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## Treball Fi de Màster

*Sustainable urban drainage systems (SUDS): a neighbourhood scale approach for urban stormwater management. The case of Bon Pastor, Barcelona*

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TECHNISCHE  
UNIVERSITÄT  
DARMSTADT



International Cooperation  
in Urban Development

MASTER THESIS

# SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS): a neighbourhood scale approach for urban stormwater management. The case of Bon Pastor, Barcelona

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“As growing urban communities seek to minimize their impact on already stressed water resources, an emerging challenge is to design for resilience to the impact of climate change, particularly in regards to ensuring secure water supplies and the protection of water environments” (Brown, Keath and Wong, 2009, p.847)

## **Abstract**

The increase of floods and the inability of aging sewage infrastructure to deal with stormwater retention led Sustainable Urban Drainage Systems (SUDS) to be one of the emerging paradigms for urban stormwater management, considering it no longer as a waste product but as a resource. Despite the fact that extensive research has been made on the technical aspects of the SUDS, there is hardly existing literature or research done in order to understand the impacts they have at a social level. The neighbourhood scale that characterizes the SUDS create a different governance system –compared to the old structures of flood risk management– where communities gain a better position of negotiation and new responsibilities. And, even though SUDS might not be popular along the general public, the social benefits they provide can create sustainable behaviours among inhabitants, and, when this becomes visible it breeds special interest towards SUDS. This master thesis objective is to recognize how the SUDS interact within the different stakeholders involved and to look into the different levels of understanding SUDS as new alternative of soft infrastructure. In order to accomplish this task, this work studies the case of Barcelona’s neighbourhood Bon Pastor, which had gone through urban transformations for the past years prompting the construction of a SUDS in 2012. Empirical evidence has been obtained from 10 semi structured interviews to government, technicians, social organizations and local community including questions on the different roles, the perception of SUDS and its impact. The results show how active the community was during the design process and afterwards, as sustainability gradually became one of the main topics in the neighbourhood to be incorporated in new developments.

**Keywords:** Sustainable Urban Drainage System; Urban Stormwater Management; Community participation; Stakeholders perception; Barcelona, Bon Pastor.

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## List of Acronyms

AVV *Associació de Veïns i Veïnes de Bon Pastor* \*\* 1

ACA *Agència Catalana de l'Aigua* \*\* 2

BAGURSA *Barcelona Gestió Urbanística SA* \*\* 3

BCASA *Barcelona Cicle de l'Aigua SA* \*\* 4

BMP Best Management Practices

CLABSA *Clavegueram de Barcelona SA* \*\* 5

EPA Environmental Protection Agency

FRM Flood Risk Management

GBM Green Blue Management SL

IUSM Integrated Urban Stormwater Management

LID Low Impact Development

SUDS Sustainable Urban Drainage Systems

TAs Techniques Alternatives

TEDUS *Técnicas de Drenaje Urbano Sostenible* \* 6

URM Urban Runoff Management

UWM Urban Water Management

WSS Water Sensitive Settlements

WSUD Water Sensitive Urban Design

WWTP Wastewater Treatment Plant

\*Acronyms in Spanish language that can be found in the Spanish language sources

\*\*Acronyms in Catalan language that can be found in the Catalan language sources

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<sup>1</sup> Neighbourhood association of Bon Pastor in English language

<sup>2</sup> Catalan Water Agency in English language

<sup>3</sup> Barcelona Urban Management Public Limited Company in English language

<sup>4</sup> Barcelona Water Cycle in English language

<sup>5</sup> Sewerage of Barcelona Public Limited Company in English language

<sup>6</sup> Sustainable Urban Drainage Techniques in English language

## 1. Introduction

Flash floods are increasing worldwide and are a latent issue in Mediterranean cities such as Barcelona, since its existing drainage infrastructure has proved to be inefficient in managing stormwater. Because of climate change, its land use and topography, Barcelona became more vulnerable to floods (Llasat, Llasat-Botija, Barnolas, López and Altava-Ortiz, 2009), regardless of the numerous improvements it had on its hard infrastructures, exposing that an interdisciplinary and holistic approach on flooding should be implemented in order to become more sustainable. From different disciplines, researchers and practitioners have looked into how to tackle this matter, defining a new shift in the paradigm: from flood defence to flood management (Brown and Farrelly, 2009, Carlson, Asce, Barreteau, Kirshen and Foltz, 2015, Scott, et al., 2013, and Perales Momparler, 2015) as a way of incorporating water as a resource in urban development. Under this framework, the Sustainable Urban Drainage Systems (SUDS) happen to be an alternative approach to efficiently manage stormwater retention. As described by the Spanish National Congress Environment Foundation (CONAMA):

“SUDS are urban infrastructures that are perfectly compatible with traditional urban stormwater management systems, making it possible to reduce the runoff received in collectors, storm tanks or WWTP, reduce the solid trawls, and discharge water to the reception centre without any treatment. Thus, the SUDS are aligned with the three basic axes of sustainability: economy, environment and sustainability” (Fundación del Congreso Nacional del Medio Ambiente, 2018, p.6)<sup>7</sup>

This master’s thesis aims to contribute to the existing literature of flood risk and urban stormwater management, specifically looking into SUDS as an alternative to involve communities in more sustainable actions. So far, extensive research has been done about the technical aspects and qualities of SUDS, but little has been discussed concerning the new implications the governance system of these practices have and how the different stakeholders respond to them. The premise of this research is that the neighbourhood scale that characterizes SUDS create a different governance system –compared to the old structures of flood risk management– where communities gain a better position of negotiation and new responsibilities (Brown 2005, Van De Meene, Brown and Farrelly 2011, Stephenson,

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<sup>7</sup> Citation translated from Spanish into English by author Andrea Nóbrega. Original version in Spanish can be found in (Fundación del Congreso Nacional del Medio Ambiente, 2018, p.6)

2008, Dahlenburg and Morison, 2009, and Newman and Mouritz, 1996). On the other hand the thesis also hypothesizes that, even though SUDS might not be popular along the general public (Carlson, et al., 2015), the social benefits they provide can create sustainable behaviours among inhabitants, and, when this becomes visible it breeds special interest towards SUDS (Perales Momparler, 2015).

The objective of this thesis is to understand how the implementation and management of SUDS interact within different local stakeholders involved in the planning and to discern the different levels of understanding SUDS as new alternative of soft infrastructure. The study aims to achieve this objective by answering the following research questions:

- i) What are the different visions in the discourse of SUDS that the main actors involved in its governance system have?
- ii) What is the perception the host community had in the project? What was the role they had?
- iii) What are the perceived social impacts of the SUDS?

The thesis aims to answer those questions by empirically analysing –through semi structured interviews done to the key stakeholders involved in the project at a governmental, technical, social organization and host community level– the implementation of SUDS in El Bon Pastor, a neighbourhood in Barcelona –a city that has embraced the use of SUDs in several urban developments–.

The thesis is structured into 6 sections. This first introductory section goes through the research topic, contribution to the field, research questions and objectives. The second section presents the conceptual framework on the SUDS. The third section presents the implementation of SUDS in Barcelona and more specifically the case of Bon Pastor. The fourth section explains the methodology used for data collection on the stakeholders involved in the Bon Pastor SUDS, using semi structured interviews. The data analysis around stakeholder's perceptions and SUDS impact is critically investigated and discussed in section five. And lastly, section six presents the final conclusion of the thesis.

## 2. Conceptual framework

Numerous are the ways in which SUDS are referred to depending on its context: Best Management Practices (BMP), Water Sensitive Urban Design (WSUD), Integrated Urban Stormwater Management (IUSM), *Técnicas de Drenaje Urbano Sostenible* [Sustainable Urban Drainage Techniques] (TEDSUS), *inter alia*. In this master thesis the term used is SUDS. The first concept of these sustainable systems has its origin as a BMP, which emerged during the 70's in United States of America when the Environmental Protection Agency (EPA) published the "Phase I stormwater rule" and the "Phase II stormwater rule", with the aim of reducing pollution of the receiving waterways. In it, it was specified that cities needed to have a legal permit in order to dump stormwater to the natural environment (Febles Dòmenech, Perales-Momparler and Soto Fernández, n.d.). Therefore, the BMP were created in order to reduce the pollution of water before being disposed and fulfil the technical requirements by the water rules. Similarly, in Australia in the late 90s Melbourne and Sydney adopted measures so as to increase the quality of stormwater, being the Water Sensitive Urban Design (WSUD) one of the practices adopted. Since the 1970's several types of SUDS have been implemented worldwide and adopted different names depending on each context. (*v.i.* Table 1)

Year	Location	SUDS Device	Name
1970	Monroe, Louisiana, USA	Construction of retention ponds	BMP
1985	Burdeaux, France	Implementation of pervious surfaces in streets and parking	TAs
1989	Scotland, UK	Construction of water ponds and wetlands	SUDS
1993	Zwolle, Netherlands	Construction of infiltration trench	SUDS
1996	North Rhine-Westphalia, Germany	Green roofs and rainwater harvesting, among others	SUDS
1998	Melbourne, Australia	Multiple interventions known as "Waterways Package"	WSUD
2000	Wuhan, China	Infiltration devices, filtered drains and perforated pipes	Sponge City
2003	Madrid, Spain	Incorporation of pervious pavements in Gomeznarro Park	TEDSUS
2006	Auckland, New Zealand	Implementation of ponds and rain gardens	LID
2009	Western Cape, Southafrica	Construction of wetlands and green roofs installations	WSS   WSUD
2006	Bogotá, Colombia	Green Roofs in supermarkets	SUDS
2010	Belo Horizonte, Brazil	Construction of water retention pond in Park	SDUS

Table 1 | List of SDUS implemented by year by country.

Source: Author

For the past two decades, SUDS became widely known and come to be on the spotlight when referring to urban runoff management because of the sustainable benefits they bring to the environment and quality of life with a low development impact (Charlesworth, 2010 and Woods-Ballard, Kellagher, Martin, Jefferies, Bray and Shaffer, 2007). SUDS are defined as surface water drainage systems that follow the concept of sustainable development and can therefore mitigate numerous of the adverse effects of urban stormwater runoff on the environment (Woods-Ballard, et al., 2007). As stated by Brown, et al. (2009), there is no doubt that more light is being shed into the urban footprints and that cities are a central point where to look into more sustainable practices, being the minimization on the impact on water resources an opportunity for action.

The SUDS framework is quite extensive and comprehensive. In the interest of organizing the spheres of knowledge that covers it, four subsections will explain the matter: 2.1) A shift in the paradigm of Urban Water Management; 2.2) SUDS: objectives and benefits; 2.3) SUDS' implications for new governance systems; and 2.4) Challenges of SUDS.

## **2.1 A shift in the paradigm of Urban Water Management**

It is vital to understand first how and why in Urban Water Management (UWM) there has been a paradigm shift that influences directly the stormwater management field. This is explained by Brown, et al. (2009) giving the example of Australia as one of the countries that has evolved significantly in terms of UWM making it evident that there has been a transition from a 'water supply city' to a 'water sensitive city' towards a more sustainable future, evolving through the different states that are represented below in Figure 1. What differentiates each stage is not only the historical period, but also:

“Each of the six city states is marked by a distinct shift in the dominant pillars of institutional practice (cognitive, regulative and normative). The six transitions states are a nested continuum, so the hydro-social contract in previous city states influences and shapes the hydro-social contract in subsequent transition states.” (*ibid.*, p. 851)

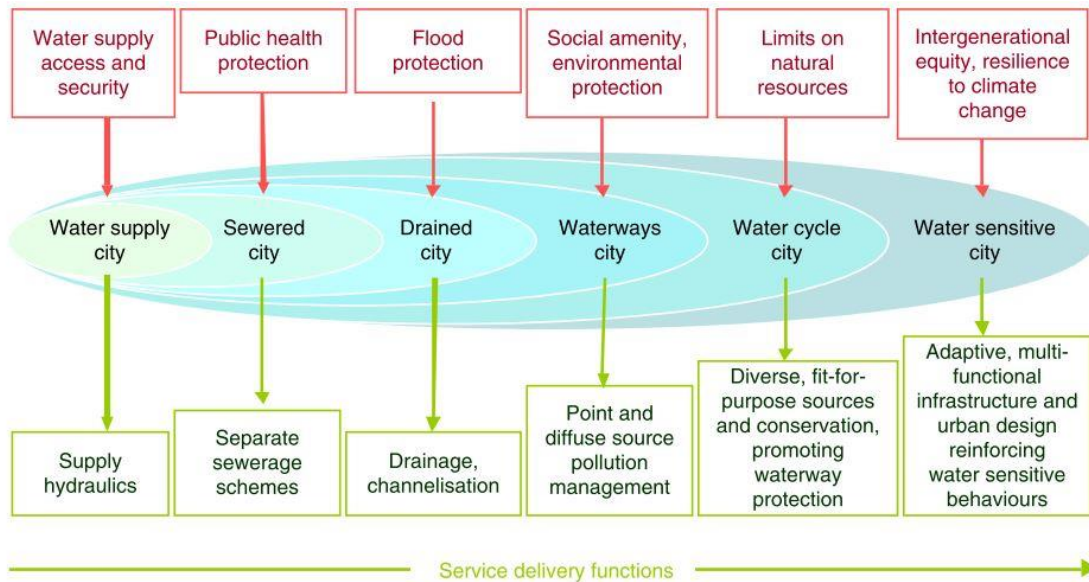


Figure 1 | Urban Water Management transitions network. Source: Brown and Farrelly (2009)

However, the authors understand that it does not exist yet an example of a Water sensitive city, but is definitely on the interest of many scientists, practitioners and governments for the future. The reason for this is mainly that the water sensitive stage is characterized by a driven force on integration equity towards natural resources and ecological issues, looking into preparedness among communities to face climate change. And, in order to achieve this, major institutional, economical, technical and social behavioural changes should take place for the redevelopment of water management that looks towards a more holistic system of water as a 'total water cycle' (Brown and Farrelly, 2009).

This idea is also supported by Perales Momparler (2015) and Carlson, et al. (2015) but from another perspective, since they both analyse stormwater as an isolated object, and highlight how it used to be considered as a waste product while now is conceived as a resource. For the past decade, rapid urbanization and soil sealing led to an increase of floods, and therefore countries rushed to look into solutions seeing stormwater as a threat that needed to be tackled fast and in quantity. As a matter of fact, flood risk management started to change its speech of "Keeping flood water out" towards a more strategic, holistic and long-term approach characterized by mitigating both flood risk and adaptation, or increasing resilience to flooding events" (Scott, et al., 2013, p.1).

Taking both concepts into consideration: the shift of water as a waste product to a resource, and looking forward to the water sensitive city, SUDS gained popularity by being aligned with these two and other sustainable principles.

## 2.2 SUDS: objectives and benefits

The increase of flash floods worldwide and the traditional way of managing stormwater brought with it a decline in habitat and water quality of streams, and had consequences in more severe flood flows, stream erosion and potential for decreased base flow, as explained by Elliott and Trowsdale (2007). And not only this, but also inefficient traditional drainage systems have caused overflows and pollution by water contamination from trash, pathogens, nutrients and other elements that can be found at a surface level (Perales Momparler, 2015). As highlighted in the previous section, flood risk management's objective used to be to keep water out of any urban system, so that it caused the minimum harm possible. While the conventional drainage systems tend to prioritize quantity over water quality, SUDS aim to create an equal balance in between the triangulation of water quantity, water quality and biodiversity/amenity (Charlesworth, 2010). These three areas take into account the effects of climate change by which resource management and climate mitigation and adaptation need to be achieved. (*v.i.* Figure 2)

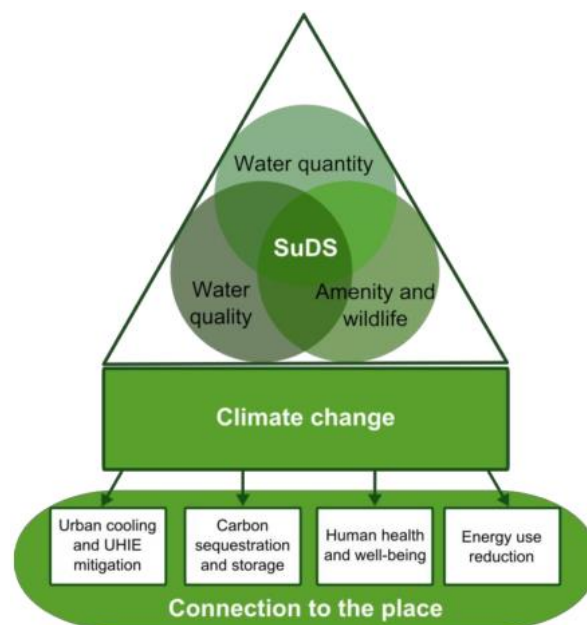


Figure 2 | The SUDS landed rocket (after Woods-Ballard et. al (2007) and Charlesworth (2010). Source: Perales Momparler (2015)

The objective of the SUDS as explained in the *SUDS Manual* by Woods-Ballard, et al. (2007) is to “reduce runoff by integrating stormwater controls throughout the site in small, discrete units” (p. 1), fostering decentralization processes. According to CONAMA (2018), SUDS are based on the existing hydrological processes that took place before urbanization (*viz.* infiltration, filtration, storage, lamination and evapotranspiration) but additionally incorporates these runoff controllers into the existing environment. This is an alternative way of managing runoff systems, in which water becomes an asset:

“Instead of constraining surface water into pipes and conduits, forcing it to leave a city as quickly as possible, SUDS encourages infiltration and detention of surface water on site. It is a different way of managing water; instead of treating it as an embarrassment, to be hidden from sight and forgotten, it should be treated as a ‘liquid asset’ (Semadeni-Davies, et al., 2008) in which society takes account of the behaviour of water, rather than water’s behaviour having to change for the sake of society.” (Charlesworth, 2010, p. 4)

The main benefits of applying these systems are twofold: firstly, they provide control of quality and quantity of runoff water and, secondly, they offer environmental and social services as its built form contributes to natural surroundings in urban developments. However, since SUDS comprehend a more holistic and sustainable way of managing stormwater, their benefits vary not only from the hydrological, environmental, and social aspects but also from the landscape, urban and the economical ones (CONAMA, 2018). Some of these benefits are represented in the lower diagram represented on Figure 2, and all of these covered by the “connection to the place” concept, in which people reconnect to the environment. Perales Momparler (2015), suggests that one of the most vital outcomes of these systems is that “people “are vitalized and become intrinsically motivated to care for it” as a result, bringing about “the transformation of our cities into places that are life enhancing and regenerative” (Mang, 2009)” (p.9). This is precisely what this thesis seeks to look into by studying the relation between people and its environment and how they interact with each other when SUDS are implemented.

Other aspect to take into consideration is the different types of SUDS, their material form and their technical aspects. The way of implementing SUDS can be extensive, since there are numerous typologies: they can either be structures located above or below ground, hard – such as porous pavements– or soft –which include vegetation–, aimed to infiltrate water to the ground or, on the other hand, to accumulate and dissipate it slowly afterwards. According to Woods-Ballard, et al. (2007) the types of SUDS can be reduced to: filter strips, swales, infiltration basins, wet ponds, extended detention basins, constructed wetland, filter drains and perforated pipes, infiltration devices, pervious surfaces and green roofs. Nevertheless, it is beyond the remit of this master thesis to explore the different types and characteristics of each system, for further information please refer to Annex 1 where a table summarizes the different SUDS.



### 2.3 SUDS' implications for new governance systems

The paradigm shift in stormwater management and the aims of the SUDS imply changes to the existing water governance scheme. To achieve SUDS' effective planning, design, construction and operation, various stakeholders need to be involved (Woods-Ballard, et al., 2007). This section will navigate through these new changes.

Firstly, it is worth noting that there are mainly three ideal governance systems to manage stormwater according to Van de Meene, et al. (2011), namely: hierarchical, market and network approaches<sup>8</sup>. For the past decades, there has been a change in the water governance schemes as the historical hierarchy governance shifted towards a market oriented approach, still the operating of urban water systems remained unaffected (*ibid.*). Others like Newman and Moritz (1996) emphasize that because of its nature, the market oriented governance system based in capitalism cannot deliver social and environmental needs. While some support the idea that it should follow a hierarchical, market or network approach, others (Van de Meene, et al., 2011) suggest for the need of a hybrid governance system –consisting of a mixture of these latter three– at a practical and operational level that better adapts to the principles of sustainability. In this line of thought, the authors see that “These hybrid arrangements tended to comprise network and hierarchical approaches with market governance instruments.” (*ibid.* p.1117) Moreover, it is well established that traditional ways of managing stormwater lead to jurisdictional and institutional fragmentation in many cases, which caused institutional overlapping and a lack of clear roles among institutions (Brown, 2005). Perales Momparler and Doménech (2016) explain through Jefferies and Duffy (2011), that when planning and implementing SUDS several actors should be involved: government, service companies, water users, neighbourhood associations, academia, NGOs, research institutions, local champions, the media and investors. None of these stakeholders is purely new to the urban stormwater management but the relationships between them transforms and with it, their responsibilities, as supported by the hybrid system.

Secondly, as Carlson, et al. (2015) argue, traditional schemes of stormwater management depend generally on the national and local government, following a vertical hierarchical structure where homeowners and individuals barely have a say in the topic. Notwithstanding the domestic sector (households) being the larger urban water user, only those who are

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<sup>8</sup> Hierarchical governance refers to the first types of governance for urban runoff management, as formal and democratic arrangements that follow a very vertical structure with little stakeholder participation. Market governance consists of applying private sector management into services that were previously provided by the public sector, that lead to monopolizations and limited access to water. And network governance is based on consensus by public, private and citizens that can have self-governing tendencies (Van de Meene, et al., 2011).

economically powerful or playing an important role in agriculture or industry can become influential in urban runoff management (Perales Momparler and Doménech, 2016). Nevertheless, because of the new technologies that characterize SUDS, multiple of these systems can be developed around the city, decentralizing the water runoff structures. Contributing to the decentralization of stormwater governance, SUDS provide opportunities to manage stormwater at a neighbourhood level reducing need for expensive and large drainage systems and thus decreasing the economic burden borne by municipalities (Carlson, et al., 2015, Dahlenburg and Morison, 2009, Newman and Mouritz, 1996).

And thirdly, –and as a consequence of the decentralization feature explained previously– local communities gain importance on the planning process which means that its goals and values are represented and taken into account for an efficient long term management. Both Brown (2015) and Perales Momparler (2015) trust that the redesign of the stormwater administration will allow the participation from all actors involved, where social organizations will gain a new position of power. Because of the localized scale, the ownership of these assets can belong to local actors, but, until nowadays, urban stormwater management interventions are located in public areas and developed by city councils or private entities. With SUDS local scale approach, it makes more sense to involve communities to seek for solutions at a public and private level (Dhalenburg, et al., 2009), something that with conventional Urban Runoff Management (URM) hardly happened. The nature of water cycle demands that it should be localized, as a community-scale approach, state Newman and Moritz (1996). Stormwater should therefore be captured directly where it falls, providing the opportunity to create small scale recycling systems that allow to reuse the water for local purposes.

However, several challenges are making the process towards the implementation of SUDS too slow and limiting its reapplication worldwide.

## **2.4 Challenges of SUDS**

While there have been remarkable innovations in technology and improvements in social behaviours towards sustainable water management practices, there are still two factors that challenge SUDS in different ways: lack of interest of citizens for stormwater management issues and the socio institutional barriers.

On the one hand, civil society and governmental institutions tend to perceive stormwater management with a low level of interest (Carlson, et al., 2015): “it is apparent that the shared perception of the reality of climate change is not itself sufficient to produce a change in

stormwater practice, when starting with a too low perceived importance of the issue.” (p.11) Cettner, Ashley, Hedström, and Vikander (2017) express how there is little engagement in practitioners towards sustainable stormwater management as too much pressure is put on technology as the best solution, and then becomes very technical and interests only those linked to high tech. In a similar way, Perales Momparler (2015) criticises how there is a common lack of interest of users when benefits are not immediate, tangible or local. Water management can be seen as a public good provision, which brings some critical aspects related to the level of involvement of stakeholders, creating a social dilemma of being an environmental collective issue (Carlson, et al., 2015).

On the other hand, the implications at its governance system represents the main challenges on the matter. Numerous are the authors that refer to barriers being largely socio institutional (community, resources, responsibility, vision, commitment and coordination) rather than technical (Brown and Farrelly, 2009, Brown, et al., 2009, Cettner, et al., 2017, Saurí and Palau-Rof, 2017, Perales Momparler, 2015). One of the main aspects to be criticized is the ambiguity and vagueness by which SUDS goals are defined by the different actors involved, which leads to diverse interpretation and allows evolving negotiations between them (Cettner, et al., 2017). It does not come as a surprise then, the different views on the concept, being many of them conflictive to each other by prioritizing their own agendas. This leads to a wide range of negotiations and flexibility in new perspectives and interpretations of the problem in order to achieve a water sensitive city (Brown, et al., 2009).

Another of the institutional impediments is that engagement among stakeholders may not be reached equally (Perales Momparler, 2015). This is a matter that is common when aiming urban sustainability and, according to Brown and Farrelly (2009), this collaboration depends on the inter organizational capacity, external rules and incentives implemented to delimit or not SUDS practices. Communities, policy makers and politicians should work together, putting less emphasis on the technical and scientific matters and looking more into the social aspects that interest a wider range of people (Birtles and Dahlenburg, 2012).

Despite the fact that the transition towards a more sustainable urban rainwater management (URM) demands critical changes in both, the level of interest among stakeholders and socio institutional reforms, the reality is that traditional ways of managing urban stormwater have proved to be jurisdictional and institutional inefficient and most importantly it demonstrated to be economically, socially and environmentally unsustainable. It is vital to achieve engagement among public in order to increase diffusion in different contexts and also to understand SUDS under the same guidelines with a clear legal framework that benefits collaboration among all

stakeholders equally. In this way, Barcelona became in the past few years one of the main promoters of SUDS in Spain, demonstrating that these changes can be possible. However, the literature among how its governance system works and the social impact they have remains unclear.

### **3. Case Study: El Bon Pastor, Barcelona**

El Bon Pastor is one of neighbourhoods Barcelona, and for the past years it has been part of a large urbanization project of the City Council (*Ajuntament de Barcelona*), where the old cheap houses (*Casas Baratas*) were and still are being demolished to build new social housing blocks. In the third phase of the project in 2012, a SUDS was implemented, creating new sustainable open spaces surrounding the new residential blocks and the streets.

The selection of this case is based on the importance the SUDS project had, as an opportunity for neighbours to participate on the design, as an improver of living and environment conditions and as a promoter of sustainability for other development projects of the area. During the design and implementation, Bon Pastor has demonstrated how active its Neighbourhood Association (AVV) is, particularly in topics related to the urban transformation of the neighbourhood.

This section will navigate through an overview of Barcelona's situation towards SUDS, to then narrow it down to the neighbourhood scale of Bon Pastor and the SUDS project.

#### **3.1 The evolution of flood risk management in Barcelona**

Floods are the most common disaster of natural origin in the region of Catalonia. Barcelona is no exception to it, as it had been struggling with floods since its beginnings (Chelleri and Favaro, 2018; see also Annex 2, Figure 1). There are several reasons that make Barcelona vulnerable towards floods. Firstly, due to its geographical location, it has a Mediterranean climate which is characterized by dry seasons with low precipitations (250 mm to 1,000 mm per year) but with occasional torrential rains. Usually in Barcelona the annual precipitation is about 580 mm (Blanquet, 2004), but have been through history several periods in which the

annual rainfall<sup>9</sup> surpassed 1,000 mm, which was the case in 2018 (Nadeu, 2018) creating flash floods around the city.

Nevertheless, the statistics of the period between 1982-2006 analysed by Llasat, et al. (2009), revealed that for the past years, Barcelona became more vulnerable to floods not because of rainfall events but because of city exposure caused by land use (Barrera, Barriandos, and Llasat, 2005 and Llasat, Llasat-Botija, Gilabert and Marcos, 2012). As explained by Chelleri and Favaro (2018), by 1982, more than 90% of the soil was impermeable (excluding Collserola Park), and exposed the inefficiency of the unplanned growth drainage system to cope with floods. Impermeable land represents the major issue when it comes to managing stormwater according to most practitioners and academics.

And secondly, its topography enables the concentration of stormwater mainly in certain areas of the city such as Poblenou, Casc Antic and Zona Franca (*v.i.* Figure 3). The Collserolla Park is located in the North with a steep slope that cannot filtrate water, letting it flow until it reaches lowland (Matos Silva, 2011). In addition to this, the city is also limited geographically by the Besòs and Llobregat River and the Mediterranean Sea, which generates high urban density.

Another issue to take into account is that nowadays the stormwater captured is extremely polluted and less than half of the volume is treated before being disposed. More than 60% per year of the stormwater produced is dumped directly into the receiving water bodies, without being previously treated which brings devastating consequences to the water body (Chelleri and Favaro, 2018).

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<sup>9</sup> Measured by the *Observatori Fabra* located in Barcelona. This observatory specializes in Meteorology, Seismicity and Astrology matters.

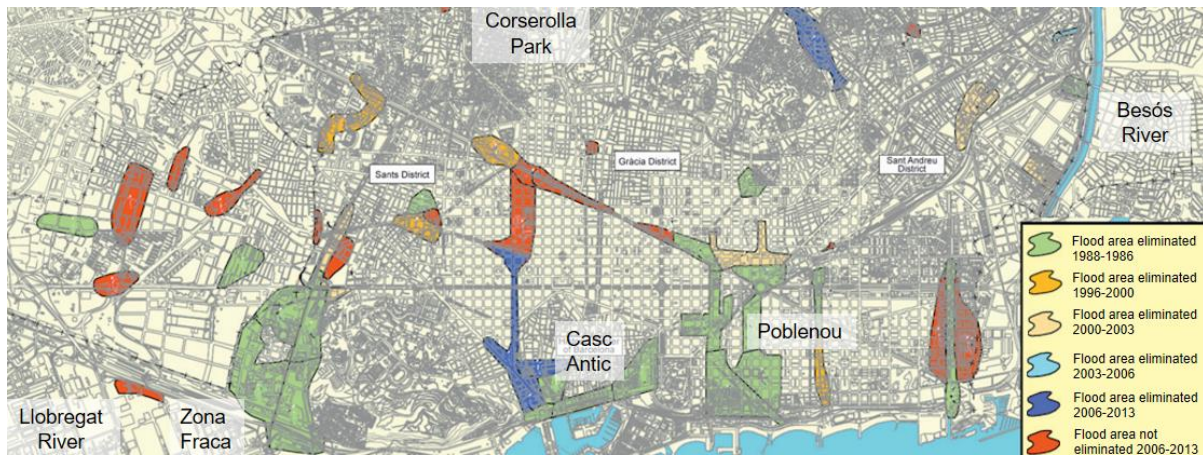


Figure 3 | Evolution of flooding areas in Barcelona. Source: Adapted from Chelleri and Favaro (2018)

### 3.1.1 Developments of flood risk management in Barcelona

The nature of Barcelona's morphology and its urban developments have created a city prone to floods. However, there has been an evolution from the first systems of capturing stormwater in the city. With the Cerdà Plan of 1859, stormwater management became a key element to be taken into account for Barcelona's expansion. Several drainage collectors were created around the city to prevent floods and separate wastewater from stormwater (Please refer to Annex 2, Figure 2). Nevertheless, not all of the drainage systems were built due to financial issues, and the plan failed to cope with water borne diseases (Chelleri and Favaro, 2018). This is why the next plan in 1891 by García Faria was based on health principles and consisted of a combined drainage system in which stormwater and wastewater were drained together. After this, the 1969 Sanitation and Sewerage Plan (*Pla de Sanejament i Clavegueram*) sustained that water needed to be treated before being received by another water body, which entailed the construction of new drainage underground networks that increased gradually within the following years.

With the urbanizations for the Olympic Games of 1992, a new city drainage plan was carried out that defined new parameters such as decentralization and flexibility of urban runoff management (*ibid.*) with the incorporation of IT systems and the construction of several stormwater retention tanks spread through the city (*v.i.* Figure 4).<sup>10</sup>

<sup>10</sup> These tanks are underground reception centres that capture stormwater when the drainage system exceeds its capacity, and assist water treatment plants not to be overflowed when intense rainfall occurs.

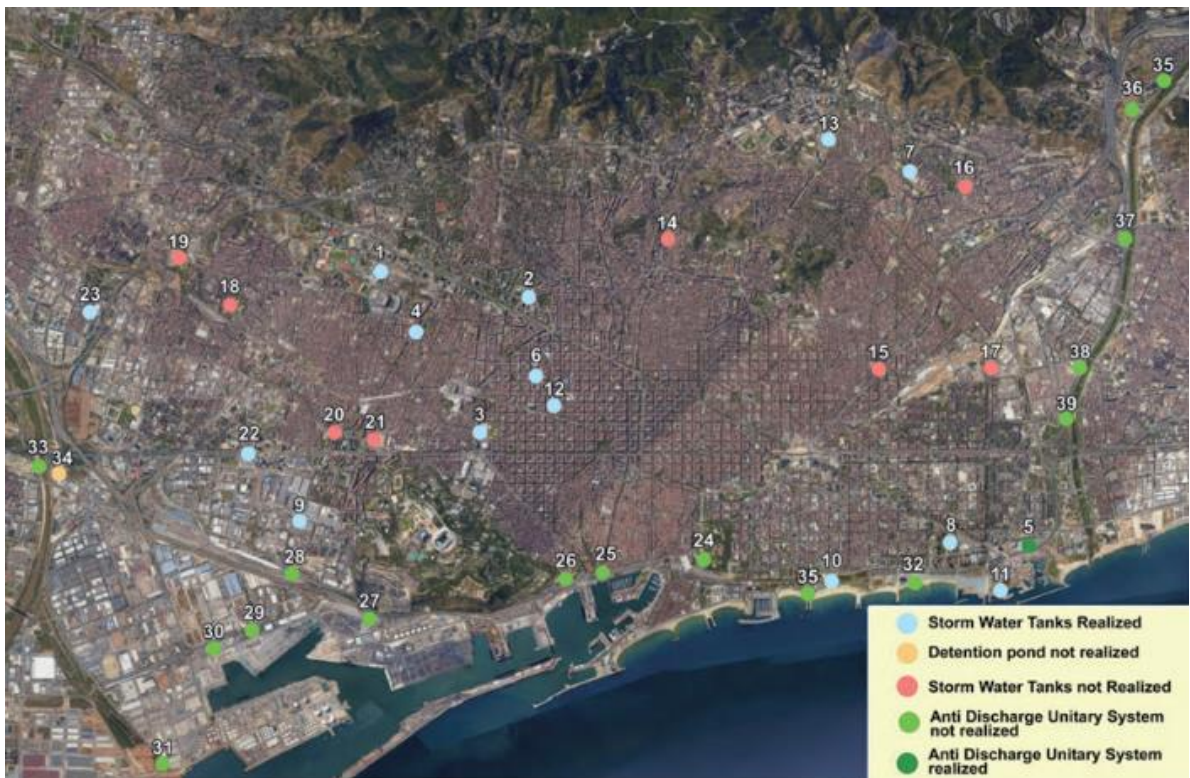


Figure 4 | Localization of stormwater tanks and anti-discharge unitary systems tanks planned and realized by 2017. Source: Chelleri and Favaro (2018)

The Integrated Sewerage Plan of Barcelona of 2006 (*Pla Integrat de Clavegueram de Barcelona*) was the last action taken towards flood management (*ibid.*) which introduced the implementation of SUDS in Barcelona as a complementary solution to water retention tanks and the existing unitary drainage system. The first two SUDS implemented in Barcelona were located in the neighbourhood of Torre Baró and La Marina de la Zona Franca (*v.i.* Figure 5).



Figure 5 | Map of firsts SUDS in Barcelona. Source: Author

### 3.1.2 The trajectory of SUDS in Barcelona and its institutional framework

The first reference for SUDS is made in 1997, with The Special Sewer Plan of Barcelona (*Pla Especial de Clavegueram de Barcelona*) of 1997 created by CLABSA (*Clavegueram de Barcelona SA*) which made recommendations for the implementation of SUDS (Castro-Fresno, Valeri, Sañudo-Fontaneda and Rodriguez-Hernandez, 2014). Although SUDS have been implemented worldwide, its existence in the Mediterranean region was scarce (Perales Momparler 2015). Nevertheless, with the Integrated Sewerage Plan of Barcelona of 2006, several have been implemented in Barcelona and are planned to be built in the near future (v.i. Table 2).

SUDS BUILT UP TO 2016	SUDS TO BE BUILT FROM 2017 - 2019
<ul style="list-style-type: none"> <li>• Torrent de les Monges, jardins de Joan Reventrós</li> <li>• Can Caralleu</li> <li>• Torre Baró</li> <li>• Plaza de los Eucaliptus (Torre Baró)</li> <li>• Portal del Coneixement</li> <li>• Martí I Franqués</li> <li>• Marina del Prat Rojo</li> <li>• Can Cortada</li> <li>• Remodelación del paseo de Sant Joan</li> <li>• Bon Pastor</li> <li>• Vallbona</li> <li>• Vallcarca plaza de Mons</li> <li>• Jardines de Ernst Lluch</li> <li>• Jardín de los Drets Humans</li> <li>• Jardines del Gran Capità</li> <li>• Parque del Clot</li> <li>• Jardín de la Casa dels Xuklis</li> <li>• Ampliación del parquet del Putxet</li> <li>• Jardines de Can Mantega</li> </ul>	<ul style="list-style-type: none"> <li>• Estación de la Sagrera, AVE (Construction paralyzed. 3<sup>rd</sup> Stretch is paralyzed for the moment)</li> <li>• Proyecto de la plaza de las Glòries (Under construction. 1<sup>st</sup> Phase is finished)</li> <li>• Av. Diagonal</li> <li>• Av. Meridiana</li> <li>• Can Batlló</li> <li>• Parque Central de la Marina del Prat Vermell (Under construction)</li> </ul>

Table 2 | Existing and future SUDS in Barcelona. Source: Author. Adapted from Ajuntament Barcelona (2017)

The reality is that the legal framework that comprehends urban drainage systems is complex and has not facilitated its implementation at national level. In Spain, each territorial Hydrographical Confederation control its own water basin (Castro-Fresno, et al., 2014) which means that different entities within local governments are responsible for their own water management. Therefore, the water management's legal framework for Barcelona should be studied from different levels: European Union, Spain, the Autonomous Community of Catalonia and the Local Administration of Barcelona. Spain lacks of a complete or uniform legislation, but it has three isolated norms that support SUDS: *Real Decreto* 1290/2012, *Real Decreto* 233/2013 and *Real Decreto* 1/2016 (Perales Momparler, 2018). This latter one, specifically obliges new urbanizations, industrializations and extensive urban developments to implement SUDS in order to mitigate floods.



As explained by Barcelona Cicle de l'Aigua, S.A. and Green Blue Management, S.L.P (2018) this same concept is being supported at a regional level by the Management Plan for the river basin district of Catalonia for the period 2016-2021 (*Pla de gestió del districte de conca fluvial de Catalunya per al període 2016-2021*) by the Catalan Water Agency (*Agència Catalana de l'Aigua, ACA*), in which SUDS need to be implemented in new sizeable urban developments. In the Flood Risk Management Plan for the river basin district of Catalonia (*Pla de gestió del risc d'inundació del districte de conca fluvial de Catalunya*) approved in 2018 by ACA, the responsibility of planning, implementing and maintaining SUDS is given to the City Council of Barcelona which leads to a clear establishment of roles. Moreover, Perales Momparler (2018) highlights how for the case of Barcelona, the City Council has created a General Guide for technical criteria of the sewerage network of the city of Barcelona (*Guia de criteris tècnics generals de la xarxa de clavegueram*), which regulates the implementation of SUDS in its technical and legal aspects.

In this line of action, it has been of particular interest to the City Council of Barcelona to foster urban sustainability in an integrated manner, through different pillars that nourish SUDS in several plans<sup>11</sup>. All these plans represent the municipality response to the dwellers' needs towards more sustainable and healthier styles of life as they are increasingly demanding products and services that can be tangible in terms of health and eco efficiency (Febles Dòmenech, et al., n.d).

In most of the cases in Barcelona, SUDS emerged as part of major infrastructure developments, mainly because the city is constantly being renovated and redeveloped and the construction of these systems can be easily implemented when housing and public spaces are being renovated jointly. This was the case of El Bon Pastor SUDS, conceived as part of a holistic project that transformed housing, public spaces and infrastructures of the neighbourhood.

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<sup>11</sup> Some of the plans and studies created by the City Council comprehend: Green Plan and Biodiversity 2012-2020 (*Pla del Verd i la Biodiversitat 2012-2020*), Citizen Commitment for Sustainability 2012-2022 (*Compromís Ciutadà per la Sostenibilitat 2012-2022*), Barcelona Urban Mobility Plan 2013-2018 (*Pla de Mobilitat Urbana de Barcelona 2013-2018*), Technical Criteria for the Implementation of the Super Islands in Barcelona (*Criteris Tècnics per a la Implantació de les Superilles a Barcelona*), Study of Experimental Compilation and Analysis with Sustainable Drainage Systems and Devices in the City of Barcelona (*Estudi de Recopilació i Anàlisi de les Experiències amb sistemes i Dispositius de Drenatge Sostenible a la Ciutat de Barcelona*), Climate Plan (*Pla Clima*) and Green Infrastructure Boost Plan (*Pla d'impuls a la Infraestructura Verda*), (Ajuntament de Barcelona, 2017).

### 3.2 Urban transformations of El Bon Pastor

El Bon Pastor is one of the neighbourhoods of Sant Andreu district, located in the North East part of Barcelona city. Bon Pastor has 12,594 inhabitants (2018) in an area of 188.20 hectares, resulting in 67 inhabitants per hectare (Ajuntament de Barcelona, 2018).

In its beginnings, Bon Pastor was part of the surroundings of Barcelona city (v.i. Figure 6). As explained by Salas (2016) and Remesar (2018) its proximity to the Besòs river to transport goods and the existence of a hydraulic infrastructure that provided water to Barcelona –called Rec Comtal– was a magnet for the installation of textile and machinery industries in the beginning of the 1900s.<sup>12</sup>



Figure 6 | Map of Barcelona, 1930. Source: Santamaría Concha (2018), adapted from Institut Cartogràfic i Geològic de Catalunya

However, the story of the housing boom of El Bon Pastor starts in 1929, when the cheap houses law<sup>13</sup> was implemented, while Barcelona was suffering significant urban transformations for the International Exposition of 1929. In this context, the Municipal Institute of Housing and Rehabilitation of Barcelona (*Institut Municipal de l'Habitatge i Rehabilitació de Barcelona*) built 784 one storey houses of 43 and 59 m<sup>2</sup>, to harbour dwellers that were reallocated from the informal settlements of Montjuic and new immigrants coming to the city.

<sup>12</sup> Some of these were: Can Sala, Enric Sanchís, La Maquinista Terrestre y Marítima and the old slaughterhouse. The first villages for industry workers were built along Torrent de Estadella Street, and these were called *Barriada Estadella*, *Las Carolinas* and *Barrio Sanchis* (v.i. Figure 7).

<sup>13</sup> The Cheap Houses law was created in 1853, but it has suffered alterations. In 1929 the law aimed to facilitate credit by building a large number of housing, allowing some to become owners and others to rent, eliminating the possibilities of expropriation (Santamaría Concha, 2018).

By that time, this development was called Milans del Bosch and was the biggest development of cheap houses in Barcelona<sup>14</sup> (*ibid.*).

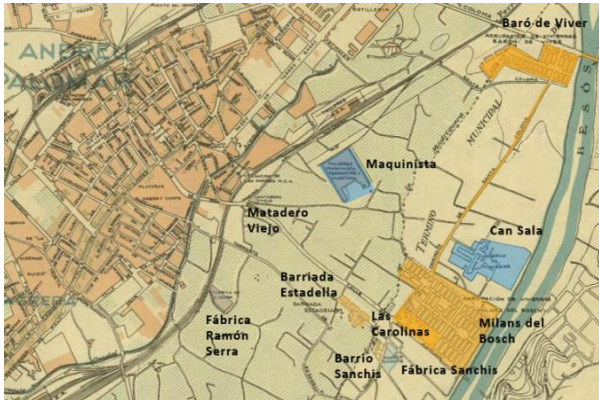


Figure 7 | Urban transformations of Bon Pastor by 1930. Source: Salas (2018)



Figure 8 | Aerial picture of Casas Baratas. Source: Salas (2018)

The cheap houses project was highly criticized. On the one hand, the houses were built to be delivered rapidly and many of them lacked water sanitation and electricity and were easily flooded. On the other hand, these houses were built in one of the most marginalized areas, since its location was next to the Besòs river and far away from the bridge of Santa Coloma (Salas, 2016, Santamaría Concha, 2018 and Remesar, 2018), which was the bridge that communicated the neighbourhood to its district (since Bon Pastor belonged to Santa Coloma municipality until 1944).

In 2002 a plan within the General Metropolitan Plan for renovating the neighbourhood was approved, which included the demolition of all cheap houses due to its bad building conditions, being replaced with housing blocks to be built in five different phases. However, the plan suffered transformations as it became a polemic issue among dwellers of the area, claiming that the cheap houses were part of their cultural heritage and some resisted to be reallocated, being sceptical about an increase in the rents. For it, the City Council created a referendum for the inhabitants of the cheap houses in 2003, but the results were positive to continue with the plan. Still, there was tension among neighbours and therefore the Independent Neighbours Association (*Associació Avis del Barri*) was created as an association that defends the tenants of the cheap houses. After several negotiations, the City Council has agreed with the neighbours to keep one row of cheap houses that will be part of a museum telling the story of Bon Pastor neighbourhood as a symbol of its heritage (Salas, 2016).

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<sup>14</sup> The other three developments were: Eduard Aunós in Zona Franca, Ramón Albó in Horta and Barón de Viver in Sant Andreu.

The project is nowadays in phase 4, which is planned to be finalized by 2021, and the construction of the surrounding area of these building is expected to be started in 2019. Nowadays the neighbourhood is socially active and the City Council describes it as open, dynamic and committed to its future.

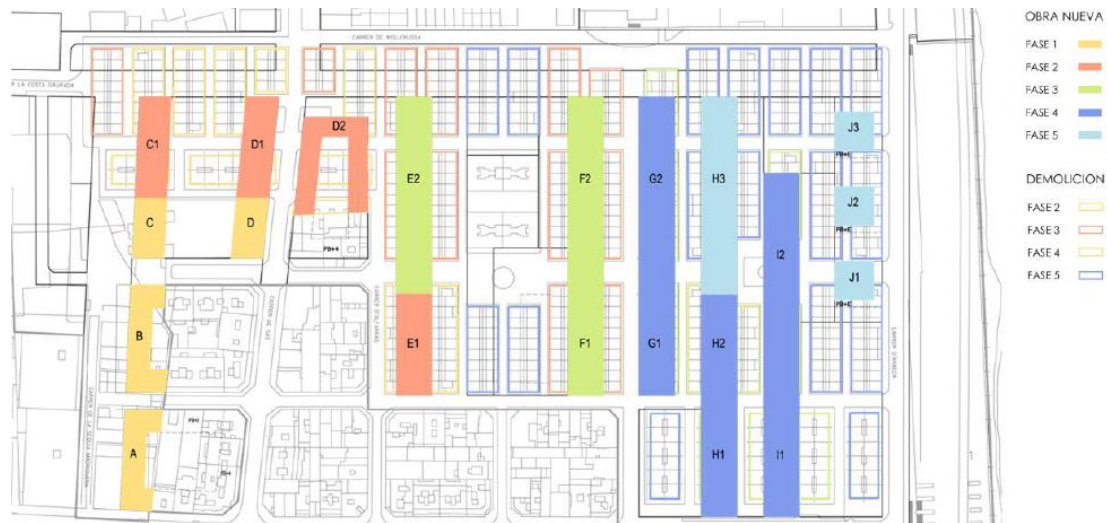


Figure 9 | Master plan for demolition of *Casas Baratas* and new residential buildings, by phases. Source: Ajuntament de Barcelona (2010)

### 3.3 Implementation of SUDS project in Bon Pastor

The idea behind this urban development was to create a giant plaza containing the residential blocks (Santamaría Concha, 2018). As stated by Soto Fernández and Perales Momparler (2017), the transition of replacing single family houses with new housing blocks sets free a large amount of area to be urbanized, that can be destined to green spaces. Therefore, the 2012-2016 SUDS project is the result of multiple interventions in the remaining space between the new buildings or the new buildings and the street.

The project aimed to collect stormwater from 22,000 m<sup>2</sup> of impermeable area into 1,400 m<sup>2</sup> of vegetation area that is able to completely absorb it (*v.i.* Figure 10). The vegetated area represents less than 10% of the total area, and can filtrate and alleviate the amount of stormwater that goes to the unitary system –because of the sandy soil of the Besòs area–. Soto Fernández and Perales Momparler (2017) explain how this project sustains the concept of circular economy since it is based on ecological principles that seek to resemble to natural processes in order to benefit from it but without damaging the environment.

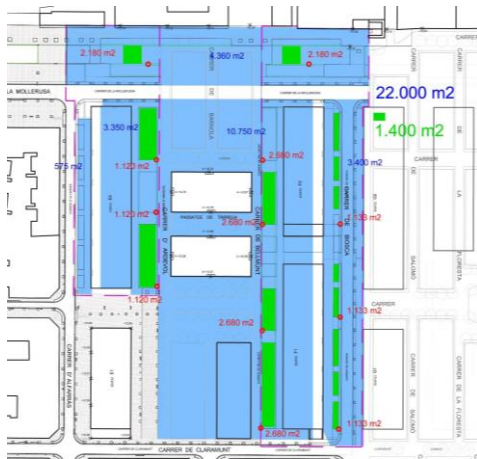


Figure 10 | Floor plan with the intervention that describes the different areas, runoff surface (blue) directed to vegetated areas (green). Source: Soto Fernández and Perales Momparler (2017)

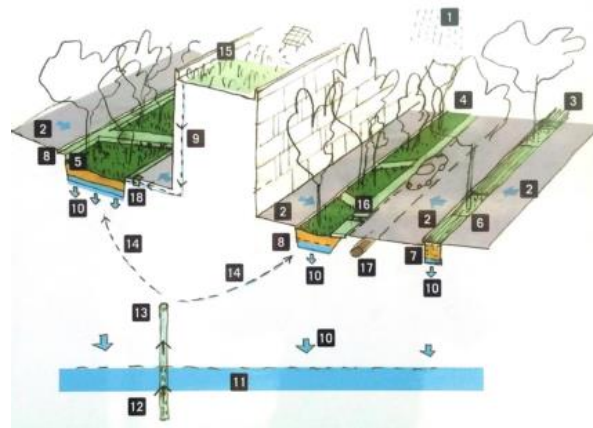


Figure 11 | Rainwater management scheme in Bon Pastor. Source: Soto Fernández and Perales Momparler (2017)

Different types of SUDS have been implemented in Bon Pastor. On the one hand, in the closed areas of the blocks and green areas, floodplains of 45 cm high were created. On the other hand, in conventional streets they opted for designing a strip of bio retention that allowed to retain water in rainfall peak hours and to treat water pollutants while being filtered. And the third option chosen was to put permeable pavements in streets and sidewalks (*ibid.*).



Figure 12 | The three different typologies of SUDS implemented. Source: Soto Fernández and Perales Momparler (2017)

#### 4. Methodology

The methodology implemented in this thesis reflects the research strategy in order to respond the three research questions presented in the introduction and is based on two actions and tools that will be described below.

#### 4.1 Review of stakeholders involved

The thesis reviewed the existing documentation of the City Council (Ajuntament de Barcelona, 2010) and private institutions (Soto Fernández and Perales Momparler, 2017 and Barcelona Cicle de l'Aigua, S.A. and Green Blue Management, 2018) in relation to this project in order to create a stakeholder map as a summary. However, the documents were not specifically focusing on the SUDS but on the cheap houses project instead, for which it was important to reinforce with interviews and incorporate the different highlighted voices that will be explained next.

#### 4.2 Semi structured interviews with governmental institutions, technicians, Bon Pastor's social organization and community

Qualitative data on perception and the relationship between stakeholders was obtained from semi structured interviews done to 10 different actors of the Government, technicians, social organization and community of Bon Pastor that were part of the SUDS planning or implementation process. The selection of each person interviewed is the result of research done towards a holistic understanding of the key stakeholders involved in the project and the availability they had to take part of the interviews<sup>15</sup> (*v.i.* Table 3).

n°	STAKEHOLDER TYPE	NAME	ROLE	DATE OF INTERVIEW
1	Government	José María Fanlo Ruiz	Councillor of Bon Pastor neighbourhood, District of Sant Andreu and member of AVV Neighborhood Association	8 <sup>th</sup> April, 2019
2	Government	Gerard Sentís Garcés	Technical Councillor of District of Sant Andreu	8 <sup>th</sup> April, 2019
3	Technical	Arch. Roberto Soto Fernández	Architect from BAGURSA, designer of project	5 <sup>th</sup> April, 2019
4	Technical	Dr. Eng. Sara Perales Momparler	CEO of Green Blue Management	15 <sup>th</sup> April, 2019
5	Neighbourhood Association	Paquita Delgado	President of AVV Neighborhood Association	2 <sup>nd</sup> May, 2019
6	Neighbourhood Association	Salvador Angosto	Member of AVV Neighborhood Association. In charge of historical memory and education	2 <sup>nd</sup> May, 2019
7	Community	Anonymous	Lived in a Cheap House, reallocated to housing blocks Lives next to SUDS. Member of AVV Neighborhood Association	2 <sup>nd</sup> May, 2019
8	Community	Anonymous	Lived in a Cheap House, reallocated to housing blocks Lives next to SUDS. Member of AVV Neighborhood Association	2 <sup>nd</sup> May, 2019
9	Community	Anonymous	Lived in a Cheap House, reallocated to housing blocks Lives next to SUDS. Member of AVV Neighborhood Association	2 <sup>nd</sup> May, 2019
10	Community	Anonymous	Lived in a Cheap House, reallocated to housing blocks Lives next to SUDS. Member of AVV Neighborhood Association	2 <sup>nd</sup> May, 2019

Table 3 | Summary of key informants interviewed. Source: Author

<sup>15</sup> The target was to have as much representatives as possible, but due to the interviewee's tight agendas, this was resumed to a small sample.

Some of the interviews were conducted in person in Barcelona, while others were done via Skype or email, during the period from 5th April to 2nd May. Face-to-face interviews were done individually or in groups, lasting approximately 60-90 min and were developed in Spanish language. The name of the interviewees is displayed publicly in this thesis with their consent and the audio of the interviews was recorded also with their positive consent. The questions used for the interviews were divided into six categories: introduction, role of stakeholder, relationship between stakeholders, perception of SUDS, outcomes of the project and future of SUDS and the neighbourhood. The 22 questions used for this part –with some few variations depending on the interviewee– can be consulted in Annex 3.

## **5. Analysis of results and discussion**

The following section presents the results and discussion of this master thesis. It is divided into three sections: the first one as a synthesis of the stakeholders involved in the project looking into their roles and relationships, the second one analyses the different perceptions towards the SUDS and the third one examines the impact this project had for them.

### **5.1 Stakeholders involved in El Bon Pastor SUDS: their roles and relationships**

Since the implementation of SUDS was part of El Bon Pastor redevelopment, numerous stakeholders were involved, which included local and regional Governmental institutions, public institutions, private companies and community. Table 4 presents a summary of all the stakeholders involved in the SUDS project and their roles. The ones in bold font were interviewed and will be the central point of the analysis, these are: the District of Sant Andreu, the neighbourhood association of Bon Pastor (henceforth AVV), BAGURSA (*Barcelona Gestió Urbanística SA*), Green Blue Management and the host community of Bon Pastor.

NAME	DESCRIPTION	ROLE IN PROJECT
Regional Government of Catalonia	Regional Government of Catalonia	Created the ACA to manage and take full responsibility of water cycle in Catalonia
City Council of Barcelona	City Council of Barcelona	Plan, implement and maintain the SUDS. Assigned by Local Government of Catalonia
<b>District of Sant Andreu</b>	District of Sant Andreu	Social support for families who were reallocated
Agència Catalana de l'Aigua (ACA)	Public company of the Generalitat de Catalonia	Responsible for the planning and management of the water cycle in accordance with the basic principles of the Water Framework Directive
Municipal Institute of Housing and Rehabilitation of Barcelona	Public entity from the City Council of Barcelona that manages housing in Barcelona	Developer of the houses and manager of the adjudication process
Municipal Institute of Parks and Gardens	Public entity from the City Council of Barcelona for the provision of services and other activities, with the basic objectives of conservation and improvement of all parks and gardens, trees and public garden planter facilities	Maintenance of parks, squares and SUDS in Bon Pastor
Barcelona Cicle d'l Aigua (BCASA)	Society created by the Ajuntament de Barcelona. It is attached to the Deputy Management of Environment and Urban Services within the Area of Ecology, Urbanism and Mobility	Manage the water cycle of the city, carry out activities and provide services related to water cycles. Developer of the new Alternative Water Resources Master Plan that will include SUDS
<b>Barcelona Gestió Urbanística SA (BAGURSA)</b>	Public company created by Ajuntament de Barcelona	Designer and developer of the SUDS Project in El Bon Pastor
<b>Green Blue Management</b>	Private engineering company hired for the project	Technical consultancy on efficient management of water
Obres i Serveis ROIG	Private construction company hired for the project	Construction of SUDS
Auding - Intraesa	Private engineering and consultant company hired for the project	Construction management and As-Built blueprints specialist
MOR Arquitectura tècnica	Private architecture firm hired for the project	Executive project editor
<b>AVV</b>	Neighborhood association of El Bon Pastor	Represent the community of Bon Pastor during all the participation process. Its association is formed by neighbours of Bon Pastor
Follow up commission	Commission created by the AVV and District of Sant Andreu	Intermediary between the neighbourhood and District. To help families during the reallocation process with legal paperwork and social support
<b>Community</b>	Community of El Bon Pastor	"Beneficiaries" of the urbanization project

● Private institutions ● Government institutions ● Public institutions (by the Gov.) ● Community (& comm. org.)

Table 4 | Summary of institutions involved in Bon Pastor SUDS. Source: Author

Several governmental institutions took part in the urbanization process, some specifically focusing on the housing renovation while others worked on urbanization and infrastructures. As mentioned previously, the stormwater management institutional structure in Spain is complex and involves multiple actors. There was a clear distinction of roles within each part involved: in terms of the administration and partnerships, the City Council hired the public



company BAGURSA<sup>16</sup> to take the lead and be the responsible of SUDS projects in the city, and Bon Pastor was one of them. However, the project was managed by *Barcelona Cicle de l'Aigua SA, BCASA* (Barcelona Water Cycle), a society created by the City Council (Saurí, and Palau-Rof, 2017). The construction company hired was a private one called *Obres i Serveis Roig*, the technical consultancy for the hydrological-hydraulic design was done by *Green Blue Management* (GBM), –a private engineering company specialized in SUDS that had previously worked at other SUDS in Spain– *Auding-Intraesa* was in charge of the construction management and As-Built blueprints, and *MOR arquitectura técnica* was the executive project editor (Ajuntament de Barcelona, 2010 and Interview #4).

In terms of community organizations, the neighbourhood association (AVV) had an important role in the urban design of public spaces where SUDS were implemented. During the interviews, the host community, the AVV, the District and the architect of the project, all agreed that the public participation was first limited to the design phase of the parks and sidewalks (Interviews #3, #5, #6, #7, #8 and #10). The SUDS project was the result of a participation approach between stakeholders where the AVV worked hand in hand with the District of Sant Andreu and BAGURSA (*v.i.* Figure 13). The president of the neighbourhood association reaffirmed this critical interaction between AVV, the district and BAGURSA:

"The AVV was constantly meeting with them [BAGURSA and the District]. Every time something new was proposed, we would supervise it to make sure it was achieved. The negotiations were held in parallel to the execution. The engineers and architects saw it from their perspective, and we saw it under the context where we live, knowing better whether it could work or not. It was also important to be flexible. Agreements were reached, but under several conditions we asked for, and they have been fulfilled."  
(Interview #5)

The fact that the community of Bon Pastor was well positioned for debating is aligned with several theories presented previously in this thesis, that look into how local communities gain importance on the planning process of SUDS (Brown 2005, Dhahlenburg, et al., 2009, Newman and Mouritz, 1996, Perales Momparler 2015, and Van De Meene, 2011). As explained by the Councillor of Bon Pastor (interview #1), BAGURSA had been working together with the AVV

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<sup>16</sup> BAGURSA has implemented numerous SUDS –90% of the ones in Barcelona– as part of urban development transformations after the Integrated Sewerage Plan of Barcelona of 2006 (Fundación del Congreso Nacional del Medio Ambiente, 2018, Saurí and Palau-Rof, 2017). However, it has ceased its contract with the municipality in January 2018 and its responsibilities are now part of the Municipal Institute of Housing and Rehabilitation of Barcelona and the Municipal Urban Institute.

since the first phase, which created a fluent communication for the following phases. The constant dialogue between the public administration and institutions and the AVV enabled the community to gain importance in the project. Teams from BAGURSA, AVV and the District were meeting weekly to discuss the design and if any of the parts involved could not attend, the meeting was rescheduled. Contrary, as stated by the representative of Green Blue Management (GMB) other stakeholders such as GMB and the architecture firm MOR were only consulted for particular issues and were not part of the regular meetings (Interview #4). Compared to traditional drainage systems, the local scale of SUDS allowed this new type of participation which may resemble to the hybrid structure posed by Van de Meene, et al. (2011) where water cycle's power structures are redefined. In this sense, SUDS allowed the community stakeholder (AVV) to have an important say over the local water cycle in Bon Pastor and particularly, the Councillor of the neighbourhood was in a privileged position of negotiation –as he could reach the City Council straightforward– by being not only the Councillor but also an active member of the AVV.

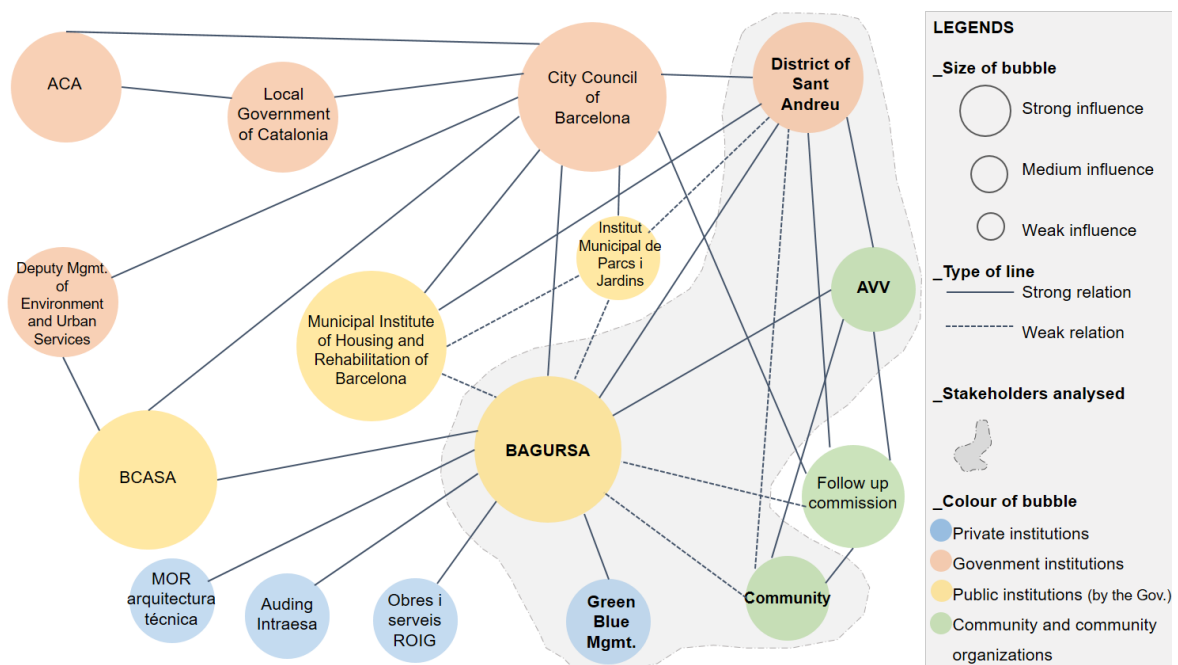


Figure 13 | Stakeholders map of Bon Pastor SUDS. Source: Author

While there was a clear distinction of roles during the implementation of SUDS, nowadays it is blurry who should be in charge the maintenance of the SUDS. This fact, contradicts what has been previously theorized by Brown (2005) in the sense that SUDS might become a solution towards institutional overlapping and lack of clear roles compared to traditional ways of managing stormwater. In Bon Pastor's context, at first maintenance was done by BAGURSA when several bushes and plants of the park got destroyed and the company replanted them again. Afterwards GMB was asked to elaborate a plan of the maintenance (Interview #4). To

date, the Municipal Institute of Parks and Gardens (*Institut Municipal de Parcs i Jardins*) is the one maintaining the vegetation and green covers of SUDS, but the District of Sant Andreu and the AVV are looking forward to share this responsibility with people, for them to appropriate it and take care of. Some members of the community remark that this issue was already discussed and warned to BAGURSA and the District from the very beginning, since they argued that the new green urbanization demanded new responsibilities of care of the public space. Therefore, the community reached the AVV to insist in the maintenance:

“Cleaning once a week the gardens was clearly not enough. We have been persistent with the authorities on the cleaning. When you see that a public space is being taken care of, it creates a snowball effect and people will follow that behavior.” (Interview #7)

Creating consciousness and educating on sustainable habits is one of the priorities of the AVV, community and District nowadays. Several issues have aroused about the maintenance and preservation of the green spaces of SUDS. They believe that the system is well designed, but it may fail for maintenance, not because the administration is not being responsible, but because of uncivil behaviors among the community that have damaged the gardens repeatedly. This minority who is damaging the SUDS might not be aware of the benefits the system brings to the neighborhood as a common good, as stated by a member of the community (Interview #10).

The SUDS project in El Bon Pastor was an example of participation among different stakeholders under their own principles and capacity. The good level of cooperation among them allowed the community to have a strong influence in the negotiation of the design and maintenance. Some actors were more familiar with SUDS than others –as they have been working on them for the past two decades while the community and neighbourhood association had a basic idea of them– and therefore the concept evolved differently for each of them through the project.

## **5.2 Stakeholder’s perceptions of SUDS**

Once explained the choreography of actors over the development and maintenance of SUDS in El Bon Pastor, now the thesis aims to elucidate the diverse understandings of what SUDS meant to those actors. This concurs with what Cettner et al. (2017) and Brown and Farrelly (2009) expose on the multiple perspective around SUDS by different stakeholders. In what follows, this section discuss the results of the interviews on SUDS done to the different actors. First and foremost, it is vital to stress the clear distinction between the actors with technical

knowledge on SUDS (*viz.* interview #2, #3 and #4) and the other stakeholders (*viz.* interview #1, #5, #6, #7, #8, #9 and #10).

Technicians such as the architect of BAGURSA and the CEO of GBM were aware that SUDS in Spain are increasing in number and popularity mainly because the traditional drainage systems have proved inefficient to manage stormwater over the past years (interviews #3 and #4). They also claim that as SUDS gained importance over the last decade since they tackle issues among popular debate, such as environmental protection and climate change. The architect of BAGURSA started working with SUDS in 2001 in Spain and this experience allowed him to improve the system and learn from the first ones. On the other hand, the CEO of GBM started working with SUDS in 2002 in the UK and became instantly interested on applying these in Spain by creating the company GMB<sup>17</sup>.

Contrary, for both the AVV and the community, the knowledge about SUDS was limited to Bon Pastor's project, as it was the first one to which they –and the District– were related to. While it is true that they have been already looking into ways of implementing green roofs, they never thought this idea would fit with the neighbourhood profile, until the technicians designed a first draft and explained to them that Bon Pastor environmental characteristics would benefit SUDS. The AVV claimed it was “very innovative” (interview #5), as it provided the opportunity of reusing rain water while beautifying the urban space. Other neighbour explained:

“We [community of Bon Pastor] had been talking about green roofs for a long time and we had seen systems like this in places outside of Barcelona, but we never thought that it could be developed here in Bon Pastor...not because we did not have the elements to enable its construction, but just because it was not a priority issue. When the technicians raised the whole issue of ecology, sustainability and energy recovery, we understood that this did not have to remain only in the execution but had to reach the schools and the community.” (Interview #6)

This quote reflects on SUDS as something relatively new for the neighborhood, mainly because in the past this was not a priority to the community. This point is raised in the second part of this thesis, described as the lack of interest of citizens for stormwater management issues (Carlson, et al., 2015). In this case numerous interviewees agreed about it, since the neighbours were more concerned with what the future held for their housing situation. Thus

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<sup>17</sup> The company GBM (Green Blue Management) is specialized in SUDS and was first founded under the name *PMEnginyeria* by Dr. Eing. Sara Perales. It was one of the first companies to introduce SUDS in Spain.

as stated by the Technical Councillor of the District of Sant Andreu, the neighbourhood has had urgent priorities like the housing situation for the past years, and the debate was always around it. It was when the first phases were finished that institutions and community started to think about urban infrastructure combined with sustainable solutions such as the SUDS.

However, the AVV argued that the system seemed to interest more academia and practitioners than citizens as people simply use these spaces as regular squares or parks, without being conscious of their function as SUDS and only a small portion might be intrigued on how they actually work. While members of the AVV knew from the very beginning how the system worked, many of the inhabitants who did not have direct connection with AVV had the opportunity to learn from informative panels created by GMB and BAGURSA that were installed in the parks and streets. However, most of the times it was students from schools and universities the ones reading the panels (Interview #4). (v.i. Figure 14)

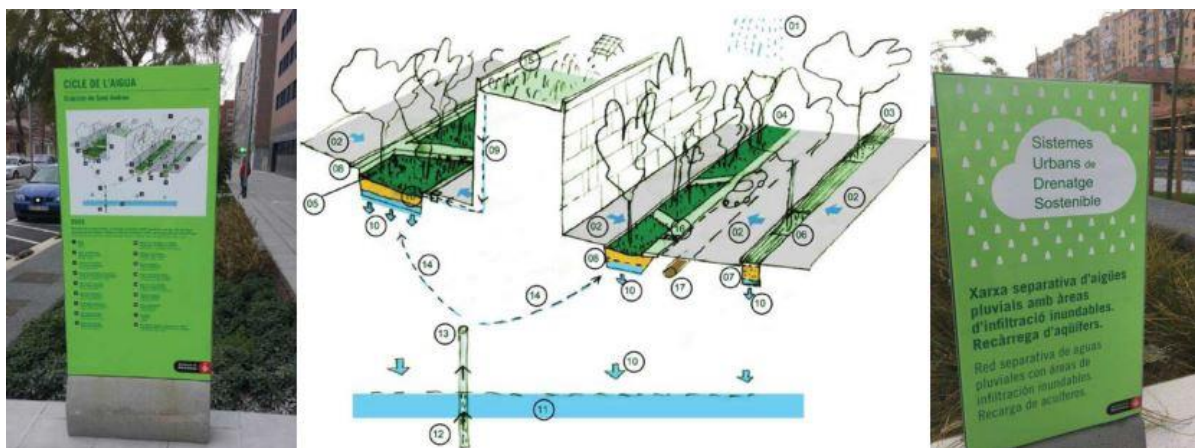


Figure 14 | Informative panels installed in Bon Pastor. Source: Soto Fernández and Perales Momparler (2017)

Other stakeholders like the Councillor of the Neighbourhood believe that since it has been part of a complex urban regeneration process, not all the community supported the idea: “Some groups were not interested in participating in the SUDS project, simply because it was part of the cheap houses project” (Interview #1). This interpretation was not shared by the AVV education responsible, who sees it as something completely different. He argued that despite being true that the cheap houses project created tensions among inhabitants<sup>18</sup>, the SUDS project is now part of an urban area of the neighborhood that is used by all inhabitants,

<sup>18</sup> The AVV decided to support the urban renovation project only if in the referendum -created by the City Council in 2003-, more than 70% of votes were positive. More than 70% agreed and the AVV backed this plan creating along with the District a follow up commission in order to mediate between the administration and the neighbours (Ajuntament de Barcelona, 2010). This commission helped dwellers with paperwork during the reallocation process. The AVIS did not supported this decision.

regardless if it belonged to the main project of cheap houses or not. This type of massive open space in the past did not exist, as the cheap houses sidewalks had 80cm and there was no space left in-between houses. Today, everyone –those who moved to the new blocks and those who did not– can enjoy the open space freely (Interview #6).

Interestingly the term used to refer to SUDS by technicians and government actors was “SUDS” (interviews #1, #2, #3 and #4), but in the interviews with the AVV and the community these two referred to SUDS as the “landscaping/gardening project” (interviews #5, #6, #7, #8, #9 and #10). Since they were directly linked to the design of the urban parks and sidewalks, both the AVV and the community saw it as a holistic urban design that provided extra benefits. When asked about what a SUDS was, the community and AVV emphasized how these gardens have the capacity to reuse stormwater to water its plants, which is vital for Mediterranean climates during the dry periods. By the same token, members of the District, the CEO and civil engineer of GBM and the architect of BAGURSA describe SUDS as urban elements that manage stormwater as a resource and not as a waste product, promoting the multi-use of urban areas (interviews #3 and #4). It can be seen from above analysis that Bon Pastor is following the principles of a ‘water sensitive city’ (Brown and Farrelly, 2009). And, despite the fact that Brown and Farrelly (2009) argue that ‘water sensitive city’ does not exist yet, Bon Pastor fits the category of an “adaptive, multi-functional infrastructure and urban design reinforcing water sensitive behaviours.” (p.850)

As seen in this section, there are diverse perceptions of SUDS as a new way of managing stormwater and also as an articulator of the urban spaces, depending on the nature of each stakeholder. This can also be observed in the way different actors explain the impact it had to them, exposing what was the benefit they prioritized, the things they would change and the take away from this practice.

### **5.3 Impacts of the project to the different stakeholders**

The thesis has already exposed the relationships between stakeholders, their roles and perceptions of SUDS in Bon Pastor. But, an equally significant aspect of SUDS is the benefits they can offer to the actors involved, which can unveil some differences among them. During the interviews, some of the actors described it from a practical and hydrological perspective, but others emphasised the social and ecological impacts it brought to the neighbourhood and how this project influenced to look for new sustainable horizons.

The positive impacts of SUDS in terms of controlling quality and quantity of runoff water in Barcelona –as recognized by the technical actors– are aligned with what the positive benefits

of SUDS in other contexts are (CONAMA, 2018 and Woods-Ballard, et al., 2007). The architect from BAGURSA and the civil engineer from GMB highlighted in their interviews the results of the SUDS project in this technical way. The CEO of GBM stated: “we focused on the hydrological and environmental aspects, but we coordinated with other stakeholders further aspects. Our objective was related to stormwater quantity and quality.” (Interview #4)

Evidence in supporting this position, can be found in the article written by both –the CEO of GMB and the architect from BAGURSA– where they explain the quantity results of the project. They measured these with a hydrological-hydraulic modelling software in order to evaluate reception centres that could “capture, retain and evacuate (by evaporation, evapotranspiration and infiltration to the ground) processes in less than 48 hours the volume of water associated with the 80th percentile storm, which in the case of Barcelona is 15 mm” (Soto Fernández and Perales Momparler, 2017, p.6)<sup>19</sup> The results have shown that 99.9% of the stormwater gets infiltrated, while only a 0.01% reach the traditional drainage system and that there is a reduction of the peak water flows of an 85%. During the interview, the architect from BAGURSA focused on the success of it after the flashfloods of October 2018, where the system worked perfectly and none of the streets got flooded. Members of the community and the District (interview #1, #6, #8, #9, #10) also highlighted how October 2018 was the ultimate test for the SUDS, but they see the success of SUDS more linked to the housing situation. This vision is captured by the Councillor of Bon Pastor neighbourhood:

“Previously, there were numerous humidity problems in the cheap houses. Some streets had drainage collectors, while others did not and this caused flooding in several areas. Some neighbors were very affected by this, as the entrance to their house was flooded and needed to sweep the water somewhere else.” (Interview #1)

Nevertheless it also brought environmental and social benefits such as the multi-use of public spaces, the decrease of the "heat island" effect, and the contribution to the recharge of the underlying aquifer, among others (Soto Fernández and Perales Momparler, 2017). It brought responses at social level as nowadays the community represented by the AVV is more committed to sustainability issues and is standing up to implement numerous sustainability projects that contribute to the SUDS network (Interview #7). This concept was presented previously on this thesis, with the author Perales Momparler (2015), where she suggested that SUDS may be a trigger for people to become motivated to take care of the environment. Some

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<sup>19</sup> Citation translated from Spanish into English by author Andrea Nóbrega. Original version in Spanish can be found in (Soto Fernández and Perales Momparler, 2017, p.6)

of these projects are the industrial polygon and the Zero Waste project in Barcelona (*Residu Zero*)<sup>20</sup>, being the first neighbourhood of the city to apply it, as a pilot project. Also the Rubió i Tudurí Institute (*Institut Rubió i Tudurí*)<sup>21</sup> will be relocated in the neighbourhood and will develop research on the most suitable vegetation of their SUDS, by petition of the AVV.

The reurbanization of Bon Pastor also influenced the relationships between stakeholders, as argued by the Technical Councilor of the District of Sant Andreu: “This project of SUDS boosted the relationship between Bon Pastor, the District of Sant Andreu, BAGURSA and the City Council. It has smoothen the path for other participatory projects that the three of us are working together nowadays” (Interview #2). However, the engineering consultant company (GMB) nowadays has lost contact with the other stakeholders involved in the project and might only be contacted for technical support of future SUDS (Interview #4).

For the design of the green spaces on the 4th phase, the AVV has been participating in the digital participation platform of Barcelona’s Local Council: We Decide Barcelona (*Decidim Barcelona*)<sup>22</sup> that aims to take into account everyone’s voice. As the 4th phase will generate greater changes at the urban scale, the neighbours of the AVV have expressed which open spaces they want, for which uses and how to urbanize them. In this sense, as the Technical Councillor of the District of Sant Andreu argues, “the SUDS concept emerges again in this phase, but more critically, looking into new improvements. SUDS have now a value of getting back the green to the city.” (Interview #2) The president of the AVV recognizes that at first they were still reluctant to design again big open spaces like the ones of the 3<sup>rd</sup> phase, as it took some time for inhabitants of Bon Pastor to become familiar with them. However, with time neighbours incorporated this new morphology and started asking for more green, as the president of the AVV recognized: “We became aware of the importance of green, not only for the landscaping benefits but also because it is good for our health” (Interview #5). Indeed, some of the proposals of this phase are to build a Botanic Garden –that reuse the water from

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<sup>20</sup> *Residu Zero* is a project held by the City Council of Barcelona that aims for the prevention, segregation and reduction of waste generation with the purpose of reusing and recycling, following the circular economy principles. The project was first implemented in Barcelona on the 8<sup>th</sup> of April, 2019, in Bon Pastor.

<sup>21</sup> The *Institut Rubió i Tudurí* is an education institution that provides professional training in the fields of gardening, landscape and the natural environment. It offers the studies in Garden and Nursery Assistant, Gardening and floristry, Forest management and natural environment and Landscaping and rural environment. It is currently located in Montjuic but will be reallocated and reopened by the beginning of 2020 in Bon Pastor.

<sup>22</sup> *Decidim Barcelona* is a participatory digital platform created by the City Council of Barcelona that aims to create a more democratic city. In this platform, urbanization issues are discussed following a participation approach between community and the public/private sector (see [www.decidim.barcelona](http://www.decidim.barcelona)).



SUDS to water the plants– or a new green park that links the neighbourhood to the river (Interview #2).

In this way, the District of Sant Andreu is looking forward to implement circular economy concepts in terms of waste management, runoff water, water supply, green rooftops, *inter alia*. The civil engineer of GMB recognizes that Bon Pastor became one of the pioneers and benchmark of SUDS in Spain, and looks forward for it to continue in this path of sustainability. In order to do so, she argues that what is needed is a campaign to monitor these operations and collect data on required maintenance. Other actors believe that the main challenges towards this network of sustainable practices are related to creating civil consciousness, as stated by the architect of BAGURSA (interview #3) and some members of the community (interviews #8 and #9) who believe that incivility from a small portion of the neighbourhood is slowing down the integration of sustainable practices in Bon Pastor.

This latter one is the main challenge for the next 15 years, according to the technical Councillor of the District of San Andreu (Interview #2), and the AVV is highly committed to continue with sustainability and ecological projects in the neighbourhood, regardless of which party is in the Government (Interview #6). The AVV is working hard to create civic consciousness among community:

“Today the AVV is very focused on creating awareness of citizenship, and in that line we talk about sustainability in terms of reusing and recycling resources. We are conscious that we are damaging the Earth, and even though we might not see it, we want to conserve our neighbourhood in the best conditions for our future generations.”  
(Interview #5)

While the issue of incivility can slow the process towards carrying out more sustainable practices, the reality is that the vast majority of the community is engaged to see improvements in the place they belong to. Moreover, the government institutions and private sector have already proved the potential the neighbourhood has and are interested in promoting it.

## 6. Conclusion

This thesis navigates through the topic of SUDS as a relatively new sustainable alternative and complement to the traditional drainage systems that resulted to be inefficient when managing stormwater (Brown, 2005, Elliott and Trowsdale, 2007 and Perales Momparler, 2015). However, SUDS discourse often remains technical and elaborates on the hydrological, landscape, environmental, urban and economic benefits it has, relegating into the background the social ones. This thesis aim is to look specifically into it by analysing the stakeholders involved in SUDS, their roles and relationships, the different perceptions among them and its impact.

In order to achieve this, the thesis elaborated an empirical analysis and presented several discussions related to the conceptual framework. Firstly, in terms of the new implications at the governance structure, it was demonstrated that the case of Bon Pastor has touch points with the hybrid governance system presented by Van de Meene, et al. (2011). As a local scale approach, social organizations and community were involved before during and after the project was implemented. By a long negotiation process, people had a say in this topic, which with conventional drainage systems might have been impossible (Brown 2005, Dhahlenburg, et al., 2009, Newman and Mouritz, 1996, Perales Momparler 2015, and Van De Meene, 2011). While in a first instance their participation was limited to the design phase of the urbanization, afterwards they became more involved in the maintenance and are actually willing to replicate more of them. Secondly, the thesis reflected on how the term SUDS may present ambiguity among the stakeholders (Brown, et al., 2009). While the neighbors and community organization referred to SUDS as “landscape or gardens”, highlighting the urban benefits it provided, the technical sector used the term “SUDS” and explained the technical improvements it brought to the neighborhood. For the community, AVV and District, SUDS was a not a totally new concept, but never imagined it may fit the neighborhood profile. For technicians, the hydrological and environmental aspects of the system fitted perfectly in the area. And thirdly, it was evident that stormwater management was not a priority for the community of Bon Pastor inhabitants as they were more focused on housing. This was aligned to what is stated by Carlson (2015) in the second section of the thesis, having SUDS a low level of interest among community. Nevertheless, SUDS gradually brought social benefits which created sustainability consciousness among inhabitants who now see the importance of reusing water and are looking forward to create a sustainable network of urban infrastructures.

Having considered these findings, it is also reasonable to look into the policy implications they bring. While the case of Bon Pastor resulted positive in different ways, the main criticism relies on the fact that who is responsible the maintenance of the SUDS was never clear. Not only special effort should be put into the government institutions in order to maintain the gardens, but also to educate inhabitants about how the systems work any why it is necessary to take care of them. It is important to note, however, that SUDS concept is still unfamiliar to many, and prioritizing the social value of SUDS in technical literature and government campaigns is fundamental to attract the general public. By doing so, individuals and communities can start getting related and become more active towards the 'total water cycle' (Brown and Farrelly, 2009).

However, it should be mentioned that the limitations of the thesis were mainly resources and timing constrains, which meant that only a small sample of interviewees were reached and willing to participate. Further research should be done in order to enlarge the scope of stakeholders and understand the visions of a larger group of inhabitants, not only those who supported the construction of SUDS but also those who lack of interest on them. It would also be enriching to approach and incorporate the voice of other Government institutions –such as the ACA and BCASA– that are interested in developing more of these systems in the city.

While focusing only in a small portion of the stakeholders involved, it is important to highlight that this thesis has demonstrated how several patterns in the conceptual framework of SUDS were observed in Bon Pastor's situation. Based on the results of this study, SUDS have proved to be more than a technical solution to manage stormwater. Nowadays Bon Pastor is not only following the 'water sensitive city' principles (Brown, et al., 2009), but is also creating a sustainable network based on behavioural changes.

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## Annex 1: SUDS Components

Component	Description	Example
<b>Filter strips</b>	These are wide, gently sloping areas of grass or other dense vegetation that treat runoff from adjacent impermeable areas.	
<b>Swales</b>	Swales are broad, shallow channels covered by grass or other suitable vegetation. They are designed to convey and/or store runoff, and can infiltrate the water into the ground (if ground conditions allow).	
<b>Infiltration basins</b>	Infiltration basins are depressions in the surface that are designed to store runoff and infiltrate the water to the ground. They may also be landscaped to provide aesthetic and amenity value.	
<b>Wet ponds</b>	Wet ponds are basins that have a permanent pool of water for water quality treatment. They provide temporary storage for additional storm runoff above the permanent water level. Wet ponds may provide amenity and wildlife benefits.	
<b>Extended detention basins</b>	Extended detention basins are normally dry, though they may have small permanent pools at the inlet and outlet. They are designed to detain a certain volume of runoff as well as providing water quality treatment.	

Component	Description	Example
<b>Constructed wetlands</b>	Constructed wetlands are ponds with shallow areas and wetland vegetation to improve pollutant removal and enhance wildlife habitat.	
<b>Filter drains and perforated pipes</b>	Filter drains are trenches that are filled with permeable material. Surface water from the edge of paved areas flows into the trenches, is filtered and conveyed to other parts of the site. A slotted or perforated pipe may be built into the base of the trench to collect and convey the water.	
<b>Infiltration devices</b>	Infiltration devices temporarily store runoff from a development and allow it to percolate into the ground.	
<b>Pervious surfaces</b>	Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water.	
<b>Green roofs</b>	Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation.	

SUDS Components. Source: Woods-Ballard, et al. (2007)

## Annex 2: Evolution of Barcelona towards flood risk management

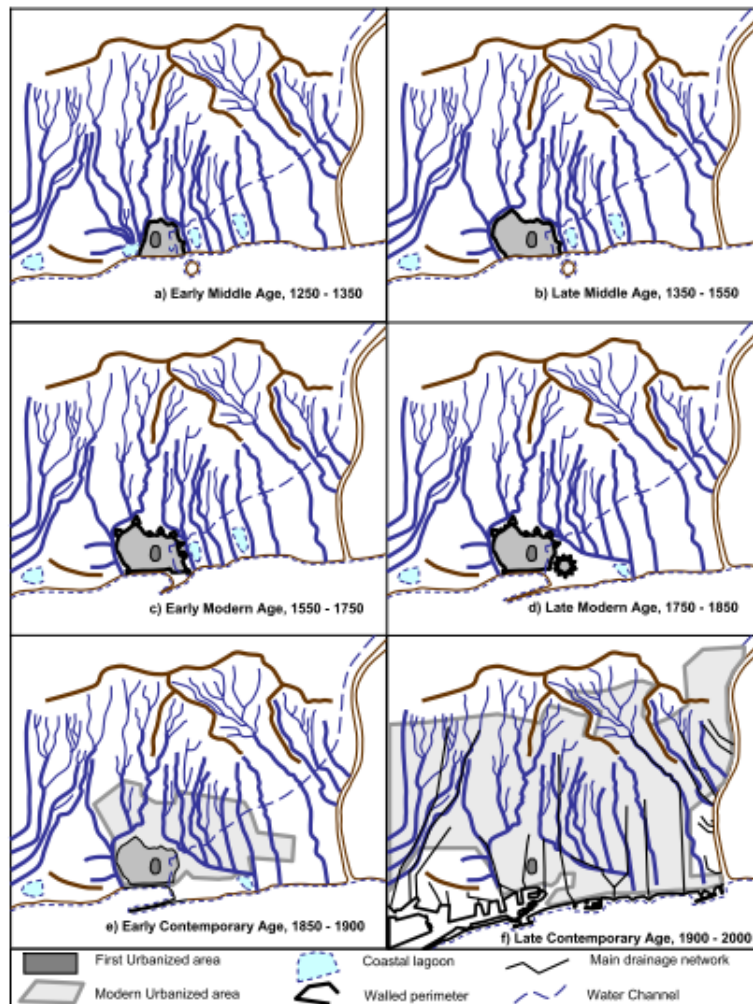


Figure 1 | Barcelona city evolution from the 14th century to the present. Source: Barrera, Barriendos and Llasat (2005)

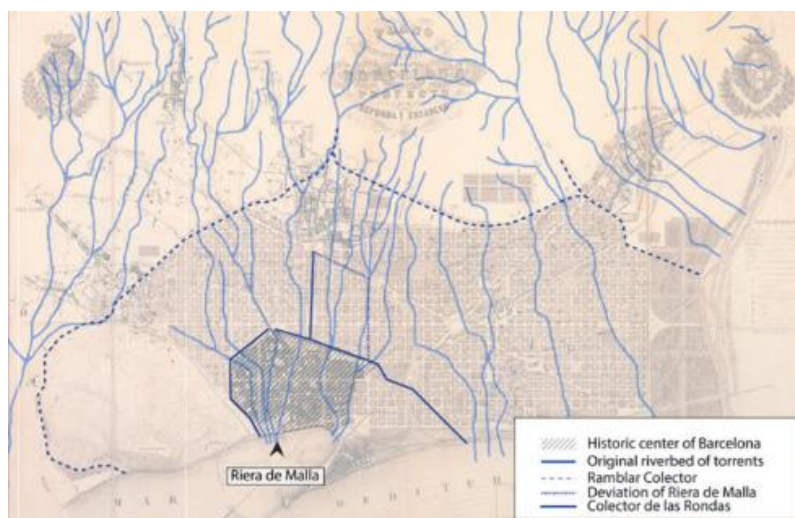


Figure 2 | Localization of three Projects of Plan Cerdà: Ramblar Colector, Colector de las Rondas and Deviation of Riera Malla. Source: Chellini and Favaro (2018)

## **Annex 3: Semi structured interview guide**

Fecha:

Nombre de la persona entrevistada (si corresponde, o nombre de la organización):

(G)= Preguntas sólo para el gobierno

(T)= Preguntas sólo para parte técnica

(OVC)= Preguntas sólo para organizaciones vecinales y comunidad

### **1- Introducción**

- a) ¿Cuándo fue la primera vez que tu organización estuvo involucrada en un proyecto de SUDS?
- b) ¿Cómo explicarías qué es un SUDS a alguien que no conoce el concepto?
- c) ¿Detectas un auge de los SUDS en los últimos 5 años? ¿Cuál crees que es el motivo principal de este auge; o si no, ¿por qué no)? (G+T)

### **2- Rol de la parte interesada (G+T)**

- a) ¿Por qué comenzaron a interesar los SUDS a tu organización? (G+T)
- b) ¿Cuál fue el rol de tu organización en este proyecto de drenaje sostenible?
- c) ¿Cuál fue el objetivo que tu grupo tuvo con la implementación del proyecto en Bon Pastor en relación a los beneficios que éstos proporcionan? ¿Dirías que fueron hidrológicos, ambientales, sociales, urbanísticos y/o económicos? (G+T)
- d) ¿Te parece que se ha/n logrado? (G+T)
- e) ¿Han cambiado los objetivos de implementación de SUDS en tu grupo hoy en día en otros proyectos? (G+T)

### **3- Relación de las partes interesadas**

- a) ¿Podrías decirme quienes son las otras partes involucradas en este SUDS?
- b) ¿Crees que ha habido un buen nivel de cooperación entre todos?
- c) ¿Por qué sí/no?
- d) ¿Dirías que ha habido participación por parte de la comunidad previo, durante, luego del proyecto o que no lo ha habido por completo?
- e) ¿Por qué crees que ha habido / no ha habido participación?
- f) En caso positivo: ¿Cómo ha sido esta participación?

### **4- Percepción de los SUDS**

- a) ¿Crees que este proyecto ha sido una solución efectiva para gestionar las aguas de lluvia?
- b) ¿Cómo fue la respuesta de estos SUDS con las intensas lluvias en otoño (Octubre) del 2018?
- c) Si tuvieras que hacer un balance, ¿dirías que este proyecto resultó positivo o negativo para el barrio?
- d) ¿Te parece que al formar parte del proyecto de casas baratas perjudicó la percepción que tienen los residentes de Bon Pastor sobre los SUDS?
- e) ¿Crees que el sistema de drenaje fue recibido positivamente por los vecinos?

### **5- Resultados del proyecto**

- a) Una vez finalizado el proyecto. ¿Éste ha influenciado en la relación que tiene tu organización con las otras partes involucradas en el proyecto (el gobierno, la parte técnica, o las organizaciones vecinales)? ¿Han trabajado de nuevo juntos?
- b) ¿Ha causado este proyecto que tu organización se interese en otros temas no relativos a tu ámbito? (OVC)
- c) ¿Crees que a raíz de este proyecto la imagen del barrio cambió? (OVC)
- d) ¿Cambiarías algo de este SUDS implementado?

### **6- Futuro de los SUDS y el barrio**

- a) ¿Tu organización sigue involucrada de alguna manera en este proyecto hoy en día? Ej. mantenimiento, mejoras, etc.
- b) ¿Crees que la implementación del proyecto trajo cambios a nivel social dentro del barrio? Ej. el interés por cubiertas vegetadas
- c) ¿Cuáles son para ti las principales barreras que presenta el barrio para la integración de otras prácticas sostenibles?
- d) ¿Cómo te imaginas el barrio dentro de 15 años en términos de sostenibilidad urbana?