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Bringing community perceptions into Sustainable Urban Drainage Systems: the experience of Extremadura, Spain

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Abstract

Sustainable Drainage Systems (SuDS) have arisen as an alternative to "grey" conventional drainage in order to manage stormwater in urbanised areas. While technical aspects regarding the design and construction of SuDS have received most of the attention by academics and practitioners across the world, social aspects such as amenity, health, governance or equity, amongst others, still are not fully considered for design, planning and operation. The present research introduces human aspects of water management beyond traditional schemes to examine community perceptions about SuDS. With this aim, the Smart PLS Path Modelling method has been designed to measure social unobserved variables through indicators, using the UNESCO's principles. A case study was developed at three neighbouring communities in Cáceres (region of Extremadura), Spain, in order to check the potential of SuDS to be considered for full implementation in Southern Europe. A questionnaire was designed and conducted using 276 dwellers whose average was 39. The participants showed significant sensitivity towards the implementation of SUDS. This research opens a new research line by tackling the knowledge gap identified, informing on how to approach young communities with few or no knowledge about SuDS.

Keywords: Amenity; Community Resilience; Food and Water Systems; Green Stormwater Infrastructure; Self-organisation; Water Sensitive Urban Design.

1. Introduction

Food and water systems are under threat due to instability processes governed by climate change, biodiversity loss and intense urbanisation, affecting community resilience across the globe (Altieri et al. 2015). Flood events, water pollution and large periods of droughts are increasingly dominating planning scenarios for cities whilst inducing insecurity both in food and water systems, not only in urban environments but also in rural areas (Nguyen et al. 2019). Extreme values within design parameters have changed drastically in many cases (Stephens et al. 2018), leading the path towards newer techniques and knowledge to sustainably manage water under scenarios of climate change and large waterproofed urbanised areas (Allende-Prieto et al. 2018). There is a wide agreement amongst scientists and practitioners in pointing out Sustainable Drainage Systems (SuDS) as the most complete set of techniques to provide resilient water systems for practice under the "*new paradigm for water management*" which confers value to rainwater in comparison to conventional drainage systems (Morison and Brown, 2011; Morison and Chesterfield, 2012; Perales-Momparler et al. 2017; Rodríguez-Rojas et al. 2017). Despite the fact that this paradigm was key in Ancient Civilisations as shown in Charlesworth et al. 2016, the driving factor in drainage has been to focus on taking rainwater away from the urban environment considering it as waste.

SuDS design comprehends four main pillars according to the UK CIRIA SuDS Manual (Woods Ballard 2015): water quantity, water quality, biodiversity and amenity. SuDS philosophy often referred as Water Sensitive Urban Design (WSUD) (Fletcher et al. 2014) shows a wide range of benefits from SuDS implementation, highlighting Ecosystem Services amongst others. Furthermore, an ecohydrological approach could comprehend multiple benefits comprising flood mitigation, water supply, thermal comfort, and social amenity using the natural flow paradigm (Fletcher et al. 2014). Linking ecosystem services from Green Stormwater Infrastructure (GSI) to human well-being requires a multidisciplinary approach where planners have to follow very often a route from multifunctionality towards multiple ecosystem services (Hansen and Pauleit 2014). Thus, the socio-cultural context or human well-being should be linked to the ecosystem and biodiversity. In addition, human health is directly related to the promotion of ecosystem services by using GSI (Tzoulas et al. 2007). Thus, ecosystem services have been investigated before in relation with human aspects. Following this route, Lundy and Wade (2011) described cultural services as part of a category of ecosystem services which provides spiritual and educational values, aesthetics and recreation. These human aspects from the ecosystem services associated with GSI impacted positively in mental and physical well-being, increased environmental awareness and house prices (Lundy and Wade 2011). Kong et al. (2007) also linked amenity values to market prices. Age is also a factor that influences environmental awareness and the interaction with nature (McKeiver and Gadenne, 2005; Kanchanapibul et al. 2014) and should be taken into consideration when undertaking amenity surveys in SuDS as an environmental solution.

Moreover, Wong et al. (2009) defined three pillars of practice for water sensitive cities based upon cities as water supply catchments, cities providing ecosystem services and cities comprising water sensitive communities. The later could be considered as the recipient for human aspects and behaviours, being the other two pillars those related to infrastructure and built and natural environments.

Given the complex nature of the problem and the multifunctional scale offered by "*the new paradigm for water management*", there is a need to link natural, social and environmental systems, and the role of communities around them in increasing resilience to change (Morison and Chesterfield, 2012). Community self-organisation plays a key role through adaptation processes which should be led by information and understanding schemes about the techniques available and the potential implementation at their specific locations (Djalante et al. 2013; Atkinson et al. 2017). Following up from this reasoning, Bos and Brown (2012) highlighted that SUDS technologies should be socially embedded in order to create a path towards successful implementation in practice. Previous researches have showed a socio-technical transition for the implementation of the WSUD philosophy where community-based research has been proved a key tool to produce resilient practices under climate change scenarios (Visconti 2017). Wong et al. (2009) and Ferguson et al. (2013) also identified that the socio-institutional dimension of WSUD was a major area of research, which needed further development as it is key for SuDS implementation.

In consequence, human aspects have been merely considered through the amenity concept of SuDS, being defined as "*a useful or pleasant facility or service*" by Woods Ballard et al. (2015). This concept for amenity comprehends urban design or space quality, liveability or quality of life for inhabitants, and aesthetic appreciation amongst others. Furthermore, Fletcher et al. (2015) mentioned amenity as the second point within the WSUD objectives, being commonly associated with habitat/biodiversity as per pointed out by Woods Ballard et al. (2015).

Based upon the need to incorporate human aspects to water related problems, Ramírez et al. (2016) proposed a new approach to water management by considering human aspects and their impact in the implementation of best water management practices in Mexico. Further research was carried out in South Africa, challenging the Smart Partial Least Squares (PLS) method for impoverished settlements, showing that water services can benefit from considering human aspects in their planning (Ramírez and Sañudo-Fontaneda, 2018). PLS represents a powerful and effective means to test multivariate structural models with latent variables. The primary purpose of the PLS approach is to predict the indicators by means of the components expansion (Jöreskog and Wold, 1982). In line with this notion, Hair et al. (2011) recommend using PLS if the goal is predicting key target constructs or identifying key 'driver' constructs. The authors used an application of the well-known technology acceptance model estimation which uses a dataset called Smart PLS (Ringle et al., 2015). Ramírez and Sañudo-Fontaneda's research introduced principles of "*human dignity*" and "*human equality*", travelling beyond traditional schemes of water management, in order to envisage water policies to provide basic water services, using as a framework the UNESCO's principles (UNESCO, 2011). UNESCO's principles refer to a set of water related ethics and values, which help achieving sustainable water management: human dignity and the right to water, equity, vicinity, frugality, transaction, multiple and beneficial use of water, mandatory application of water quality and quantity measures, compensation and user pays, polluter pays, participation, and equitable and reasonable utilization. The authors found a positive impact on the "*Principles of water governance*" and the "*Water principles*", showing the path for further research in what has been called as "*the new paradigm in water management*" chiefly sustained by the application of the WSUD philosophy and the design and implementation of SuDS techniques.

Nevertheless, regions such as Southern Europe lack generally of standards and laws that empower the use of SuDS at a national and/or regional level (Andrés-Valeri et al. 2016), representing an interesting case study to test new methods which include human aspects at core. Spain represents the case for a developed country where SuDS are not fully developed yet despite the fact that multiple researches have been conducted over the last 20 years (Castro-Fresno et al. 2013). Furthermore, Spanish climate offers multiple challenges due to its wide variety from low rainfall regimes, including desert areas in the South, up to high annual rainfall volumes in the North (AEMET, 2018).

The role of communities in defining water sensitive strategies to overcome water-related problems has increased drastically over the last years (Wong et al. 2009). However, it still is an underdeveloped area in countries like Spain and other countries in the wider Southern Europe region. It is important to note that SuDS implementation has proven to be effective from a technical point of view in Mediterranean regions of Spain (Perales-Momparler et al. 2015) and other climates within the country (Castro-Fresno et al. 2013; Andrés-Valeri et al. 2016), leading the path to further implementation over the last 5 years.

This article targets three neighbouring communities of dwellers in Cáceres (region of Extremadura), Spain (Figure 1), where the average annual rainfall is 518 mm, corresponding to a C_{sa} in the Köppen-Geiger climatic classification (Essenwanger, 2001). This case is representative for larger parts of South Spain and the Mediterranean region in Southern Europe. This research also introduces a novel approach to communities of young dwellers whose average age was 39 for our case study, and how they are willing to uptake new approaches to water management based on cultural ecosystem services which empowered social interactions as stated by Riechers et al. 2018.

The application of Ramírez and Sañudo-Fontaneda´s (2018) approach, based on the Structural Equation Modelling using variance (SEM) and the PLS, was especially tailored-made for this research embodying human aspects. The methodology contains a transformative potential for change, related to community self-organisation (Bos and Brown 2012), where an informed community of dwellers could implement SuDS at a stakeholder level, leading the way for resilience in water systems within buildings and their surrounding areas. Therefore, these initial experiences working with communities at these targeted areas with potential for SuDS development in Southern Europe could inform policies which enable the wider design, practices, planning and operation. With this main aim, this research was set under two main objectives:

1. To demonstrate that the combination of the SEM and PLS methods can sustain the development of an integral approach to value community perceptions for SuDS practice.
2. To check whether communities of young-aged people present significant sensitivity towards SuDS when setting up environmental, ethical and Nature-Based Solutions (NBS).

2. Methods

2.1. Experimental Design and Hypotheses for the Study

Hypotheses for this research were designed focusing in understanding how the local communities of dwellers were open-minded or not to uptake SuDS for implementation in their buildings and surrounding urbanised areas by being informed about the benefits provided by them in line with improving liveability conditions. An integrated approach based on the four pillars of SuDS (Woods Ballard et al. 2015) was taken, testing the following latent variables, which are underlying variables that cannot be observed directly, also known as constructs or factors as explained by Chin (1998): "*Environmental Benefit for the*

Ecosystem" (EBE), the "*Environmental Transformation in Urban Areas*" (ET), the "*SuDS methods*" (SuDS), and the "*Amenities Benefit for the Community*" (ABC) (Figure 2); under the following hypotheses:

- H_1 – SuDS positively influence EBE.
- H_2 – SuDS positively influence ET.
- H_3 – ET positively influences EBE.
- H_4 – SuDS positively influence ABC.
- H_5 – ABC positively influences ET.

Based on Chin´s definition of Latent variables (Chin, 1998), the purpose of the present research is to turn the not directly observed variables or constructs into observable items that can be analysed. This allows getting the members of the community's opinion in order to build the SEM model. Therefore, conceptualizing each latent variable, and then, building the items based on the literature review. The model showed in Figure 2 is centred in community perceptions for practice under the change in the water management paradigm. With this aim, SuDS are tested under two main premises: firstly, to define the degree of importance given by the dwellers to stormwater management under climate change scenario; and secondly, as to how willing communities are to implement SuDS through a process of information focused on the multiple benefits provided by them. Therefore, four main latent variables were selected using the previously cited four pillars of SuDS (Figure 2).

2.2. Questionnaire and area of study

The indicators drafted for this research (Table 1) were constructed based on an extensive literature review carried out prior to this stage. Several meetings were organized with the objective to explain the scientific aims of the study as well as the hypotheses. The aim for the first meeting was to present all information to the Municipality´s Urban Department and the managers of the residential areas targeted for this research (three neighbouring communities as it can be seen in the three buildings highlighted in Figure 1). Then, four meetings were organised to collect the data (two of them were celebrated at the Cáceres City Council House and the remaining two at the neighbouring Association´s office). The meetings were organised each two weeks within a period of two months between October and November 2018. The attendees were the Urban Service´s Manager Director, two Engineers and one Biologist from the Maintenance Service of the City Council, and the Neighbouring Association´s Manager Director and two Workers which run the public services between the neighbourhood and the City Council. Finally, three neighbours who are responsible to deal with the Neighbouring Association were also involved. Therefore, ten professionals were actively involved in those meetings. 276 neighbours out of a total of 288 from this residential area (12 non-valid questionnaires were excluded due to some not answered questions), constructed in 2005, participated in the study, presenting an average age of 39 years old. The demographic characteristics of the participants are shown in Table 2. The studied area was especially selected due to this low average age; likewise, the interaction with the environment has been reported to be strong in previous studies (McKeiver and Gadenne, 2005; Kanchanapibul et al. 2014). The neighbourhood is surrounded by two parks whilst a lake is located in the central area (Figure 1). Families spend long time during the weekend on the green areas due to its appropriate facilities and their recreational value, showing already one of the most characteristic social ecosystem services provided by lakes, wetlands and ponds in urban environments

The second meeting was organised with the focus set in discussing the way in which the items turned into questions to be formulated through focus groups organised in October 2018 (Table 1). A pre-test was conducted according to the questions proposed in this meeting. Then, ten households were randomly selected to validate the questionnaire. Eventually, four out of fifteen questions were improved accordingly as seen in Table 1. Additionally, twenty questionnaires were not completed appropriately, being removed from the study.

The data were analysed through Smart PLS Path Modelling. This method is conveniently used when the data are interdependent one to another within the constructs and the indicators. Those observables variables measure the latent variables (Sarstedt, et al. 2016). For an initial assessment of PLS-SEM model, some basic elements should be covered in the research report. If a reflective measurement model is used, which is the case for this study, the following topics have to be discussed: indicator reliability, internal consistency reliability, convergent validity, discriminant validity, checking structural path, and significance in bootstrapping. Smart PLS presents path modelling estimations not only in the Modelling Window but also in a text-based report which is accessible via the “Report” menu (Ringle et al. 2015). The PLS method was also applied, having been reported to be recommended for use in composite constructs (Rigdon et al. 2017). PLS-SEM allows estimating latent variables that represent different model types such as composite models. Those composite can be ‘Mode A’ in case of reflective measurement, which is the case of this research (i.e., the outer weights are the correlations between the construct and the indicators).

3. Data analyses

3.1. Analyses of the measurement model

The individual reliability was measured in first place. Table 3 shows the load (λ) of each item, being basically applied at a level of acceptance for the items. Values were higher than $\lambda >= 0.707$ (Carmines and Zeller, 1979).

Reliability and convergent consistency of each construct were assessed. Firstly, two indicators were used to test the consistency of the construct based on Götz et al. 2010: Cronbach's alpha and its Composite Reliability (CR). Those indicators (Cronbach's alpha and its Composite Reliability) evaluates the rigour with which each indicator measures their correspondent latent variable. The limit of acceptance for each construct is generally established between 0.6 and 0.7 for both the Cronbach's alpha and the CR (Hair et al. 2005). As it can be seen in Table 3, all the results ranged between those limits for minimum validity. Moreover, another indicator is tested (the rho_A) based on Dijkstra and Henseler (2015). It was also verified in all constructs which values exceeded 0.7.

Secondly, the Average Variance Extracted (AVE) was used in order to measure the convergent validity in PLS-SEM. The value of this indicator should be higher than 0.5 to be accepted. Table 3 shows that all constructs met this criterion.

Henseler et al. (2015) found the lack of studies to appropriately justify the discriminant validity. Therefore, they addressed a new technique known as the heterotrait-monotrait ratio (HTMT). The results obtained from the current research by applying this method have been listed in Table 4, showing that the assessed model is satisfactory. Thus, the HTMT ratio presented values lower than 0.9 (Gold et al. 2001).

the Standardized Root Mean square Residual (SRMR) was utilised in order to analyse the adjustment of the model. This indicator indicates the correlation matrix implied in the model and the observed correlation matrix. In the studied case, SRMR value was 0.073 which is lower than 0.08 which is the upper limit established by Hu and Bentler (1998), therefore providing good fit.

3.2 Structural model analyses

The structural model analysed the hypotheses formulated in 2.1. The analytical significance of the path coefficients was calculated using the Bootstrapp technic based on a 5000-sample (Tenenhaus, 2005). According to Chin (1998) the coefficient of determination (R^2) evaluates the structural model. In consequence, Chin (1998) reported that R^2 values ranging from 0.67 down to 0.33 and 0.19 can be considered strong, moderate and weak, respectively.

Our internal latent variable provided moderate values (ABC's R^2 = 0.360, ET's R^2 = 0.505). The main endogenous construct yielded strong values (EBE's R^2 = 0.783). AS a result of these findings, it is concluded that the results convey the applicability of the model within SuDS. Therefore, meaning that EBE has a high explanatory capacity through the remaining two latent variables ABC and ET.

In addition, Table 5 showed that the results reached in this study supported all relationships. Then, and according to the results expressed in Table 5, all relationships were significant at 99.9% confidence level, except for the relationship between ABC and EBE (β = 0.269, p-value = 3.503) and SuDS and EBE (β = 0.205, p-value = 0.027). Whereas the first one was supported by a 99% of confidence interval the second one was alternatively supported at 95%. The relationships which presented the highest load values were SuDS and ET (β = 0.710, T-Statistic = 11.702) and SuDS and ABC (β = 0.600, Statistical T = 10.914).

The blindfolding measures the level of prediction within the established model. In this regard, several data from the construct were be used as the estimation parameters in order to estimate the predictive capacity following Chin (1998). The application of Stone-Geisser's test (Q^2) (Stone, 1974; Geisser, 1974) allowed the analysis of the prediction capacity, revealing that the fixed model is predictive (Q^2 = 0.437) since $Q^2 > 0$.

4. Discussions

4.1 Theoretical implications

This research studied the perception of SuDS among neighbouring communities in a residential area located in Cáceres. Theoretical implications can be drawn from the results obtained, adding new findings to the general knowledge gap identified in the literature about the perception of SuDS in residential communities in Southern Europe.

These findings from this research unfold that neighbours gave special consideration to SuDS under a new scenario for stormwater management derived from the new paradigm of water management. This importance was significantly manifested by the fact that the relations showing higher statistical load were achieved in H_2= SuDS → ET (β = 0.710, T-Statistic = 11.702). This also translates into the fact that SuDS has a strong potential to environmentally transform urban areas. Similarly, SuDS are perceived by the community as providers of amenities and benefits for communities as per indicated by SuDS → ABC (β = 0.600, Statistical T = 10.914). Both hypotheses were accepted under a 99% confidence level. Hence, from the theoretical point of view, this research conveys that the application of SuDS has an important effect not only for the communities but also for the urban environment, as it was strongly perceived by the community studied in this case study.

In addition, H_3= ET -> EBE (β = 0.526, Statistical T = 4.046) and H3= ABC-> EBE (β = 0.269, Statistical T = 3.053) were found to be highly significant. This means that both the environmental transformation in urban areas, as well as its benefit for the community and amenities, impact positively in the ecosystem as perceived by the social fabric.

Nevertheless, the direct effect of SuDS over the environmental benefit for the ecosystem has the lowest significant level (95% interval confidence), nevertheless being high and significant in any case. This implication can be explained due to the novelty of SuDS and by the fact that they had not been appropriately understood by the community prior to this research. Therefore, further guidance and information are needed in order to improve understanding of SuDS techniques within the community supported by what it was reported by Bastien et al. (2012). Moreover, the barriers were identified as organisational such as lack of information about procedures, legal (i.e. uncertainty of the normatives to apply SuDS as per indicated by Williams et al. 2019), technical (uncertainty about the systems performance), planning (coordination of the steps to carry out the method and its relation to future problems), and economic such as the cost of maintenance.

4.2 Practical implications

SuDS not only influenced the improvement of the ecosystems through an environmental transformation in urban areas at an empirical level, but also through its benefits for the communities and amenities as it has been demonstrated by this study. Communities are aware of the potential benefit for the urban environment and its functional uses for them through consultation and participation in the process developed in this research. In consequence, communities understood that SuDS contributes towards protecting nature, prioritising environmental matters and help to develop consciousness of the potential environmental damage that the current conventional drainage systems have been contributing to develop under climate change scenarios.

Finally, communities showed a significant sensitivity towards SuDS by setting up environmental and ethical solutions. This reasoning meaning that the community studied in this research was willing to consider environmental solutions related to ecosystem services through the design and implementation of SuDS. Furthermore, when SuDS are designed within the framework of water ethics provided by the UNESCO's principles (UNESCO 2011), the scenario could be even brighter for them to be considered for full implementation by the community. This new environmental path helped communities to discover and explore new options to look after the environment beyond a mere comply with the legal requirements from an engineering/technical perspective. This standard approach has alienated human perceptions and its key role in design and planning for a long time. The ethical relationship showed in this research could influence future decision-making of these communities as it is assured by the capacity of prediction of the model ($Q^2 = 0.437$).

Thus, it is crucial to understand what barriers community has to raise in order to design and implement educational protocols and procedures, so to deliver a more effective model. Finally, the result showed is strongly high (EBE's $R^2 = 0.783$), concerning the explanatory capacity of the model, and thus ensures that SuDS would be accepted among those young-aged communities. This result highlights the importance of human aspects in SuDS as an integrated approach to value community perceptions for practice.

5. Conclusions

5.1 Main conclusions

The combination of the SEM and PLS methods allowed the development of an integral and robust approach to value community perceptions for practice in SuDS in low informed communities on the ecosystem benefits provided by these environmentally focused drainage techniques. Therefore, demonstrating that the wider method proposed by Ramírez and Sañudo-Fontaneda (2018) to deliver more ethical and environmental water management can be translated and tailored to the specific case of SuDS.

This new methodology contains transformative potential for change where informed communities of dwellers could implement SuDS through self-organisation, leading the way for resilient water systems in buildings and their surrounding areas in Southern Europe. This finding supports the conclusions from Atkinson et al. (2017) for the specific area of SuDS implementation through community self-organisation. This research reveals that neighbours gave special importance to SuDS when considering the new scenario for water management under climate change conditions in relation with its new water paradigm. This key role was significantly demonstrated by the strong statistical relationship between H_2, SuDS and ET (99% confidence level) which translates into a high potential to environmentally transform urban areas.

In addition, SuDS are strongly perceived by the community as amenity providers as it was demonstrated statistically through the relationship SuDS and ABC (99% confidence level). This pioneering experience conducted in the city of Cáceres could help to inform policies which enable further design and planning of these practices to uptake SuDS in the wider Southern European region. This work also complements the approach taken previously by Perales-Momparler et al. (2015, 2017) for cities in the Mediterranean region of Southern Europe from a social perspective.

Young-aged communities such as the ones targeted in this research presented significant sensitivity towards the implementation of SuDS when setting up environmental, ethical and NBS. This finding supports what it was reported by McKeiver and Gadenne (2005), and Kanchanapibul et al. (2014) about how young people are usually more opened to uptake environmental and ecological practices.

In consequence, this research demonstrated at a theoretical and practical levels that communities perceived that the implementation of SuDS could have a wider benefit for the urban environment by linking this benefit to amenity.

This work opens a new research line on the impact of human aspects in SUDS implementation, having further implications in design, construction and maintenance. Thus, it would help Southern European cities transition towards more sustainable urban water management, resilient to floods and droughts, following the path of other regions in the World as per referenced by Bos et al. (2012) and Ferguson et al. (2013), amongst other researches.

5.2 Limitations of this research and future research

This study could be also conducted in communities with different average ages in order to identify the barriers for SuDS implementation based upon age ranges. With this aim, we would recommend to extend this methodology to other cities in Southern Europe in order to inform communities across the Mediterranean region and to implement SuDS at a higher scale. In addition, further research could be carried out in other knowledge gaps identified in this paper such as: SuDS perception by engineers, architects and other practitioners in water management related areas in Sotuher Europe.

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FIGURES

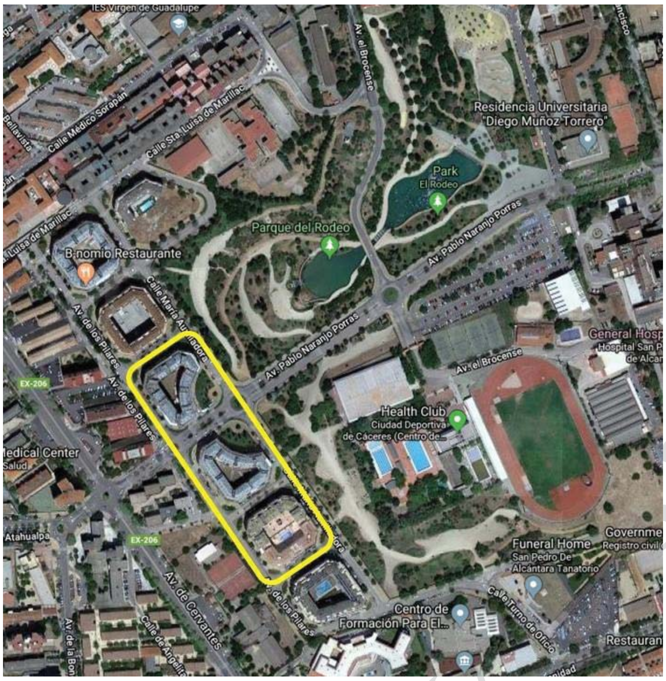

Figure 1. Neighbouring communities of dwellers participating in the study (highlighted in yellow), and surrounding areas (Source: Adapted from Google Maps).

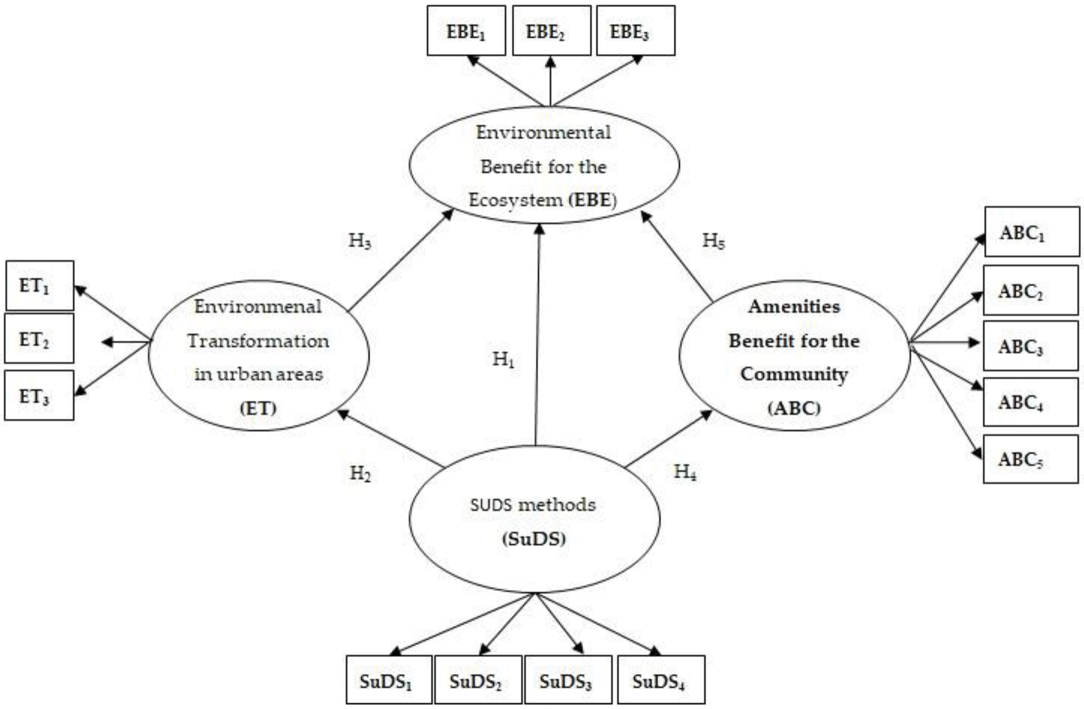

Figure 2. Human Aspects of SuDS: a model to value community perceptions for practice considering the 4 pillars of SuDS.

TABLES

Table 1. Original indicators and questions.

Original indicators	Questions
EBE_1: Environmental: SUDS provide secure surface water management	Is important for you to have an adequate system to control, catch, infiltrate, store and reuse water?
EBE_2: Socio-economic: increase in investment in comparison to conventional drainage systems, water saving, socio-economic value.	Do you consider as an important matter the investment to avoid the deterioration of the drainage system in order to save potable water?
EBE_3: Develop resilience/adaptability to future change: SUDS designed considering climate change, SUDS contributing to climate change, SUDS contributing to climate resilience, SUDS impact for community resilience and adaptation.	Do you give importance to have new drainage systems available beyond conventional drainage which adapt better to climate changes scenarios including extreme temperatures and rainfall events?
ET_1: planting and vegetation such as bioretention areas, wetlands, ponds and raingardens, creating attractive landscapes	How would you value drainage systems based upon the improvement of green areas like gardens and ponds, providing more attractive places for the neighbourhood?
ET_2: engineered and robust solutions such as permeable pavements	Do you account as a key factor the planning to implement drainage solutions such as permeable pavements and bioretention in order to improve to the existing drainage systems?
ET_3: treat water close to the point where it falls, avoiding combined sewer overflows, flooding issues and ponding effects in the streets	Is it important for you to reduce overflows, flooding issues and the negative effects of stagnant water by providing solutions applied at source level.
ABP_1: Enhance visual character/historical: integration in the surrounding area, SUDS designed to be visually attractive, level of support of local heritage and landscape.	Do you think that SuDS techniques could be implemented in your residence area making it more attractive visually and integrated in the larger urban area?
ABP_2: Improve security/safety: security	Do you believe that SuDS techniques are robust and safe

perception in the public, impact on safety measures, prevention.	solutions to manage rainfall and runoff water, reducing flooding issues whilst saving potable water?
ABP_3: Maximise multi-functionality: number of uses/functions, quality of multifunctional uses, ecosystem services.	Do you think that SuDS favor áreas such as recreation, socio-educative, health, tourism and aesthetics?
ABP_4: Legal: local regulations, legal barriers, national and international contexts.	Do you perceive barriers for the implementation of SuDS in your residential areas (i.e. legal, technical, organisational, economical, planning based barriers, etc.)
ABP_5: Community learning/education: community awareness, school involvement, education strategies.	Do you believe that SuDS could improve ecological consciousness in residential areas as well as in education centres?
$SUDS_1$: runoff quantity control	Do you consider important the implementation of SuDS applied to buildings like green roofs in order to control problems derived from intense rainfall at a building level?
$SUDS_2$: runoff quality management to prevent pollution	First flush effect produces significant pollutant risks in urban environments. Do you perceive as an important issue the option to have drainage systems able to reduce these pollution effects?
$SUDS_3$: create and sustain better spaces for people to live	Do you perceive SuDS as tools that help in creating greener spaces which contributes to the improvement of liveability conditions?
$SUDS_4$: create and sustain better spaces for nature bringing biodiversity back to the city	Do you think that SuDS promote biodiversity in urban environments?

Table 2. Main characteristics of the participants.

Information	**N=242**	**Percentage (%)**
Gender		
Male	132	55%
Female	110	45%
	242	100%
Age		
25 years or younger	52	21%
26-35 years old	92	38%
36-45 years old	39	16%
46-55 years old	29	12%
56-65 years old	16	7%
60 years old and above	14	11%
	242	100%
Type of family		
Live alone	32	13%
Family without children	42	17%
Family with two or less children	122	50%
Family with three or more children	46	19%
	242	100%
Education		
Primary School	10	4%
Secundary school	32	13%
Bachelor	80	33%
University	120	50%
	242	100%
Family incomes (per year)		
Less than 10,000€	8	3%
10,000-15,000€	10	4%
15,001€-20,000€	42	17%
20,001€-30,000€	118	49%
30,001€-50,000€	52	21%
Higher than 50,000€	12	5%
	242	100%

Table 3. Individual reliability, Cronbach Alpha, rho_A, Composite Reliability and Average Variance Extracted (AVE).

Latent variables	Indicator	Loadings	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
EBE	EBE_1	0.827	0.854	0.855	0.853	0.659
	EBE_2	0.819				
	EBE_3	0.765				
ET	ET_1	0.706	0.751	0.752	0.752	0.502
	ET_2	0.719				
	ET_3	0.701				
ABC	ABC_1	0.754	0.891	0.898	0.891	0.622
	ABC_2	0.784				
	ABC_3	0.701				
	ABC_4	0.754				
	ABC_5	0.931				
SuDS	$SuDS_1$	0.775	0.871	0.874	0.871	0.628
	$SuDS_2$	0.755				
	$SuDS_3$	0.769				
	$SuDS_4$	0.866				

Table 4. Measurement Model: Discriminant validity.

Heterotrait-monotrait ratio (HTMT)				
	ABC	**EBE**	**ET**	**SuDS**
ABC				
EBE	0.721			
ET	0.604	0.830		
SuDS	0.596	0.736	0.710	

Table 5. Comparison of Hypotheses.

Hypotheses	Effect	Path coeff (β)	t-statistic (β/STDEV)	p-Value	Supported
H_1	SuDS -> EBE	0.205	1.927	0.027	Yes *
H_2	SuDS -> ET	0.710	11.702	0.000	Yes ***
H_3	ET -> EBE	0.526	4.046	0.000	Yes ***
H_4	SuDS -> ABC	0.600	10.914	0.000	Yes ***
H_5	ABC -> EBE	0.269	3.053	0.001	Yes **

Notes: For n = 5000 subsamples, for t-distribution (499) Student´s in single queue: * p < 0.05 (t(0.05;499) = 1.64791345); ** p < 0.01 (t(0.01;499) = 2.333843952); *** p < 0.001 (t(0.001;499) = 3.106644601), n.s. : not significant.