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Community Involvement in the Implementation of Sustainable Urban Drainage Systems (SUDS): The Case of Bon Pastor, Barcelona

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Abstract: The persistence of urban floods and the inability of aging sewage infrastructure to deal with stormwater make sustainable urban drainage systems (SUDS) one of the emerging paradigms in urban water management, in which stormwater is no longer a hazard but a resource. Although most of the global research has been done on the technical aspects of SUDS, their social impacts are not always taken into consideration. The neighborhood scale that characterizes SUDS creates a different governance system—compared to the old structures of flood risk management—characterized by decentralization practices and where communities gain a better position of negotiation and new responsibilities. The objective of this research is to recognize how the diverse stakeholders involved in SUDS interact with each other and to look into the different levels of understanding SUDS as a new alternative of stormwater infrastructure. In order to accomplish this task, the paper introduces the case of the neighborhood of Bon Pastor (Barcelona, Spain), which has gone through urban transformations over the past years, promoting the development of SUDS in 2012. Empirical evidence was obtained from 10 semi-structured interviews with government, technicians, social organizations, and local community citizens as well as revision of existing policy documents and grey literature on SUDS and historical documents on the development of the neighborhood. The results show how active the community was during the design process and afterward, as sustainability gradually became one of the main topics in the neighborhood to be incorporated in new developments. However, it also unveiled several issues related to maintenance and the ambiguity of the term SUDS for the different stakeholders involved.

Keywords: sustainable urban drainage system; urban stormwater management; community participation; stakeholders perception; Barcelona

1. Introduction

Flash floods are increasing worldwide and continue to be a latent issue in Mediterranean cities, such as Barcelona (Spain), since its existing drainage infrastructure often experiences difficulties during some stormwater episodes [1,2]. Because of its land use, topography, and especially extreme precipitation events, Barcelona remains vulnerable to floods [1–3], regardless of numerous improvements in the conventional drainage system of the city [2,4]. From different disciplines, researchers and practitioners are approaching this matter by defining a new paradigm that essentially consists in moving from flood defense to flood management [4–10] as a way of incorporating water as a resource in urban

development. Under this framework, sustainable urban drainage systems (SUDSs) are an alternative approach to manage stormwater retention efficiently. 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 [Wastewater Treatment Plant], reduce the solid trawls, and discharge water to the reception center without any treatment. Thus, SUDS are aligned with the three basic axes of sustainability: economy, environment and society” [11] (p. 6) (our translation).

This paper aims to contribute to the existing literature on flood risk and urban stormwater management, specifically looking into SUDSs as an alternative in flood management with the potential to involve communities in more sustainable actions. So far, most of the research has been done around the technical aspects and qualities of SUDS [4,8,9,12], but the implications in terms of governance derived from these practices and how the different stakeholders respond to them are not always taken into consideration. The premise of this research is that communities are better positioned for negotiation and gain new responsibilities compared to the traditional drainage works, due to the fact that SUDSs are decentralized systems located at a neighborhood scale [13–17]. The paper also hypothesizes that, even though SUDSs might be unknown among the general public [6], the social benefits they provide may create sustainable behaviors among citizens [12]. When this becomes visible, it breeds particular interest towards SUDS [18,19].

The objective of this research was to understand how different local stakeholders involved in the implementation and management of SUDS interact with each other and to discern the different levels of understanding SUDSs as a new alternative of stormwater infrastructure. The study aimed to achieve this objective by answering the following research questions:

- (i) What are the different discourses on SUDSs by the main actors involved in their governance?
- (ii) What is the role of host communities in these projects?
- (iii) What are the perceived social impacts of SUDSs?

The paper answers those questions by empirically analyzing the implementation of SUDS in the Barcelona neighborhood of El Bon Pastor. Barcelona has embraced the use of SUDSs in several urban projects [20–23]. The development of SUDS in this area was analyzed through qualitative research, consisting of semi-structured interviews with key stakeholders involved in the project, and from different perspectives: Governmental, technical, social, and also that of the community groups.

2. Conceptual Framework

2.1. A New Paradigm in Urban Water Management

For the past two decades, SUDS have become widely known when referring to urban runoff management because of the benefits they bring to the environment and quality of life in cities against low development impacts [2,9,24,25]. SUDS are defined as surface water drainage systems inspired in the concept of sustainable development able to mitigate numerous adverse effects of urban stormwater runoff in cities [25].

It is vital to understand first how and why a new paradigm in urban water management (UWM) influencing stormwater management was created. According to Brown et al. [26], through the example of Australia, there has been a transition from a ‘water supply city’ to a ‘water-sensitive city’, the latter characterized by the existence of adaptive and multi-functional infrastructure as well as an urban design that reinforces water-sensitive behaviors while pursuing intergenerational equity and resilience to climate change [5]. However, the authors understand that such an example does not exist yet, other than as a future goal for many scientists, practitioners, and governments. The water-sensitive stage is driven by integrating ecological equity and preparing the communities to face climate change. Moreover, in order to achieve this objective, significant institutional, economic, technical, and social behavioral changes should take place for the redevelopment of water management towards a more holistic system of water as a ‘total water cycle’ [26,27].

This idea is also supported by Perales Momparler [18], Carlson et al. [6], and Zhou [9] but from another perspective, since they analyze stormwater as an isolated subject, highlighting how it used to be considered as something to “get rid of” while in the new paradigm, it is conceived of as a resource. For the past centuries, rapid urbanization and soil sealing has led to an increase of urban floods. Therefore, solutions saw stormwater as a threat that needed to be tackled fast. Flood risk management is shifting its attention from “keeping flood water out to a more strategic, holistic, and long-term approach characterized by mitigating both flood risk and adaptation, or increasing resilience to flooding events” [7] (p. 1). It is against this backdrop that SUDSs have emerged.

2.2. SUDS: Objectives and Benefits

The increase of floods and especially flash floods worldwide and the traditional way of managing stormwater implied the decline in water quality and stream habitats, and the increase in stream erosion and potential for falling base flows [28]. Moreover, traditional drainage systems may cause overflows and pollution [9,18]. As highlighted in the previous section, the main objective of flood risk management used to be to keep water out of the city, so that it caused the minimum harm possible. In contrast with conventional drainage prioritizing quantity over water quality, SUDSs aim to create multi-functional systems, achieving an equal balance of water quantity, water quality, and biodiversity [9,24,27,29,30]. These three areas take into account the effects of climate change against which new resource management actions and climate mitigation and adaptation actions need to be developed.

The objective of SUDSs is to “reduce runoff by integrating stormwater controls throughout the site in small, discrete units” [25] (p. 1), fostering decentralization processes [9,27,31,32]. According to the Spanish National Congress Environment Foundation, CONAMA [11], SUDS are based on hydrological processes widely present before urbanization (*viz.* infiltration, filtration, storage, lamination, and evapotranspiration). These processes of runoff modification are incorporated into the existing environment. “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’ [33] in which society takes account of the behaviour of water, rather than water’s behaviour having to change for the sake of society” [24] (p. 4).

The main benefits of applying these systems are twofold. First, they provide quality and quantity control of runoff water and, second, they offer other environmental and positive impacts [12,29,30,32]. However, since SUDS convey a more holistic and sustainable way of managing stormwater, their benefits extend not only to hydrological, environmental, and social aspects but also to landscape, urban, and economic issues [11,12,32]. At a broader scale, Mang [34] suggests that in order to regenerate cities, one of the most vital aspects to consider is the motivation by citizens to take care of new technological systems, and how can these new concerns bring about “the transformation of our cities into places that are life-enhancing and regenerative” [34] (p. 6).

2.3. SUDSs’ Implications for New Local Water Governance Schemes

SUDSs imply changes to existing water governance schemes [35]. To achieve SUDSs’ effective planning, design, construction, and operation, a number of stakeholders need to be involved [24].

First, it is worth noting that there are three ideal governance systems to manage stormwater according to Van de Meene, et al. [14]: Hierarchical, market and, network (hierarchical governance refers to the first type of governance for urban runoff management, characterized by centralized public authorities and following a very vertical structure with little stakeholder participation. Market governance consists of applying private sector management models into services that were there previously). 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 [14]. Newman and Mouritz [17] emphasize that, because of its nature, market-oriented governance cannot deliver social

and environmental needs. To achieve these needs, other authors [14] call for a hybrid governance system, consisting of a mixture of network and hierarchical approaches with market governance instruments (hybrid governance systems take from the hierarchical approach its administrative framework, political leadership, and authority; from the network approach the flexibility of implementation that provides alternative strategies, such as collaboration and inter disciplinary interaction; and from the market governance approach its efficiency in resource use and incentives and stimulation so as to achieve outcome in the industry competition [14]). Moreover, it is well established that traditional ways of managing stormwater lead to jurisdictional and institutional fragmentation in many cases, which in turn caused institutional overlapping and a lack of clear roles among institutions [13]. Many authors, such as Jefferies and Duffy [36], Perales Momparler and Doménech [8], and Sañudo-Fontaneda and Robina-Ramírez [12], argue that a wide range of actors should be involved when planning and implementing SUDSs, including government, service companies, water users, neighborhood associations, academia, NGOs, research institutions, the media, and investors. None of these stakeholders is purely new to urban stormwater management, but the relationships between them change and their responsibilities change as well.

Second, as Carlson, et al. [6] argue, traditional schemes of stormwater management generally depend on national and local governments, following a vertical hierarchical structure where homeowners and groups interested in the topic (such as environmental NGOs, community groups, and civic organizations) barely have a say in the topic. Notwithstanding the domestic sector (households) being the larger urban water user, only those who are economically powerful or play an important role in agriculture or industry can become influential in urban runoff management [8]. Nevertheless, SUDSs can be developed at a variety of scales, thus decentralizing the water runoff structures [9,27,32]. SUDSs provide opportunities to manage stormwater at the neighborhood level [12], reducing the need for expensive and large drainage systems, thus easing the economic burden borne by municipalities [6,16,17,32,33].

Third, as a consequence of the decentralized nature of those systems, local communities gain importance in the planning process. Sañudo-Fontaneda and Robina-Ramírez [12] maintain that community-based research is a key tool in order to create successful SUDSs. This research is based in the interaction between community and technicians, with the aim to reduce the gap between them since many communities have little or no knowledge about SUDSs. Both Brown [13] and Perales Momparler [18] argue that the redesign of the stormwater administration will allow the participation of more actors, and social organizations might gain a new position of power. Because of its decentralized nature [9,27,32,37], the ownership of these assets can belong to local actors, but, until today, urban stormwater management interventions are located in public areas and developed by city councils or private entities. With the local scale approach of SUDSs, it makes more sense to involve communities to seek alternatives for urban drainage at a [16,37], something harder to do in the case of conventional urban runoff management (URM).

2.4. Challenges Faced by SUDS

While there have been remarkable innovations in technology and improvements in social behaviors towards sustainable water management practices, there are still two factors that challenge SUDS in different ways: The lack of interest for stormwater management issues and socio-institutional barriers. When society has not been impacted directly by pluvial floods, it tends to approach stormwater management with a low level of interest: “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” [6] (p. 11). Traditional systems treat stormwater as a simple waste, which downplays the impacts stormwater can have on certain sectors of the population. Cettner, Ashley, Hedström, and Viklander [38] express how there is little engagement in practitioners towards sustainable stormwater management as too much pressure is put on technology as the best solution. From here, the issue becomes very technical and appeals only those with technical interests

and backgrounds. Similarly, Perales Momparler [18] criticizes the usual lack of interest of users when benefits are not immediate, tangible, or local.

Similarly, numerous authors refer to barriers faced by SUDSs as largely socio institutional (community, resources, responsibility, vision, commitment, and coordination) rather than technical [5,18,20,26,31,38]. One of the main aspects to be criticized is the ambiguity and vagueness with which SUDS goals are defined by the different actors involved, leading to diverse interpretations and involving costly and lengthy negotiations [38]. It does not come as a surprise, then, that the different views on the concept, many of them in conflict with each other, prioritize their own agendas. This, in turn, increases and diversifies negotiation processes, needs flexibility in new perspectives, and adds a variety of interpretations of the problem in order to achieve a water-sensitive city [26].

The transition towards more sustainable urban runoff management (URM) demands critical changes in the level of interest among stakeholders as well as socio-institutional reforms. However, the reality is that traditional ways of managing urban stormwater have proved to be jurisdictional and institutional inefficient and economically, socially, and environmentally unsustainable. It is vital to achieve engagement among the public in order to increase diffusion in different contexts and also to understand SUDSs under the same guidelines, with a clear legal framework that fosters collaboration among all stakeholders in equal terms.

3. Case Study

The El Bon Pastor neighborhood (Figure 1) has been part of a large urban redevelopment project promoted by the City Council of Barcelona (Ajuntament de Barcelona) (Spain), where the old and cheaply built houses of the late 1920s (Casas Baratas) (Figure 2) are being demolished and replaced by new medium-rise social housing blocks. In 2012 and during the third phase of this project, a SUDS was implemented, using the open spaces surrounding the new residential blocks and streets (*v.i.* Figure 3) [21]. The selection of this case is based on the importance of the SUDS project for transforming the neighborhood. This project represents an opportunity for neighbors to participate in the design of new areas, to improve living and environmental conditions, and to promote sustainability for other development projects. The community group of the neighborhood (AVV) has been particularly active in topics related to the urban transformation of the neighborhood, including SUDS.

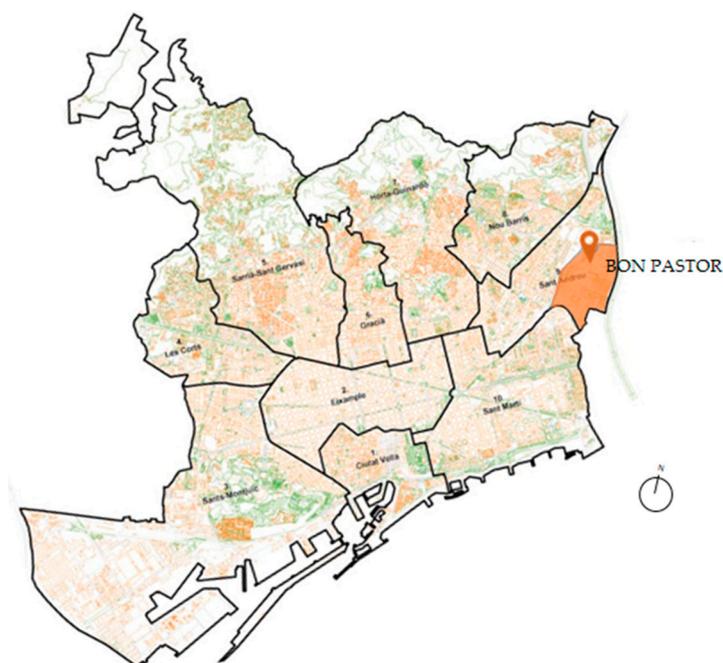


Figure 1. The Bon Pastor neighborhood in the district of Sant Andreu, Barcelona. Adapted from [39].

The development of El Bon Pastor can be traced back to 1929 when a law promoting low-income housing (the Law on Cheap Housing was created in 1853, and has undergone many alterations since then. In 1929, the law was used to build a large housing stock, allowing some citizens to become owners and others to become tenants, eliminating the possibilities of expropriation [40]) was implemented to respond to the demand associated with the International Exposition of 1929, held in Barcelona [22]. In this context, the Municipal Institute of Housing and Rehabilitation of Barcelona (Institut Municipal de l'Habitatge i Rehabilitació de Barcelona) built 784 one-story houses of 43 and 59 m², to receive dwellers relocated from the slum settlements of Montjuic or incoming immigrants from other parts of Spain [41,42].

In 2002 a plan derived from the General Metropolitan Plan for renovating the neighborhood was approved. The plan included the demolition of all houses due to their deteriorated conditions, and their replacement with apartment blocks to be built in five phases [21] (see Figure 2). However, the plan underwent transformations and became controversial among dwellers of the area, who claimed that houses were part of their cultural heritage. Some of them resisted relocation, fearing an increase in rents. The City Council organized a referendum among the dwellers of the project in 2003, and the results were positive to continue with the plan. Still, there was tension among neighbors and therefore the Independent Neighbors Association (Associació Avis del Barri) was created as an association that defends tenants of the cheap houses. After several negotiations, the City Council agreed with the neighbors to keep one row of cheap houses that will be part of a museum telling the story of Bon Pastor neighborhood as a symbol of its heritage [42]. The project is currently in phase 4, which is scheduled to be finalized by 2021, while the arrangement of the area surrounding these buildings is expected to begin in the second part of 2019.

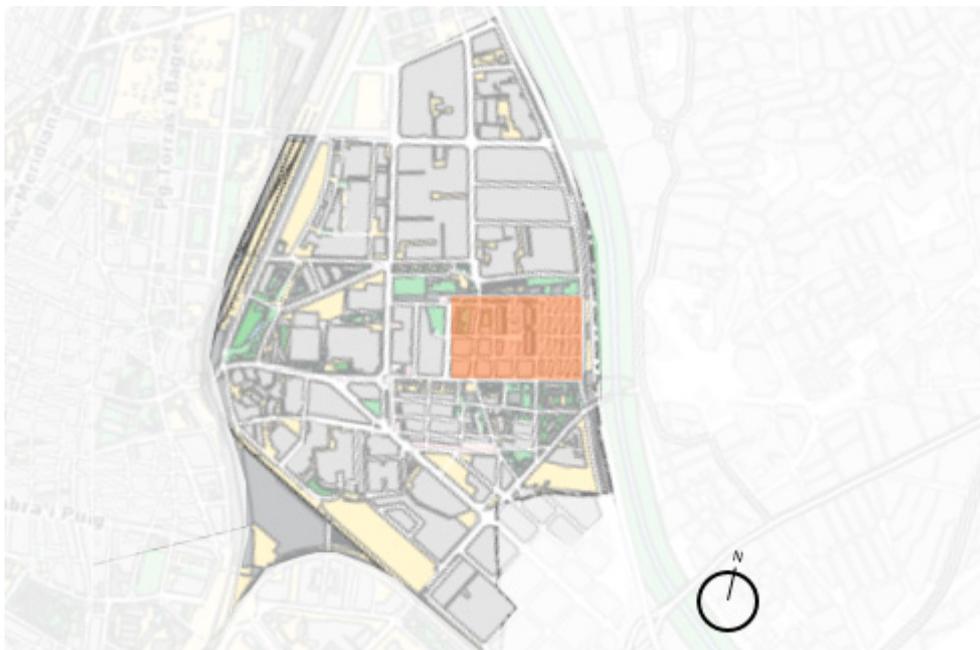


Figure 2. Location of *Casas Baratas* in Bon Pastor. Adapted from [43].



Figure 3. Master plan for the demolition of *Casas Baratas*, and the construction of new residential buildings, and SUDS. Adapted from [21].

The idea behind this urban development was to create a large plaza containing the residential apartment blocks [40]. As stated by Soto Fernández and Perales Momparler [44], the transition of replacing single-family houses with new apartment blocks releases a large amount of land that can be devoted to green space. In this context, the 2012–2016 SUDS project is the result of multiple interventions in the remaining land between the new buildings or between the new buildings and the streets (see Figure 3).

The project aims at collecting stormwater using different types of SUDSs in order to mitigate flooding, since in the past, various areas were affected by urban runoff. In the closed areas between the apartment blocks (22,000 m²), hollowed gardens were used as collection points. These gardens act as infiltration surfaces located 45 cm below the ground, allowing the absorption of runoff. Underneath these gardens, gravel infiltration wells of approximately 3 m deep reach the draining stratum. The vegetated area (1400 m²) represents less than 10% of the total area and can filter pollution loads going to the unitary sewer network—because of the sandy soils of the Besòs area where this neighborhood is located—on the other hand, in conventional streets, a strip of bio-retention material was placed in the curb between the street and the sidewalks. Because of its concave surface, the strip allows water retention from both the street and the sidewalk during peak rainfall periods and treats water pollutants (such as hydrocarbons) through biological processes. The third option chosen was to put permeable pavement in streets and sidewalks [44]. On the sidewalks, 20 cm of permeable concrete was placed in situ over a polyethylene mesh. The mesh prevents concrete from filling in the gaps of its polypropylene cells, creating an empty space 5 cm thick and allowing water storage before passing on to the structural soil formed by granite ballast and topsoil, thus improving the quality of the final soil layer.

4. Methodology

The methodological approach for this research was fundamentally qualitative and consisted in the review of grey literature on different aspects of the project and 10 semi-structured in-depth interviews with stakeholders involving several interested parties in the project, from the local government (Barcelona City Council) to technical managers from the city and from the city district and the neighborhood community group as well as individual dwellers. However, limitations in terms of resources as well as time constrains meant that only a small sample of interviewees willing to participate could be created. Several stakeholders were contacted (approximately 31), but only 10 participated. 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 lacked interest in them. It would also be enriching to approach and incorporate

the voice of other government institutions that are interested in developing more of these systems in the city. More than searching for statistical significance, interviews had the objective of mapping the plurality of views regarding SUDSs [45–50].

First, the research reviewed the existing documentation of the City Council [21,22] and other involved actors [23,44] about the redevelopment project in Bon Pastor in order to create a stakeholder map. The documents reviewed did not explicitly focus on SUDSs but on the urban renewal project instead. For this reason, it was essential to reinforce the arguments made with interviews and incorporate voices of different stakeholders (please refer to Appendix A: Semi-structured interview guide).

Qualitative data on the different visions of SUDSs, the perceived social impacts, and the role of the community on the project, as well as the relationships between actors, was collected from semi-structured interviews with 10 different actors from the local government, the government, technical managers, and members of the neighborhood community association of El Bon Pastor. Several members of the association were also interviewed individually. Actor recruitment followed the criteria of collective representativeness as well as willingness and availability to participate. Because of the qualitative approach followed, there is no claim as to the statistical significance of the sample of actors (Table 1) [45–49]. In contrast, qualitative methods, such as semi-structured interviews, allow for a deeper understanding and more nuanced views of the issues being discussed. Some of the interviews were conducted in person by the first author in Barcelona while others were done via Skype or email by the first author, from 5 April to 2 May 2019. Face-to-face interviews were done individually or in groups (there was one group interview), lasting approximately between 60 and 90 min and were conducted in Spanish. The names of the interviewees are not disclosed for privacy issues. The questions used for the interviews were divided into six categories: Introduction, the role of the stakeholder in the project, the relationship between stakeholders, perception of SUDSs, outcomes of the project and future of SUDSs, and the neighborhood (please refer to Appendix A: Semi-structured interview guide).

Table 1. Summary of the key informants interviewed.

n°	Stakeholder	Role	Date of Interview	Type of Interview
1	Government	Councilor of Bon Pastor neighborhood, District of Sant Andreu and member of AVV Neighborhood Association.	8 April 2018	Individual
2	Government	Technical Councilor of District of Sant Andreu.	8 April 2018	Individual
3	Technical	Architect from BAGURSA, designer of project.	5 April 2018	Individual
4	Technical	Representative and CEO of Green Blue Management.	15 April 2018	Individual
5	Neighborhood Association	President of AVV Neighborhood Association.	2 May 2018	Individual
6	Neighborhood Association	Member of AVV Neighborhood Association. In charge of historical memory and educational matters	2 May 2018	Individual
7	Community member A1	Lived in a Cheap House, relocated to housing blocks Lives next to SUDS. Member of AVV Neighborhood Association.	2 May 2018	Group interview A
8	Community member A2	Lived in a Cheap House, relocated to housing blocks Lives next to SUDS. Member of AVV Neighborhood Association.	2 May 2018	Group interview A
9	Community member A3	Lived in a Cheap House, relocated to housing blocks Lives next to SUDS. Member of AVV Neighborhood Association.	2 May 2018	Group interview A
10	Community member A4	Lived in a Cheap House, relocated to housing blocks Lives next to SUDS. Member of AVV Neighborhood Association.	2 May 2018	Group interview A

5. Results and Discussion

5.1. Stakeholders Involved in El Bon Pastor SUDS: Their Roles and Relationships

Since the implementation of SUDSs was part of El Bon Pastor urban regeneration, an important number of stakeholders were involved, including local and regional governmental institutions, public institutions, private companies, and the community neighborhood (see Table 2). Names in bold font constitute the central focus of the analysis: The District of Sant Andreu, the neighborhood association of Bon Pastor (henceforth AVV), BAGURSA (Barcelona Gestió Urbanística SA), Green Blue Management, and the host community of Bon Pastor.

Table 2. Summary of institutions involved in Bon Pastor SUDS.

	Name	Description	Role in Project
Government institutions	Regional Government of Catalonia	Regional Government of Catalonia (Generalitat de Catalunya, in Catalan)	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
	District of Sant Andreu	District of Sant Andreu (part of the administrative structure of the City Council of Barcelona)	Social support for families who were relocated
Public institutions (by the Government)	Agència Catalana de l'Aigua (ACA)	Public company of the Regional Government of 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 superficial part of SUDS in Bon Pastor
	Barcelona Cicle de l'Aigua (BCASA)	Society created by the City Council of Barcelona. It is attached to the Deputy Management of Environment and Urban Services within the Area of Ecology, Urbanism and Mobility	Management 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
	Barcelona Gestió Urbanística (BAGURSA)	Public company created by Ajuntament de Barcelona	Designer and developer of the SUDS Project in El Bon Pastor
Private institutions	Green Blue Management	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 (technical 2d blueprints).
	MOR Arquitectura tècnica	Private architecture firm hired for the project	Executive project editor
Community (& community organizations)	AVV	Neighborhood association of Bon Pastor	Representing the community of Bon Pastor during all the participation process. Its association is formed by neighbors of Bon Pastor
	Follow up commission	Commission created by the AVV and District of Sant Andreu	Intermediary between the neighborhood and District. To help families during the relocation process with legal paperwork and social support
	Community	Community of El Bon Pastor	"Beneficiaries" of the urban development project

Several governmental institutions took part in the urban redevelopment process; some explicitly targeted the housing renovation part while others worked on urbanization and infrastructures. The institutional structure for stormwater management in Spain is complex and involves multiple actors. In this case, there was a clear distinction of roles within each part involved. In terms of the administration and partnerships, the City Council commissioned the public company BAGURSA to take the lead of SUDS projects in the city, as part of urban development transformations related to the the Integrated Sewerage Plan of Barcelona of 2006 [11,24]. The project was managed by Barcelona Cicle de l'Aigua SA, BCASA (Barcelona Water Cycle), a society created by the City Council that assumes responsibilities in local drainage [24]. The contractor was a private company called Obres i Serveis Roig while the technical consultancy for the hydrological-hydraulic design was provided by Green Blue Management (GBM), a private engineering company specialized in SUDSs that had previously worked in other SUDS in Spain. Auding-Intraesa was in charge of construction management and As-Built blueprints and MOR arquitectura técnica was the executive project creator ([21] and interview #4).

In terms of community organizations, the neighborhood association (AVV) played an essential role in the design of public spaces where SUDSs were implemented. Members interested in the topic met once or twice a week to discuss matters internally, and afterwards with the District of San Andreu and BAGURSA. It is important to note that the councilor of the Bon Pastor neighborhood was also a member of the AVV Neighborhood Association, which facilitated communication among actors. During the interviews, the host community, the AVV, the district, and the architect of the project agreed that public participation was limited to the design phase of the parks and sidewalks (interviews #3, #5, #6, #7, #8, and #10). Therefore, the SUDS project was the result of a participatory approach where the AVV worked hand in hand with the District of Sant Andreu and BAGURSA (Figure 4). The community was able to propose how they wanted the public spaces to be designed and what aspects to take into consideration, but the final decision had to be consensual with the district and BAGURSA. If consensus was not achieved, the process started again until a common decision was made. This was not of interest to everyone in the community, since the Independent Neighbors Association (AVIS del Barri) was not part of any participatory process because they opposed the housing project from the start.

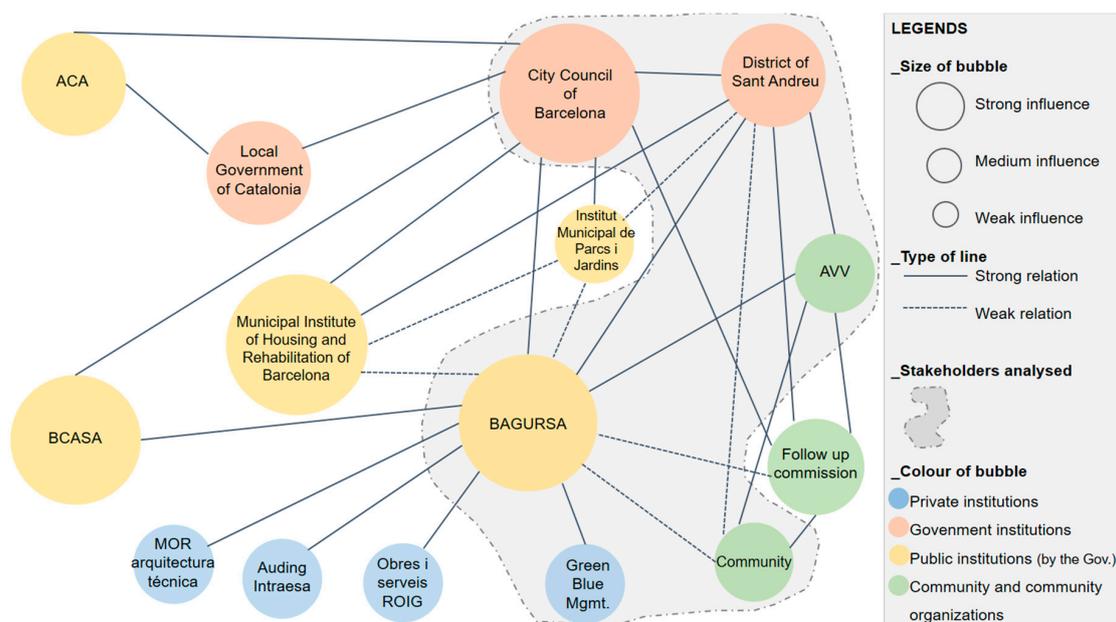


Figure 4. Stakeholders map of Bon Pastor SUDS.

The fact that the neighborhood community of Bon Pastor was well-positioned for debating the implementation and management of SUDS coincides with several arguments presented previously in the paper looking into how local communities gain importance in the planning process of

SUDS [13,14,16–18]. As explained by the Councilor of Bon Pastor (interview #1), BAGURSA had been working together with the AVV in group discussions and meetings since the first phase, which created a fluent communication atmosphere for the following phases. The constant dialogue between the public administration and the AVV enabled the community to gain prominence in the project. Teams from BAGURSA, AVV (those interested in participating), and the district met weekly to discuss the design, and if any of the parties involved could not attend, the meeting was rescheduled. Contrarily, as stated by the representative of Green Blue Management (GBM), other stakeholders, such as GBM and the architecture firm MOR, were only consulted for particular issues and did not participate in the regular meetings (interview #4).

Compared to traditional drainage systems, the local character of SUDS allowed this new type of participation, which resembles the hybrid structure proposed by Van de Meene et al. [14], in which the traditional power structures of the water cycle are redefined. In this sense, SUDSs allowed the community stakeholder (AVV) to have a significant say over the local water cycle in Bon Pastor. Particularly, the neighborhood councilor was in a privileged position of negotiation as he could reach the City Council directly, by being not only the councilor but also an active member of the AVV.

While there was a clear distinction of roles during the implementation of SUDS, the responsibility for their maintenance was more blurred. This fact contradicts Brown [13] in the sense that SUDSs might become a solution towards the current institutional overlapping and lack of clear roles regarding traditional ways of managing stormwater. However, other authors, such as Dierkes, Lucke, and Helmreich [31], believe that this deadlock would not entirely be solved by SUDSs, since there is still some uncertainty regarding the long-term performance of these systems. In Bon Pastor's context, the maintenance of SUDSs was initially performed by BAGURSA. For instance, when several bushes and plants were damaged, the company replanted them again. Afterwards, GBM was asked to elaborate a maintenance plan (interview #4). To date, the Municipal Institute of Parks and Gardens (Institut Municipal de Parcs i Jardins) is maintaining the vegetation and green covers of SUDSs, but the District of Sant Andreu and the AVV are looking forward to sharing this responsibility with people in order to increase popular commitment to SUDS. Some members of the community remark that this issue was already discussed with BAGURSA and the district from the very beginning, arguing that the new green urbanization demanded new responsibilities of care for the public space. Therefore, the community asked the AVV to insist on the maintenance: "Cleaning the gardens once a week was clearly not enough. We have been persistent with the authorities on cleaning. When you see that 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, the community, and the district. Several issues have arisen about the maintenance and preservation of the green spaces around SUDSs. Neighbors believe that the system is well designed, but that it may fail regarding maintenance, not because the administration is not being responsible but because of uncivil behaviors by members of the community that have damaged the gardens repeatedly. The minority damaging the SUDSs 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).

In sum, the SUDS project in El Bon Pastor was an example of participation among different stakeholders under their own principles and capacities. Cooperation allowed the community to have a strong influence in the negotiation of the design and maintenance of SUDSs. Some actors were more familiar with SUDSs than others, as they had been working on them for the past two decades, while the community and neighborhood association had only a basic idea of what SUDSs are and how they work. Therefore, the concept evolved differently for each stakeholder through the project.

5.2. Stakeholders' Perceptions of SUDSs

The diverse understandings of what SUDSs meant to actors concurs with what Cettner et al. [38] and Brown and Farrelly [5] report on the multiple perspectives on SUDSs raised by different stakeholders. First and foremost, it is vital to stress the clear distinction between the actors with

technical knowledge on SUDSs (viz. interview #2, #3, and #4) and the rest (viz. interview #1, #5, #6, #7, #8, #9, and #10).

Managers, such as the architect of BAGURSA and the representative of GBM, were aware that SUDSs in Spain are increasing in number and popularity mainly because traditional drainage systems have shown difficulties in managing stormwater over the past years (interviews #3 and #4). They also claim that SUDSs have gained importance over the last decade since they confront popular issues, such as environmental protection and climate change.

Contrarily, for both the AVV and the community, knowledge about SUDSs 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 both had already been looking into ways of implementing green roofs, they were not aware that SUDSs would fit with the neighborhood profile until the technical managers drafted the plan and explained that the environmental characteristics of Bon Pastor would benefit from SUDSs. The AVV claimed it was "very innovative" (interview #5), as it provided the opportunity of reusing rainwater while embellishing the urban space. Another neighbor highlighted the novelty and potentiality of SUDSs for the community: "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 shows how SUDSs are something that is relatively new for the neighborhood, mainly because in the past, this was not a priority for the community. This point is raised in the second part of this research, described as the lack of interest of citizens for stormwater management when they have not been directly affected by pluvial floods [6]. In this case, numerous interviewees agreed, since the neighbors were more concerned with what the future held for their housing situation. Thus, as stated by the Technical Councilor of the District of Sant Andreu (interview #2), the neighborhood had more urgent priorities, such as whether or not to redevelop the Casas Baratas, and the debate was always around this issue. It was when the first phases were completed that the institutions and the community started to think about urban infrastructure combined with sustainable solutions, such as the SUDSs.

However, the AVV argued that the system seemed to interest more academia and practitioners than citizens as people use these spaces as regular squares or parks, without being conscious of their function as SUDSs, and only a small portion might be intrigued by how they work (interviews #5 and #6). While members of the AVV knew from the very beginning how the system worked, many of the neighbors who did not have a direct connection with AVV had the opportunity to learn from informative panels created by GBM and BAGURSA that were installed in the parks and streets. Most of the time, students from schools and universities were the only ones reading the panels (interview #4).

Other stakeholders, like the councilor of the neighborhood, 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 responsible for education efforts, who saw it as something completely different. He argued that despite being true that the urban renewal project created tensions among inhabitants, the SUDS project is now part of an urban area of the neighborhood that is used by all inhabitants, regardless of whether it belonged to the main renewal project or not. This type of massive open space did not exist in the past, as the sidewalks of the late 1920s houses were just 80 cm wide and there was no space between houses. Today, both 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 SUDSs by managers 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). As stated previously by Lähde, Khadka, Tahvonen, and Kokkonen [29], the multifunctionality of SUDSs

is frequently reduced to the benefits it brings as urban green space. Both the AVV and community directly intervened in the design of parks and sidewalks, and therefore perceived 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 can reuse stormwater to water its plants, which is vital for Mediterranean climates during dry periods. By the same token, members of the district, the CEO and representative of GBM, and the architect of BAGURSA described SUDSs 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 the above analysis that Bon Pastor was following the principles of a 'water-sensitive city' [5]. Moreover, although Brown and Farrelly [5] argue that the 'water-sensitive city' does not exist yet, Bon Pastor fits well into 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 a defining element of the urban space, depending on the nature of each stakeholder. This can also be observed in the way different actors explain the impact of SUDS on them, exposing the benefits they prioritized, the lessons learned, and the overall positive aspects of this practice.

5.3. Perceived Impacts of the Project to the Different Stakeholders

The positive impacts of SUDSs in terms of controlling quality and quantity of runoff in Barcelona as recognized by the technical actors coincide with the positive benefits of SUDS in other contexts [11,25,32]. The architect from BAGURSA and the representative from GBM highlighted in their interviews the results of the SUDS project in technical terms. The representative of GBM stated: "We focused on the hydrological and environmental aspects, but we coordinated with other stakeholder's further aspects. Our objective was related to stormwater quantity and quality" (interview #4).

Evidence supporting this position can be found in the article written by both the CEO of GBM and the architect from BAGURSA, where they present the quantitative results of the project. These were assessed with hydrological and hydraulic modelling software that measures if the gardens and bioretention strips are able to collect, retain, and evacuate (by vaporization and evapotranspiration processes and ground infiltration) in less than 48 h, with a water volume associated to a percentile storm 80 (that in the case of Barcelona is 15 mm) [44]. The results from the software showed that 99.9% of the stormwater infiltrates while only 0.01% reach the traditional drainage system. In addition, it showed that there was a reduction of the peak water flows of 85% [44]. During the interview, the architect from BAGURSA focused on the success of SUDS after the flash floods of October 2018 (usually, in Barcelona, the annual precipitation is about 580 mm per year, with some years above 1000 mm, such as in 2018 (with 1016 mm/m²), causing flash flooding in the city [50], where the system worked perfectly and none of the streets was flooded (interview #3). 2018 recorded the rainiest October since 1987, with a total precipitation of 195.6 mm. It rained 16 out of the 31 days of the month, with a maximum registered value of 105 mm on the 9 October.

Members of the community and the district (interviews #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 since the new drainage system implemented absorbed pluvial flooding in the area and the new buildings did not seem to have humidity problems. It is vital to note that previously to this plan, not all streets were equipped with stormwater collectors.

The project 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 [12,42]. It also stimulated positive responses at the social level as the community represented by the AVV is today more committed to sustainability issues and willing to implement numerous sustainability projects that contribute to the SUDS network (interview #7). This concept was presented previously in this paper by Perales Momparler [18], where she suggested that SUDSs may be a trigger for people to become motivated to take care of the environment. Some of these projects are the industrial polygon and the Barcelona city council-led Zero Waste project (Residu Zero), which aims

for the prevention, segregation, and reduction of waste generation to reuse and recycling, for which Bon Pastor serves as the first pilot project. Also, the Rubió i Tudurí Institute (Institut Rubió i Tudurí) will be relocated in the neighborhood and will develop research on the most suitable vegetation of their SUDS, under requests by the AVV.

The redevelopment 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 smoothed the path for other participatory projects on which the three of us are working together” (interview #2). However, the engineering consultant company (GBM) has lost touch with the other stakeholders involved in the project and might only be contacted for technical support of future SUDSs (interview #4).

For the design of the green spaces of the fourth redevelopment phase, the AVV has been present in the digital participation platform of Barcelona’s Local Council: We Decide Barcelona (Decidim Barcelona) 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 participatory approach between the community and the public/private sector. The participatory processes are a series of meetings delimited with a specific timeframe, aiming to promote debate and include different stakeholders’ view (citizens, municipality, etc.) on a specific urban proposal. (see www.decidim.barcelona).

As the fourth phase will also foster significant changes at the urban scale, the neighbors of the AVV met with the City Council of Barcelona and District of Sant Andreu several times and debated on which open public spaces they want, for what uses, and what to prioritize in its design. In this sense, as the Technical Councilor of the District of Sant Andreu argues, “the SUDS concept emerges again in this phase, but more critically, looking into new improvements. SUDS now have a value of promoting green spaces in the city” (interview #2). The president of the AVV recognizes that initially, they were still reluctant to design big open spaces like those of the third phase again, as it took some time for neighbors to become familiar with them. However, with time, neighbors incorporated this new morphology and started asking for more green spaces, 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 uses the water from SUDSs to water the plants, or a new green park that connects the neighborhood with the river (interview #2).

In this way, the District of Sant Andreu is looking forward to implementing sustainable actions in terms of waste management, runoff water, water supply, or green rooftops. The representative of GBM recognizes that Bon Pastor became one of the pioneers and a benchmark of SUDSs in Spain and looks forward to continuing to develop SUDSs in the region. 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 the uncivility of a few neighbors is slowing down the integration of sustainable practices in Bon Pastor.

This last issue is the main challenge for the next 15 years, according to the technical councilor of the District of San Andreu (interview #2), but the AVV is highly committed to continuing with sustainability and ecological projects in the neighborhood, regardless of which party is in the local government (interview #6). The AVV is working hard to create civic consciousness among the community: “Today, the AVV is very focused on creating awareness of citizenship, and in that regard, we talk about sustainability in terms of reusing and recycling resources. We are aware that we are damaging the Earth, and even though we might not see it, we want to conserve our neighborhood in the best conditions for our future generations” (interview #5).

6. Conclusions

Discourses on SUDSs often remain technical, elaborating on the hydrological, landscape, environmental, urban, and economic benefits to be achieved, and relegating the more social aspects [12]. This paper looked specifically into the social dimension of SUDSs by analyzing the stakeholders' involvement in SUDSs, their roles and relationships, and the perceived impacts of SUDSs. The paper first elaborated the implications of SUDSs in new governance structures for stormwater management [13,16–18] as fostering a hybrid governance system [13]. Secondly, it focused on the ambiguity that the concept SUDS [37] brings to the different stakeholders (“landscape or gardens” for civil society vs. “SUDS” for technical managers). Thirdly, it elucidated the perceived impacts this project had for the community on Bon Pastor, since sustainability regarding pluvial floods was not a priority [6] in the past as it is today. Finally, and most critically, the paper offered a case study showing how to overcome the usual barriers and limitations between technically sophisticated solutions and public acceptance by involving in the process a wide variety of local stakeholders from the very beginning. SUDSs need to make sense not only environmentally but socially, and in our view, the Bon Pastor case provides an example of successful community involvement in SUDS development for other projects in Barcelona and globally.

Having considered these findings, it is also reasonable to look into the policy implications SUDS bring. While the case of Bon Pastor can be regarded as positive in different ways, the main criticism relies on the fact that who is responsible for the maintenance of the SUDS was never clear. Special efforts should be placed by the government institutions in order to maintain the gardens, and to educate neighbors about how the systems work and why it is necessary to take care of them. Regional success of SUDSs highly depends on this education, since this is not only happening with the case of Bon Pastor but also with other SUDSs developed in Barcelona as most stakeholders involved are the same (but with different communities and neighborhood associations). It is important to note, however, that while the project involved the community, SUDSs are still unfamiliar to many and prioritizing the social value of SUDSs in the technical literature and government campaigns is fundamental to attract the general public. By doing so, individuals and communities can start getting related to and become more active in the ‘total water cycle’ [5].

Further research is needed in order to broaden the scope of stakeholders and understand the visions of a larger group of inhabitants, not only those who supported the construction of SUDSs but also those who lack interest in them. Although including explicitly only part of the stakeholders involved, it is important to highlight that this research has demonstrated how several patterns in the conceptual framework of SUDSs were observed in Bon Pastor. As said above, and according to the results of this study, SUDSs have proved to be more than a technical solution to manage stormwater. Additionally, since sustainable habits are at the core of the discussion, the implementation of SUDSs through participatory processes can be translated and tailored into other communities that, like Bon Pastor, had little or no prior knowledge about SUDSs.

This research opens a new floor to discussion about the social aspects of SUDSs and how by tackling sustainable urban water management they can have an impact on further habits, even when communities have no knowledge about SUDSs. After the project, Bon Pastor is not only following the ‘water-sensitive city’ principles [25] but also creating sustainable socio environmental networks in which behaviors change and in which fundamental components of environmental management, such as public participation, are respected.

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Appendix A. Semi-Structured Interview Guide

Date:

Name of the interviewee or organization:

(G) = Only applies for Government organizations.

(T) = Only applies for Technical organizations.

(OVC) = Only applies for neighborhood associations and community.

1—Introduction

- (a) When was your organization involved for the first time in a SUDS project?
- (b) How would you explain what SUDS are to someone who is not familiar to the concept?
- (c) Do you detect a rise of SUDS in the last 5 years? Which do you think is the main reason for this boom? If not, why not? (G + T)

2—Stakeholders Role (G + T)

- (a) Why did SUDS start to interest your organization? (G + T)
- (b) What was your organization's role in this sustainable drainage project?
- (c) What was the objective that your group had with the implementation of the project in Bon Pastor in relation to the benefits they provide? Would you say they were hydrological, environmental, social, urban and/or economic? (G + T)
- (d) Do you think it has been achieved? (G + T)
- (e) Have the objectives of implementing SUDS in your group changed today in other projects? (G + T)

3—Stakeholders Relation

- (a) Could you tell me who are the other parties involved in this SUDS?
- (b) Do you think there has been a good level of cooperation between all of them?
- (c) Why yes/no?
- (d) Would you say that there has been participation by the community: previous, during or after the project implementation? Or that it has not been at all?
- (e) Why do you think there has been/has not been participation? In case of positive answer: How would you describe this participation?

4—SUDS Perception

- (a) Do you think this project has been an effective solution to manage rainwater?
- (b) How was the response of these SUDS towards the heavy rains last autumn (October) of 2018?
- (c) If you had to make a balance, would you say that this project was positive or negative for the neighborhood?
- (d) Do you think that being part of the cheap housing project impaired the perception that Bon Pastor dwellers have about SUDS?
- (e) Do you think the drainage system was positively received by the neighbors?

5—Outcome of the Project

- (a) Once the project was finished: Has this influenced your organization's relationship with the other parties involved in the project (the government, the technical part, or the neighborhood organizations)? Have you worked together again?

- (b) Has this project caused your organization to be interested in other issues not related to your field? (OVC)
- (c) Do you think that since this project the image of the neighborhood changed? (OVC)
- (d) Would you change something about this SUDS project?

6—SUDS and Neighborhood Future

- (a) Is your organization still involved in any way in this project today? E.g., maintenance, improvements, etc.
- (b) Do you think the implementation of the project brought changes at the social level within the neighborhood? E.g., interest in vegetated roofs
- (c) What are the main barriers that the neighborhood presents for the integration of other sustainable practices?
- (d) How do you imagine the neighborhood in 15 years in terms of urban sustainability?

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