occupation of 100% of the risk areas closed by Civil Defence.
	Manage occupied risk areas	Application of slope protection techniques through the installation of Geomantas. Expand the urban drainage system to mitigate flooding. Development of intervention projects with non-structural strategies to establish preventive and corrective actions aimed at mitigating potential risks through immediate measures. By 2030, finalise intervention projects to mitigate risk in 10 (ten) areas listed in the PMRR. By 2024, establish a bank with 100 per cent of the executive projects for structuring works in areas R3 and R4. By 2030, reduce the number of areas affected by flooding by 20 per cent, according to the Municipal Risk Reduction Plan.
	Urbanisation of Precarious Settlements	By 2030, finalise intervention projects to mitigate risk in 10 (ten) areas listed in the PMRR. By 2024, establish a bank with 100 per cent of the executive projects for structuring works in areas R5 and R4. By 2030, reduce the number of areas affected by flooding by 20 per cent, according to the Municipal Risk Reduction Plan.
	Resettlement of the population in risk areas	
	Adaptation of existing built-stock to estimated temperature	Minimise the effects of heatwaves with the Adopt a Square programme, which involves the restoration, preservation and conservation of public spaces, with a view to urban afforestation.
	Adaptation of the Infrastructure Network to New Climate Projections	-
Socioeconomic	Participation and Awareness	Implementation of Community Civil Defence Centres (NUDEC). Communication of the plan and its results through the local and official press and social networks.
	Affordable and social housing	Ensuring decent housing through municipal housing and land regularisation programmes.

Governance	Monitoring	It proposes an Action and Monitoring Plan for adaptation and resilience measures.
	Actors involved	-
	Technical support	The plan was drawn up under the Resilient São Paulo Municipalities Programme in conjunction with PROADAPTA. It therefore received technical support from the São Paulo State Government and GIZ.
	Financial support	The plan aims to raise funds and financial support from other federal entities such as the state and federal governments.
	Cooperation with other planning scales	Raising funds from federal and state government bodies by creating a bank of projects for structuring works in R3 and R4 areas.
	Coordination and secretariats involved	Intersectoral. Organised by the Director of Strategic Affairs.

Plan	Mairiporã Municipal Master Plan. Available at: https://www.mairipora.sp.gov.br/wp-content/uploads/2023/02/PLANO-DIRETOR-438-2021.pdf and https://leismunicipais.com.br/a/sp/m/mairipora/lei-complementar/2022/45/455/lei-complementar-n-455-2022-dispoe-sobre-alteracoes-a-lei-complementar-n-438-de-24-de-setembro-de-2021-que-institui-o-plano-diretor-participativo-de-mairipora-e-da-outras-providencias . (Accessed on September 11, 2023).
Year	2021/2022
Law	Supplementary Law No. 438 of 24 September 2021, as amended by Supplementary Law No. 455 of 28 November 2022.
Political-administrative limit	Mairiporã

URBAN DYNAMICS		
	Elements	Summary of coded segments
Ecological	Environmental Protected Areas	Respect the guidelines and dictates of State Law No. 15,790/15, which establishes the Alto Juquery Riverbank Protection and Recovery Area APRM-AJ. Protection and recovery of permanent preservation areas, with the implementation of linear parks along watercourses. The creation of the Integral Protection Macrozone is characterised by territories with legal restrictions on occupation and use, characterised by the presence of state parks and listed properties.
	Green leisure and recreational areas - ecological connectivity	Creation of the Protected Areas, Open Spaces and Green Areas System with the aim of forming ecological corridors at municipal and regional level, conserving areas that provide environmental services, protecting and restoring natural remnants and upgrading public green areas. Maintenance and expansion of urban afforestation, promoting interconnections between open spaces and green areas of local and regional environmental importance, through the Municipal System of Green and Leisure Areas.
	Eco-tourism	To promote ecotourism as a factor in the sustainability of the areas visited, with the socio-cultural and economic involvement of the communities in the development of the activity. Encouraging the development of rural tourism, gastronomy, adventure, entertainment and events in general. Setting up rural and ecological tourism routes, taking advantage of the different natural and cultural attractions. Drawing up the management plan, as well as the carrying capacity of the natural attractions in order to protect them and control access by predatory tourism. The ZATE - Environmental Zone for Ecological Tourism is the portion of the territory set aside for activities that are compatible with the protection of the water source and that support ecological tourism.
	Agroecology / Agriculture	Encouraging urban agriculture in open spaces.
Urban	Centralities	Consolidate existing centralities, guaranteeing local identity. Decentralisation of the network of basic social facilities in neighbourhoods, in order to contribute to the formation of small centralities. Revitalising the centre and upgrading urban standards.
	Avoid urban sprawl	Curbing the advance of urbanisation into environmentally fragile areas by regulating the process of urban expansion. Containment of deforestation, preservation and recovery of the remaining masses of native vegetation in the Atlantic Forest biome, as well as riparian forests, in accordance with the municipal conservation and recovery plan.
	Reorganising built-up areas	Drawing up a plan for the occupation, reorganisation and revitalisation of medium-sized and large areas, in order to avoid disorderly occupation by various urbanistically dissociated social facilities.
	Diversity of land use - mixed uses	Diversify uses and organise the distribution of urban activities. Encourage developments that use active façades on the ground floor, ensuring public enjoyment on the ground floor of developments. Creation of Zones of Diversified Uses in Mananciais, portions of the territory in which the diversity of non-residential uses is encouraged within the Alto Juquery Mananciais Protection and Recovery Area - APRM-AJ. Creation of the Centrality Zone, comprising the portion of the territory where non-residential uses and the diversification of economic activities are encouraged. Creation of the Densification and Connection Zone, comprising the territory where diversified uses and greater densification are encouraged within the Alto Juquery Mananciais Protection and Recovery Area - APRM-AJ.
	Proximity - Spatial distribution of public facilities and services	Distributing infrastructure and public utility services in a spatially balanced and socially just way. Reducing socio-spatial inequalities by making up for the lack of facilities and urban infrastructure in the most socially vulnerable neighbourhoods. Provide all housing areas with the necessary facilities to meet the basic health, education, leisure, sport, culture and social assistance needs of their population. Encourage developments that use active façades on the ground floor, guarantee public enjoyment on the ground floors of developments in the Predominantly Residential Zone a.
Compactness	Densify the areas suitable for occupation. The ZAC - Zona de Adensamento e Conexão (Densification and Connection Zone) is made up of the territory where diversified uses and greater densification are encouraged within the APRM-AJ - Área de Proteção e Recuperação dos Mananciais do Alto Juquery (Alto Juquery Springs Protection and Recovery Area). In these areas, developments are encouraged that use active façades on the ground floor, guarantee public enjoyment on the ground floor, and expand pavements, open spaces, green and permeable areas.	

Continue

	Zero/Low emissions zone	-
	Connectivity and Accessibility	Ensuring universal accessibility. Prioritising collective public transport over individual transport and non-motorised modes of transport over motorised ones. Improving the quality of public transport services, discouraging the use of individual motorised transport. Structuring the municipality's road system to adequately meet current and future travel needs. Integrating the municipality into the metropolitan mobility system. Improving mobility conditions for the population, reducing journey times and guaranteeing comfort, safety, modal diversity, fare modality and an increase in the number of routes and the public transport fleet. Indication of optimised flows for public transport, taking into account their integration with pedestrian and cycling flows, and the latter with the green areas system, in the search for efficient commuting alternatives in the municipality.
	Energy-efficient Construction and Renovation	-
	Diversity of mobility modes (low carbon)	Prioritising collective public transport over individual transport and non-motorised modes of transport over motorised ones. Create road conditions for mobility and accessibility for pedestrians, cyclists and people with special needs or mobility restrictions, Reducing the need for motorised travel and encouraging the use of cycling. Improving pavements, making them as wide as possible. Increasing accessibility to the network of facilities and urban mobility systems, including pedestrian and cycle paths.
	Diversity of energy sources	IPTU Verde (Green Urban Property Tax) - tax benefits granted, in accordance with specific legislation, in relation to the Urban Property Tax for property owners who adopt environmental protection or recovery measures, such as: use of water reuse systems; rainwater harvesting systems; solar hydraulic heating systems; maintenance of high levels of permeability and green areas on the property, among others.
Socioeconomic	Professional Qualification and Education	-
	Employment and income generation connected to green and sustainable economy.	Providing areas for local economic development in an environmentally sustainable way that is compatible with environmental protection. Training for the planning and management of tourism enterprises in the areas of food, accommodation, attractions and commerce and encouraging entrepreneurship in commerce and services related to tourism, with a view to setting up small businesses and supporting the MEI - Individual Microentrepreneur. The Economic Development Policy should include actions aimed at the tourism sector, based on recognising and valuing the municipality's environmental heritage and its capacity to support public use and visitation, as well as low-impact activities in appropriate areas to increase the generation of employment and income for the population. ZEDEC - Special Zone for the Development of Economic and Cultural Activities, territory in which the municipality's economic and cultural activities are concentrated and for which an urban plan must be developed to promote the expansion of the development capacity of activities that support tourism and the development of the economic and cultural activities present.
	Affordable and social house	The Municipal Policy for Social Housing and Land Regularisation includes the production of HIS - Social Interest Housing and HMP - Popular Market Housing, and land regularisation of precarious settlements and irregular areas. Expansion of the basic sanitation system in conjunction with urbanisation and land regularisation of precarious settlements. Establishment of ZEIS - Special Zones of Social Interest, portions of the territory dedicated to urbanisation, land regularisation and social housing provision.

WATER AND ECOSYSTEM SERVICES

	Elements	Summary of coded segments
Ecological	Recovery of environmentally degraded areas	Valuing local biodiversity and preserving, conserving and restoring the landscape and natural ecosystems. Indication of priority areas for conservation and recovery of native vegetation. Restoration of open spaces and degraded green areas of landscape-environmental importance. Protection and recovery of permanent preservation areas, with the implementation of linear parks along watercourses.
	Ecological connectivity and urban greenery that articulate different scales	Creation of the Protected Areas, Open Spaces and Green Areas System with the aim of forming ecological corridors at municipal and regional level, conserving areas that provide environmental services, protecting and restoring natural remnants and upgrading public green areas. Upgrading the urban environment by implementing a system of protected areas, open spaces and green areas in the municipality. Maintenance and expansion of urban afforestation, promoting interconnections between open spaces and green areas of local and regional environmental importance, through the Municipal System of Green and Leisure Areas.
	Environmental protection of riverbanks	Protection and recovery of permanent preservation areas, with the implementation of linear parks along watercourses.
	Local food production	Encouraging urban agriculture in open spaces.
	Renaturalisation / Restoration of Riverbanks	Renaturalisation and/or restoration of river and stream banks.

Continue

WATER AND ECOSYSTEM SERVICES		
	Protect green areas	Protection and recovery of permanent preservation areas, with the implementation of linear parks along watercourses. The creation of the Integral Protection Macrozone is characterised by territories with legal restrictions on occupation and use, characterised by the presence of state parks and listed properties.
	Protect the spring areas	Respect the guidelines and dictates of State Law No. 15,790/15, which establishes the Alto Juquery Riverbank Protection and Recovery Area APRM-AJ. Ensure the protection and restoration of the environmental quality of water resources, including groundwater.
	Rainwater Infiltration	Increase soil permeability and prevent environmental degradation. Adopt specific parameters for the design of the road system and pavements, using drainage surfaces and encouraging safe sharing of roads in order to reduce soil sealing.
	Access to quality green spaces	Expand and distribute leisure and cultural areas throughout the city's neighbourhoods and regions and encourage the conservation of privately owned green areas. Creation of leisure areas in neighbourhoods and implementation of leisure streets.
	Depollution of water bodies	Control pollution through drainage systems and effluent treatment.
	Water reuse	Encouraging the use of alternative technologies to capture and reuse rainwater, with mandatory adoption of measures to this end by industries and large enterprises. IPTU Verde (Green IPTU) - tax benefits granted, in accordance with specific legislation, in relation to the Urban Property Tax for property owners who adopt environmental protection or recovery measures, such as: use of water reuse systems; rainwater harvesting systems; solar hydraulic heating systems; maintenance of high levels of permeability and green areas on the property, among others.
Urban	Waste Management and Recycling	Implementation of environmental sanitation, using alternative technologies, especially with regard to sewage disposal and solid waste disposal. Adoption of adequate procedures for the collection, treatment and final disposal of solid waste generated in the municipality. The search for economic sustainability of waste management actions in the urban environment.
	Sewage supply	The Municipal Sanitation Policy will adopt as its planning and management model the integration of drinking water supply systems, sanitary sewage, urban cleaning and solid waste management, drainage and urban rainwater management, in accordance with Federal Law No. 11.445 of 5 January 2007, which establishes the National Basic Sanitation Policy, and Federal Law No. 12.305 of 2 August 2010, which establishes the National Solid Waste Policy. Definition and implementation of alternative sanitary sewerage solutions for condominiums or low-density neighbourhoods. Protecting, restoring and improving environmental conditions by expanding sanitation systems in order to guarantee the universalisation of drinking water supply and sewage collection, disposal and treatment.
	Water supply	
Socioeconomic	Environmental Education and Awareness	Promoting actions aimed at reducing waste generation by raising public awareness and improving the management and control of services. Promotion of environmental education as an instrument to support public environmental policies, in conjunction with other sectoral policies, including through environmental education projects in schools.
	Foster creative industries in this area	Training for the planning and management of tourism enterprises in the areas of food, accommodation, attractions and commerce and encouraging entrepreneurship in commerce and services related to tourism, with a view to creating small businesses and supporting the MEI - Individual Microentrepreneur. Training human resources for the tourism sector, especially the training of tour guides, motivating and encouraging young people to take up this type of activity. Promoting the socio-economic inclusion of waste pickers by encouraging the creation of co-operatives.
	Professional Qualification and Job Creation	

RISKS AND VULNERABILITIES		
	Elements	Summary of coded segments
Ecological	Depollution of water bodies	Control pollution through drainage systems and effluent treatment.
	Renaturalisation / protection of riverbanks	Protection and recovery of permanent preservation areas, with the implementation of linear parks along watercourses.
	Afforestation	Implementation of an urban afforestation programme, respecting local biomes. Prioritising native species in urban afforestation. Maintenance and expansion of urban afforestation, promoting interconnections between open spaces and green areas of local and regional environmental importance, through the Municipal System of Green and Leisure Areas.
	Wetlands	-
	Multifunctional NbS (Parks, leisure, recreational and agricultural areas)	-

Continue

Urban	Prevent the occupation of risk areas	Mitigate geological-geotechnical risk situations by avoiding occupation of unsuitable areas. The implementation of the Municipal HIS Policy - Social Interest Housing and Land Regularisation - should be articulated with the policies of the Environment and Sanitation axis, with a focus on inhibiting new irregular occupations in environmentally fragile areas, and recovering risk areas and environmental protection areas, especially those occupied by housing that are not subject to urbanisation or land regularisation. Maintaining and restoring vegetated areas, protecting the soil from erosion and landslides.
	Manage occupied risk areas	The creation of the AIUPRR - Urban and Peri-urban Intervention Areas for the Recovery of Areas of Geotechnical Risks, Floods or Other Risks specified by law aims to identify territories that require action to eliminate, correct or manage risks. Protecting the territory against extreme hydrological situations in order to minimise the risks associated with floods and landslides. Prioritising the care of the low-income population living in unhealthy properties or areas, risk areas and permanent preservation areas and implementing programmes for the physical and environmental rehabilitation of these areas, in order to guarantee their physical integrity, the right to housing and the recovery of their environmental quality.
	Urbanisation of Precarious Settlements	Urbanise and regularise precarious settlements and provide social housing. Promote the urbanisation and land regularisation of irregular urban centres classified as being of social interest.
	Resettlement of the population in risk areas	Proposed solutions to environmental, urban planning and occupant resettlement issues, where appropriate. In the event that the occupation poses a risk to the life or health of the occupants, the public authorities will guarantee that the owner can exercise their right to decent housing elsewhere.
	Adaptation of existing built-stock to estimated temperature	-
	Adaptation of the Infrastructure Network to New Climate Projections	-
Socioeconomic	Participation and Awareness	-
	Affordable and social housing	Guarantee access to urbanised land, reversing the trend towards peripheralisation and the occupation of unsuitable spaces by the low-income population, using the instruments provided for in the City Statute and this Master Plan.

Governance	Monitoring	Establish a permanent monitoring and evaluation process for programmes, instruments and projects. Creation of SPAM - Urban and Environmental Policy Monitoring System, which aims to provide information for planning, monitoring, implementing and evaluating urban policy, subsidising decision-making throughout its implementation process.
	Actors involved	Encouraging partnerships between the public and private sectors. Social participation - municipal councils.
	Technical support	-
	Financial support	Social Interest Housing Fund Municipal Fund for Urban, Economic and Social Development Municipal Environment and Sanitation Fund Municipal Urban Mobility Fund
	Cooperation with other planning scales	-
	Coordination and secretariats involved	-

Plan	Cajamar Municipal Master Plan. Available at: https://cajamar.sp.gov.br/leiscomplementares/wp-content/uploads/sites/31/2020/12/lei-complementar-179-19-revisao-plano-diretor.pdf (Accessed on September 11, 2023).
Year	2019
Law	Supplementary Law No. 179 of 18 December 2019
Political-administrative limit	Cajamar

URBAN DYNAMICS		
	Elements	Summary of coded segments
Ecological	Environmental Protected Areas	Regulating the Cajamar Environmental Protection Area (APA). Protection of preservation areas, where only green areas, recreation areas, linear parks and retention basins will be allowed, and building construction will be prohibited.
	Green leisure and recreational areas - ecological connectivity	Creation of a municipal green area system, including linear parks with leisure facilities for appropriate use of valley bottoms and the expansion of street tree planting to improve the ratio of green area per inhabitant in the municipality. The municipal government should implement structuring elements, such as the road and transport system, and enhance the urban landscape by integrating linear parks with public facilities for diversified use.
	Eco-tourism	Draw up an Inventory/Survey of Tourist Offers and Demands as part of the start of Municipal Tourism Planning. Create a tourism policy centred on the rescue and permanent presence of imaginary and architectural production, with a view to the continuous revision and appropriation of citizenship values. Developing projects to boost local tourism potential, increase the flow of visitors and, consequently, generate new economic and social opportunities. It includes the preservation and restoration of historical and cultural buildings, the creation of specific tourist routes and the implementation of linear parks, with infrastructure for tourists and visitors, along the old Perus Pirapora Railway and at other points relevant to tourism.
	Agroecology / Agriculture	Promoting and encouraging rural work to create community gardens, family farming, nurseries and floriculture, beekeeping, fish farming and other rural activities.
Urban	Centralities	Consolidate municipal centrality. Creating conditions for new centralities and public spaces in areas of unconsolidated or precarious urbanisation.
	Avoid urban sprawl	
	Reorganising built-up areas	Adapt densification to the carrying capacity of the physical environment, maximising the use of areas well provided with infrastructure and avoiding overloading installed networks. A policy of consolidating programmes, projects and activities approved by the Municipal Council for Cultural Policy, qualifying existing cultural spaces, generating new spaces and linking these projects to decentralised cultural action, thus guaranteeing optimum access to culture for peripheral social strata. Create urban planning instruments to stimulate the requalification of buildings and neighbourhoods protected by cultural property legislation, adapting them to functions appropriate to their characteristics and preserving them as elements of reference for the population. Promote the distribution of uses and the intensification of land use in a balanced way in relation to infrastructure, transport and the environment, so as to avoid idleness or overload and optimise collective investments; Encourage urban restructuring and redevelopment to make better use of areas with infrastructure. Stimulate the growth of the municipality in the already urbanised area, with services, infrastructure and equipment, in order to optimise the use of installed capacity and reduce costs.
	Diversity of land use - mixed uses	Avoiding the segregation of uses by promoting the diversification and mixing of compatible uses in order to reduce the population's commuting and balance the distribution of jobs and work in the municipality.
	Proximity - Spatial distribution of public facilities and services	Raising the quality of life of the population, ensuring environmental sanitation, infrastructure, public services, social facilities and qualified green and leisure spaces. The distribution of social facilities and services must respect regional needs and priorities defined on the basis of demand, giving priority to areas of precarious urbanisation, with attention to Special Zones of Social Interest.
	Compactness	Control of construction densification in areas with saturated road infrastructure or in the process of saturation. The promotion of building and population densification in areas of urbanisation under development with the capacity to support the installed infrastructure.
	Zero/Low emissions zone	
	Connectivity and Accessibility	Ensure universal accessibility by developing an accessibility plan that ensures safe movement for pedestrians, including people with special needs, as well as access to urban services. The municipal government undertakes to improve road and transport infrastructure to promote the development of the city, including the creation of cycle paths, pedestrian safety, inter-city traffic management and sustainable paving criteria. Drawing up a Municipal Transport and Urban Mobility Plan that takes into account the different demographic densities of the districts, integrates public transport lines, improves road infrastructure and promotes operational control of public transport, including direct and integrated lines to the metropolitan region, the opening up of avenues to integrate neighbourhoods and control access to isolated areas.
	Energy-efficient Construction and Renovation	-
	Diversity of mobility modes (low carbon)	Creation of cycle paths.
Diversity of energy sources	-	

Socioeconomic	Professional Qualification and Education	Establish agreements for vocational courses for the community, training and qualifying the workforce for the competitive job market, as well as for the development of alternative livelihood proposals.
	Employment and income generation connected to green and sustainable economy.	Supporting and enabling the creation of associations of traders, artisans and professionals dedicated to the tourist industry, with the aim of integrating not only each other and their class, but also actively participating in segmented trade. Promoting social inclusion, reducing the inequalities that affect segments of the population and are reflected in the territory, through sustainable public policies. Promote the creation of incentives for small and micro-entrepreneurs through the creation of business co-operation networks and support for productive links in both urban and rural areas; Promote the creation of co-operatives that foster employment and income. Encouraging associations and entrepreneurship as alternatives for generating employment and income. Promoting and encouraging rural work to create community gardens, family farming, nurseries and floriculture, beekeeping, fish farming and other rural activities.
	Affordable and social house	Ensuring the universal right to decent and affordable housing, democratising access to land and quality public services. Combating socio-spatial segregation, proposes the provision of housing areas for lower income groups, including central areas, as well as the urbanisation and land regularisation of low-income occupations to promote social inclusion. The distribution of social facilities and services must meet regional needs and prioritise precarious urban areas, with a focus on Special Zones of Social Interest. Priority is given to families in irregular areas, such as risk areas, preservation areas and cultural areas. Different programmes aim to meet housing needs, such as the purchase of flats and houses, housing construction and real estate production, prioritising low- and middle-income families, with support and resources from the federal, state and municipal governments and private companies, including partnerships between the city government and entrepreneurs.

WATER AND ECOSYSTEM SERVICES		
	Elements	Summary of coded segments
Ecological	Recovery of environmentally degraded areas	Recovery of degraded green areas of landscape-environmental importance.
	Ecological connectivity and urban greenery that articulate different scales	Create, implement and maintain a Green Areas System, improving the green area per inhabitant ratio in the municipality. Incorporation of significant private green areas into the Municipality's Green Areas System, linking them to the Municipality's actions aimed at ensuring their preservation and use. Maintenance and expansion of street tree planting, creating green strips that connect squares, parks or green areas. Create interconnections between green areas to establish links of regional environmental importance. Creation of municipal parks and reserves, nurseries for seedlings of native forest essences and fruit trees.
	Environmental protection of riverbanks	Implement green areas in drainage headwaters and establish recovery programmes. Control of the use and occupation of valley bottoms, areas subject to flooding, springs, areas of high slope and drainage headwaters. Monitoring of the Water Resources System, with the aim of providing information on the quality of water in local and regional water sources.
	Local food production	Promoting and encouraging rural work to create community gardens, family farming, nurseries and floriculture, beekeeping, fish farming and other rural activities.
	Renaturalisation / Restoration of Riverbanks	
	Protect green areas	
	Protect the spring areas	Promoting a balance between the protection and occupation of spring areas, ensuring their function as producers of water for public consumption.
	Rainwater Infiltration	Adopt permeable paving in local road and pedestrian pavement programmes and create legal mechanisms for uncovered areas to be paved in this way.
	Access to quality green spaces	Create programmes for the effective implementation of green areas in housing developments and allotments. Landscaping and squares in various parts of the municipality. The linear parks to be built must offer sufficient recreational and leisure facilities for the population, guaranteeing comfort in their use.
	Depollution of water bodies	Cleaning up watercourses, restoring riverbanks and riparian forests. Reducing the vulnerability of surface and groundwater to contamination from point and diffuse sources.
	Water reuse	Encouraging the use of self-sustaining practices and technologies such as effluent treatment, rainwater collection and use techniques and water reuse.
Urban	Waste Management and Recycling	The preparation of a Municipal Solid Waste Treatment Plan, with an emphasis on recycling, reuse, selective collection and composting, through the active participation of the population.
	Sewage supply	Public authorities must promote effective actions to improve the Environmental Sanitation System, whether through service concessionaires, inter-municipal consortia or even local actions. Immediately define the locations for the Municipality's Sewage Treatment Plants and establish a timetable for their implementation, with the respective networks required.
	Water supply	

Continue

Socioeconomic	Environmental Education and Awareness	Linear parks should guarantee a socio-cultural character through environmental awareness programmes and tourist attraction. Incorporation of the theme of Green Areas into the Municipal Environmental Education Programme in order to minimally cover land use and occupation and preservation areas in all their forms, with a view to the participation and involvement of the population and its leaders. Encouraging the adoption of habits, customs, attitudes, social and economic practices aimed at protecting and restoring the environment.
	Foster creative industries in this area	Promote local economic development in a socially and environmentally sustainable way. Raising the quality of the education system as a way of guaranteeing professional qualifications. Establish agreements for vocational courses for the community, training and qualifying the workforce for the competitive job market, as well as for the development of alternative livelihood proposals. Promoting and encouraging rural work to create community gardens, family farming, nurseries and floriculture, beekeeping, fish farming and other rural activities; Promote the registration of professional activities hired by local companies in order to supply this labour force, promoting the creation of technical and vocational courses in line with existing activities. Strengthen the tourism sector by economically exploiting the territory's potential for this purpose.
	Professional Qualification and Job Creation	

RISKS AND VULNERABILITIES		
	Elements	Summary of coded segments
Ecological	Depollution of water bodies	
	Renaturalisation / protection of riverbanks	Create green areas at the headwaters of drains and establish recovery programmes.
	Afforestation	An afforestation plan should be drawn up for the linear parks, taking into account the characteristics of the region's native vegetation and its suitability for the urban uses to which they are to be put.
	Wetlands	Protection of preservation areas, where only green areas, recreation areas, linear parks and retention basins will be allowed, and building construction will be prohibited.
	Multifunctional NbS (Parks, leisure, recreational and agricultural areas)	The implementation of cycle paths in linear parks should be studied. The linear parks should incorporate sanitation infrastructure works, such as sewage and rainwater networks, guaranteeing better environmental conditions. Implement linear parks equipped with community leisure facilities, as a way of making appropriate use of valley bottoms, discouraging invasions and undue occupation.
Urban	Prevent the occupation of risk areas	Implement linear parks equipped with community leisure facilities, as a way of making appropriate use of valley bottoms, discouraging invasions and undue occupation. Control of the use and occupation of valley bottoms, areas subject to flooding, springs, areas of high slope and drainage headwaters.
	Manage occupied risk areas	Create a programme to control and prevent urban erosion, by drawing up a geotechnical map to determine the occupation and use of the land, according to its urban, agricultural and mining potential, identifying risk areas, in order to outline measures to recover degraded areas and actions within the scope of Environmental Sanitation. Carrying out a survey of the hydrological characteristics of the entire municipality, including risk areas and production capacity for public supply.
	Urbanisation of Precarious Settlements	Urbanise, requalify and regularise shanty towns and irregular allotments, with a view to integrating them into the different neighbourhoods. Promoting land and urban regularisation in low-income housing settlements, guaranteeing access to public transport and other public services and facilities.
	Resettlement of the population in risk areas	Programme for the Acquisition or Production of Plots and Housing - PROALM - aimed at families who pay rent and/or live in and intend to acquire plots of land to build their own homes, as well as the construction of affordable housing for the families to be displaced. to be relocated or resettled.
	Adaptation of existing built-stock to estimated temperature	-
	Adaptation of the Infrastructure Network to New Climate Projections	-
Socioeconomic	Participation and Awareness	Creation of Emergency Committees for risk situations containing special transport, Civil Defence and Public Security agents. Promote public awareness campaigns and community participation in the planning, implementation and operation of flood control actions.
	Affordable and social housing	The municipality's master plan proposes a number of housing programmes that include drawing up and updating the municipal register to implement a housing policy. In addition, there are programmes for acquiring or producing plots of land and housing for families who pay rent or live in rented accommodation and wish to build their own homes, as well as the construction of affordable housing for families to be relocated or resettled. There are also programmes to buy flats and houses for low- and middle-income families, using funds from the federal and state governments, as well as construction, renovation and housing production programmes to meet the population's housing needs. There is also a housing provision programme in support of existing federal and state housing programmes.

Continue

Governance	Monitoring	
	Actors involved	Encouraging partnerships between the public and private sectors. Social participation - municipal councils.
	Technical support	Developing regional, national and international relations with multilateral associations and institutions, as well as with government bodies, in order to establish partnerships and agreements of interest to the City, making funding and technical assistance programmes possible.
	Financial support	
	Cooperation with other planning scales	Establish and maintain partnerships or agreements with the Federal Government, the State Government, the private sector and the third sector with a view to pursuing sustainable socio-environmental development through scientific research, biodiversity conservation, social promotion and the integration of the various agents working in their area. Integration with the other municipalities involved in managing the region's water resources and springs.
	Coordination and secretariats involved	The various municipal departments involved in the implementation of social policies are responsible for drawing up plans and sectoral goals to be debated with the participation of civil society, especially in the areas of entrepreneurship, culture and tourism, Education, Health, Social Assistance, Housing, Sport and Leisure, Events and Recreation, Public Urban Services, Urban Equipment and Accessibility.



