

Grenoble Alps University
Institute of Urban Planning and Alpine Geography
Master's thesis for the MSc Transformative Urban Studies degree

Designing resilient public spaces in Paris

*The case of rainwater management strategy in the Saint-Vincent-de-Paul
district*

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Abstract

This dissertation aims to understand how resilience issues are being integrated into the design of public spaces, through a paradigm shift in rainwater management. It comes shortly after the publication of the 6th IPCC report which highlights an unpredictable future within which cities, first affected by climate change, will have to adapt.

We suggest to address this paradigm shift through three hypotheses: new technical devices for rainwater management change the landscape of public spaces; these devices should be socially accepted to be sustainable; rainwater issues influence the governance of urban projects.

These hypotheses are being investigated through the study of the Saint-Vincent-de-Paul eco-district, which is used as an example in several environmental plans of the City of Paris. This study involves interviews with various stakeholders of the project.

This qualitative study focuses on a specific case to provide food for thought on how the concept of resilience is being implemented in practice.

key words: *rainwater management, public spaces, resilience, technical devices, governance, social acceptance*

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List of main acronyms

DTEC: Direction de la Transition Écologique et du Climat (Ecological Transition and Climate Directorate)

DPE: Direction de la Propreté et de l'Eau (Cleanliness and Water Directorate)

DEVE: Direction des Espaces Verts et de l'Environnement (Green Spaces and Environment Directorate)

DVD: Direction de la Voirie et des Déplacements (Roads and Transportation Directorate)

RPRI: Pôle Résilience, Prospective, Recherche et Innovation (Resilience, Foresight, Research and Innovation Unit)

AESN: Agence de l'Eau Seine Normandie (Seine Normandy Water Agency)

PRP: Paris Rain Plan

PCAET: Plan Climat Air Energie (Climate Air Energy Plan)

PLU: Plan Local d'Urbanisme (Local Urban Plan)

DLE: Dossier Loi sur l'Eau (Water Law Declaration File)

SVdP: Saint-Vincent-de-Paul

CB: Clichy-Batignolles

ZAC: Zone d'aménagement concertée (joint development zone)

MOA: Maîtrise d'ouvrage (contracting authority)

MOE: Maîtrise d'oeuvre (project manager)

AMO: Assistance à maîtrise d'ouvrage (contracting authority support)

MLP: Multi-level Perspective

INTRODUCTION

“A drop of powerful water is enough to create a world and to dissolve the night. To dream of power, all that is needed is a drop imagined in depth. Water thus energized is a germ; it gives to life an inexhaustible rise” (Bachelard, 1942, p.21)

Blue gold, this expression refers to water as a limited natural resource. Water, a resource at the origin of life, is now threatened by human activities and climate change. Around the world, it seems that the relationship between water and the city is changing.

In the Netherlands, a paradigm shift has taken place since the 1980s. This new doctrine is based on an integrated management of water resources in order to live with it, especially by giving more space to rivers. Thus, when designing planning projects, water no longer becomes a threat, but rather an opportunity. (Guerrin and Bouleau, 2014) In Rotterdam for instance, Water Plazas are public spaces which have a double function: Recreational during "dry" periods; Technical during heavy rainfall, turning into a retention basin. This illustrates the role of public spaces in rainwater management by playing on their floodability.

The doctrine used by the Dutch was not only limited to the internal part of the country, however, it was also exported across the Atlantic. Indeed, after hurricanes Katrina and Sandy that hit New Orleans (2005) and New York (2012) respectively, the United States launched an international invitation to tender for the reconstruction projects of both cities. In New Orleans, the Delta Plan¹ was cited as an example and the Netherlands were the first to offer technical assistance (Maret and Cadoul, 2007). This led to the creation of the "Urban Water Plan"² in 2013, which aims to address nature-based solutions and the reintegration of water into the urban landscape. In New York the Rebuild By Design³ project, launched by Barack Obama, has appointed Henk Ovink, a Dutch specialist known worldwide for his expertise on water issues, as its director.

¹ “The Delta Plan includes a total of 9 dams, including 4 main dams and 5 secondary dams in the second line. These colossal works, unique in the world, lasted 32 years and cost 5.6 billion euros. They were completed in early October 1986 and required multiple technological innovations.” (Maret and Caboul, 2007)

² Urban Water Plan is a program created in 2013 by the Greater New Orleans Foundation. More information at: <https://www.planning.org/awards/2015/greaterneworleans.htm>

³ More information at: <https://www.rebuildbydesign.org/>

In Asia, China has also launched a program of "sponge city" in 2013. Inspired by Dutch methods, it aims to restore a more natural water cycle in urban areas. It is based on two objectives, the first is to move towards resilience in the face of flooding and the second to ensure the sustainability of water resources in cities.

These alternative solutions based mainly on nature are more integrated into the urban fabric and public spaces. In this research, we will use the plural of public spaces defined as "places accessible to the public, used by the inhabitants, whether they live nearby or not. These are streets and squares, forecourts and boulevards, gardens and parks..." (Paquot, 2009, paragraph 1). Unlike public space, which refers more to the political philosophy of place. (Paquot, 2009)

Rainwater management, which is increasingly integrated into public spaces, appears to be a lever for adapting cities to climate change. It also contributes to the trend towards the dynamic concept of urban resilience: "contemporary urban policies tend to reverse the situation: the presence of water in the city becomes the symbol of the implementation of techniques, based especially on the creation of aquatic or vegetated environments, which aim to limit risks and increase urban resilience" (Thébault, 2019, p.8). Referring to the definition from the Resilient Network program initiated by the Rockefeller Foundation in 2013, urban resilience means "The ability of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and address whatever types of chronic stresses and acute shocks they experience."⁴

Thébault (2019) reviews the history of the evolution of rainwater management techniques, in Paris, since the 1970s. Thus, it seems that Paris is moving towards a more integrated approach to rainwater in urban projects, similar to programs addressed worldwide.

This research focuses on understanding how resilience issues are translated into public spaces in Paris. The rainwater management strategy in the Saint-Vincent-de-Paul (SVdP) neighborhood under construction will be investigated in more detail. SVdP is part of

⁴ **Resilient Cities Network.** *Urban resilience*, [online]. Available on: <https://resilientcitiesnetwork.org/urban-resilience/> (consulted on, 23/06/2022)

several environmental plans of the City of Paris⁵ and it is the first one to have the ambition of zero discharge for rainwater management.

To understand all the issues surrounding this subject, our plan is divided into two parts. The first one establishes the research context, on both an international and local scale. The second one examines the design of public spaces of SVdP regarding rainwater management. Before we begin, a description of the methodology is made to understand the research process.

METHODOLOGY

This research is part of an apprenticeship at the City of Paris in the Resilience, Foresight, Research and Innovation Unit. (RPRI) This is a new unit within the Ecological Transition and Climate Directorate (DTEC) created on the 1st January 2022.

- **Determination of the research field**

The research was conducted using an empirical approach. Since resilience is a broad and abstract concept, determining the field of research was a preliminary step. We had the opportunity, this year, to participate in project meetings between the City of Paris, researchers and stakeholders for the OCAPI⁶ project in Saint-Vincent-de-Paul (SVdP) district. The environmental ambitions carried by several stakeholders in this project have revealed the potential of this research field. One interviewee said that “Saint-Vincent-de-Paul environmental excellence strategy can be summarized in six words: zero carbon - zero waste - zero discharge.” (Perseus Responsus⁷, March 2022). This project is part of the Resilience Strategy and mentioned in the Climate Air Energy Plan (PCAET). It is also promoted as a showcase by the City of Paris, which wishes to make it an example in terms of rainwater management.

⁵ For the rest of the dissertation, when the word City is capitalized, it represents the institution and not the spatial entity

⁶ **OCAPI project** aims to set up a toilet system that allows urine to be collected at the source in the SVdP urban renewal project. This device will enable the production of fertilizer, which will be used for parks and gardens in Paris.

⁷ Refer to table 1

- **First data collection**

To understand deeper related-issues to rainwater management we did a literature review of scientific and technical documents. That first information allowed us to build a solid base of knowledge on the evolution of rainwater management in Paris. We then realized that it was a relevant topic in order to adapt the city to future changes, especially climate change. Technical devices were not only designed to ensure their function, but if well thought, they could exceed it to improve living environment and social cohesion in public spaces. Last year, as part of an academic course, our work was based on the reconstruction of New Orleans and New York after the storms Katrina and Sandy. We discovered that a more integrated rainwater management brings multiple benefits in public spaces. We found that the same philosophy was used in the SVdP project, although the context is different.

Once we had acquired some theoretical knowledge, we were able to conduct exploratory interviews to determine the approach and to understand the project issues. These exploratory interviews were conducted with researchers, rainwater experts. We met Emma Thébault during a one-hour skype interview. Then Catherine Carré, who is an expert in issues related to comparing the city's water and sanitation systems, through practices, utility management and urban development, during the launching days of the EGOUT⁸ project (cf. figure 1). It is supported by the City of Paris and during which we visited the sewer museum to understand how the sewage system works. We were able to immerse ourselves into the logic of the "all to the sewer"⁹. In addition, during the first steering committee of the OCAP project, I had the opportunity to discuss with Bernard de Gouvello, a specialist on rainwater harvesting and use in urban areas, and on green roofs, by having lunch with him.

⁸ **EGOUT project** aims to provide the City of Paris with a wastewater geochemical observatory. The data collected by this observatory will allow the creation of a socio-economic map of the Parisian territory. More information on: <https://egout.cnrs.fr/>

⁹ Traditional operation that refers to the use of a combined sewer system for wastewater and rainwater disposal.

Figure 1. Photographies from the EGOUT project during launch days



Source: François Dubreuil, March 2022

● Interviews

Finding the right partner is a major step in the collection of data. In this research, no particular difficulties were encountered, given that the City of Paris is strongly involved in the SVdP project, through its contracting role (MOA)¹⁰. Our initial contact came from our team and the relation they have with P&Ma on the OCAPI project. A first interview was therefore carried out with an employee of P&Ma in charge of the sustainable city and the new services, following the advice of our team. During our exchange, he gave us advice on who we should prioritize for interviews and how we should approach them to make them as relevant as possible. All stakeholders interviewed proved to be skilled on the subject and contributed with a different perspective depending on their role in the project.

We decided to interview only experts in rainwater management and public space design. We focused on stakeholders (P&Ma, City of Paris and ATM) who had already worked together on Clichy-Batignolles (CB) district, a key project in rainwater management in Paris. In addition we interviewed Empreinte, which is the project manager (MOE) of public space in SVdP. This selection was done in order to have a panel, although restricted, as representative as possible.

In order to avoid real names, we determined a reference one for each of them. First name is a Greek one constructed around the first letter of the structure. Last name is the Latin

¹⁰ For readability reasons, we have decided to keep the French acronyms in the whole thesis

root of their function. For instance, the supervisor working for P&Ma is Perseus Responsus. The list of stakeholders interviewed is described in the table below:

Table 1. Stakeholders interviewed

Institution / Organism	Role of the organization in the project	Reference name	Date and duration	Place
Paris & Métropole Aménagement (P&Ma)	MOA	Perseus Responsus	03/10/2022 1 hour and 8 minutes	Cafe
City of Paris - DTEC	MOA	Calliope Caput	04/20/2022 54 minutes	Video conference
City of Paris - Cleanliness and Water Directorate (DPE)	MOA	Cyra Ingenium	04/28/2022 1 hour and 31 minutes	Interviewee's office
Empreinte	MOE of public space	Elias Manus	05/02/2022 1 hour and 9 minutes	Cafe
ATM agency	Consulting authority support (AMO)	Abercius Urbanus	05/06/2022 1 hour and 12 minutes	Video conference

We conducted semi-directive interviews in order to let the interviewee answer freely on specific issues. This approach allowed us to go deeper into the subject of regulatory, technical, social acceptance and governance issues related to rainwater management in SVdP.

Thanks to the significance and involvement of the City of Paris in this project, we did not encounter any difficulties in getting interviews. First contact was done by e-mail. Attached to it, we systematically sent them a five-page overview of the research, composed of an introduction explaining the context of the research, the initial hypotheses and a table of stakeholders we wished to interview. With this methodology, when we began interviews, the interviewee knew what we were looking for, what the research area was, and why we wanted to interview him or her. This helped us save time and get to the heart of the matter quickly.

Interviews lasted a long time. The longest one was 1 hour and 31 minutes. We recorded them after obtaining their permission. The process was relatively different according to the speakers, some of them spoke more and we only asked a few questions, while with others we followed the interview grid prepared beforehand. For instance, our first interview with Perseus Responsus started with a long speech from him explaining the context of SVdP, the objectives of the project, etc. We gathered all the information we wanted without asking many questions, thanks to the document we had sent before. He himself addressed the subject of rainwater management and gave us information on technical devices, project philosophy and issues encountered. This allowed us to collect a lot of useful data on rainwater management. Our last interview was with Abercius Urbanus, a reference in rainwater management in Paris. The objective of this interview was to confirm research hypotheses, and friction points that had emerged from the previous ones. We asked as many questions as possible following the main themes of our interview grid. You will find an extract below:

Table 2. Extract from the interview grid used for the exchange with Abercius Urbanus

THEMES	QUESTIONS
General information	<ul style="list-style-type: none"> - Could you introduce yourself and your agency? What are your missions? - How can the cross-cutting approach that you advocate be implemented? Does it encounter difficulties or reluctance?

<p>Regulation</p>	<ul style="list-style-type: none"> - What is the role of the State in the water regulation in France? - For how long has the City of Paris started to implement regulations/requirements in rainwater management? Was the Paris Rain Plan its first one? - Do you think that the Bioclimatic Local Urban Plan (PLU) will bring new constraints in rainwater management?
<p>Water inside urban project</p>	<ul style="list-style-type: none"> - On your website we can read that “water is the support of nature in the city”, what do you mean by “support”? - Have new approaches emerged in the last 5 to 10 years? Has the role of the agency changed?
<p>Focus on Saint-Vincent-de-Paul</p>	<ul style="list-style-type: none"> - What are the main rainwater management devices on public spaces and private lands? You mentioned the notion of mutualization between private and public stakeholders, could you further develop? - How is the maintenance of technical devices done? Do you think about the maintenance of these devices from the conception? - What emerged from previous interviews is the lack of knowledge on evapotranspiration capacities. How did you size the technical devices without knowing exactly the evapotranspiration capacities?
<p>Governance</p>	<ul style="list-style-type: none"> - Can water be considered as a stakeholder of the urban project today? Does it influence the design and governance of urban projects?

	- Do you think that the city is a political object and that rainwater management depends on it?
Perspective	<ul style="list-style-type: none"> - Are there any factors that are not sufficiently taken into account in SVdP now? - Are the technical devices used in SVdP applicable to other urban projects? - Are regulatory constraints necessary to progress?

Thanks to the interviews, we collected multiple documents, which are not available to the public, listed in the table below:

Table 3. Documents collected from interviews

Autor	Title	Type of document	Pages	Year
Empreinte	Landscape instruction (AVP 1)	Technical document	82	2019
P&Ma	Eco-district Clichy-Batignolles	Presentation guide	25	2019
Prefect - Water Police Department	Water law file instruction	Institutional document	2	2021
ATM	Water law declaration file (DLE)	Technical document	89	2021
City of Paris	Rainwater management - <i>Public space planning for water and storage</i>	Powerpoint	111	2022
City of Paris	The pluvial zoning of Paris <i>- Le Parispluie</i>	Powerpoint	59	2022

All these documents allowed us to collect technical, regulatory and institutional data on the SVdP projects and some on CB. Once we had collected a lot of information on these projects, we also had the opportunity to attend multiple conferences, including one on bio-solar roofs. This conference explored the issue between renewable energy production and rainwater management through green roofs. Given the surface area they represent in Paris, roofs are a major issue in rainwater management on private plots especially.

- **Data analysis**

We took notes during each interview and then reviewed them in order to identify key elements. We then listened to the recordings to transcribe interviews. The retranscription represented 65 pages, in Calibri, size 12. To analyze them we used a color code. (cf. figure 2) In orange, we highlighted key issues and elements that we wanted to analyze further in the thesis. In red, it was for technical or regulatory documents mentioned. Thanks to the blue color, we identified key stakeholders and their roles in the SVdP project in order to create a stakeholder's map. Yellow was used to highlight key sentences in the speech.

Figure 2. Extract from the analysis method

- Quels sont les principaux acteurs de la réglementation de l'eau en France ?

- Ce qui est clair c'est que déjà on a les services de l'Etat. Déjà on a les directives cadres qui impliquent les dossiers loi sur l'eau qui impliquent la loi sur l'eau. On a cet axe régalien autour de la gestion de l'eau mais on a aussi les SDAGE qui sont à l'échelle des grands bassins versants des agences de l'eau qui se déclinent après en SAGE donc ça c'est opposable comme document. Il faut savoir que le nouveau SDAGE en tout cas pour la partie Seine/Normandie il est tout neuf depuis quelques mois et il est assez contraignant. Mais en tout cas par rapport à votre recherche sur le dérèglement climatique, le précédent SDAGE et disons que depuis quelques années les SDAGE ont intégré un peu plus cette dimension-là qu'avant. Après on va retrouver la réglementation pour la gestion de l'eau, donc ça et le SDAGE mais en fait ça, ça se répercute sur les PLU et après on peut même avoir des organismes, des doctrines Police de l'eau. A partir du moment où on est soumis à un dossier loi sur l'eau, on doit rentrer dans la doctrine DDT (Direction Départementale des Territoires). La DRIEAT (Direction régionale et interdépartementale de l'environnement, de l'aménagement et des transports) aussi chez nous à Paris, qui est l'ancienne DRIEE et DRIEA, c'est elle qui a instruit SVdP. Après on peut avoir aussi des règlements locaux des syndicats de rivière, bref tous les exutoires des eaux pluviales. Donc on a une multitude de règles qui peuvent même être contradictoires parfois mais en tout cas on a intérêt à chaque fois de regarder toute cette réglementation.

PART I: THE CITY OF PARIS FACING GLOBAL ISSUES

This section sets out the overall theoretical framework within which the research is conducted. The food for thought is inspired by the scientific literature and the political orientations of the City of Paris. The first section addresses two global trends: urbanization and climate crisis. Then, the environmental policy of the City of Paris over the last 10 years is analyzed. Finally, a discussion of the concept of resilience, starting from its origin and its foundations, is introduced.

I. Global trends: Focus on urbanization and climate crisis

This section introduces initial food for thought around key issues that are rapid urbanization and climate change. It attempts to understand how these trends are affecting the urban system in a holistic way.

a) Cities facing their controversies

Today's anxiety-inducing context is leading researchers, policymakers, engineers, urban planners, architects, etc. to question the sustainability of our society. The Meadows Report of 1972, the Rio de Janeiro Earth Summit of 1992, or even the COP 21 are examples among many others.

Cities seem to be the reflection at a small scale of the society: if they are not doing well, the whole system is in trouble. (Blanquart, 2004) Cities are increasingly studied as a combination of complex systems such as transport, energy networks, housing, industries, etc. which are at the origin of CO₂ emissions. (Lhomme, Serre and al., 2011) In addition, cities should not only look at the emissions of the city itself, but also take into account the induced emissions such as food needs, induced traffic (road & air), etc. taken into account by the PCAET of Paris.¹¹ It is about reconsidering the scale of intervention in order to have a more global and integrated approach to environmental issues. (Lhomme, Serre and al., 2011)

¹¹ **City of Paris official website.** *Paris Climate Action Plan.* 2018, p.100 [online]. Available on: <https://cdn.paris.fr/paris/2020/11/23/257b26474ba3ba08ee02baa096f9c5dd.pdf>, (consulted on: 04/13/2022)

However, cities also concentrate decision-making power as well as a density of stakeholders and companies in many sectors that stimulate innovative adaptation such as green buildings, public and soft mobilities, renewable energies, partnership with nearby local authorities to promote sustainable food etc. (Forest, Hamdouch, 2015) Based on these facts, cities are both the cause and solution to challenges (resource scarcity, biodiversity erosion, climate change, strengthening of socio-economic inequalities...) of the coming decades. Debra Roberts, co-chair of the IPCC Group II, said:

“Together, increasing urbanization and climate change create complex risks, especially in cities that already suffer from poorly planned growth, high levels of poverty and unemployment, and a lack of basic services,” [...]“ However cities also offer opportunities for climate action – green buildings, a reliable supply of clean water and renewable energy, sustainable modes of transport connecting urban and rural areas can all create a more inclusive and equitable society.”¹²

In 2007 a major step was reached in human history: for the first time urban population exceeded rural one and this trend has been confirmed these last few years.¹³ Today, according to the United Nations¹⁴, 55% of the population is living in urban settlements representing 4.2 billion people, a proportion that is expected to increase at 68% by 2050.

“As the world continues to urbanize, sustainable development depends increasingly on the successful management of urban growth, especially in low-income and lower-middle income countries”¹⁵ Demographic variable, although not the only one, is a significant factor in addressing socio-ecological issues. As a result of industrialization and economic globalization, urban areas have expanded very significantly in recent decades.¹⁶ This expansion, often mismanaged, leads to consequences on climate change, living environment and public health by disrupting natural cycles. (Desailly and al., 2009) For instance, soil artificialisation has consequences on the carbon cycle by limiting the soil capacity to trap it. (Desailly and al., 2009) In addition, it also has repercussions on the water cycle by increasing

¹² **IPCC.** *Press Release*, February 28, 2022, [online]. Available on: <https://www.ipcc.ch/report/ar6/wg2/resources/press/press-release-french/> (consulted on 04/09/2022)

¹³ **United Nations.** *World Urbanization Prospects 2018 - Highlights*. 2018, 38p [online]. Available on: <https://population.un.org/wup/Publications/Files/WUP2018-Highlights.pdf>, (consulted on: 04/09/2022)

¹⁴ Ibid

¹⁵ Ibid, p.1

¹⁶ Ibid

the runoff velocity which sometimes leads to disastrous floods as was the case in Germany and Belgium last July.

We understand that the process of urbanization affects the natural cycles and we shall now try to determine if the dynamics of urbanization are the same worldwide.

b) Is urbanization the same worldwide?

First, before going into detail, we must begin by defining what urbanization is. If we take as reference the definition of the United Nations, urbanization means:

“a complex socio-economic process that transforms the built environment, converting formerly rural into urban settlements, while also shifting the spatial distribution of a population from rural to urban areas. It includes changes in dominant occupations, lifestyle, culture and behavior, and thus alters the demographic and social structure of both urban and rural areas”¹⁷

According to the report, to study this process, experts are using the proportion of urban population's indicators, calculated on population living in urban settlements. Traditionally, a high urban population rate correlates with high development of a country. In 2018, 82% of the population in North America, 78% in Europe, 50% in Asia and 43% of the population in Africa lived in cities¹⁸. However, cities are growing rapidly in Asia and Africa. Three main factors are responsible for this increase: a) Natural growth, which is the difference between births and deaths; b) Migration that can be internal or external and represents the population displacement; c) Reclassification, which is directly related to urban growth, a city that expands and integrates rural areas within it.

This process induces a shift of the population from rural to urban areas and therefore an increasing pressure on cities' systems and resources such as raw materials, water, food, space etc. (Lhomme, Serre and al., 2011) Urbanization covers everything from infrastructure to lifestyle, from governance to health and education systems, etc. (Lhomme, Serre and al., 2011) This process somehow describes the city ecosystem construction. However, what

¹⁷ **United Nations.** *World Urbanization Prospects 2018 - Highlights.* 2018, 38p [online]. Available on: <https://population.un.org/wup/Publications/Files/WUP2018-Highlights.pdf>, (consulted on: 04/09/2022)

¹⁸ Ibid

exactly does the term ‘city’ mean? Is there a single definition, or does it depend on national contexts?

Using many definitions from agencies and scientific articles on the subject, Wu suggests that cities, in most cases, can be described based on two main factors: high human population density and extensive impervious surface area (Wu, 2014). However, this raises issues about the fact that in its own characterization, a city is defined by impervious surfaces, which are at the base of many environmental issues. In national frameworks, cities are usually defined depending on the total size of the population. For instance, in France, urban units are based on this principle and on a morphological definition of the city that is defined as “a municipality or a group of municipalities with a continuous built-up area (no break of more than 200 meters between two buildings) that has at least 2,000 inhabitants.”¹⁹ Would not this definition require the "villages" to urbanize in order to meet the 200-meter rule?

The urbanization process is closely related to the sustainable development dimensions.²⁰ Actions on climate-change adaptation taking into account socio-ecological dimensions are needed at different scales and especially by local governments. (La Branche, 2011) Based on this, the following question is legitimate: How can we adapt our society to current and future changes? How can we make our cities sustainable and resilient?

c) IPCC report and cities adaptation to climate change

The new IPCC report²¹ gives some guidelines on this issue: Reducing energy consumption by renovating housing, creating walkable cities, city greening, improving carbon storage and water management, and transports electrification with low-emission energy sources... Cities have an important place in this 6th IPCC analysis. A new special report on climate change and cities should be published by the end of the year. François GEMENNE, during the first seminar of the new Ecological Transition and Climate

¹⁹ **INSEE**. *Unité urbaine / Agglomération / Agglomération multicommunale / Agglomération urbaine*, 12/09/2020 [online]. Available on:

<https://www.insee.fr/fr/metadonnees/definition/c1501#:~:text=Les%20unit%C3%A9s%20urbaines%20sont%20construites,a u%20moins%202%20000%20habitants>, (consulted on: 04/09/2022)

²⁰ **United Nations**. *World Urbanization Prospects 2018 - Highlights*. 2018, 38p [online]. Available on: <https://population.un.org/wup/Publications/Files/WUP2018-Highlights.pdf>, (consulted on: 04/09/2022)

²¹ **IPCC**. *Climate Change 2022, Mitigation of Climate Change, Summary for Policymakers*, 2022 [online]. Available on: https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_SummaryForPolicymakers.pdf, (consulted on: 04/09/2022)

Directorate²², highlights the need to move away from binary logic and to recognize that climate change is a gradual issue. Every tenth of a degree matters and we must be aware of it: “we still talk about climate change as a battle that we will win or lose”. Climate change, related to its inertia, appears to require cities to prepare for large-scale changes. Thus, synergies must be found between mitigation and adaptation solutions (Klein, Schipper and al., 2005) In order for this synergy to work, it seems necessary to address active institutional organizations. (Forest, Hamdouch, 2015) It is a question of avoiding the design "What is the point if I do something if my neighbor does nothing, what is the point if France does something if China reopens coal mines".²³

If these adaptation policies aim to be effective, they should also take into account the inequalities between individuals and countries. (Guivarch and Taconet, 2020) Local and national governments should take into account the degree of vulnerability of the population as people are not affected by natural hazards in the same way. (Gemenne and al, 2017) The capacity to face natural hazards depends on time, space and socio-economic characteristics (Gemenne and al, 2017). Poor populations are more vulnerable to climate change because they live in risky areas, have unsafe housing and are not well-informed. (Gemenne and al, 2017) The IPCC report²⁴ also highlights the fact that the more unequal the society, the more vulnerable it is. There is a real risk of getting into a negative circle where vulnerability will lead to more inequalities which will lead to more vulnerabilities.²⁵ Therefore, it is about how mitigation policies may be integrated into the justice of the transition concept (Guivarch and Taconet, 2020)

Those issues are even more relevant in Megacities, a city with more than 10 million inhabitants.²⁶ By 2030, there should be 43 megacities around the world and Paris will be a part of it, with an expected population of 11.7 million inhabitants in the urban area.²⁷ The City of Paris is the institution which covers the city center and represents 2.2 million inhabitants. The research is focusing on it. As mainly cities worldwide, Paris is and will be

²² **City of Paris.** *Seminar of the Ecological Transition and Climate Directorate*, May 9, 2022, at the Du Breuil school. During the day, François Gemenne gave a 20-minute presentation to the whole Directorate on the new IPCC report.

²³ Ibid.

²⁴ **IPCC.** *Climate Change 2022, Mitigation of Climate Change, Summary for Policymakers*, 2022 [online]. Available on: https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_SummaryForPolicymakers.pdf, (consulted on: 04/09/2022)

²⁵ **City of Paris.** *Seminar of the Ecological Transition and Climate Directorate*, May 9, 2022, at the Du Breuil school. During the day, François Gemenne gave a 20-minute presentation to the whole Directorate on the new IPCC report.

²⁶ **United Nations.** *World Urbanization Prospects 2018 - Highlights*. 2018, 38p [online]. Available on: <https://population.un.org/wup/Publications/Files/WUP2018-Highlights.pdf>, (consulted on: 04/09/2022)

²⁷ Ibid

confronted with many environmental issues such as air pollution, flooding, drought, resource scarcity, biodiversity erosion, growing socio-economic inequalities and so on.²⁸²⁹ So the questions are: How is the city adapting? What are the environmental policies implemented by the City of Paris to address those challenges?

II. City of Paris challenges, how is the city adapting ?

Following an overview of global trends, we now focus on their local impacts in the City of Paris. In this section, the focus will be on the socio-ecological plans and strategies established by the City of Paris over the past 10 years.

What is the City of Paris like? The City of Paris has a specific regulation since January 1, 2019, and the union of municipal and department competencies: “The City of Paris is substituted for Paris municipality and Paris department in all their rights and obligations, in all deliberations and acts that fall within their jurisdiction, as well as in all administrative and jurisdictional procedures in progress at the date of its creation.”³⁰ Through this, the City of Paris recovered competencies such as traffic, public health and fight against unhealthy housing, noise pollution, etc. which were previously exercised by the Police Prefect. This new organization simplifies administrative procedures by allowing faster decision-making. For instance, it allows only one budget to be approved, instead of two previously.³¹³²

Today, 53,000 agents are working for the City of Paris, distributed among 24 directorates. These directorates cover many fields, from citizen and territorial democracy to housing, including roads and transportation, urban planning, green spaces and environment, etc. Two new directorates were created at the beginning of 2022, the Directorate of Public

²⁸ **City of Paris official website**, *Paris in the face of climate change*. 2021, 24p [online]. Available on: <https://cdn.paris.fr/paris/2021/11/16/088fcde428650ff1e3d9680f155a54a7.pdf>, (consulted on: 04/16/2022)

²⁹ **City of Paris**. *Paris Resilience Strategy*, 2017, p.128 [online]. Available on: https://resilientcitiesnetwork.org/downloadable_resources/Network/Paris-Resilience-Strategy-English.pdf, (consulted on: 04/13/2022)

³⁰ **LégiFrance**. *LOI n° 2017-257 du 28 février 2017 relative au statut de Paris et à l'aménagement métropolitain*, 28/02/2017, [online]. Available on: <https://www.legifrance.gouv.fr/loda/id/JORFTEXT000034103927/>, (consulted on: 04/10/2022)

³¹ **City of Paris official website**. *Paris : fusion de la Ville et du conseil départemental*, 07/01/2019, [online]. Available on: <https://www.paris.fr/pages/paris-fusion-de-la-ville-et-du-conseil-departemental-6373>, (consulted on: 04/10/2022)

³² **City of Paris official website**. *La loi sur le statut de Paris promulguée*, 07/01/2019, [online]. Available on: <https://www.paris.fr/pages/comprendre-le-projet-de-modernisation-du-statut-de-la-ville-de-paris-3224/>, (consulted on: 04/10/2022)

Health and the DTEC. This trend illustrates the political significance given to environmental issues, a major support in project management.

Over the past 10 years, the City of Paris intends to build its public policies around social and ecological issues. The Paris Agreements resulting from the COP21 are an illustration, on an international scale, of the City of Paris ambitions. It intends to place itself as a leading city of the socio-ecological transition in the world. This vision has been expressed once again through the 2024 Olympic and Paralympic Games. The City of Paris wishes to use this event as a showcase of its political aspirations, especially in terms of the legacy that such an event can potentially leave behind.³³

The City of Paris as mainly cities worldwide has to adapt itself to future climate crisis. A study entitled “Paris in the face of climate change”³⁴ was published in November 2021 and shows challenges that the city should be prepared to face in the future. For instance, the study highlighted water as a powerful lever in order to adapt the city to climate change. The study indicates that a greater intensity of precipitation should be expected due to an increase in rainfall quantity, while the number of rainy days should decrease. Consequences are flooding risks by overflowing rivers, but also by runoff in the city due to waterproof surface.³⁵ Meanwhile, as temperatures rise, the risk of drought increases, with significant impact on biodiversity, human health, energy networks, etc. Domino effects are emerging on urban systems, highlighting the interconnection between them.

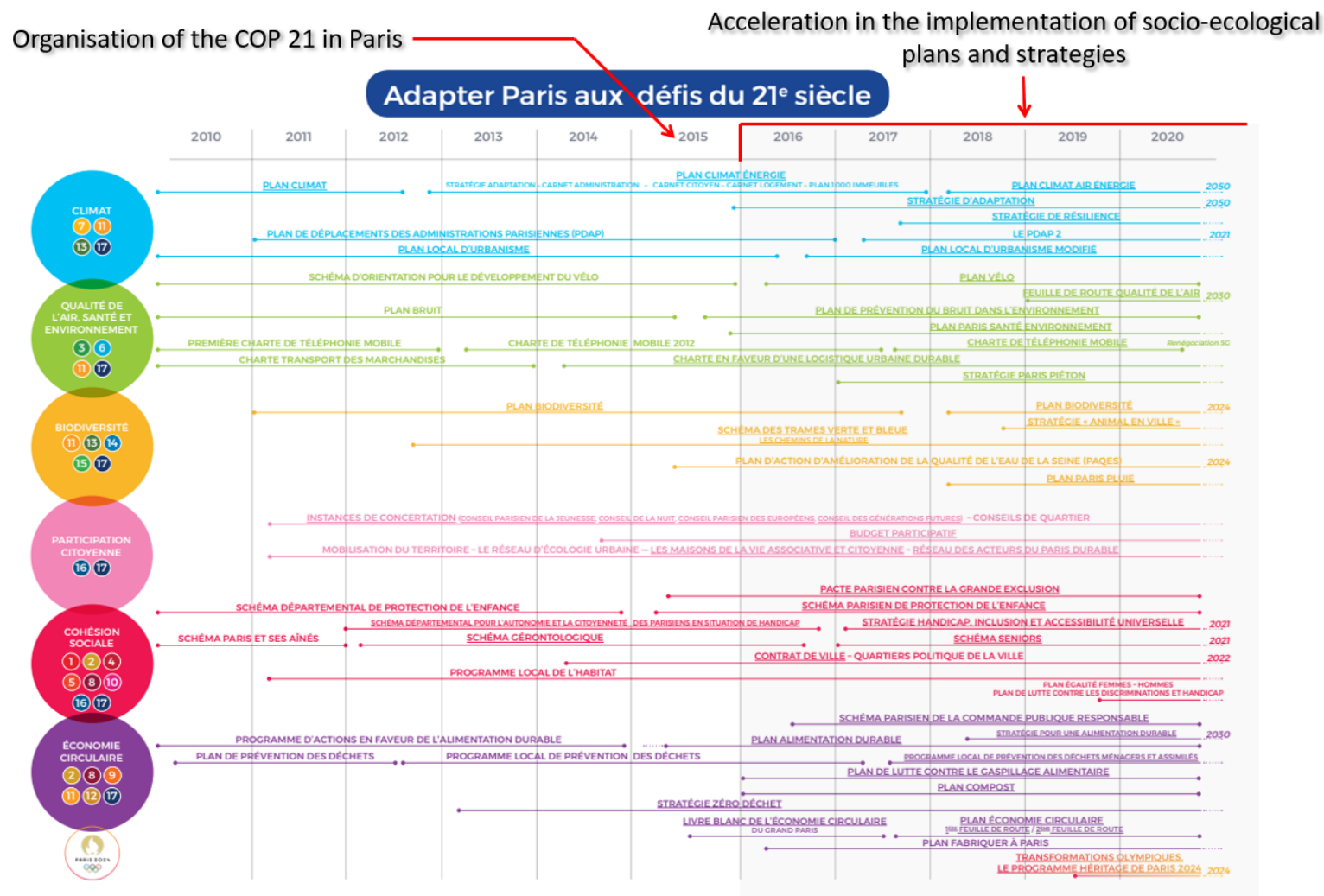
The scheme below (cf. figure 3) is showing municipal policies regarding climate, air quality, biodiversity, citizens participation, social cohesion, circular economy and lately Olympics and Paralympics games issues. This diagram is based on the 17 sustainable developments goals. As we may notice, following the COP 21 in 2015, in Paris, an acceleration in the implementation of environmental plans and strategies occurred.

³³ Information from this paragraph comes from a lot of internal city reading, as well as informal discussions with colleagues and researchers.

³⁴ **City of Paris official website**, *Paris in the face of climate change*. 2021, 24p [online]. Available on: <https://cdn.paris.fr/paris/2021/11/16/088fcde428650ff1e3d9680f155a54a7.pdf>, (consulted on: 04/16/2022)

³⁵ **City of Paris official website**. *Paris Climate Action Plan*. 2018, p.100 [online]. Available on: <https://cdn.paris.fr/paris/2020/11/23/257b26474ba3ba08ee02baa096f9c5dd.pdf>, (consulted on: 04/13/2022)

Figure 3. Diagram of the socio-ecological plans and strategies distribution, produced by the City of Paris³⁶, over the last 10 years



³⁶ City of Paris. *Le développement durable à Paris*, 2022, [online]. Available on: <https://www.paris.fr/pages/le-developpement-durable-a-paris-5340> (consulted on 04/16/2022)

Among all these strategies and plans, we focused on five of them. The selection was initially based on the five interviews that were conducted. Thus, as indicated (cf. table 4), the PCAET, the Bioclimatic PLU and the PRP were mentioned. In addition, to provide a complete overview, the Biodiversity Plan will also be analyzed in greater depth due to its vegetation and waterproofing objectives. The Resilience Strategy, related to its more flexible and holistic approach, provides a link between the plans discussed.

Table 4. Main information on strategies and plans analyzed

Plan or strategy name	Lead directorate	Publication year	Mentioned in interviews
PCAET³⁷	DTEC	Published in 2018 but currently under review	2 interviews (2times)
Biodiversity Plan³⁸	Green Spaces and Environment Directorate (DEVE)	2018	None
PRP³⁹	Cleanliness & Water Directorate (DPE)	2018	4 interviews (33 times)
Bioclimatic PLU⁴⁰	Urban Planning Directorate	In progress, expected to be published in 2023	4 interviews (9 times)
Resilience Strategy⁴¹	DTEC	Published in 2017 but currently under review	None

³⁷ **City of Paris official website.** *Paris Climate Action Plan.* 2018, p.100 [online]. Available on: <https://cdn.paris.fr/paris/2020/11/23/257b26474ba3ba08ee02baa096f9c5dd.pdf>, (consulted on: 04/13/2022)

³⁸ **City of Paris official website.** *Plan Biodiversité de Paris 2018-2024.* 2018, p.130 [online]. Available on: <https://cdn.paris.fr/paris/2021/02/17/fbb551749cd3dabdf2b730d5f4097629.pdf>, (consulted on: 04/13/2022)

³⁹ **City of Paris official website.** *PlanParisPluie.* 2018, p. 108 [online]. Available on: <https://cdn.paris.fr/paris/2019/07/24/843a7be4c5c6c532a4eaab07a15724da.pdf>, (consulted on: 04/13/2022)

⁴⁰ **City of Paris official website.** *Révision du plan local d'urbanisme bioclimatique : quel visage pour Paris en 2030 ?*, 15 mars 2022, [online]. Available on: <https://www.paris.fr/pages/la-revision-du-plan-local-d-urbanisme-plu-17018>, (consulted on: 04/13/2022)

⁴¹ **City of Paris.** *Paris Resilience Strategy.* 2017, p.128 [online]. Available on: https://resilientcitiesnetwork.org/downloadable_resources/Network/Paris-Resilience-Strategy-English.pdf, (consulted on: 04/13/2022)

- **PCAET**

The PCAET⁴² is composed of 500 measures that include buildings, energy, living environment, waste, etc. The main goal of this plan is to lead the City of Paris towards carbon neutrality while creating a resilient city. To achieve this ambitious goal, by 2050, energy consumption must be divided by two and 100% of energy consumption within Paris must be renewable, including 20% produced locally. The plan addresses the main pollution-causing sectors such as air transportation, food and road traffic. The City of Paris, by acting on these multiple dimensions, wishes to reduce air pollution in order to improve the living environment and health of its inhabitants. In addition to these measures, other objectives are supported by this plan, especially in the refreshment of public space through new facilities. This goal includes the reintegration of water in Paris, for instance, through the restoration and creation of 50 wetlands by 2030.

The case study, SVdP is mentioned several times as "In the north of the 14th district of Paris, the joint development zone (ZAC) Saint Vincent-de-Paul will be the first urban project that aims to be carbon-neutral and resilient." (City of Paris, 2018a, p.41). CB is also mentioned "as laboratories for the city of the future." (City of Paris, 2018a, p.41). This shows the political significance given to the projects as an interviewee mentioned "This is somewhat the luck of our operations, they are clearly identified as the showcase of the environmental policy of the City of Paris." (Perseus Responsus, March 2022)

To meet climate challenges, biodiversity is a significant lever of adaptation. The City of Paris addresses the issue by creating the biodiversity plan.

- **Biodiversity Plan**

In a context of climate change and the 6th species extinction, the biodiversity plan⁴³ allows the City to promulgate the benefits of biodiversity. Biodiversity has for a long time been unexploited, polluted, destroyed by urban sprawl but today, it appears as a significant lever to adapt the city to future changes.⁴⁴ It is about favoring rainwater infiltration, improving

⁴² **City of Paris official website.** *Paris Climate Action Plan.* 2018, p.100 [online]. Available on: <https://cdn.paris.fr/paris/2020/11/23/257b26474ba3ba08ee02baa096f9c5dd.pdf>, (consulted on: 04/13/2022)

⁴³ **City of Paris official website.** *Plan Biodiversité de Paris 2018-2024.* 2018, p.130 [online]. Available on: <https://cdn.paris.fr/paris/2021/02/17/fbb551749cd3dabdf2b730d5f4097629.pdf>, (consulted on: 04/13/2022)

⁴⁴ Ibid

the living environment, or refreshment of public space by evapotranspiration and so on. To promulgate the biodiversity inside the city, it is about developing citizens' awareness, including measures in urban plans and to encourage actions from the bottom that promotes biodiversity such as urban farming. We are especially interested in action n°19 called “participating in the urban resilience and adaptation to the territory to climate change” (City of Paris, 2018b, p.81). It focuses on reducing soil sealing by developing nature-based solutions. Those solutions enable the development of ecosystem services, services provided by nature to human societies. The final objective of this action is to reach 50% of permeable surfaces by 2030 on the Parisian territory.

This plan makes the link with the PCAET, the resilience strategy and the PRP on a specific element that is biodiversity. Furthermore, by greening the city, it meets rainwater management objectives as developed in the PRP.

- **PRP**

In terms of rainwater management in Paris, the PRP⁴⁵ is a major component. It was mentioned several times during interviews (cf. table 4) and it is a significant lever to change the way we conceive urban projects. The main purpose is to restore the natural water's cycle and strengthen the water and nature presence in public and private spaces in Paris. It is even more complicated to achieve that Paris is dense, mineral and with constrained subsoils. The PRP, by setting up the rainwater zoning, annexed to the PLU, established for the first time significant rainwater management requirements. It involves current rainwater harvesting and draining within 24 hours. It is now required on all development or construction projects that reach a given size.

This plan is a revolution in the way the city of tomorrow is designed. “The Paris Rain Plan can be considered, for me, I won't say what bears the pencil of landscaping but almost.” (Calliope Caput, April 2022). Due to implementing such important constraints, “the Paris Rain Plan took more than 10 years to come out. You have strong constraints in terms of planning, you shake up all the agents' habits.” (Calliope Caput, April 2022). To achieve the objectives, practitioners used greening techniques such as ditches, rain gardens, green roofs

⁴⁵ City of Paris official website. *PlanParisPluie*, 2018, p. 108 [online]. Available on: <https://cdn.paris.fr/paris/2019/07/24/843a7be4c5c6c532a4eaab07a15724da.pdf>, (consulted on: 04/13/2022)

and so on. The City of Paris is using the SVdP district to highlight “that the objectives of the Paris Rain Plan are achievable and even in much greater proportions than those prescribed by the rain zoning for all operations in a very constrained site” (Perseus Responsus, March 2022)

- **Bioclimatic PLU**

Unlike the previous plans, the bioclimatic PLU⁴⁶ is not yet published, it is still in progress. The consultation on the new planning and sustainable development project (PADD) ended on April 1st. At the end of 2022, consultation on the regulations of the local urban plan and on the orientation of development and programming (OAP) should begin. This involves

"many actors working on it: there are already the services of the City of Paris, but there is also the APUR (Parisian Agency of urban planning) which is doing all the work with a diagnosis, etc., there is a group of consultancy firms working on the PLU itself, and then there is another group of contracting authority support (AMO) on the bioclimatic PLU, and this group of AMO, it is a group with all the professions, we are in it for the rainwater management part" (Abercius Urbanus, May 2022).

Why is the City of Paris reviewing its PLU? Facing multiple challenges, the City of Paris is convinced that a fundamental change should be made regarding the conception of the city. This should be done through partnerships with stakeholders, by encouraging good practices, but also through a change in the regulatory framework. As mentioned earlier, multiple environmental plans are being reviewed. Thus, the future bioclimatic PLU must integrate and gather the objectives of these plans to make them mandatory in urban projects.

What does bioclimatic mean? Bioclimatic is an architectural design method that depends on the site and the surrounding environment (wind, sunshine, geomorphology...) of the project in order to obtain optimal conditions of livability while respecting ecosystems.⁴⁷ Bioclimatic approach, by taking into account the environmental conditions, aims to make the city more energy efficient, to reduce the amount of waterproofed surfaces to renaturalize and restore the water cycle in the city. It is also about reusing materials as in SVdP where “the deconstruction [...] were reduced as the choice, well the essence of the project consisted in transforming the hospital and not in terraforming or demolishing/reconstructing everything.

⁴⁶ City of Paris official website. *Révision du plan local d'urbanisme bioclimatique : quel visage pour Paris en 2030 ?*, 15 mars 2022, [online]. Available on: <https://www.paris.fr/pages/la-revision-du-plan-local-d-urbanisme-plu-17018>, (consulted on: 04/13/2022)

⁴⁷ Ibid

This perspective is related to the orientations that the City of Paris is taking with the revision of its PLU in bioclimatic PLU” (Perseus Responsus, March 2022). This is in order to meet the objectives set by the city's other environmental plans. Regulation is used as a tool with which it is possible to create a city in symbiosis with its environment. The bioclimatic approach should influence a new trend, a new way of understanding and designing the city of tomorrow.⁴⁸

The revision of the PLU into a bioclimatic PLU is therefore an opportunity to move towards resilience which is intended to be flexible and holistic as developed in the resilience strategy.

- **Resilience Strategy**

Paris' Resilience Strategy⁴⁹ is built around three pillars, nine objectives and thirty-five actions to address six main issues: socio-economic inequalities, terrorism, climate change, air pollution, risks related to the Seine and territorial governance. Until the end of 2021, it was led by the Resilience Mission, which depended on the Secretary General (SG) of the City of Paris. However, today it is led by the DTEC and its RPRI unit. The DTEC has a key role in adapting the city to future challenges by developing a holistic approach within the city to the ecological transition and climate issues. It ensures that the most vulnerable are supported in this process. The RPRI unit, which is part of it, is involved in a dynamic approach that constantly anticipates socio-ecological challenges.⁵⁰ The RPRI unit is currently in charge of the redesign of the resilience strategy, which is expected to be published in late 2023.

The resilience strategy was not mentioned in any interviews, however, it attempts to develop a multidisciplinary approach in its actions, a need expressed by interviewees. The term "strategy" means that it does not remain fixed and actions can evolve based on current events. This format corresponds more to the concept of urban resilience. In Pillar 2, Objective C, which addresses the issue of resilient urban planning, we find Action #21 entitled

⁴⁸ **City of Paris official website.** *Révision du plan local d'urbanisme bioclimatique : quel visage pour Paris en 2030 ?*, 15 mars 2022, [online]. Available on: <https://cdn.paris.fr/paris/2019/07/24/843a7be4c5c6c532a4eaab07a15724da.pdf>, (consulted on: 04/13/2022)

⁴⁹ **City of Paris.** *Paris Resilience Strategy*, 2017, p.128 [online]. Available on: https://resilientcitiesnetwork.org/downloadable_resources/Network/Paris-Resilience-Strategy-English.pdf, (consulted on: 04/13/2022)

⁵⁰ Presentation coming from internal documents of the City of Paris.

"Develop the first resilient and climate-sensitive neighborhood in Saint Vincent de Paul." SVdP appears as a key element of the City of Paris' environmental policy.

After having discussed resilience from an institutional point of view, it is appropriate to define the limits of the concept through the scientific literature.

III. Resilience: a lever for transforming public policies?

Resilience is a multi-disciplinary concept by nature, it originally came from physics in which it refers to the ability of a material to resist following a shock or deformation. (Lhomme, Serre et al., 2011) This term was then taken up by the ecological sciences before becoming a widely used concept in politics today.

Recently, resilience has been institutionalized at different scales. Many international cities networks have been created in the last decade: 100 Resilient Cities (100RC), Making Cities Resilient 2030 (MCR2030), C40, etc. At the European scale following COVID crisis, a program called "Recovery and Resilience Facility"⁵¹ was launched to help Member's State by providing financial support. Within this context, France has presented "The national recovery and resilience plan"⁵² which is made of three majors sections: ecological transition, competitiveness, territorial and social cohesion. Last year, the "Climate and Resilience law"⁵³ was approved to support goals of the ecological transition. A controversial law that included only part of the measures proposed by the Citizens' Climate Convention. In February 2022, a report was presented to the National Assembly on territorial resilience⁵⁴. In addition, many structures and organizations are working on resilience such as CEREMA, Comity 21, Bouygues Construction etc. Why is this term suddenly used in politics? What does it really mean?

⁵¹ **European Commission.** *Recovery and Resilience Facility*, 2021 [online]. Available on: https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_fr, (consulted on 04/17/2022)

⁵² **French Economy, Finance and Recovery Ministry.** *The national recovery and resilience plan*, 2021 [online]. Available on: <https://www.economie.gouv.fr/plan-national-de-relance-et-de-resilience-pnrr#>, (consulted on 04/17/2022)

⁵³ **LegiFrance.** LAW No. 2021-1104 of August 22, 2021 on the fight against climate change and strengthening resilience to its effects. [online]. Available on: <https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000043956924>, (consulted on 04/17/2022)

⁵⁴ **National Assembly.** *Information Report on territorial resilience*, 2022 [online]. Available on: https://www.assemblee-nationale.fr/dyn/15/rapports/resinat/115b5119_rapport-information, (consulted on 04/17/2022)

a) Origin of the resilience concept

The concept was introduced in 1973, by Crawford Stanley Holling which defined it as “the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist.” (Holling, 1973, p.17). From this perspective, resilience represents the persistence of a system, taking into account its properties, to keep working through space and time in spite of the variability, expressed by shocks or chronic stresses, of its surroundings. In a way, resilience is about finding equilibrium in a changing environment. Alternative configurations of a system exist, there are multi-stable states (Holling, 1973). The reality of multi-stable states means that a high degree of variability, characteristic of ecological systems, should be expected to maintain the existence of the system and its learning functions. Therefore, a resilient system is one that constantly learns from its environment to transform fluctuations into opportunities. (Holling, 1973)

However, it existed and still exists a divergence in the resilience speeches. Holling (1996) identified two types of resilience which are fundamentally different. On one hand, engineering resilience from environmental sciences is focusing on prediction, efficiency and consistency. It promotes the stability of the system near equilibrium, the maintenance of a predictable world, and the harvesting of nature's excess production with as little fluctuation as possible. On the other hand, ecological resilience embraced unpredictability with the final goal to achieve the system's persistence through space and time. Holling suggested that to implement ecological resilience there is a “need to keep options open, the need to view events in a regional rather than a local context, and the need to emphasize heterogeneity”. (Holling, 1973, p.21)

For a long time, engineering resilience dominated ecological ones, with the aim to return as quickly as possible to the initial state before the disturbance. (Folke, 2006) It is from engineering resilience that came the definition of resilience that has long been used: the ability of a system, affected by a shock or chronic stress, to return to its equilibrium point as quickly as possible. From this perspective, the environment is stable and does not evolve through space and time. By not taking into account the changing variables of the environment (demographic growth, climate change, resource scarcity), it exposes the society to not be adapted to its environment anymore.

The concept of resilience experienced a turning point in the early 2000s with the integration of social sciences. (Lhomme, Serre and al., 2011) This evolution was driven by the creation of the "resilience alliance",⁵⁵ an international organization composed of multidisciplinary researchers working on the understanding and operationalization of the resilience concept to address human well-being and ecosystem health. This alliance has brought together the social and ecological sciences. Today, the alliance focuses on the study of adaptive social-ecological systems (SES).

Resilience, therefore, focuses more on the adaptive capacity of a system. Walker et al (2004) identified three attributes that affect the ongoing trajectories of an SES: adaptability, transformability, and resilience. Resilience is thus defined as "the ability of a system to absorb disturbances and reorganize itself while undergoing change to retain essentially the same function, structure, identity, and feedbacks" (Walker, Holling et al, 2004, p.6). The notion of change emerges and the adaptability of the SES "is the collective ability of the human actors in the system to manage resilience." (Walker, Holling et al, 2004, p.7) The two dimensions that constitute the SES, institutions and ecosystems, are, in fact, intertwined and "The link between ecosystem and management practice is provided by ecological knowledge and understanding" (Berkes et al, 2003). This means that a solid understanding of nested ecosystems will allow for better management of institutions at different scales. The term "social-ecological resilience" is now being used to describe disturbances as opportunities to innovate and transform in order to become more resilient. The table 5 below, summarizes the different types of resilience discussed in this section:

⁵⁵ Read more: <https://www.resalliance.org/>

Table 5. Summary of resilience concepts, inspired by Folke (2006)

Resilience concept	Sciences	Focus on	Ultimate goal
Engineering resilience	Environmental sciences	Return in time, predictability, consistency, recovery	To stay near the equilibrium point
Ecological resilience	Ecological sciences	Persistence, unpredictability, robustness	To achieve persistence of the system through space and time
Socio-ecological resilience	Multidisciplinary sciences	Adaptive and learning capacity, transformability, innovation	To develop an integrated system, that adapts to change and turns disruptions into opportunities

b) Socio-ecological resilience applied to a complex system: Cities.

Cities are complex systems. They are small-scale reflections of society through its history, natural environment, technical progress, etc. (Lhomme, Serre et al., 2011) They provide many urban functions such as economic activities, political organization, public health, education, etc. Thierry Vilmin (2019) establishes the metaphor between urban infrastructure and the behavior of an organism. Thus, for instance, urban fabric is described as the skeleton on which are connected the vital organs that are the urban functions. All these organs are interconnected, which means that a failure of one organ will have repercussions on the others. This is called the domino effect. (Vilmin, 2019) Moreover, the city is also a perceived and lived object. (Lhomme, Serre, et al., 2011) According to the authors, the city is shared both by the users of its functions and by those who think about it, who think about how to design it.

Systems thinking was introduced by Donella Meadows. (Meadows, 2008) She is considered to be one of the pioneers of ecology. She is especially known for co-writing the Meadow report, also called Limit to Growth in 1972. She defined systems as “an interconnected set of elements that is coherently organized in a way that achieves something. [...] a system must consist of three kinds of things: elements, interconnections, and a function or purpose” (Meadows, 2008) The systemic approach consists in saying that the whole is

greater than the sum of its parts.⁵⁶ Systemic approach is giving tools to study complex systems such as: city (Lhomme, Serre, Diab and al., 2011). It consists of thinking that each infrastructure, each social organization, technology, network, ecosystems from the micro to the macro function: everything is integrated or is part of a system. (Bunge, 2000). Moreover, the systemic perspective influences the policy design. According to Mario Bunge, going beyond individualism by taking into account both the collective and individual dimensions.

The systemic approach may be difficult to implement. For instance, Marianna Mirabile, an economist at the OECD, interviewed by the Systems Transition Program⁵⁷, provided an illustration of how systemic theory may be applied to the transportation field. Since the democratization of the car, cities have been transformed by designing infrastructures (roads, parking, bridges) for this new transportation means. When congestion emerged, even larger roads were built, which led to the emergence of new traffic jams again. The systemic approach applied to this example means that public policy must take into account the mobility of the population, investing in new systems such as bicycle facilities, public transport, etc. Rather than the domino effects being negative, it becomes positive (reduction of air and noise pollution, improvement of the living environment...)⁵⁸.

Cities are open systems, which means that they also depend on their external environment. (Lhomme, Serre, and al., 2011) It is, therefore, important to analyze the relationship between the city and the countryside. For instance, New York City established the New York City Watershed Agreement⁵⁹, approved in 1997, to protect New York City's water supply. The agreement addresses the source of pollution due, in large part, to agricultural practices rather than the consequences of it. A farm-specific pollution control plan, which identifies the investments needed to change practices has been developed by farmers.⁶⁰ New York City covered the cost of investment, paying for the ecological services provided by farmers. Systemic approach is about getting to the root of each issue.⁶¹

⁵⁶ Introduction of the systemic transition in a seminar of the RPRI on 06/28/2022.

⁵⁷ **Systemic transition**, Marianna Mirabile. *Systemic innovation levers for a sustainable transport system*, 2021, 01:01:14 time [online]. Available on: <https://transitionsystemique.fr/programme-indicatif/leviers-dinnovation-systmique-pour-un-systme-de-transport-soutenable>, (consulted on 04/18/2022)

⁵⁸ Ibid

⁵⁹ **New York City official website**. *New York City Watershed Program*. Available on: <https://dos.ny.gov/new-york-city-watershed-program> (consulted on 08/06/2022)

⁶⁰ Ibid

⁶¹ Ibid

Urban resilience is the concept of socio-ecological resilience applied to urban systems. In the City of Paris, it is used to adapt the city to future changes. Urban resilience to be effective must take three main elements: systems (seen above) agents, "capable of deliberation, independent analysis, voluntary interaction and strategic choice when facing new information. [...] and private and public sector organizations (government departments or offices, private companies, civil society organizations)" (Tyler & Moench, 2012, p.5). It seems that each city is unique, depending on variables such as demographic, cultural, political, environmental, economic etc.

Resilience, beyond the climate dimension, seems to raise another issue: resilience for whom? (Cretney, 2014) Several studies suggest a positive correlation between a high-level of social capital of the inhabitants of a territory and its resilience to disasters. (Klinenberg, 2002; Aldrich, 2012; Aldrich 2014). It is fundamental to strengthen social cohesion and to co-design the resilience strategy of a territory in the long-term by using tools of the citizens' participation.

Designing the city, in an unpredictable environment, is a real puzzle as there are many environmental and social issues at stake. Adaptation to climate change may also provide an opportunity to reconnect with natural cycles that have disappeared from cities. (Desailly and al., 2009) We intend to understand how rainwater management can become a lever of action to be activated to ensure the liveability of cities.

PROBLEMATIZATION

Previous thoughts established a framework to position our work between global trends, Paris environmental policies, as well as the conceptual theory of resilience. An interesting point is that resilience is increasingly being integrated into institutions at different scales. However, this concept by incorporating tools of systems thinking may be difficult to grasp. (Tyler & Moench, 2012) Therefore, we focus on an example, the rainwater management strategy at SVdP to understand how resilience is being implemented in urban planning. SVdP seems to be an interesting example to explore as it has the political support of the City of Paris and it is currently being renovated. It represents what is currently being done in urban projects. Thus, it seems relevant to address the relationship between resilience and public spaces in order to understand how issues raised from resilience are being taken in hand by stakeholders that are designing public spaces. The following problematic emerged from this observation: To what extent are resilience issues being integrated within the design of public spaces? - The example of rainwater management in Saint-Vincent-de-Paul.

Research hypothesis. We intend to address this issue through three hypotheses: (1) Paris, following Dutch design thinking, is moving towards rainwater integrated management in public spaces. This integrated management leads to new technical devices that modify the landscape and the function of public spaces. (2) This technical integration in public spaces cannot be sustainable if it is not socially accepted. It is therefore essential to make citizens aware of the rainwater management issues. (3) To achieve the goal of zero discharge as promoted in the SVdP, a new governance model must emerge. Therefore, water seems to get involved in urban project governance as a non-human stakeholder.

Expected contributions. There have been numerous previous research studies on rainwater management in Paris. Most have focused on the story of rainwater management over the past 50 years or more. (Barles and Thébault, 2018; Thébault, 2019; Seidl, 2020) This research contributes to the previous ones in order to fill the knowledge gap on the evolution of practices over the last 5-10 years in Paris. This evolution is illustrated by a new regulation called the PRP, which has led to major transformations in the way water is apprehended in urban context.

PART 2 : SAINT-VINCENT-DE-PAUL OR HOW CAN WE MAKE PARIS OTHERWISE?

In this section, we address in depth the example of Saint-Vincent-de-Paul based on data collected during our interviews. Initially, we address all the aspects of the district, starting with its location, its history, the main angles of the urban project, etc. As the project is ambitious concerning rainwater, a reminder of the main regulations in France and in Paris is provided. Then, we analyze data collected from interviews and explore the three pillars that emerged: technical devices, social acceptance and governance.

I. Saint-Vincent-de-Paul: A neighborhood that flows

This section provides an overview of SVdP. The urban fabric and the regulations that apply to this district are all part of this context. This neighborhood is very diverse, as illustrated by the following.

a) Contextualisation of Saint-Vincent-de-Paul

SVdP is located in the north of the 14th district of Paris. (cf. figure 4) It is located on a strategic place nearby the metro line 4 and 6 and the Montparnasse railway station. It is also located in a touristic site with the Paris catacombs and Luxembourg Gardens. It has two accesses: one from Denfert-Rochereau avenue near Paris Observatory and one from Boissonade street. The neighboring parcels are occupied by religious, charitable or cultural establishments: the Visitation Monastery, the Charitable Organization for Young Blind Girls and the Cartier Foundation. (cf. figure 5)

SVdP has a long history. It was in 1650 that the site experienced its first transformation with the founding of the Catholic priest's novitiate. It was decided that the novitiate would be established on the clergy's land, which included many enclosed gardens organized around an orthogonal grid that was the basis for the distribution of the buildings. In 1800, the site changed its function and became an orphanage managed by the Hospice Foundation for Foundlings or Assisted Children. Then in 1930, Saint-Vincent-de-Paul became

a hospital that expanded more and more until 2010 when it closed. The site is now composed of 16 buildings. (ATM, 2021) (cf. figure 6)⁶²

The public space of Saint-Vincent-de-Paul had a central role in the planning of the neighborhood from the earliest phase of the project. Indeed, a temporary urbanism was developed on the site between 2011 and 2020. Aurore, Yes We Camp and Plateau Urbain composed what was called "Les Grands Voisins" in order to occupy the site during its vacancy period (cf. figure 7). This approach allowed to create an identity for the area, to develop social cohesion and to explore new ways of living the city, more united, more sustainable and more convivial.⁶³ Temporary urbanism is part of Paris' Resilience Strategy, which aims to ensure that "all urban projects follow this principle, which will be set out in a temporary/transient occupation charter"⁶⁴

In 2016, a joint development zone (ZAC) was created and conceded to P&Ma. The operation consists of developing housing through the rehabilitation and renovation of preserved historic buildings, as well as new public and private facilities, shops and activities related to the social and solidarity economy. It also includes the design of green, multi-use public spaces, mainly reserved for soft mobility and rainwater management. (ATM, 2021) The table below summarizes the main characteristics of the project:

⁶² The figures have been left in French due to lack of time

⁶³ **P&Ma.** *Saint-Vincent-de-Paul (Paris 14th) Make Paris Otherwise, a mixed program, embodied, open to all, 2020*, [online]. Available on: <https://www.paris-metropole-amenagement.fr/fr/saint-vincent-de-paul-paris-14e#scrollNav-4>, consulted on (06/09/2022)

⁶⁴ **City of Paris.** *Paris Resilience Strategy*, 2017, p.128 [online]. Available on: https://resilientcitiesnetwork.org/downloadable_resources/Network/Paris-Resilience-Strategy-English.pdf, (consulted on: 04/13/2022)

Table 6. Some key data on the SVdP's project⁶⁵

Constructability	59 000 m ² including 4200 m ² of cultural facilities, 9300m ² activities, 5300m ² of public facilities and 40 200 m ² of housing
Number of housing	600 units including 50% of social housing, 20% of intermediate accomodation and 30% of private housing
Renovation	60% of heritage buildings preserved
Public space	13260 m ² including a central vegetated crossroad of 4000m ²
Mobility	One parking space per 10 inhabitants

SVdP will be divided into 10 units (cf. figure 8). Six of them will be preserved and renovated: Lelong, Pinard, Doctors' House, Lingerie, Oratory and Robin. The last four, Petit, Chaufferie, Denfert and Lepage, will be the object of an architectural creation in connection with the existing heritage. Each of them will be led by a different developer and must respect the environmental objectives set by P&Ma and the City of Paris:

"Our job in monitoring real estate operations, in monitoring the design studies of the owners of each of the lots, namely Paris Habitat, RIVP, QUARTUS, COGEDIM, P&Ma and now Lepage with Paris Habitat on behalf of the City of Paris real estate company, is to make sure that the rainwater management objectives are met, to be able to bring the teams together at each moment and at the different stages of the project on the achievement of the objectives by going into sufficient detail." (Perseus Responsus, March 2022)

P&Ma, as a developer, coordinates the landlords to ensure that environmental objectives, especially in terms of rainwater management, are met on private plots. If we now focus on mobility, the project will not offer private parking for the residents of the neighborhood. The only parking that will be proposed is located outside the site, under the Denfert lot and as a multi-modal parking facility. (cf. figure 9)

⁶⁵ **P&Ma.** *Saint-Vincent-de-Paul (Paris 14th) Make Paris Otherwise, a mixed program, embodied, open to all, 2020*, [online]. Available on: <https://www.paris-metropole-amenagement.fr/fr/saint-vincent-de-paul-paris-14e#scrollNav-4>, consulted on (06/09/2022)

"We thought of the site as not being impervious to cars but allowing people to live without cars. For instance, there is no parking lot designed specifically for the operation, except for a place at the entrance of the ZAC where we are installing an alternative mobility center, that is, by creating underground spaces that will not be assigned to any of the housing units. We are aware of how it works, and therefore that the people who will want to live in SVdP will be people who accept to live without a car because they will not have their own parking lot. We know that this has a performative power; if we had put parking lots, there would have been cars, but since we did not, there will be fewer cars which is also a signal that we wish to send." (Perseus Responsus, March 2022)

Thus, priority will be given to soft mobility. In addition, SVdP will be organized around a central vegetated crossroads for pedestrians and cyclists (cf. figure 9). Cars will only be allowed on the traffic loop around the neighborhood as a "meeting zone", without pavement or sidewalk and with a speed limit of 20km/h. (ATM, 2021) The goal is to address the mobility issue in order to create calm, quiet and eco-friendly public spaces.

The issue of public spaces is central to any eco-district. However, this issue is even more central for SVdP since public spaces are designed to be multi-use. Beyond mobility issues, biodiversity is also a major issue in the design of public spaces. In order to meet these challenges, public spaces at SVdP will be composed of various green spaces: cultivable gardens, water meadows, lawns, etc. These spaces will be subject to a differentiated management. Each green space will have its own vegetation palette, determined by the DEVE and Empreinte, to identify the species that will be planted in order to increase biodiversity. This aspect is even more relevant as SVdP is located near large vegetated areas, rich in biodiversity, which are opportunities to address ecological corridors.

"As the map shows (cf. figure 10), we are next to large natural spaces that are not always accessible to the public, such as the Visitation Monastery, which is a great park below, and on the other side we have the Cartier Foundation garden, which is classified as part of an ecological dynamic with the label "Les Oasis Nature" with Humanité et Biodiversité, supported by Ribbs. [...] There are many resources and in the middle there is one link, ours, which is not so green today, it is extremely mineral, a hospital with a distribution of built lots in the program, which does not allow to find an ease in the vegetation." (Elias Manus, May 2022)

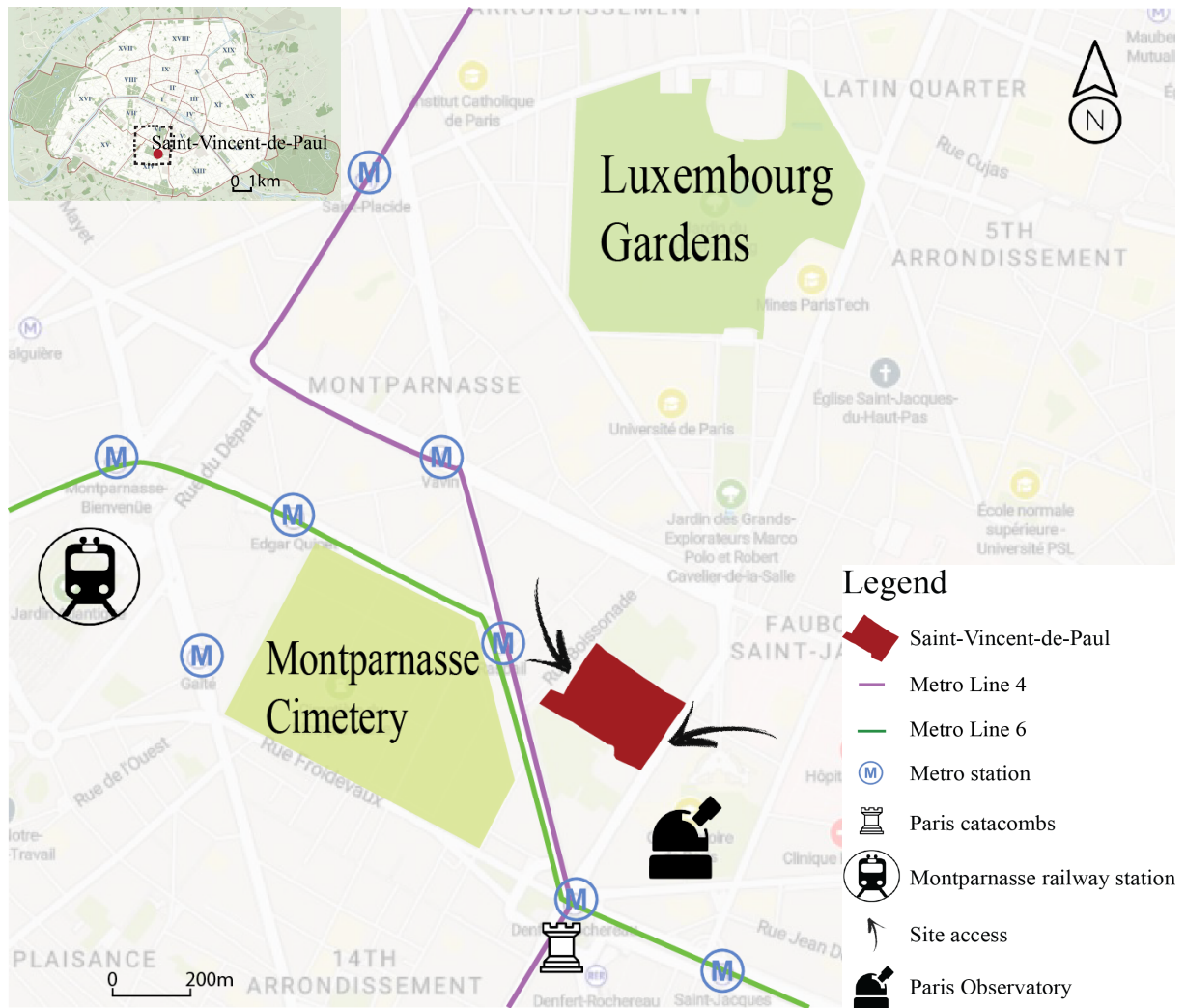
It is also an opportunity to open up the district and create openings with the neighboring parcels (cf. figure 11). “We said we might as well go further and stretch the project so that it would be well implanted and finally have the same identity and not split up the interior of a block which is quite small and go from wall to wall or even cross the walls to make ecological corridors, but this was not accepted by the neighbours.” (Elias Manus, May 2022) For instance, the implementation of a glass wall (cf. figure 12) between SVdP and the Visitation Monastery encountered some reluctance and was finally abandoned. The wall will be left as it is now, as it also supports biodiversity.

“The Cartier Foundation was not a problem, after the Visitation Monastery which is a little further down, they like to stay between themselves. We intended to put up a glass wall directly in the axis to open onto the Visitation Monastery, but again, we couldn't do it. There are great plans but in the end everyone is holding back, everyone wants change but is afraid of change. This makes the whole idea a bit frustrating. However, it is in this kind of project that we have to go, we are not on a big avenue with many constraints.” (Elias Manus, 05/02/22)

This speech shows us that addressing an eco-district project in an urban fabric with a long history can be both an opportunity and a constraint. A constraint because the entities that border the land do not necessarily welcome the change desired by stakeholders. However, it is also an opportunity to start from an identity already built around the site. Indeed, a part of public spaces will also be dedicated to a “space of possibilities” where citizens can use it as they wish. Public spaces will also involve the citizens “to manage rainwater in situ and how to enhance water in different forms, not only technical but also by creating something pleasant for the users. There are different ways of doing it, making it playful... A public space that supports biodiversity, a public space that is flexible and reversible according to the different uses and functions.” (Elias Manus, May 2022) All these elements show how public spaces in SVdP will have a prominent place in the functioning of the neighborhood (cf. figure 13).

Zero discharge is the issue we wish to address in this research. In a few words, zero discharge means that there is no rainwater going down the sewer. This is done through reuse, infiltration, evapotranspiration etc. For the first time, such an objective is sought in an urban project in Paris. In a second subsection, we will describe the main regulations that apply to the rainwater management strategy in SVdP.

Figure 4. Location of the Saint-Vincent-de-Paul neighborhood



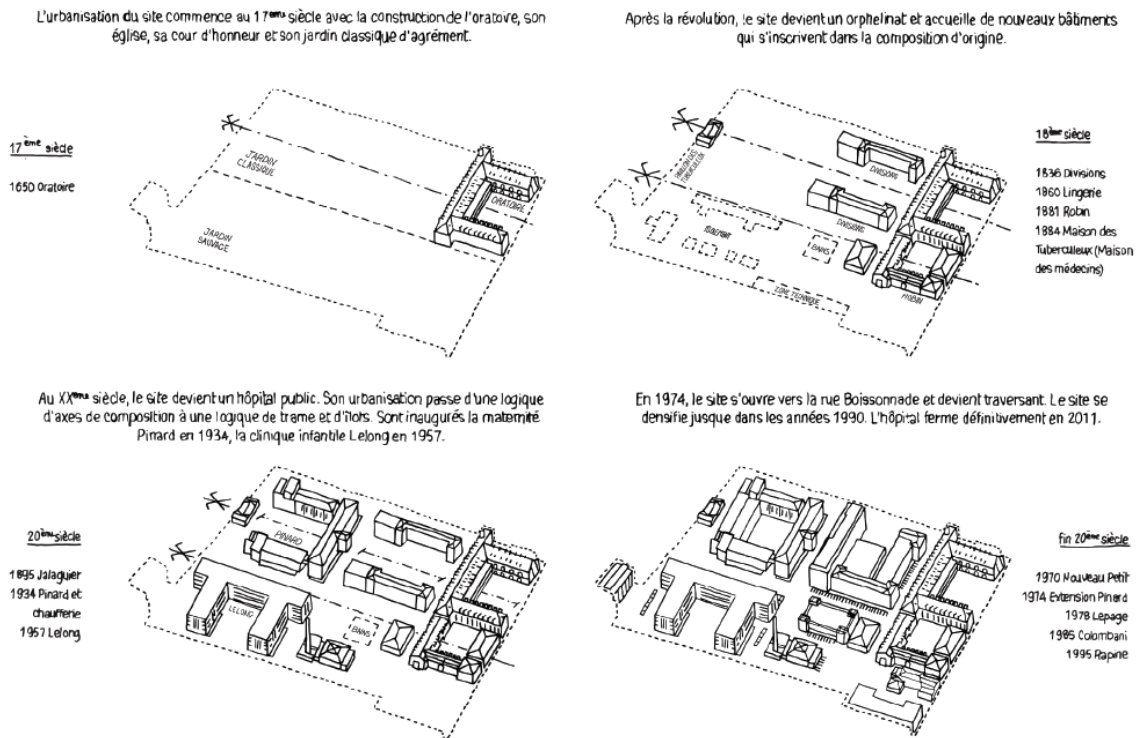
Source: François Dubreuil 2022

Figure 5. Local context of SVdP



© ATM

Figure 6. History of the development of SVdP



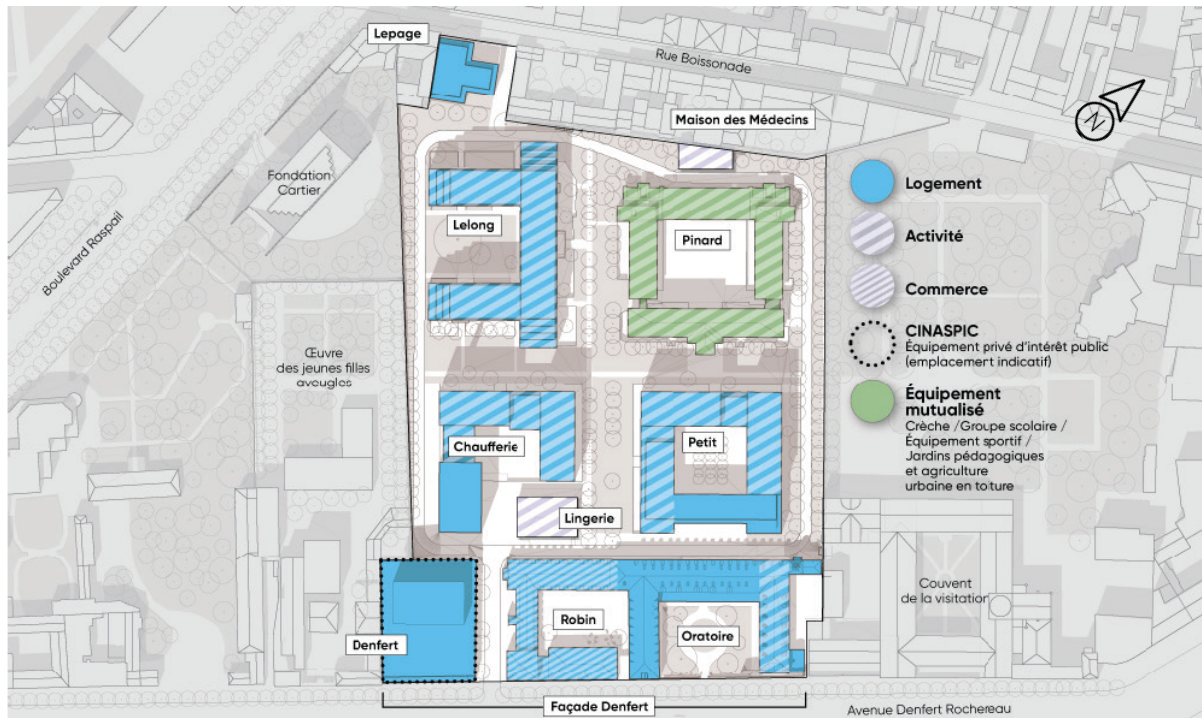
© Anyoji Beltrando

Figure 7. Pictures of “Les Grands Voisins”, temporary occupation



Source: P&Ma

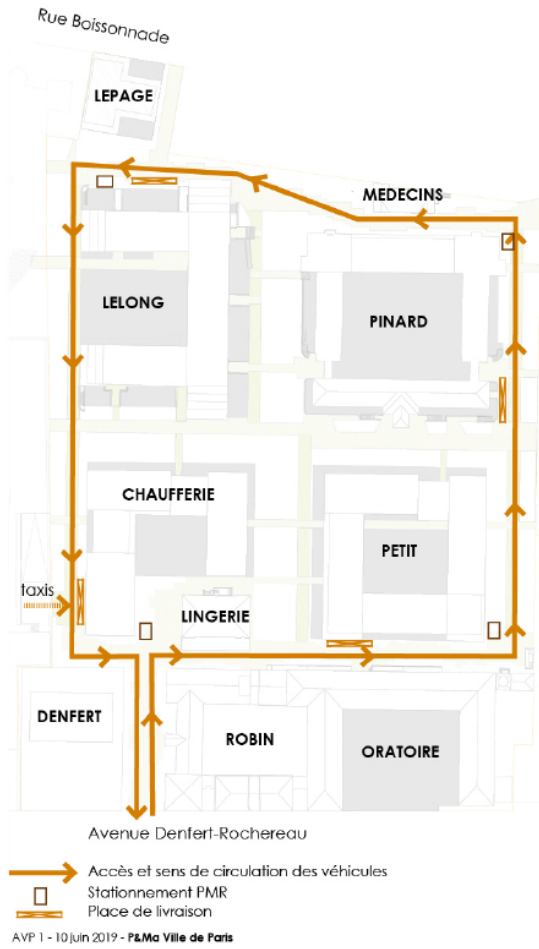
Figure 8. Program Plan Distribution



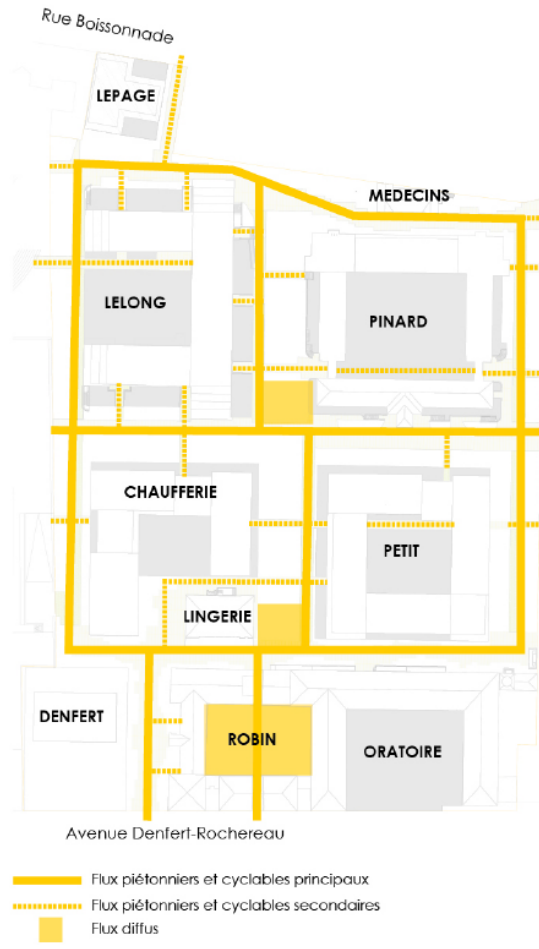
© Anyoji Beltrando

Figure 9. Mobility plans

CIRCULATION DES VÉHICULES

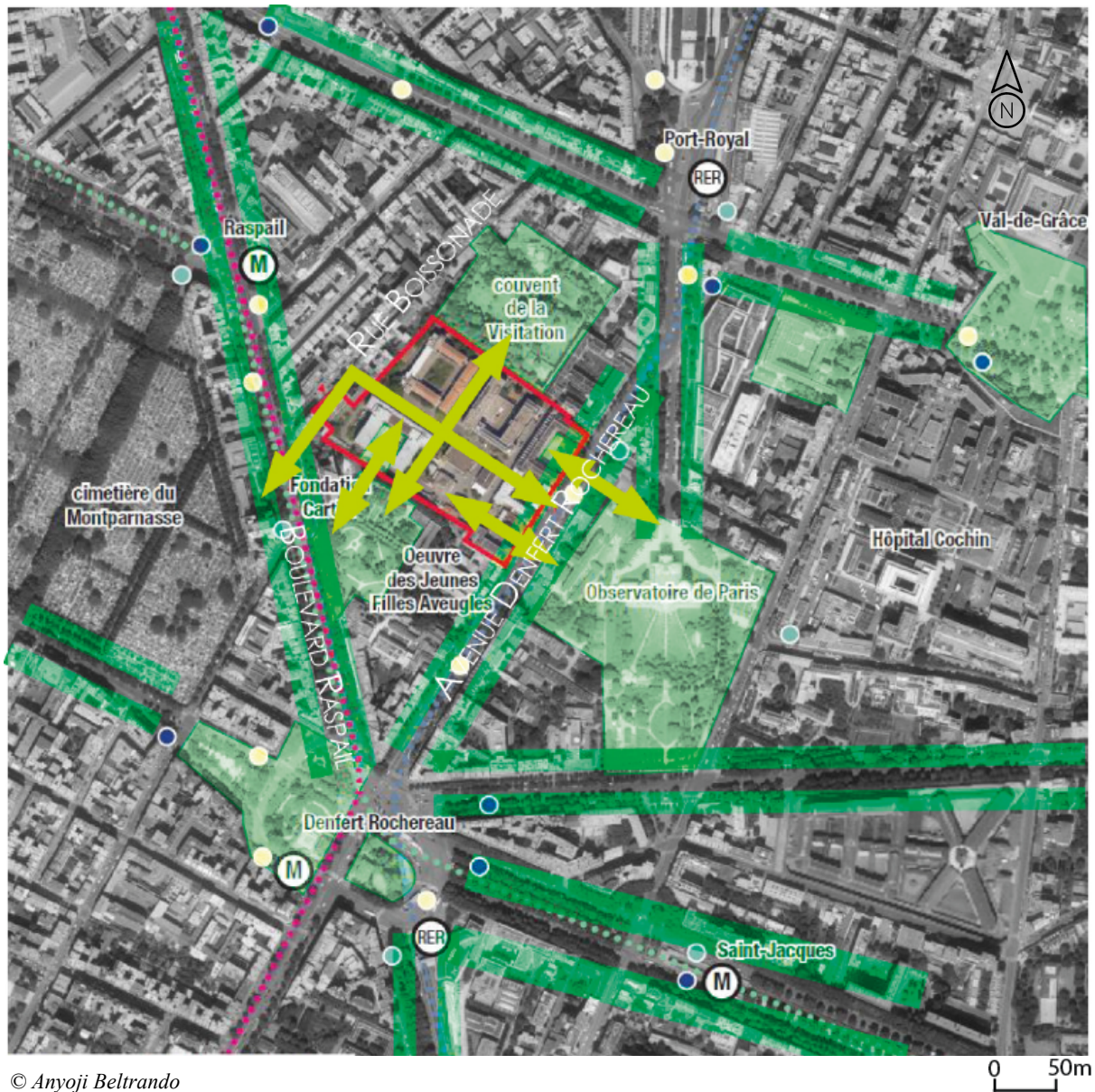


CIRCULATION DES PIÉTONS ET CYCLISTES



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Figure 10. Ecological corridors near SVdP



© Anyoji Beltrando

Figure 11. Photo montage of the wall between the Foundation Cartier and SVdP



© *empreinte bureau de paysages*



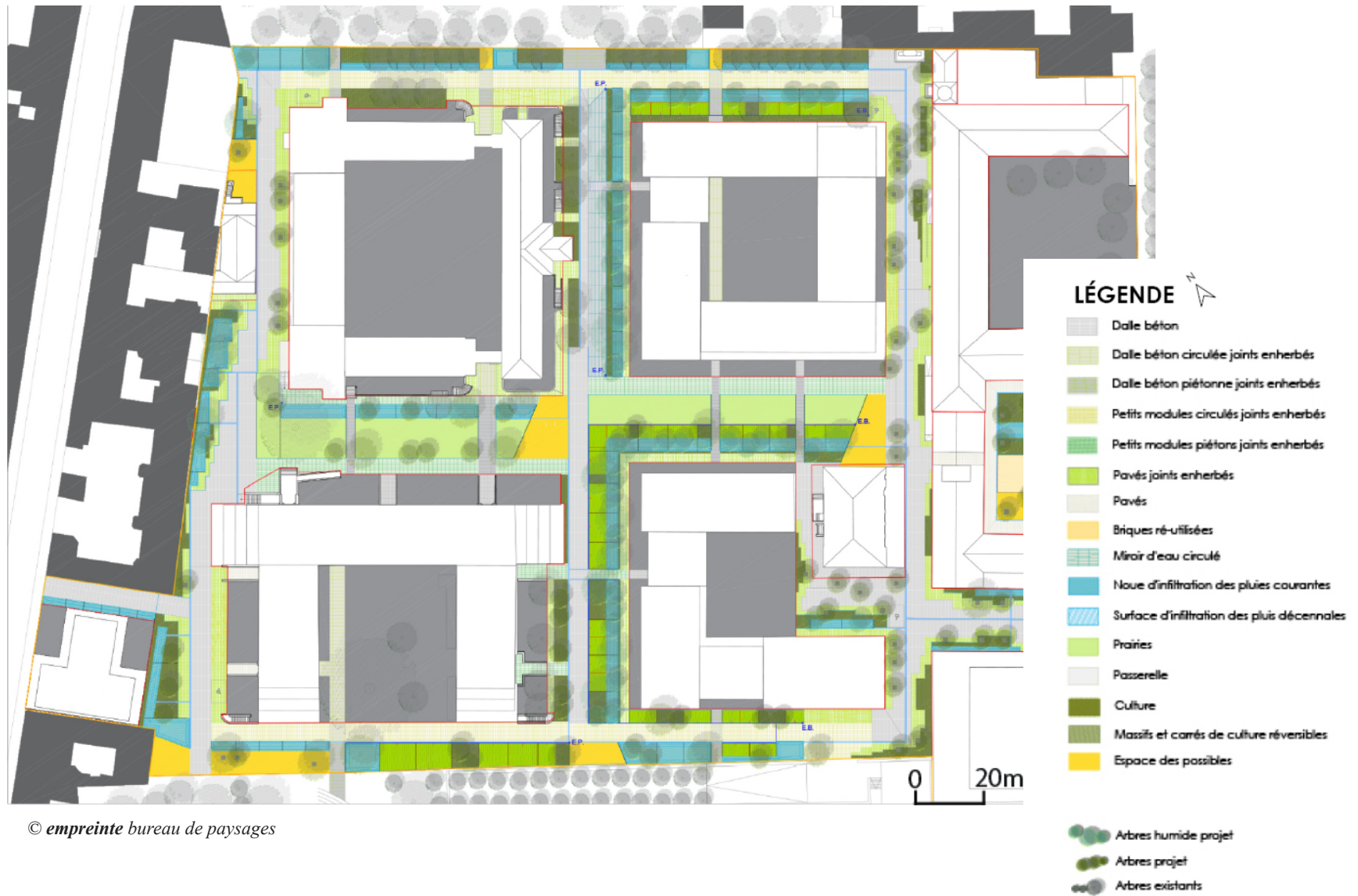
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Figure 12. Planning Strategy of public spaces



© P&Ma

Figure 13. Overall Plan of SVdP



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b) Rainwater management strategy in SVdP

- **Main water regulations**

In this subsection, we discuss the main regulations in France on the issue of rainwater management. We compare the main key elements of the rainwater management strategy of SVdP with Clichy-Batignolles, another urban project almost completed in the 17th district of Paris.

The history of rainwater management began in 1805 with the Civil Code under Napoleon. It explained that urban projects should not obstruct runoff from above and should not increase natural flow. The regulations mentioned for the first time the notion of time and gravity, two major issues related to rainwater. The first water law in 1964 led to the creation of the first water agencies (public institutions), including the Seine Normandy Water Agency. (AESN) These agencies were able to collect fees and finance projects to maintain and restore the quality of water.⁶⁶ The action scale evolved "we have started to work on the scale of the watershed, we go beyond the administrative limits (department...), and we tend more towards a hydrological approach." (Cyra Ingenium, April 2022).

National laws generally followed a European directive, as was the case with the 1992 law on the European "urban wastewater" directive. This law dealt with sewerage zoning, a concept introduced for the first time in the regulations. This law allowed the creation of a water development and management plan (SDAGE) for each watershed and a water development and management plan (SAGE) for each sub-watershed.⁶⁷ This law introduced an obligation of compatibility with the water management objectives for any project that may have an impact on water resources.

In 2006, the third national law resulting from the European Water Framework Directive introduced a requirement to reach good ecological status of waterways. This means preserving the aquatic environment and water resources. It also reflects a change of mindset towards perceiving water-related issues not only from a quantitative perspective but also a qualitative one. "The first regulation on rainwater was to require restitution storage for heavy

⁶⁶ **Ministry of the Ecological Transition.** *Gestion de l'eau en France*, January 2021, [online]. Available on: <https://www.ecologie.gouv.fr/gestion-leau-en-france#:~:text=La%20directive%20cadre%20sur%20l,rattach%C3%A9s%20aux%20principaux%20fleuves%20fran%C3%A7ais>, (consulted on 06/22/2022)

⁶⁷ Ibid

rains. This is still the case today: the question is what is happening when there are heavy rains. It is truly a quantitative question and in fact it is little by little that the qualitative notion has started to take more and more desirable." (Cyra Ingenium, April 2022).

The 2008 order sets the framework for rainwater reuse "specifies the conditions for the use of rainwater collected downstream from inaccessible roofs, in buildings and their extensions, as well as installation, maintenance and monitoring requirements for facilities needed for their recovery and use."⁶⁸ More recently it was the July 21st, 2015 order that introduced rainwater management. "It was at that time we began to write upon this topic in an order. The term appeared for the first time in that order, although there were premises in the third water law." (Cyra Ingenium, April 2022)

Water regulations are applied at different administrative levels. There is a need for compatibility between the different documents: "It is the hierarchy of standards. (Cyra Ingenium, April 2022) First of all, as mentioned previously, there is the European directive which is translated into national laws. These laws will then be implemented by the Water Agency in SDAGE and then in SAGE. Finally, at a local level, there are the sewerage regulations and the rainwater zoning. In Paris, the rainwater zoning is the PRP. (cf. figure 14) The PRP is annexed to the PLU: "When the zoning is integrated or annexed to the PLU, it gives it a strong value because it becomes opposable. This means that if a project does not meet the objectives, it can go to court." (Cyra Ingenium, April 2022)

As SVdP is a project of more than 1ha and which manages rainwater by infiltration or evapotranspiration, it is subjected to the water law of 2006 as described above. This means that the State can examine the project, especially through the water police. SVdP is also subject to the PRP, which is intended to limit surface imperviousness and rainwater discharge. "The point is not that everyone should do the same thing, because the situation is different, we don't have the same rainfall everywhere in France, we don't have the same climate, we don't have the same topography, the same subsoil, we don't have the same urbanization. We have to take all that into account and adapt the zoning to local context" (Cyra Ingenium, April 2022)

⁶⁸ **LegiFrance.** *Arrêté du 21 août 2008 relatif à la récupération des eaux de pluie et à leur usage à l'intérieur et à l'extérieur des bâtiments*, 2008, [online]. Available on: <https://www.legifrance.gouv.fr/loda/id/JORFTEXT000019386409/> (consulted on 06/22/2022)

- **Reminder on the time and gravity notions**

In the 1960s, Paris and its inner suburbs were already urbanized with paved streets. However, floods were much less frequent than today. Two variables are responsible for this fact: time and gravity. “The notion of time, I repeat, is once again very important and the second important point is that water goes from the top to the bottom and if we have both notions, we can generally perform hydrology. The notion of gravity is something that we tend to forget quickly, even though it is essential.” (Cyra Ingenium, April 2022) Thanks to the paved streets, it took a long time for rainwater to reach the low points. In the second half of the 20th century, society was essentially based on technology and we used Carquot's formula to determine rainwater devices (Barles and Thébault, 2018). Nevertheless, this formula "no longer contains any variables related to rain" (Barles and Thébault, 2018). The devices became standardized in France even though the rainfall-related requirements were not the same. "We have become more and more engineers, that we have lost our common sense". (Elias Manus, May 2022) Subsequently, cities have become more and more impervious and "all to the sewer" (wastewater and rainwater) approach was used in urban projects. (cf. figure 15)

“We have continued to waterproof, we have put more and more smooth and waterproof surfaces and in addition all the downpipes have started to be systematically connected to the sewer, so the water goes much faster from point A to point B and it is this notion of travel time that is very very important. It is really this notion of giving time to water that is as important as waterproofing.” (Cyra Ingenium, April 2022)

If we take thunderstorms for instance, rainwater from this event is a question of quantity obviously. However, this is also a question of time; how fast the water is going to point A (where the water falls) to point B which is the evacuation of the water manhole cover. “If everything reaches the low point at the same time, that is when a flood will occur, but if it takes time, the low point has time to evacuate elsewhere.” (Cyra Ingenium, April 2022)

At the end of the 20th century, a paradigm shift occurred in the way rainwater management technology was designed. It came from a reconsideration of the relevance of buried and open basins, of waterproofed roofs and of the "all to the sewer" approach after many floods that showed the limits of the system. Taking into account the notion of time and gravity, practitioners (engineers, urban planners, architects etc.) initiated a reflection on

devices more in line with the natural water cycle. The qualitative approach thus became essential, especially for current rainfalls which represent 80 to 90% of the annual water volumes in Paris. The notion of open air emerged, which means dealing with rainwater as close as possible to where it falls (cf. figure 15). The soil-water-plant relationship became even more prominent in urban projects. This perspective requires a new conception of public spaces, which support multiple uses. For instance, the establishment of cool islands allows for thermal regulation thanks to the evapotranspiration of the vegetation. "Water has become a resource to build a more resilient city (bioclimatic city)" (Seidl, 2020, p.30). Rainwater, instead of being considered as a constraint, is perceived as an opportunity to redesign public space. It is a shift from darkness to light.

- **Rainwater in urban project in Paris**

In 2005, the City of Paris launched a diagnosis to better understand the issues related to rainwater management. Three main issues were identified. First, is to limit the impact of runoff on the city in order to prevent further flooding and to reduce the level of pollutants in water. Second, to adapt the city to climate change by reducing the urban heat island effect. Third, to "reduce wastewater discharges into the natural environment, especially discharges from storm water overflows that pollute the Seine. In addition, with the Olympic Games swimming goals, it gives a little push, since politically speaking, it is a good thing...." (Cyra Ingenium, April 2022). The Olympics Games appears to be a powerful lever to accelerate rainwater management goals.

The PCAET adopted in 2018, provided a framework on which the PRP was built. "By 2030, in a context of increasing land scarcity, the City of Paris will create new gardens and green spaces. These are veritable breathing areas that will combine "zero-emission zones", calm areas, biodiversity zones, alternative rainwater management zones, and cool islands."⁶⁹ The PRP was officially established the same year after a long controversial process of discussion and exchange between the city's own departments and external stakeholders.

"I think that, there is no secret to say that the Paris Rain Plan took more than 10 years to be published. You have strong constraints in terms of development, you shake up all the agents'

⁶⁹ **City of Paris official website.** *Paris Climate Action Plan.* 2018, p.100 [online]. Available on:<https://cdn.paris.fr/paris/2020/11/23/257b26474ba3ba08ee02baa096f9c5dd.pdf>, (consulted on: 04/13/2022)

habits. We ask them to develop roadways, public spaces and squares and at the same time we ask them to change their way of doing things, which means a lot of constraints with few staff and a limited budget. Now, the Paris Rain Plan is here, it is going to upset the way things are done, even if mentalities are evolving a little.” (Calliope Caput, April 2022)

Today, the PRP includes 4 levels of drainage objectives (4, 8, 12, and 16mm) depending on the condition of the subsoil (cf. figure 14). The first project constructed under the PRP regulation was Clichy-Batignolles (CB). Although the PRP was not officially published at the time the district was being built, it was already being implemented informally. Table 7 shows a comparison of the main characteristics of the two neighborhoods regarding their rainwater management.

Table 7. Comparison of the main characteristics of rainwater management in the Clichy-Batignolles and Saint-Vincent-de-Paul districts

Main Characteristics	Clichy-Batignolles ⁷⁰	Saint-Vincent-de-Paul
Location	17th district	14th district
Existing building before the construction	No existing buildings, construction of new ones	60% Preserved
Surface area	54 ha	3,4 ha
MO	P&Ma (Paris Batignolles Aménagement)	P&Ma
AMO for rainwater	ATM	ATM
Construction date	2018 for most of the plots	In process, first plots planned for 2024
Main public space (Surface)	Martin Luther King park (10ha)	Central vegetated crossroad (0,4ha)
Rainwater discharge area (PRP)	4mm	12mm
Percentage of current rainfall managed	50% Public space 30% Private plots	100% Public space 100% Private plots
Green roofs	30% priority for renewable	Almost 100%

⁷⁰ P&Ma. *L'écoquartier Clichy-Batignolles*, 2016, 23 pages, [online]. Available on: https://archive-clichy-batignolles.paris-metropole-amenagement.fr/sites/default/files/exe_cb_dossierpresse-fr_220217.pdf (consulted on 06/23/2022)

	energy (solar panels)	
Rainwater's contribution to the irrigation of public spaces	40%	Almost 100%
Rainwater management method	Management at the plot	District-scale management

As we may observe in Table 7, there are many parameters that distinguish both projects. However, the interviews highlighted that in some ways, CB belongs to the history of SVdP. Indeed, if the objectives are so ambitious at SVdP, it is especially linked to the experience acquired by the CB stakeholders which are now working on SVdP (The City of Paris, P&Ma and ATM for instance).

"What we may say is that the subject of rainwater management was already present in CB, even if the rainwater zoning was not established and even if there was a large park in the middle of the ZAC, this was at the very beginning of the water law. It was much less formalized than it is today [...] At CB, the level we have reached is 50% on the whole ZAC. 4 ha of green roofs in all, which is not bad. 50% is already a great step forward, besides, when you walk in the park there is water everywhere, which is also a sign that water in the city is a fundamental subject. [...] There is an effort to continue what had been started in Clichy-Batignolles (CB) on SVdP." (Perseus Responsus, March 2022)

"So at CB, there was already the PRP but it was not official. For this reason, they called us for CB because it was to try to see how we could manage rainwater there, even if the operation had already been launched for a long time and there were already a lot of things built. However, there were already instructions for the building permit which was made in relation to the PRP at the level of the City of Paris, so the developer (P&Ma) was looking to be able to recreate a link with the instructing services so that the operation could continue. This is why we developed a much simpler scheme linked to the PRP. The PRP arrived and now the difference is that we have a developer who knew from the beginning that they had to incorporate the PRP for SVdP, that's the difference." (Abercius Urbanus, May 2022)

To meet the PRP objectives, public spaces in CB need to be mobilized. Indeed, Martin Luther King Park is a key component of rainwater management. Although the pressure is much more intense on public spaces in SVdP as they are much smaller, the vision remains the same. Public spaces are becoming more permeable and include more greenery. Rainwater management somewhat influences the aesthetics of the public space to accommodate new

functions. What about private plots? The use of roofs is also a key component of CB's rainwater strategy:

"In Clichy, we worked a lot on roofs, saying that roofs must be soft, that we must have greenery on them, that they must also be used for energy production, and finally that they must be useful. This is something that is fully transposed from CB to SVdP, the fact that roofs remain 100% useful. And with, however, a slightly different balance between energy production and rainwater management, it was clearly energy production that was favored in CB." (Perseus Responsus, March 2022)

However, there is a lack of knowledge about biosolar roofs, roofs that combine solar panels and greenery to reconcile both rainwater management and renewable energy production. Initial studies show that there is a synergy between both: biosolar roof enhances solar panel production and promotes the development of various vegetation layers (Catalano and Baumann, 2017). As a result of a lack of knowledge, these two uses are often opposed. Thus, a choice was made at SVdP, the priority is given to rainwater management rather than renewable energy production:

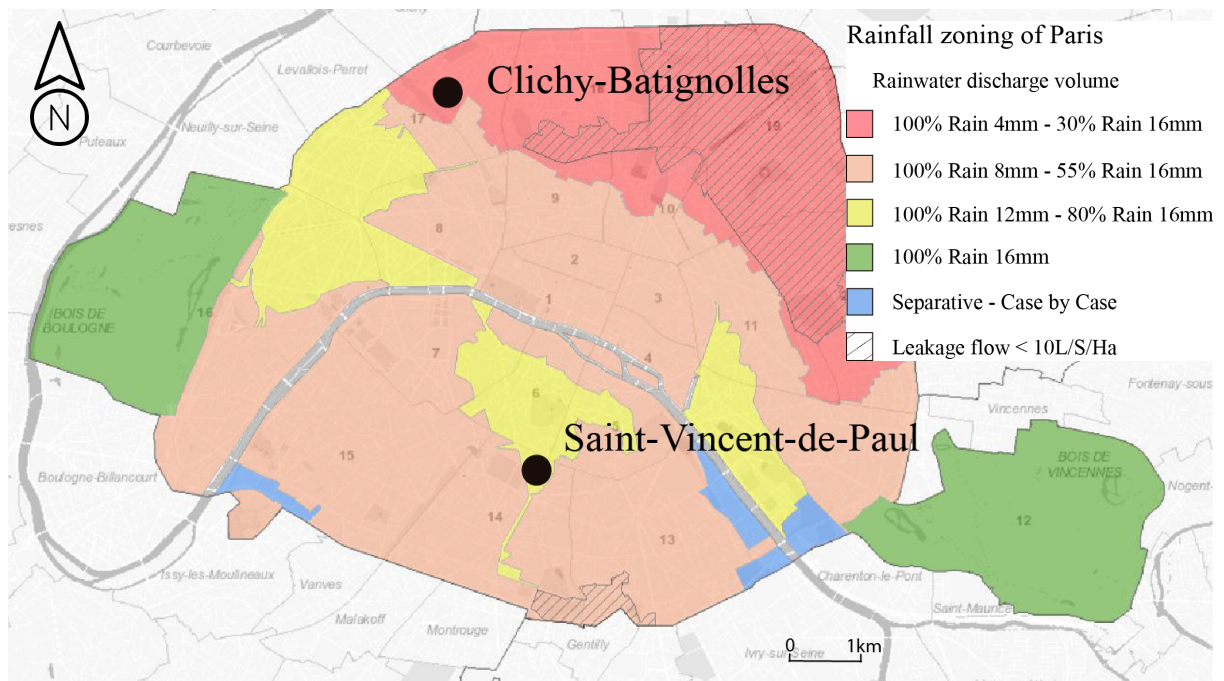
"The specificity of Saint-Vincent-de-Paul is to have announced from the beginning the objective of disconnection from the network. There is the subsoil with the quarries underneath, so we will not be able to do it completely, there will be a little bit of discharge anyway. However, this has enabled the City services and future petitioners to understand that the Paris Rain Plan will be applied and there will be no exceptions. This is a major objective of the development of the ZAC, and we want to be exemplary in this respect." (Calliope Caput, April 2022)

The rainwater management system in SVdP is designed to promote infiltration and differentiated management of regular and heavy rainfall events through the creation of open vegetated systems that allow for diffuse infiltration. However, zero discharge is an ambitious objective for a constrained neighborhood related to the density of impermeable surfaces. In addition, the site is subject to the existence of underground quarries on the site. The 14th district is affected by the presence of old quarries. (cf. figure 16) This implies certain restrictions in the PLU in order to avoid the risk of subsidence. A note from SVdP, the engineering firm, dated September 2020 explains that it is not possible to concentrate infiltration above the quarries. The rainwater management devices planned above the quarries

must be watertight in order to avoid concentrating infiltration. This constraint implies that the current rainfall is reduced to evapotranspiration and that the ten-year rainfall is evacuated to the network.

If we focus now on the topography, which is a key element in rainwater management as in integrate the gravity notion. The global slope of the district varies from south to north from 60 m at the entrance of the ZAC to 55.50 m at the level of the entrance of the underground parking of the Pinard building (future gymnasium), facing the Doctors' House. (cf. figure 17) This regular slope of 2% is relatively average. Owing to its topography, the ZAC will not intercept watersheds other than those included in its perimeter. In fact, the sidewalk of Denfert-Rochereau Avenue and Boissonnade Street both introduce a slope opposite to the SVdP neighborhood.

Figure 14. Rain Zoning of Paris



Source: City of Paris, 2018 - modification François Dubreuil, 2022

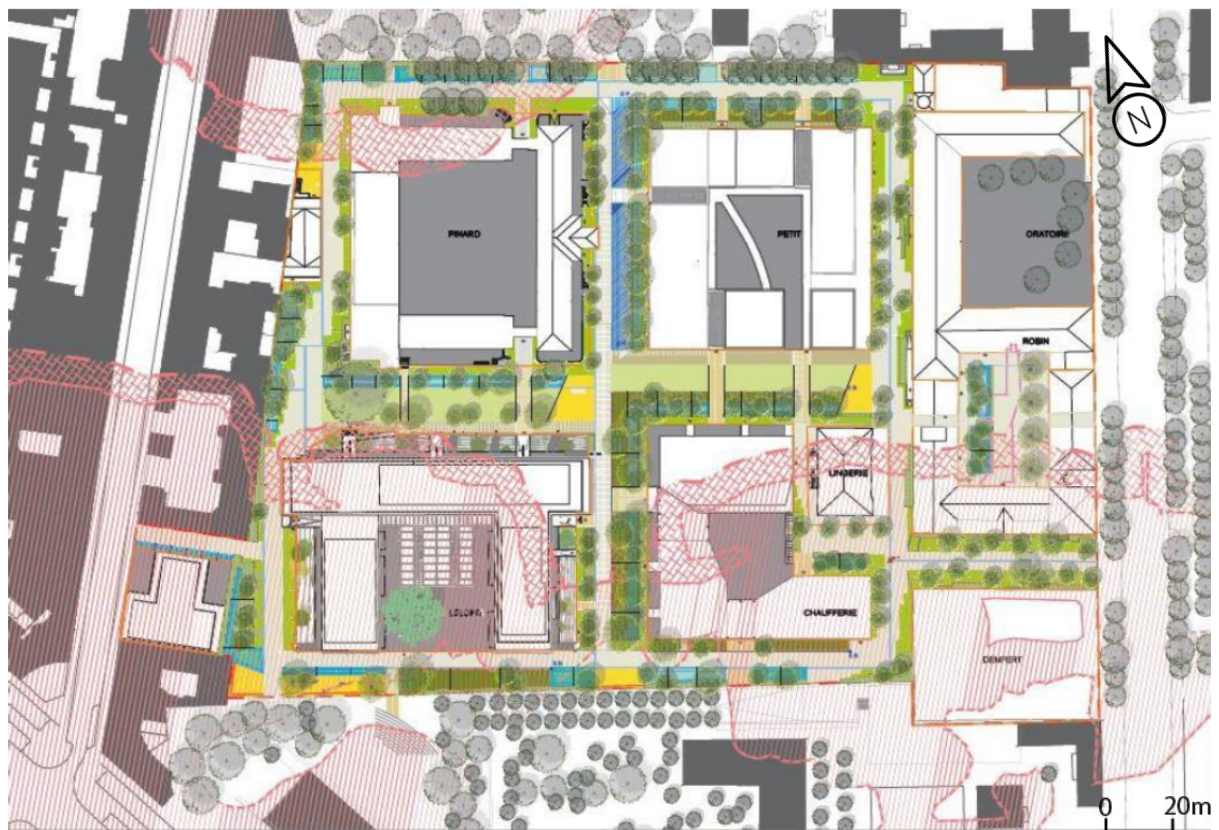
Figure 15. Evolution of technical devices

Synthèse : avant

Synthèse : après

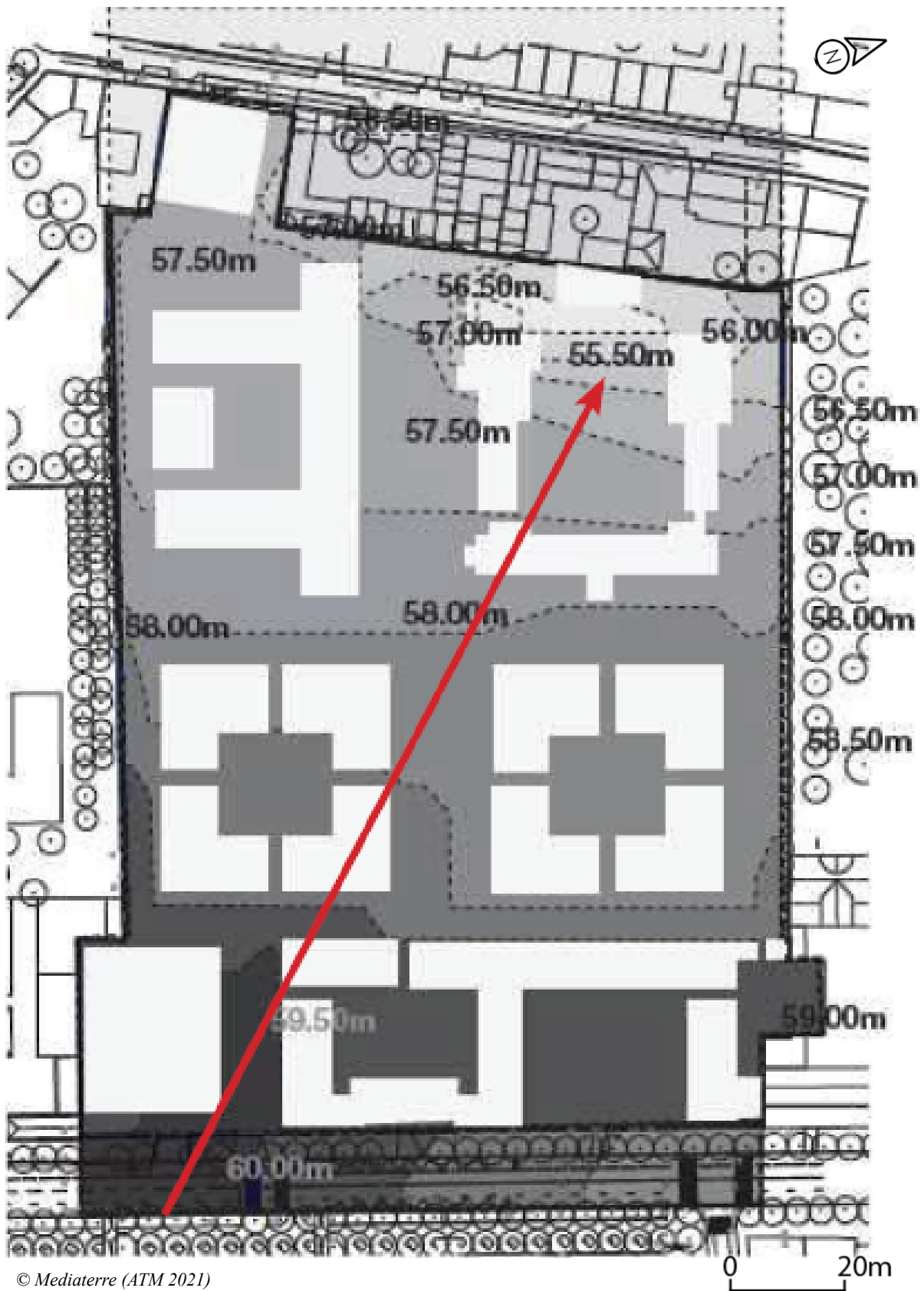
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Figure 16. Map of quarry distribution at SVdP



© City of Paris

Figure 17. Topography of SVdP



© Mediaterra (ATM 2021)

II. “Making Paris Otherwise”: Challenges of the Saint-Vincent-de-Paul eco-district project

Within this section, although mentioned earlier, we focus on the relationship between rainwater management and the design of public spaces. Through interviews and analysis of technical documents, we have identified three interconnected issues: a) technical devices; b) social acceptance; and c) governance. For each of them we start from theoretical concepts and observe how they can be applied concretely in the field. We start with the technical devices that initiated our investigation.

a) Technical devices & Innovation

Technical devices are obviously a key component of rainwater management. To address this issue we identified transitional urban studies as a theoretical concept. We intend to highlight some key concepts, to provide guidelines through which the topic of rainwater management can be approached. We would like to emphasize that rainwater management is embedded in global theoretical concepts that are evolving quickly as a result of environmental challenges, human needs and a nature-urban paradigm shift.

Transition urban studies were introduced in April 1997 by the United Nations Commission on Sustainable Development which defined transition as “a gradual, continuous shift in society from one "mode of operation" to another.”⁷¹ The transition process could usually be separated into 4 successive phases. First, a small change occurs and the system or object of study moves slightly away from its equilibrium phase. Second, a political response is being implemented but may be challenging without a "conscious political effort.”⁷² This leads us into the third step, characterized by instability due to rapid socio-ecological changes. It is related to innovation, which can be technological, social, economic or environmental, and attempts to bring the object or system back to its equilibrium point. If we integrate this theory within society, some factors such as resource scarcity, climate change, biodiversity loss, socio-economic inequalities etc. indicate that we have entered into this phase of instability. The 4th and final phase can be described as the stabilization phase “in which the place of change slows and a new form of equilibrium is reached.”⁷³ This philosophy is

⁷¹ **United Nations.** *Global Change and Sustainable Development: Critical Trends*, 1997 [online]. Available on: <https://www.un.org/esa/documents/ecosoc/cn17/1997/ecn171997-3.htm> (consulted on 27/04/2022)

⁷² Ibid

⁷³ Ibid

reminiscent of Holling's theories (Holling 1976, Holling 1996) on resilience and the existence of equilibrium points.

The pattern of urban transitions is particularly visible in the multi-level perspective (MLP) model (Geels and Schot, 2007) (cf. figure 18.) The MLP argues “that transitions come about through interactions between processes at three levels.” (Geels and Schot, 2007). The first one represents external factors of various fields such as geopolitical one, climate, biodiversity etc. represented as “Socio-technical landscape” (STL). These factors can fluctuate in space and time. The pressure they apply to the second level, the "socio-technical regimes" (STR), also fluctuates. (Geels and Schot, 2007) The STR represents internal factors of a system as economical, social or technical. If the existing system, as it is conceived, has the capacity to face changes, then it makes internal adjustments. Otherwise, systems need to integrate the third level which is “Niche-innovations” (NI) which brings the novelties necessary to face the fluctuation. (Geels and Schot, 2007) However, all the niches do not reach the second level, but the ones that do reach it transform it. This way, the perturbation is transformed into an opportunity to adapt the system to its new environment.

We may use this model for rainwater management in SVdP. Indeed, the STL may be for instance climate change, biodiversity loss and a lack of social cohesion in Paris that are putting pressure on the STR. The STR is our current system and the way we have handled the rainwater issue since the 2nd half of the 20th century. Finally, NI could be the technical alternative solution based on nature.

“The objective is not to waste the water resource but to save it as much as possible by simple systems" [...] We say simple because we start again on "forgotten" bases, but nevertheless expensive because to go back to things which are not any more in the field; it costs more because we create innovation. [...] We realize, for instance, that there are people who say we are going to do something very innovative: an infiltration ditch. Whereas we have always practiced that, we realize that it is not yet communicated well enough because it has existed for so long. Hydraulic management in the 19th century was very important” (Elias Manus, May 2022)

From this perspective, we may understand that innovation as it is used by some stakeholders are simply technical devices which were exploited before but forgotten by practitioners. In the second half of the 20th century, innovations were highly technical and

technological, but today more and more innovations are oriented towards ecological engineering. Today, technical devices are much less sophisticated but are more in line with urban sustainability.

“We used to make storage basins but you can not build one next to it because in Paris anyway you don't have any more space. So the only way to act now is on buildings. It is of course the development of the public space, these are solutions said to be closer to nature... The techniques are relatively simple because technically you will always manage to find a solution. However, everything that is closer to nature requires much more intelligence, "brain juice" and it is true because the fact of having less technical solutions forces you to be intelligent” (Calliope Caput, April 2022)

The greening of the city appears to be a lever for resilience. However it has to be thought from the design stage of the project, especially for public spaces. Stakeholders may think about the resilience of public spaces in regard with uses and ecosystem services desired. The case is even more interesting, as Paris is one of the most densely populated cities in the world. There is certainly a lack of public spaces, which leads to a certain pressure on it, "suffering " from conflicts of use. Thus, the "brain juice" is necessary to adapt the greening to each project, to each district by taking into account the subsoil constraints. (Hatchuel, Labourdette, Leduc and al., 2017) Indeed, it is not a question of solving an issue by creating another one.

To understand how the MLP and the nature based innovation (NBI) are applied concretely, we use the rainwater management strategy of SVdP as an example. In this case, we can distinguish two strategies that vary according to precipitation levels. For current rainfall, rain of 8 to 10 mm in 24h, the strategy is organized around nineteen watersheds (cf. figure 19) from public space completed with ten watersheds from private space (one for each of the plot).

“That's the beauty of the project, and the beauty of well-executed rainwater projects. The notion of watershed is simply a notion of outlet, there is water that falls and the question is to know where it goes. We will try to work as closely as possible to the water's fall point, which means that we will have many watersheds. For each device, you have a watershed that is associated because it is an outlet (infiltration ditch, green roof...). For instance, a vegetated roof is its own watershed during current rainfall.” (Cyra Ingenium, April 2022)

To manage rainfall as close as possible from the fall, an interweaving of a multitude of watersheds is necessary. The notion of watershed is linked to the notion of outlet that we call a technical device. For private space, in SVdP, it is mainly a green roof with 20cm of substrate, rainwater harvesting inside the building and the English courts that are self-sufficient.

Concerning public space there are three different types of devices: the infiltration ditch already introduced in the Martin Luther King park in CB (cf. figure 21), the storage and evapotranspiration ditch (cf. figure 22) and the dry vegetated basin (cf. figure 23). Those three devices have the same approach, a green space slightly excavated. The differences between ditches and dry vegetated basins are the excavation depth, the use that is made of it and flooding time. For the ditches, citizens can walk next to but not go inside unlike the dry vegetated basin which is the support of inhabitants activities: play games, have a picnic, relax etc. It is rarely flooded, it is only the case during ten-year rainfall. Otherwise, it represents a significant part of public space in SVdP. Regarding the storage and evapotranspiration ditch, it is a device that is used above quarries including a watertight layer in order to avoid infiltration in the subsoil. It is strongly vegetated in order to maximize the evapotranspiration. However, it can only deal with current rainfall and has to be connected to the sewerage network as a security in case of ten-year rainfall or more.

The organization of those devices for ten-year rainfall, 48mm in four hours or 36mm in one hour, vary from current rainfall. Like the storage and evapotranspiration ditches, the ten watersheds in private space cannot handle the amount of precipitation. Thus, the excess goes straight to the watersheds in public spaces: this is the notion of mutualization.

“Water is an important issue in the neighborhood with a stated desire to be able to manage all current and decennial rainwater on both public and private spaces. The private sector manages its current water and the ten-year water that they are unable to manage goes into the public space. So we, in a way, are a rainwater management station without a pipe, as decided by the ATM agency but without constraint we do not advance. [...] In the case of a ten-year rainfall, dry vegetated basins are flooded, there is an imbrication of watersheds to manage the water as close as possible to where it falls and to avoid ending up with a large watershed in which the water of the whole neighborhood would arrive at the same place.” (Elias Manus, May 2022)

The floodability of public space is something very significant in SVdP. (cf. figure 20) Rainwater serves as a transformative element of the urban landscape. Public spaces encourage this floodability and the restoration of a more natural water cycle. Technical devices, based on the triptych water-soil-plant, are designed to be integrated in the planning project without using conventional underground facilities. It is also a "qualitative" management of rainwater intended to avoid the concentration of pollutants in the discharged water, thanks to an open storage. (ATM, 2021) Local regulations, especially the PRP incorporation into the PLU, act as a lever towards the development of open storage solutions:

“Urban planning today is necessarily linked to rainwater management and we saw this on Saint-Vincent-de-Paul. Your public space design is based on what I want to do with rainwater. If I want to infiltrate, if I want to make ditches, your landscaping is different. What is important to see is that in fact the PLU has this force of action that it applies everywhere. That is to say that instead of saying anyway it is the PLU so it only applies to buildings, so I impose it on builders or to the one who is going to rehabilitate, well not really because it also applies to the public space. [...] The PRP can be considered, for me, I will not say what carries the pencil of landscaping but almost.” (Calliope Caput, April 2022)

Public spaces of SVdP are thin. Facilities size is a significant factor to design them. The first step in sizing devices is to calculate the rainfall volume that has to be managed in this watershed. The equation to calculate a volume (V) is: $V = S \times c \times L$. “S” represents the basin surface, “c” the runoff coefficient and “L” the water level. It is a hydrological concept. “Then we will do hydraulics, that is to say what is the flow that will transit in our structure, in our ditch and what is the capacity to make this flow transit there and then it is just geometry, what is the capacity of my storage structure.” (Cyra Ingenium, April 2022) However, in this calculation process an unknown variable appears: the evapotranspiration capacity of the device:

“The City of Paris is embarking on new research and we are impatiently awaiting this new research with Cerema, which will really allow us to build calculation methodologies and to have formulas to make these simulations [...]. I think that evapotranspiration has been underestimated all the time and it plays a huge role in rainwater management and it is perhaps thanks to future studies that we will be able to demonstrate what I am saying.” (Abercius Urbanus, May 2022)

“There are many things we don't know. What is the real evapotranspiration capacity of this or that structure? So increasing scientific knowledge on this subject also means benefiting from this feedback, from real field conditions. Another research subject on which we are working is that we talk a lot about vegetation for water management and in fact we want to make vegetation play many functions and today the adaptation strategy is based on vegetated walls for cooling. However, this is certainly not always true and in all places because it also depends on the real evapotranspiration of the trees. So we are working on improving the tools and knowledge on the role of vegetation for cooling.” (Perseus Responsus, March 2022)

The lack of data on evapotranspiration remains an obstacle in the calculation of the discharge capacity of devices. Stakeholders are waiting for research results on this subject. They expect to be able to calculate more precisely the discharge capacities of devices and thus the sizing of them. An infiltration ditch should be used in SVdP in order to participate in these experiments.

The issue of the replicability of these devices is also raised. Solutions have to be adapted to local context however there is only a limited range of solutions. SVdP is particularly interesting in this context as it has many constraints:

“What is great about Saint-Vincent-de-Paul is that it is a textbook case because you have the existing, the rehabilitation, the quarries, a certain density, all kinds of networks. In itself, the notion of replicability which is very important is to have feedback etc... But each project is different, that is why there are many watersheds. In fact, as it is about development and landscape, it is different because you have a topography that is not the same, you don't have the same inhabitants... There we never have the same leveling between the watersheds. So yes, we never completely reinvent the project, because here we have ditches, vegetated basins, sanitary facilities... There is a panel of finished solutions but each time it is different and that is why each time we have to anticipate the rainwater management scheme and do it from the beginning of the project, as soon as the guide plan phases. We have to start thinking about rainwater management. We wait too long to take into account this rainwater management and as it is landscape, development and grading, if we arrive too late we will end up with too complex stuff that disgusts people a little. Water is becoming more and more important in the design of the project.” (Cyra Ingenium, April 2022)

SVdP brings this novelty that rainwater management is thinking at the early stages of the project. In addition, rainwater management is not only seen from the engineering side but from a very cross-sectional perspective with multiple stakeholders working together:

“The most interesting thing is when the engineer and the urban planner manage to work together. It is when we made interventions and even meetings where I had a landscape colleague with the engineer next to him, that is when you feel that the message also carries.”
(Cyra Ingenium, April 2022)

“The quality of the landscape designers, of the architects on this site, is what the site is, where we are, what we do, why we do it, how we do it. It is about creating the story in the context.”
(Elias Manus, May 2022)

As we have seen in this section, technical devices are evolving and are significantly influencing the aspect of public spaces, especially in SVdP. However, public spaces mean citizens. Therefore, the issue of the social acceptance of these devices can be raised. This is what we attempt to demonstrate in the following part.

Figure 18. Multi-level perspective (Geels and Shot, 2007)

Increasing structuration
of activities in local practices

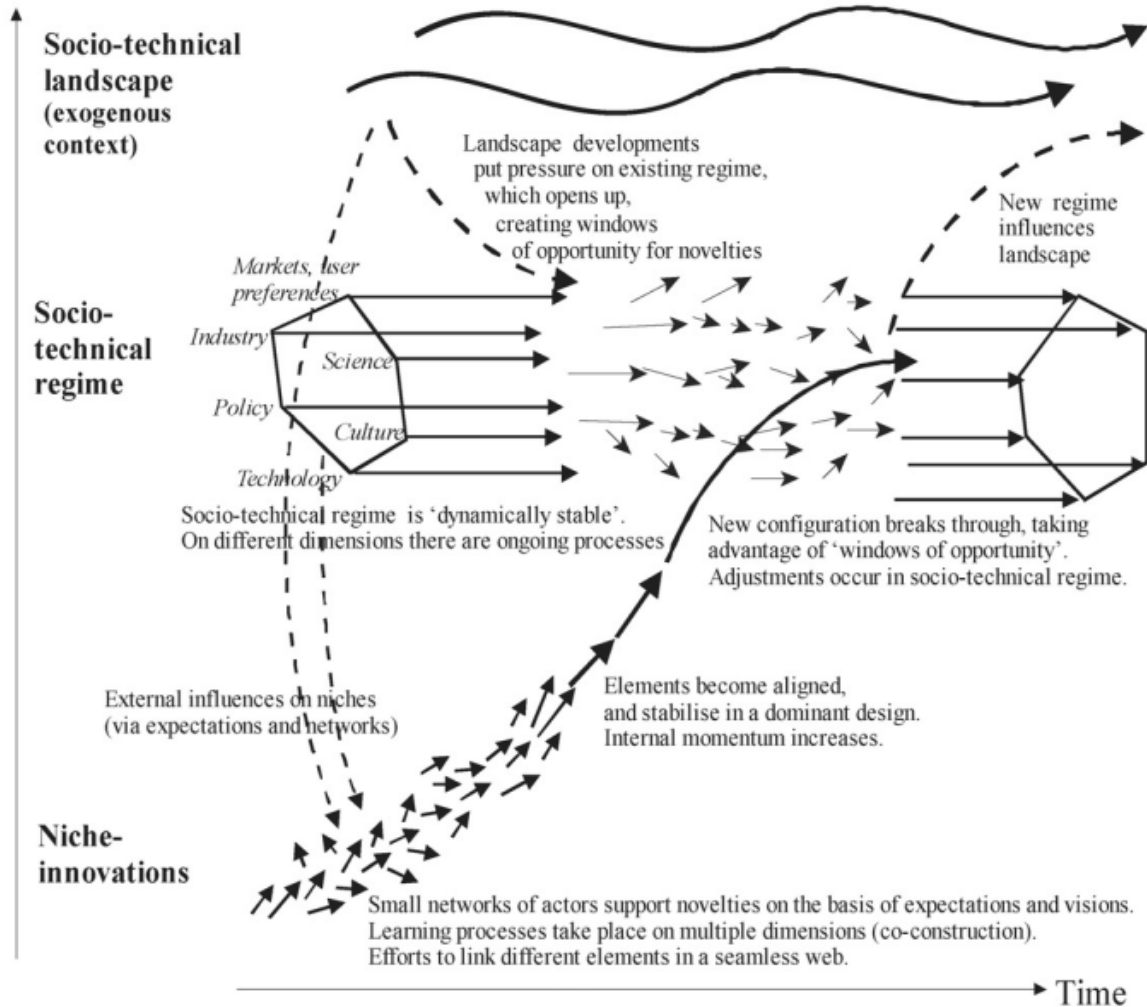
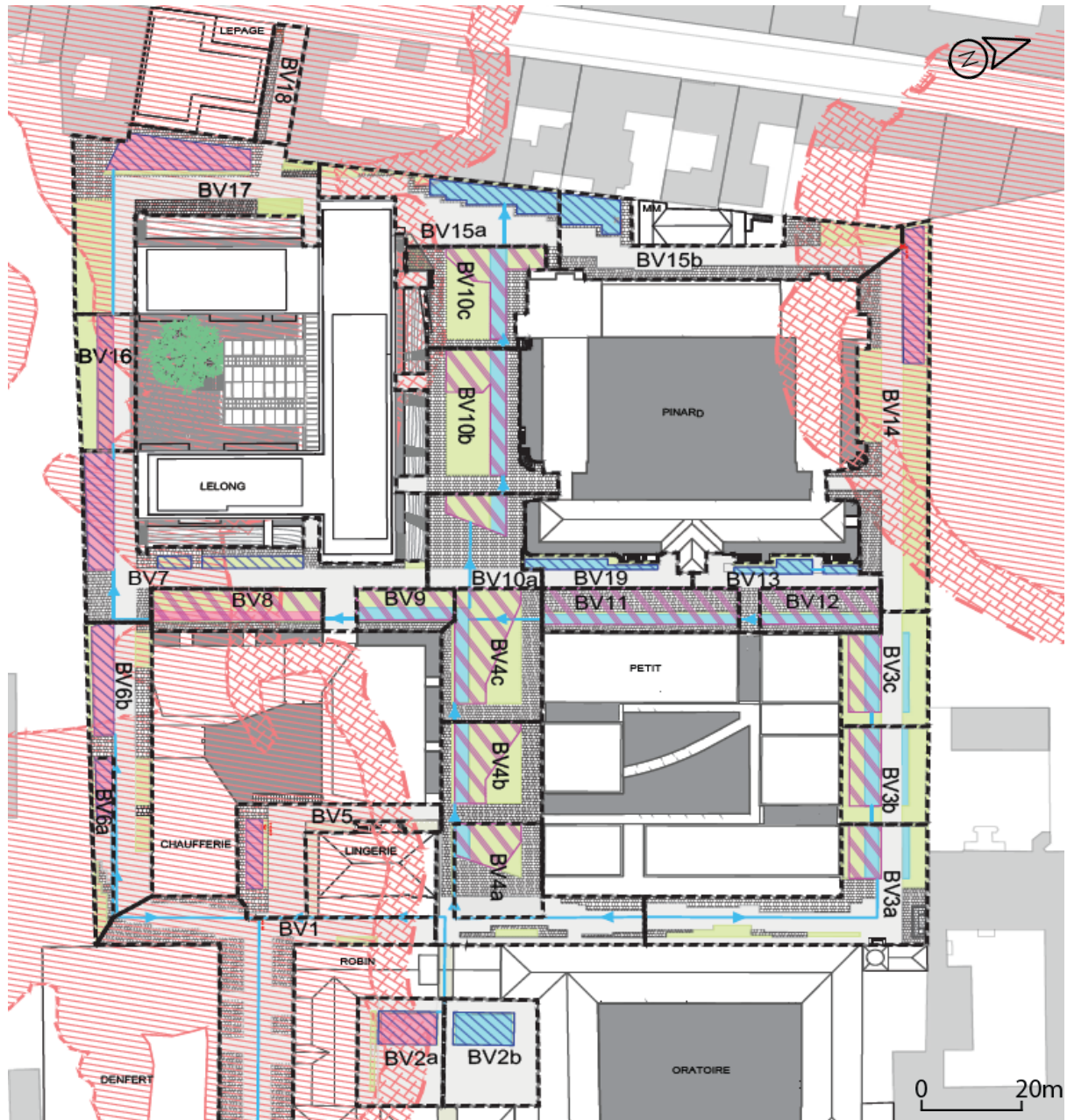


Figure 19. Watersheds in public spaces



© ATM

LEGENDE











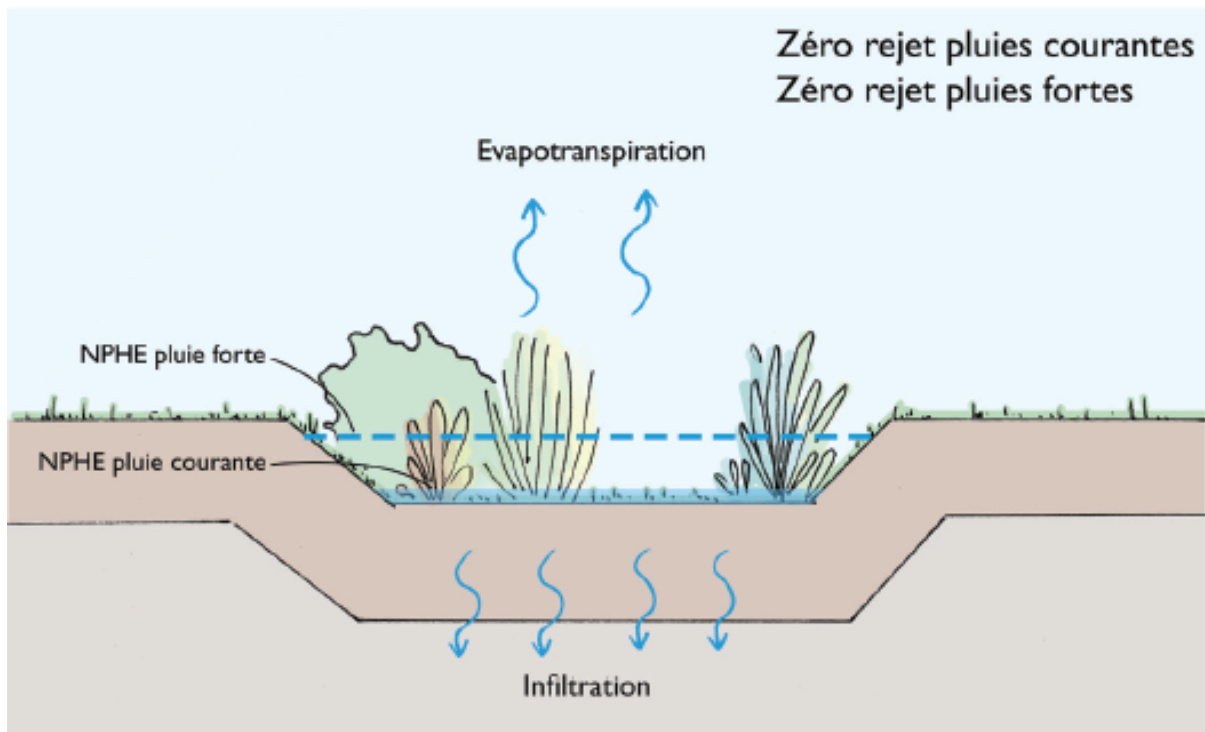
-  Sous bassin versant - espace public
-  Pavés béton - joints enherbés 2cm
-  Revêtement perméable
-  Revêtement imperméable
-  Noue d'infiltration - Pluie courante
-  Noue de stockage étanche - Pluie courante
-  Surface de stockage des pluies décennales - noue
-  Surface de stockage des pluies décennales - bassin
-  Caniveau
-  Localisation des carrières

Figure 20. Photo montage of public spaces dealing with small rainfall (picture above) and with ten-year rainfall (picture below)



© ATM

Figure 21. Infiltration ditch

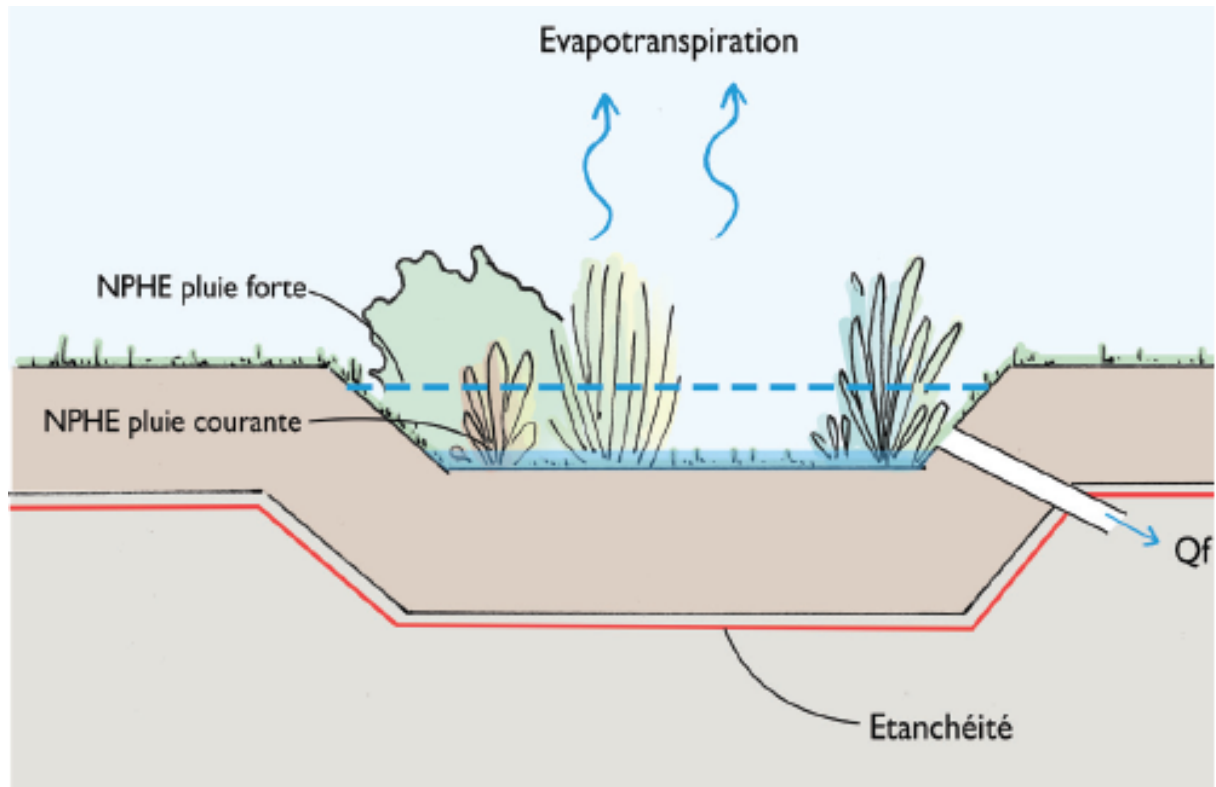


© ATM



Reference image - Green collection and storage ditch - Martin Luther King Parc, Clichy Batignolles (ATM, 2021)

Figure 22. Cross-section of a storage ditch, evapotranspiration and regulated flow discharge



© ATM

Figure 23. Reference picture of a dry vegetated basin



Jardin des eaux, Fourqueux (ATM, 2021)

b) *Social acceptance*

“To the technicians, I have attempted to demonstrate that they could not design a technical object without taking into account the human crowd, their passions, their politics, their poor calculations, and that by becoming competent sociologists and humanists, they would become better engineers and wiser decision-makers” (Bruno Latour, 2020)

For a long time we thought about infrastructures, on which human activities were based, only from a technical point of view. It appears that in the case of techniques that are based only on efficiency and technology, without taking into account the role of social stakeholders in the negotiation of these devices, will be subject to controversy. (Callon, 2013)

Many debates and controversies already exist around technical devices. On many occasions, history has seen the opposition between, on one hand, companies that think about the design of infrastructures and technologies and, on the other hand, civil society, citizens who claim more and more participation in the negotiation processes of these latter.⁷⁴ Science and technology appear as an opaque environment in the eyes of society. Callon, in order to understand the design process of these devices, has looked closely at EDF in the design project of the electric vehicle (VEL). (Callon, 2013) Thus, he studied the condition of implementation of technical devices and more specifically their social, cultural and political integration and consequences.

In the case of VEL, what he concludes about controversies is that a controversy is only technical at the end of the design process when the balance of power is established between the stakeholders. Nevertheless, in the early stages of the design process, controversies are socio-technical. The social aspect is present in order to "delimit the sphere of the technique and the sequences attributable to it" (Callon, 2013, para. 22) In the VEL case, Callon says that at the early stage of the VEL design, EDF engineers cannot think about the technical aspect without taking into account the environment and the social context into which it should fit: "The powerful public company then transforms itself into a sociologist and technologist" (Callon, 2013, para. 23).

⁷⁴ LCP. Bruno Latour, *sociologue, ethnologue et philosophe* | *Les Grands Entretiens de Guy Lagache*, 04/12/2021 [Vidéo]. Youtube. Available on: <https://www.youtube.com/watch?v=4IYL-4t7XVQ>, (consulted on 06/26/2022)

Thus, the technical and social spheres appear to be interdependent. Callon said that we have to avoid controversies which just have a residual social aspect and hardened technologies: “It is easy to see that engineers, after having solved what they call technical problems, need sociologists to continue their action and impose the world they have dreamed” (Callon, 2013, paragraph 34)

Applied to urban planning, the city has been built on advanced techniques and technologies, which appear difficult to understand for the general public. For instance, when we press a light switch, light comes out, however where does it come from? When we open a tap, water comes out, etc. The technical processes behind them are relatively complex and nevertheless these gestures are part of our daily life. The case of rainwater management is another example in which, traditionally, the devices are based on technicality without considering the environment and the social aspect within which they are integrated.

In SVdP, social aspects were clearly identified at the earlier stages of the project. The first step was to create an identity of the neighborhood by temporary urbanism with “Les Grands Voisins”. Stakeholders of SVdP have taken up this identity created by temporary occupation: “We are also inspired by the legacy of Les Grands Voisins, which created extremely flexible spaces” (Elias Manus, May 2022). We have seen in the first part that resilience is based on social cohesion. To build this social cohesion, public space is an essential element. However, we have already seen in the previous section that public spaces are increasingly influenced by technical rainwater management systems. Therefore, the aim here is to create a social cohesion around a technical device, in order to maintain it over time.

People who are going to SVdP are in some way aware that they are going in a ecodistrict but they do not know what it really means to live there. The philosophy at SVdP, based on the previous experience of CB, is to actively integrate the population in the design and maintenance of technical devices. A long speech from an interview with P&Ma illustrates the global vision of the project:

“There was a real expectation on the part of the public to live in active neighborhoods where people know each other and where there are different mechanisms of solidarity, where we are not just in an anonymous city. We saw this at CB as we stayed long enough related to the phasing of the operation meant that some phases were delivered before others in order to bring the district to life. It is a real expectation of the people, social and on the environmental

questions, i.e. they know consciously that they come to live in an eco-district but they do not know precisely what it is about however they want different things, they are available, they have just moved in, they wonder: how can I change my life a little? And that is why we would like to build on that, to build on the use of the neighborhood. It is all very well to build technical devices, however we must also think about how the inhabitants will appropriate them, so we are going to rely on the need to manage the bases in order to set up a larger device that we call the neighborhood manager and to whom we will entrust a certain number of missions. In particular, we will put at its disposal, free of charge, 3 emblematic places of the district so that it can develop an economic activity: the former hospital laundry, the doctors' house and the amphitheater of the former clinic. And we will entrust it with missions of welcoming new inhabitants and environmental education for which it might be supported by external aid. In any case, it is a question of taking in hand an offer of sensitization and training on environmental issues and on many other subjects. At CB we have worked a lot on energy, on waste management, composting is something that transcends the masses, we have been able to see that, on selective urine collection and then on rainwater management especially on ditches, why they are densely vegetated, we can not mow the stuff, how it works, why there is water at certain times and not at others. Finally, we feel that there is a need for explanation, awareness, training, and people are asking for it.” (Perseus Responsus, March 2022)

This long speech from Perseus shows that in SVdP, thanks to the experience accumulated in CB, there is a real desire to create the city otherwise: “to make the city differently is not only on the content, however, but also on the ways of doing things” (Perseus Responsus, March 2022). Next to the “neighborhood manager” project which has to be implemented when the project will be finish, P&Ma is working with a panel, already constituted and composed of three different entities: a) 40 future tenants designated by Paris Habitat and RIVP with the City of Paris for the Boiler Room and Petit lots. They have been accompanied since June 2019 by the AMO Courtoisie Urbaine to discuss of their future housing with the landlords and architects the design of their future housing; b) The Lepage project is part of the same participatory approach with the designation of 23 future purchasers in BRS (Bail Réel Solidaire) (MOA Paris Habitat) who work with the architect and Paris Habitat; c) The private operators have addressed similar arrangements for the integration of future residents (about thirty) prior to delivery for the Lelong lots (MOA Quartus) and for the

Denfert facade (MOA Cogedim/CDC Habitat).⁷⁵ These entities aim to address the social acceptance of the project by co-creating some parts with future inhabitants.

This approach to make the city otherwise is also shared by Empreinte in the design of public spaces. "This project combines uses, nature-managed technical spaces, and "spaces of possibility" in which residents can join together to make the space reflect their own identity." (Elias Manus, May 2022) These "spaces of possibility" are opportunities to foster social cohesion in the neighborhood. (cf. Figure 24) As Callon demonstrates, the involvement of social stakeholders in addressing technical devices is necessary in order to avoid technical controversies. This perspective must also be designed over time with stakeholders who will remain after the project: "Once the ZAC is dissolved, closed, and the accounts of the development are closed, each owner, each co-ownership syndicate, or each lessor finds himself with an issue: how to make the neighborhood live with its environmental ambitions: this is a real subject." (Calliope Caput, April 2022)

The ambitious 0 discharge strategy for rainwater in SVdP may be difficult to implement if citizens are not initially aware of how it works, whether there is water at one time but not another, etc. "For example, what we treat at SVdP is not done elsewhere in Paris and so if we talk about the notion of 0 discharge for current rainfall, it does not necessarily scare people, maybe for people who do not know, however for people who know a little bit, it does not scare at all." (Calliope Caput, April 2022) This participates in the fact that the first step in the social acceptance of a technical device is the communication around it. If users integrate the technical uses of public spaces, it seems that they will be able to live with it. Water will no longer be perceived as a constraint, however as an opportunity for the inhabitants. To raise public awareness, Empreinte has worked on three major issues in order to integrate the path of water in public space:

"To continue on the subject of water, there are three main water themes, the first one is the management of rainwater, especially with the management of the ten-year rainfall. Then you have everything that is the way to bring the water in these elements with main gutters, secondary gutters. We also wanted to put a water layer (cf. figure 25) in the wide right of way of the firefighters to make another use of it and after all a water device in relation to watering by using the slope and gravity as OASIS in the desert. And at the same time, water is also an

⁷⁵ Information taken from an email from P&Ma during the feedback of the first Steering Committee meeting for the OCAPI's project

educational support, playful, fun, which allows to create something, to have a thread of water which continues everywhere. (cf. figure 26) The objective is to show the path of the water in public spaces with small flaps, like a water game for children” (Elias Manus, May 2022)

“CB was, I think, a precursor, as were other places in ZAC Boucicaut. However, the idea at Saint-Vincent-de-Paul is to show the path of the water, the educational aspect is important. If we don't have the pedagogy, when tomorrow rainfall will flood public space and that even in dry weather we see water, we will be afraid. Whereas if finally, water is more or less omnipresent all the time even when it does not rain, well it will be much less shocking but it is true that in CB there is just a big park. The objective is also to renew the link between water and citizens, because water has long been considered a danger to avoid.” (Cyra Ingenium, April 2022)

We have moved from a paradigm in which we were working on rainwater management from a technical point of view, not visible to the population, to open-air management. Thus, water seems to interfere in the city through two scales. On one hand, individual scale, which represents the relationship that each person has with water, aquatic environments and urban space in his personal and intimate sphere. The water's presence is seen as an aspect of "resourcing". On the other hand, the collective scale is more political and concerns the social dimension of water in the city. These are the uses and practices around water in the city, where the regulatory spaces of the water cycle are seen as the support of collective practices, social links, etc. (Martin SEIDL, 2020, part 1, chapter 1).

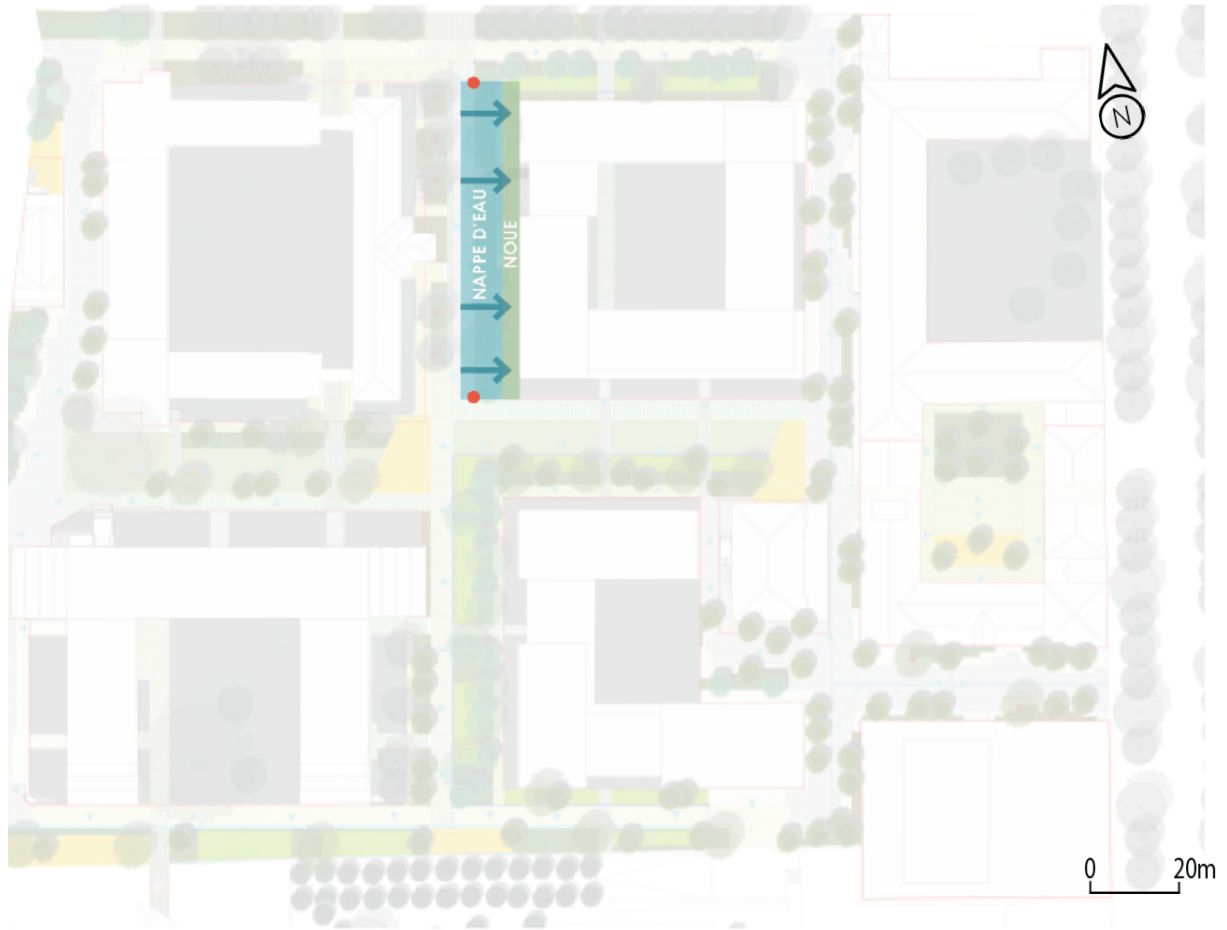
We thus understand that sustainable technical devices are socially accepted devices. However, does this paradigm shift from a techno-centric perspective to a socio-technical perspective not lead to an evolution of the governance of urban projects?

Figure 24. Photo montage of the “spaces of possibilities”



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Figure 25. Water layer

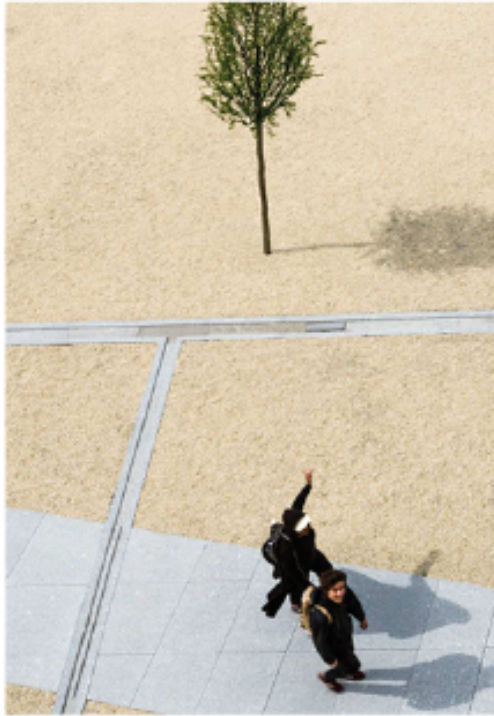


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Figure 26. European examples of educational water thread



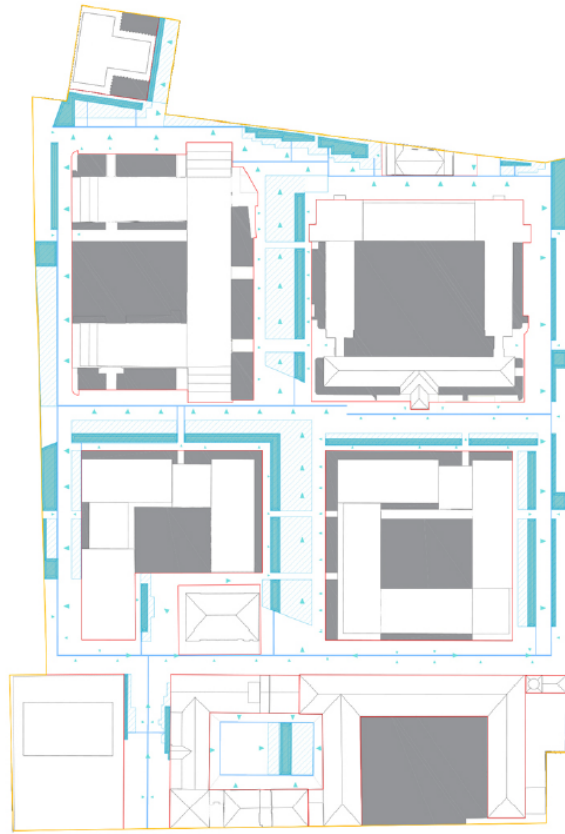
Ulls hus, Uppsala Suède

Hundsund Grendesenter, Oslo Norvège

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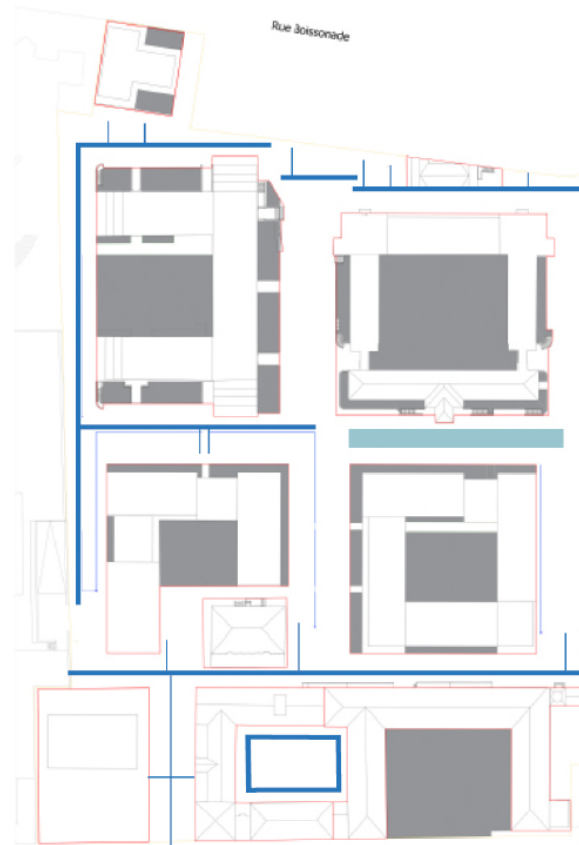
Figure 27. Synthesis of various water staging in the public space

GESTION DE LA PLUIE COURANTE ET DECENNALE



- Nœud stockant la pluie courante
- Nœud stockant la pluie décennale
- Sens d'écoulement

L'EAU LUDIQUE



- Caniveau ouvert principal
- Caniveau ouvert secondaire
- Nappe d'eau

ARROSAGE DES CULTURES



- Arrosage gravitaire : canaux d'irrigation

c) Governance

“While the excellence of the technical know-how of the City of Paris is undeniable, the organization into large departments, often described during interviews as a "silo" organization, does not encourage the integration of the issues necessary for the planning of a resilient public space. Thus, the new technical responses called for by urban challenges sometimes come up against by their transversality to divergent visions, which it is necessary to overcome.” (Hatchuel, Labourdette, Leduc and al, 2017, p.5)

The theoretical reference used for this subsection on governance is Stéphane La Branche's study on several eco-districts in Europe, which is part of the Nexus project.⁷⁶ In his article, La Branche, explains that technical solutions to environmental issues are not as innovative as they seem. In the field of energy, which he studied more specifically, he finds that the techniques used are already known. The aspect that becomes truly innovative in ecodistricts is more in the governance systems. (La Branche, 2015)

"La caserne de Bonne" in Grenoble is one of the examples studied. In this eco-district, negotiation processes emerge between developers and stakeholders in order to meet the environmental challenges of the municipality. (La Branche, 2015) The complexity imposed by new regulations seems to imply that stakeholders must change their way of doing things, and this from the design of the project. "The various requirements related to the eco-district make it necessary to take a systemic approach to the project, right from the programming stage, as well as a global vision of the investment-maintenance-operating cost, and to strengthen the team with environmental experts. " (La Branche, 2015, paragraph 65) By involving environmental experts on certain issues such as energy, this requires a greater number of stakeholders and therefore even more coordination. The systemic approach thus seems necessary in governance to respond to a specific issue. It appears to be a factor in the success of the operation over time.

To ensure the success of the systemic approach, a stakeholder should be at the center of the coordination process. Thus, the role of the municipality in the design of the eco-district is similar to the role of a "conductor" who aims to operationalize the socio-ecological objectives promoted in its policy. (La Branche, 2015)

⁷⁶ Research project in the energy field, more information at <https://sites.google.com/a/iepg.fr/nexus-energy/projet>

If we now focus on the SVdP project, the stakeholders involved in rainwater management are represented in a diagram. (cf. figure 28) This representation is intended to be as schematic as possible in order to make the relationships between stakeholders clear and understandable. The connections are in reality much more complex than the diagram suggests. There are two different scales of involvement. On one hand, stakeholders who are directly involved in the urban project such as the AMO, the MOE, the MO and the owners of each plot. On the other hand, external contributors are influencing the project in terms of regulations, subsidies and research. The stakeholders we met are shown on the map in red. This diagram represents the basis of our thinking, which we will now address in more detail.

The main innovation of SVdP, as already discussed from a technical perspective, is the idea of mutualization between private and public space. This concept must also be taken into account in the governance, especially in the coordination between the different stakeholders. "At the beginning of the project, this idea of mutualization was difficult to implement because the private lots are relatively dense, main rainwater management opportunities are on public space and it is the same, it is an idea that was quite new to talk about public/private mutualization when at the beginning it was not accepted at all by the services" (Abercius Urbanus, May 2022). This idea of mutualization is new and seems difficult to implement as it is innovative. Some City services seem to have expressed reluctance towards this approach. This may pose an issue in terms of the environmental policies pursued by the City of Paris, which do not seem to be supported by all the directorates involved.

According to interviews, mutualization should be well designed to be efficient. Stakeholders have to consider different levels of rainfall in order to design technical systems that are coherent with public spaces. This notion of mutualization is relatively new in Paris: "It is not the first time that mutualization has been used in an urban project, but in Paris it was the first time" (Abercius Urbanus, May 2022). Twenty-five years ago, rainwater management in urban projects was only a concern for the developer of public spaces. However, implementing a new approach based on an open-air management and taking into account a higher level of rainfall requires a shift in mindset. The ten-year rainfall requires stakeholders to coordinate with each other. Climate change acts as a vector of it: "Today, everyone still sees rainwater as a constraint, as something painful to manage, yet it will be even more precious with the climate change that is already underway." (Abercius Urbanus, May 2022)

In order to implement the concept of mutualization, a cross-disciplinary approach is necessary. ATM attempts to implement it, but sometimes encounters difficulties in its operationalization. "In the context of the speech, everyone wants it, however, in concrete terms, it is more difficult to implement on our missions, however, we are asked to do so. If they want something that is not cross-disciplinary, they will not work with ATM [...] It is more difficult in terms of project management, you have to get more people around the table and this cross-disciplinary approach, so desired by stakeholders, raises the issue of professions porosity, the limit of each service and it is always very delicate." (Abercius Urbanus, May 2022) The profession's porosity issue requires to address the development of training both professionally, as well as in schools and universities: "That is how, little by little, we create desires, we create people who have convictions and who can lead projects afterwards." (Abercius Urbanus, May 2022) Traditionally, stakeholders and more specifically the City of Paris appear to be organized in "silos":

"Today, even though we have been aware of it for about ten years, we are reaching the fact that the City is organized in silos. Indeed, the DVD will take care of the roadway, sidewalks, public lighting and networks (electricity...). The DPE will clean and manage the sewerage and water networks, and the DEVE will manage everything related to parks and woods (cleaning, lighting and networks). As soon as you create public spaces that are meeting areas, in which there are no more sidewalks, where rainwater is infiltrated because there is no more tar, you manage with pavements and slabs covered with grass, therefore to clean it is difficult, it will not be the same.... You shatter this organization in silos, it is the sustainable development vision of the public space which is a cross-cutting vision and we consider the space as a whole and not by functionality. There is no longer a space for cars and everything that runs, it is a global space. You are shattering the organization." (Calliope Caput, April 2022)

"when you are a designer, you would like there to be more dynamics and it is true that you come up against the management of the City of Paris services, it is true that they don't like to change too much and that they do not talk to each other too much and moreover there is a difference between the policy of doing the "City differently" and the implementation. I think that there is some kind of lobbying of services." (Elias Manus, May 2022)

The maintenance of nature-based alternatives solutions in public space is becoming increasingly difficult to manage with these new hybrid spaces: "it is complicated but we could imagine a public space directorate with a much more global and cross-disciplinary vision of the subjects." (Calliope Caput, April 2022) Indeed, stakeholders are working on

rainwater objectives at the design stage of the project, however, in the governance they have to think also in a long-term strategy. This is a subject that regularly comes up from interviews. Rainwater strategies are, in a way, changing the habits of the stakeholders and require a “brain juice” as Calliope Caput introduced before. In addition, a new mindset leads to new governance models that influence the design of the project. Traditionally, in an urban project, buildings are designed and then public spaces are designed around them. However, the situation is slightly different in the case of SVdP for two reasons: buildings already existed before and water management implies rethinking the design stages:

"They made the project according to our project for openings, waterways etc..... We did the basis of the project. That differs a little bit because usually buildings are built and then you have to do something according to them, whereas here we first do public space in an operational way, we do workshops with Anyoji Beltrando for the management of rainwater levels. Finally, this is complicated because we are on a slope and it is very important for the management of rainwater, so we have to work with them in an iterative way in order to make it work. [...] It was totally linked to rainwater management, however it was more global, it was on the whole public space that everything worked and Anyoji Beltrando was able to use it to make its project [...] To make the city differently, it is true that it differs from "classic" projects. To say that the design of public space and the management of the water come first and then buildings. Afterwards, it was already prefigured to have plots, however I think it would have worked like that anyway." (Elias Manus, May 2022)

The internal team as well as external contributors on CB remain present at SVdP. This acquired experience allows them to have already created links and automatisms. The relationship between ATM and P&Ma established at CB seems to be a key relationship for SVdP. “The whole team is still there, with a relatively low turnover. Most of them have already worked on CB and have, in fact, built up a kind of expertise on environmental issues.” (Perseus Responsus, March 2022)

"The developer decided to have a rainwater consultant from the start. This developer had already worked on the Clichy Batignolles operation. There were issues of water management and implementation of the PRP and we had a mission towards the end of the operation to put some oil in the wheels of everyone so that the operation would go well. The developer had incorporated rainwater as a relevant issue in the conduct of an urban development operation and so at the time of SVdP, as soon as it was announced, it was put in place." (Abercius Urbanus, May 2022)

However, other stakeholders involved in the project need to be made aware “It is all these stakeholders that need to be sensitized and convinced and this is what makes the project time consuming. [...] stakeholders for whom it is harder to accept this approach are rather the DEVE, perhaps also the DVD, however this is quite classic, they are part of stakeholders consulted during the whole process because it implies an open-air circulation of water with gutters, channels and things like that” (Abercius Urbanus, May 2022) Those stakeholders remain obstacles in the project: “As far as the brakes are concerned, of course there were brakes especially from the DEVE but it is not only SVdP, it is nowadays very difficult to put EP in green spaces” (Abercius Urbanus, May 2022) An opinion join by Empreinte “We are trying to think of simple things, and even that, since it is a change from everyday life, it is hard to get the departments to accept it. Our biggest issues are the management services (DEVE, DVD, DPE) who have difficulties with the change, they want to do as before.” (Elias Manus, May 2022) Linked to this reluctance, in order to develop a rainwater management strategy, it appears that strong stakeholders are needed to carry the project.

“Especially Saint-Vincent-de-Paul, what is interesting for me is that I saw the project from both sides, on the ATM side and on the City of Paris side. I saw them fighting, it is their core business, if there had not been an AMO who said go on, we will hold on, honestly we would not have half of this project. Because at one point the landscaper is annoyed to have half of its public space taken by a ditch, because at one point you have the IGC (Inspection Générale des Carrières) who does not even try to understand why, a developer who says at one point it costs too much so I am taking it away etc... It is all trade-offs with compromises, so the rainwater can quickly be lost when, if it is well done, it will not cost more and there are other benefits behind it.” (Cyra Ingenium, April 2022)

Although some aspects of the project design have changed, the methodology of consultation between stakeholders seems to remain the same, although the frequency of meetings has increased. "There have been many meetings, many exchanges, we have not invented anything new and that is perhaps what is good, it is a lot of exchanges in the form of workshops, sharing the ways of doing things of each of the different stakeholders." (Elias Manus, May 2022) Nature-based technical devices force stakeholders to think about a long-term strategy for these devices. It also implies a change in the role of some of the stakeholders that brings them back to an economic reality:

“Yes, and it is the same with energy management. We are making sustainable developments, so they must last and be able to do so, and in fact all this is not only at stake when the buildings are delivered. More and more, we have to stay, which raises questions because we also have to adapt the economic model as a developer is paid according to its development and staying longer is expensive. So, we have to try to find ways, to give ourselves the means to last and this is a real question and for the moment nobody has the answer.” (Perseus Responsus, March 2022)

This economic issue is in some way caused by temporary occupation. In a way, "Les Grands Voisins" have invited themselves into the governance process by influencing the role of stakeholders in that process:

“A developer is destined to disappear. On the other hand, we have some documentation on interesting mechanisms. We worked on SVdP on a neighborhood management mechanism. By this we mean several things. First of all, all the activity areas of the bases I mentioned will be purchased by the same investor, the RIVP, and these areas will have to be managed, and their marketing will have to be organized. And so, this management function of the pedestals, we were going to rely on it and expand it to try to reproduce in the final district what the Grands Voisins 2016-2020 scheme had done upstream” (Perseus Responsus, March 2022)

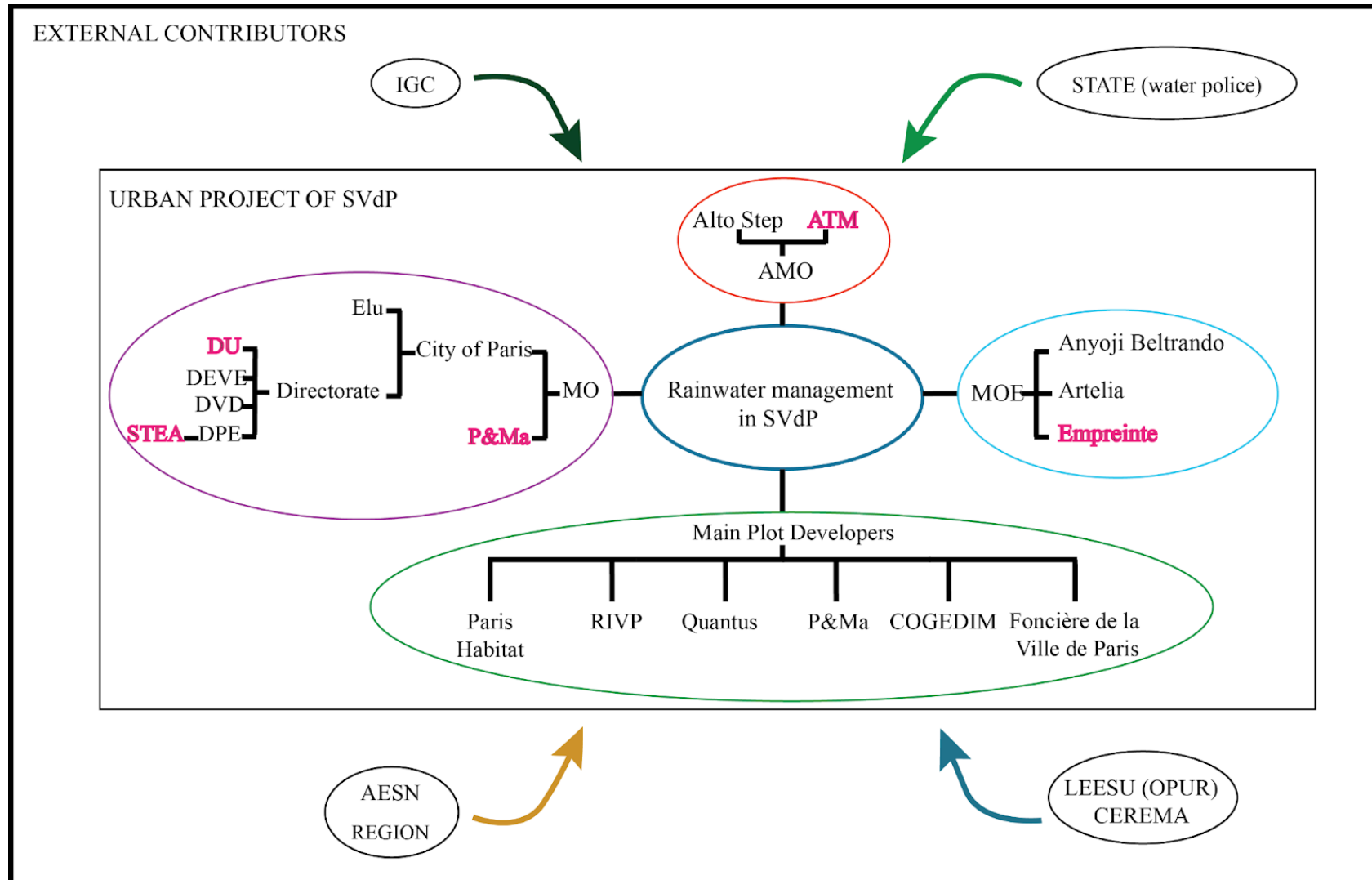
Governance in rainwater management is also influenced by external economic factors and especially the distribution of subsidies. A major stakeholder in this field is the AESN, which, by redirecting subsidies, has accelerated the paradigm shift in rainwater management techniques. “Well, and then in the detail on the management of rainwater, there is still a subject of financing from the Water Agency, which exists. We had them on Porte Pouchet, we will have them on Saint-Vincent-de-Paul, there are classic aid schemes on rainwater management, the realization, which are not null” (Perseus Responsus, March 2022) “Today, the management of development projects is done through water agencies, financial partners, and the convictions of people in city departments.” (Abercius Urbanus, May 2022) Finally, water seems to have taken its place in governance as a non-human stakeholder. This stakeholder in its own right fundamentally modifies the conception of urban project and therefore public spaces:

“I think that today, when water becomes a vector of nature in the city, it can modify the urban project, I even think that water today, I am working on it, I think that water can even be a lever of real territorial policy because of climate change, as well as the population's demand to

have a little more nature in the city, etc., Water can become a real element of a political discourse for an elected official, which was not the case before, because before, water was seen as something very negative. From the moment we give it a real value, an important value, the more we will have a heat wave, the more water will become gold, so there is a real subject and I think that water can change the governance of development projects.” (Abercius Urbanus, May 2022)









Thus, rainwater management may be a real subject in the future as it will become increasingly important as climate change, biodiversity loss and water scarcity intensify. Rainwater management can thus be integrated into the political speech related to the adaptation of the city to climate change. In this way, it may participate in the resilience of the territory by creating multi-functional public spaces.

Figure 28. Stakeholder's map



Source: François Dubreuil, 2022

LEGEND

-  Ensure that technical devices are in accordance with regulations related to quarries
-  Ensure that regulations are respected
-  Distribute subsidize
-  Contribute to knowledge development
-  Set local regulations, contribute with technical expertise and ensure that environmental objectives are met
-  Carry out the rainwater master plan and contribute with technical expertise
-  Design of public spaces, monitoring and coordination of construction work
-  Ensure completion of work on each unit
- Empreinte** Stakeholders interviewed

CONCLUSION

“The situation is tragic, however the multifaceted response is absolutely extraordinary. It is a civilization that is relearning where it is, at what point in its history it is”⁷⁷ (Bruno Latour)

The objective of this thesis was to study and understand how resilience issues could be reflected in public spaces. At the time of writing, extreme weather events have occurred and are still occurring, such as in India and Pakistan, where droughts and temperatures have regularly exceeded 40°C, and even 50°C in some places.⁷⁸ The lack of water and its consequences are painfully felt in some regions. This is also the case in Italy, the country is experiencing its worst drought in 70 years.⁷⁹ France, to a lesser extent, has also been impacted with temperatures well above the seasonal average during the week of June 13.⁸⁰ The case of the Aquaboulevard water park, near Paris, was thus the subject of an over-visitation, a symbol of a disturbed water-urban relationship.⁸¹ According to the 6th IPCC report⁸², these events are expected to increase in frequency and magnitude in the coming years. The news of the last few weeks demonstrates the need to adapt cities to the global changes in progress

Thus, the issue of water, and especially rainwater management in urban projects, is crucial and can, if properly addressed, become a powerful lever for adapting to climate change, the scarcity of resources, especially water, and the growth of biodiversity in the city. It can also be a lever for social cohesion and the reduction of inequalities. It seems that there is still a long way ahead to make our cities sustainable and resilient, however, solutions do exist.

⁷⁷ **LCP.** *Bruno Latour, sociologue, ethnologue et philosophe | Les Grands Entretiens de Guy Lagache*, 04/12/2021 [Vidéo]. Youtube. Available on: <https://www.youtube.com/watch?v=4IYL-4t7XVQ>, (consulted on 06/26/2022)

⁷⁸ **Le monde.** *L'Inde et le Pakistan écrasés par une vague de chaleur record, en photos*, May 2, 2022, [online]. Available on: https://www.lemonde.fr/international/article/2022/05/02/l-inde-et-le-pakistan-ecrases-par-une-vague-de-chaleur-record-en-images_6124482_3210.html (consulted on 06/30/2022)

⁷⁹ **Le monde.** *En Italie, une sécheresse historique affecte la production agricole et énergétique*, June 27, 2022, [online]. Available on: https://www.lemonde.fr/international/article/2022/06/27/en-italie-une-secheresse-historique-affecte-la-production-agricole-et-energetique_6132164_3210.html (consulted on 06/30/2022)

⁸⁰ **Le monde.** *En trois graphiques : la vague de chaleur de juin 2022 est intense, très précoce et amenée à se répéter*, June 24, 2022, [online]. Available on: [https://www.lemonde.fr/les-decodeurs/article/2022/06/24/en-trois-graphiques-une-vague-de-chaleur-de-juin-2022-intense-tres-precoce-et-amenee-a-se-repeter_6131905_4355770.html#:~:text=La%20temp%C3%A9rature%20moyenne%20relev%C3%A9e%2C%20samedi,dessus%20des%20normales%20de%20saison.\(consulted on 06/30/2022\)](https://www.lemonde.fr/les-decodeurs/article/2022/06/24/en-trois-graphiques-une-vague-de-chaleur-de-juin-2022-intense-tres-precoce-et-amenee-a-se-repeter_6131905_4355770.html#:~:text=La%20temp%C3%A9rature%20moyenne%20relev%C3%A9e%2C%20samedi,dessus%20des%20normales%20de%20saison.(consulted on 06/30/2022)

⁸¹ **Demotivateur.** *Bassins bondés, eau des pédiluves marron, entrées contrôlées : l'Aquaboulevard submergé de monde à cause de la canicule*, June 20, 2022, [online]. Available on: <https://www.demotivateur.fr/article/canicule-raz-de-maree-a-l-aquaboulevard-de-paris-29881> (consulted on 06/30/2022)

⁸² **IPCC.** *Climate Change 2022, Mitigation of Climate Change, Summary for Policymakers*, 2022 [online]. Available on: https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_SummaryForPolicymakers.pdf, (consulted on: 04/09/2022)

As we have seen throughout this dissertation, SVdP appears to be a relatively interesting case study related to its integration into the city's environmental plans, its history, and the environmental ambitions promoted by the project. Thus, alternative solutions of rainwater management appear to deeply modify the landscape and functions of public spaces. The techno-centric vision is replaced by a socio-technical one in which inhabitants have a central place in the conception of the district. However, this implies new models of governance in order to meet challenges of this paradigm change. The triptych between nature-based alternative technical devices, social acceptance of them and new models of governance seems necessary to build resilient public spaces of tomorrow. Rainwater management, thus, is increasingly becoming a part of urban governance and even goes beyond it by affecting the conditions of "living together".

It seems that we are witnessing a change in mentality that is gradually being reflected in regulations and therefore in urban projects. "I have been at the planning services of the City of Paris for 7 years and in 7 years we have really seen the progression of mentalities and that is why we can end up with a bioclimatic PLU and an application of the Paris Rain Plan which will be stronger and which will be done" (Calliope Caput, April 2022). To implement this change, an interdisciplinary approach seems essential. To implement this change, a cross-sectoral approach seems essential. It is based on raising the awareness of elected officials to environmental issues, through professional training for city employees and external partners. In addition, it also involves addressing cross-disciplinary programs in universities and schools, such as the AUEP program⁸³. If these mechanisms are established, they will enable stakeholders to better understand and coordinate with each other.

This research presents several limitations. The first is the limited number of interviews that were conducted: stakeholders such as Artelia, the elected officials of the City of Paris, the Water Agency, Anyoji Beltrando or the MOA of each lot were not met and could have contributed with other perspectives. The second limitation is that SVdP introduces many specificities that are not found in other districts. It would have been interesting to compare it with 2 or 3 other sites to define a more global trend on the Parisian territory. The last limitation is the fact that rainwater management solutions have not yet been implemented, so this research may be completed with field observations in the coming years. The project also

⁸³ AUEP (Architecture, Urban Planning, Political Studies) is a new program established by the Institute of Urban Planning and Alpine Geography of Grenoble. More information at: <https://formations.univ-grenoble-alpes.fr/fr/catalogue-2021/master-XB/master-urbanisme-et-amenagement-IDIVTRKA/parcours-architecture-urbanisme-etudes-politiques-auiep-ILMGL7HU.html>

involves some controversies such as those expressed by the neighborhood association (AssoQPV)⁸⁴ in which residents are also mobilized to protest against the project. They denounce the lack of real consultation, excessive density in a closed neighborhood with insufficient green spaces.

The management of rainwater seems to be tossed between the speeches and the operational today: "Certainly today, politically, socially, institutionally it seems to be going in the right direction, however there are other very concrete parameters which are money, time, on the operational which has a huge power too, so it remains a very militant activity still today, water in the city, water in greenery, the triptych water-soil-vegetation it's still a very militant activity for me" (Abercius Urbanus, May 2022). Today, a paradigm shift appears to be visible in the manner in which rainwater management is approached in urban projects. SVdP is the example that illustrates the latest advances on this subject in Paris. Thus, in the way it is designed, it integrates the issues of resilience in terms of climate, biodiversity and social cohesion issues through public spaces redesigned to accommodate multiple uses.

⁸⁴ **Association Quartier Saint-Vincent-de-Paul.** *Votre quartier va changer demain, prenez son avenir en main!*, 2022, [online]. Available on: <https://www.quartier-saint-vincent-de-paul-paris.fr/> (consulted on 06/30/2022)

BIBLIOGRAPHY

● *Research publication & Books*

Aldrich, Daniel P. *Building Resilience: Social Capital in Post-Disaster Recovery*. Chicago, IL: University of Chicago Press, 2012.
<https://press.uchicago.edu/ucp/books/book/chicago/B/bo13601684.html>.

Aldrich, Daniel P. and Michelle A. Meyer. « Social Capital and Community Resilience ». *American Behavioral Scientist* 59, 2014: 254-69.
<https://doi.org/10.1177/0002764214550299>.

Bachelard Gaston. *L'eau et les rêves : essai sur l'imagination de la matière*. Paris: Librairie José Corti, 1942.

Barles, Sabine, and Emma Thébaud. « Des réseaux aux écosystèmes : mutation contemporaine des infrastructures urbaines de l'eau en France ». *Tracés. Revue de Sciences humaines*, n° 35 (4 décembre 2018): 117-36.
<https://doi.org/10.4000/traces.8299>.

Berkes, Fikret, Johan Colding, and Carl Folke. *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge University Press, 2003.

Blanquart, Paul. *Une histoire de la ville: Pour repenser la société*. La Découverte, 2020.

Bunge, Mario. « Systemism: The Alternative to Individualism and Holism ». *The Journal of Socio-Economics* 29, n° 2 (1 janvier 2000): 147-57.
[https://doi.org/10.1016/S1053-5357\(00\)00058-5](https://doi.org/10.1016/S1053-5357(00)00058-5).

Callon, Michel. « Pour une sociologie des controverses technologiques ». In *Sociologie de la traduction : Textes fondateurs*, édité par Madeleine Akrich et Bruno Latour, 135-57. Sciences sociales. Paris: Presses des Mines, 2013.
<http://books.openedition.org/pressesmines/1196>.

- Catalano, Chiara, and Nathalie Baumann. « Biosolar Roofs : A Symbiosis between Biodiverse Green Roofs and Renewable Energy ». *Citygreen* 2017, n° 15 (novembre 2017): 42-49.
- Cretney, Raven. « Resilience for Whom? Emerging Critical Geographies of Socio-Ecological Resilience: Resilience of What, for Whom? » *Geography Compass* 8, n° 9 (septembre 2014): 627-40. <https://doi.org/10.1111/gec3.12154>.
- Desailly, Bertrand, Philippe Béringuier, Gérard Briane, and Jean-François Dejoux. « Les impacts environnementaux de l'étalement urbain », 2009, 5.
- Folke, Carl. « Resilience: The Emergence of a Perspective for Social–Ecological Systems Analyses ». *Global Environmental Change, Resilience, Vulnerability, and Adaptation: A Cross-Cutting Theme of the International Human Dimensions Programme on Global Environmental Change*, 16, n° 3 (1 août 2006): 253-67. <https://doi.org/10.1016/j.gloenvcha.2006.04.002>.
- Forest, Joëlle, and Abdelillah Hamdouch. *Quand l'innovation fait la ville durable*. PPUR Presses polytechniques, 2015.
- Geels, Frank W., et Johan Schot. « Typology of Sociotechnical Transition Pathways ». *Research Policy* 36, n° 3 (1 avril 2007): 399-417. <https://doi.org/10.1016/j.respol.2007.01.003>.
- Gemenne, François, Julia Blocher, Florence DE Longueville, Sara VIGIL Diaz, Caroline Zickgraf, Dalila Gharbaoui, et Pierre Ozer. « Changement climatique, catastrophes naturelles et déplacements de populations en Afrique de l'Ouest. Climate change, natural disasters and population displacements in West Africa », 2017, s. d., 22.
- Guerrin, Joana, and Gabrielle Bouleau. « Remparts ou menaces ? Trajectoires politiques de l'endiguement en France, aux Pays-Bas et aux États-Unis ». *Revue internationale de politique comparée* 21, n° 1 (2014): 89-109. <https://doi.org/10.3917/ripc.211.0089>.
- Guivarch, Céline, and Nicolas Taconet. « Inégalités mondiales et changement climatique ». *Revue de l'OFCE* 165, n° 1 (2020): 35-70. <https://doi.org/10.3917/reof.165.0035>.

- Hatchuel, Arthur, Auréliane Labourdette, Florian Leduc, Loucas Pillaud-Vivien, and Marine Renaudin. « La Résilience à Paris: états des lieux et préconisations multi-bénéfiques pour l'espace public », 2017, s. d., 5.
- Holling, C S. « Resilience and Stability of Ecological Systems ». *Annual Review of Ecology and Systematics* 4, n° 1 (novembre 1973): 1-23.
<https://doi.org/10.1146/annurev.es.04.110173.000245>.
- Holling, C S. *Engineering Within Ecological Constraints*. National Academies Press, 1996.
- Klinenberg, Eric. « Heat Wave: A Social Autopsy of Disaster in Chicago ». *Bibliovault OAI Repository, the University of Chicago Press*, 2002.
<https://doi.org/10.7208/chicago/9780226026718.001.0001>.
- Latour, Bruno. *Aramis ou l'amour des techniques*. La Découverte, 2020.
- La Branche, Stéphane. « Gouvernance et jeux d'acteurs dans les écoquartiers - », 2015.
<https://innovatio.univ-grenoble-alpes.fr/indexcd7b.html?id=138#tocto1n6>.
- La Branche, Stéphane. *Le changement climatique : du métarisque à la métagouvernance*. Lavoisier, 2011.
- Lhomme, Serge, Damien Serre, Youssef Diab, and Richard Laganier. « Les réseaux techniques face aux inondations, ou comment définir des indicateurs de performance de ces réseaux pour évaluer la résilience urbaine (Urban networks and floods : how to define performance indicators to evaluate urban resiliency) ». *Bulletin de l'Association de géographes français* 87, n° 4 (2011): 487-502.
<https://doi.org/10.3406/bagf.2010.8193>.
- Maret, Isabelle, and Thomas Cadoul. « Peut-on concilier risques côtiers et planification viable ? » *Territoire en mouvement Revue de géographie et aménagement. Territory in movement Journal of geography and planning*, n° 1 (1 mars 2007): 83-95.
<https://doi.org/10.4000/tem.584>.
- Meadows, Donella H. *Thinking in Systems: A Primer*. Chelsea Green Publishing, 2008.

Seidl, Martin. « Aménager la ville avec l'eau, pour une meilleure résilience face aux changements globaux - Laboratoire Eau Environnement et Systèmes Urbains (Leesu) ». 2020.

<https://www.leesu.fr/ouvrage-amenager-la-ville-avec-l-eau-pour-une-meilleure-resilience-face-aux>.

Paquot, Thierry. « Introduction », 3-9. Repères. Paris: La Découverte, 2009.

<https://www.cairn.info/l-espace-public--9782707154897-p-3.htm>.

Thébault, Emma. « La ville à fleur d'eau : doctrines, techniques et aménagements de l'eau de pluie et des cours d'eau dans l'agglomération parisienne, 1970-2015 ».

These de doctorat, Paris 1, 2019. <http://www.theses.fr/2019PA01H100>.

Tyler, Stephen, and Marcus Moench. « A framework for urban climate resilience ».

Climate and Development 4, n° 4 (1 octobre 2012): 311-26.

<https://doi.org/10.1080/17565529.2012.745389>.

Vilmin, Thierry. « L'aménagement urbain en France: une approche systémique », 2019,

s. d., 251.

Wu, Jianguo. « Urban ecology and sustainability: The state-of-the-science and future directions ».

Landscape and Urban Planning 125 (1 mai 2014).

<https://doi.org/10.1016/j.landurbplan.2014.01.018>.

- **Reports**

ATM. *Dossier Loi sur l'Eau*. 2021, 89p

City of Paris. *Paris Climate Action Plan*. 2018a, 100p

City of Paris. *Plan Biodiversité de Paris 2018-2024*. 2018b, 130p

City of Paris. *PlanParisPluie*, 2018, 108p

City of Paris. *Paris in the face of climate change*. 2021, 24p

City of Paris. *Paris Resilience Strategy*, 2017, 128p

City of Paris. *Public space planning for water and storage*, 2022a, 111p

City of Paris. *Le Parispluie*, 2022b, 59p

United Nations. *World Urbanization Propects 2018 - Highlights*. 2018, 38p

United Nations. *Global Change and Sustainable Development: Critical Trends*, 1997, 76p

IPCC. *Climate Change 2022, Mitigation of Climate Change, Summary for Policymakers*, 2022, 64p

- **Websites & multimedia**

AssoQPV. <https://www.quartier-saint-vincent-de-paul-paris.fr>

City of Paris. <https://www.paris.fr>

Demotivateur. <https://www.demotivateur.fr>

EuropeanCommission. <https://ec.europa.eu>

IPCC. <https://www.ipcc.ch>

INSEE. <https://www.insee.fr>

LCP. <https://www.youtube.com>

LégiFrance. <https://www.legifrance.gouv.fr>

Le monde. <https://www.lemonde.fr>

Ministry of Economic. <https://www.economie.gouv.fr>

Ministry of the Ecological Transition. <https://www.ecologie.gouv.fr>

National Assembly. <https://www.assemblee-nationale.fr>

New York City. <https://dos.ny.gov>

P&Ma. <https://www.paris-metropole-amenagement.fr>

Resilient Cities Network. <https://resilientcitiesnetwork.org>

Systemic transition. <https://transitionsystemique.fr>

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