Universitat Internacional de Catalunya
School of Architecture

Tesis doctoral

Assessing leisure time physical activity (ltpa) experience in urban. Stream corridors: a baseline for inclusive ltpa promotion.

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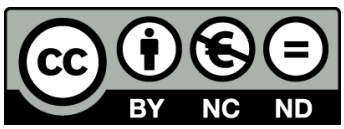

ASSESSING LEISURE TIME PHYSICAL ACTIVITY (LTPA) EXPERIENCE IN URBAN STREAM CORRIDORS:

A BASELINE FOR INCLUSIVE LTPA PROMOTION

Doctoral Thesis

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Abstract

Leisure-Time Physical Activity (LTPA) in urban stream corridors is of paramount importance for health and wellbeing promotion among urban dwellers. LTPA experience, namely how (what, with whom, when and where) and why LTPA is practised in particular places, is influenced by various social and physical environmental factors which the stream users may perceive differently. Therefore, an improved understanding of how stream users perceive environmental factors may provide relevant insights and inform on strategies intended to support inclusive LTPA promotion. To this end, combining ecological models with a qualitative Geographic Information System (qGIS) methodology is valuable. The ecological models provide a comprehensive theoretical framework which helps understand the environmental factors that influence LTPA, whilst the qualitative research methods serve to reveal any hidden meanings related to individual experiences behind factors. The collected data combined with GIS, enable the exploration of subjective perceptions of the environment with reference to its spatial dimension.

Therefore, this study assessed users' perceptions of the environmental factors that influence LTPA experiences in the Caldes Stream corridor, in the Metropolitan Region of Barcelona. Accordingly, a sequential mixed methodology based on qualitative ecological approach integrated with GIS was developed in two phases. First, in-depth map-based and go-along interviews allowed for: 1) the categorization of the different types of stream users according to their characteristics and motivations for LTPA, 2) the identification of the social and physical environmental factors influencing LTPA, 3) the assessment of factors as either barriers or facilitators to LTPA for each type of stream user according to their perceptions. Secondly, given that the safety issue emerged as a key factor influencing women LTPA in the Caldes Stream corridor, the analysis of the relationship between environmental factors and women's perceptions of safety was undertaken. In-depth interviews with women were further analysed for: 4) the identification of the environmental factors related to women's perceptions of safety in the stream corridor, and 5) the design of a safety map able to represent both the women's general and individual perceptions of safety. For the creation of this analytical tool environmental factors were

translated into spatial indicators, women's perceptions were geo-located, and the resultant data was integrated into qGIS.

Findings of the present study provided a greater understanding of the different ways in which different users interpret and interact with urban stream corridors when practising LTPA. Specifically, different types of users perceived environmental factors influencing LTPA as either barriers or facilitators contradictorily or coincidentally depending on their motivations for LTPA and their gender. The major conflicts related to divergent perceptions between genders depended on perceptions of safety. Perceptions of safety among women were related to environmental factors, yet they were mediated by women's socio-cultural background and everyday practices. Against this backdrop, the safety map based on a qualitative GIS approach designed for this study, allowed the assessment of the macro-scale spatial indicators of the environmental factors and the micro-scale of women's narratives on perceptions of safety from an integrated perspective. The macro-scale perspective provided a general explanation for the phenomenon and helped visualise conflicting domains of interventions. The micro-scale produced deeper and detailed insights into the perception of safety by comparing the big picture with women's narratives.

These findings suggest that 1) the characterisation of types of users according to their motivations for practicing LTPA in green environments and 2) their gender perspective should be at the forefront of inclusive LTPA promotion strategies. At this regard, qGIS analytical tools aimed at identifying the particular needs of the specific types of users could support the customisation of interventions by providing knowledge on the tangible and intangible dimensions associated to the different LTPA experiences. Basing on this knowledge, LTPA promotion policies should combine the provision of physical infrastructure suitable for the different types of users, and long-term educational programs addressed to overcome the limiting effects of certain socio-cultural backgrounds.

To conclude, this research has shown that the thorough understanding of the users' LTPA experience in urban stream corridors provides significant knowledge to inform policies for inclusive LTPA promotion, thus mitigating the risk of health inequalities among different types of stream users.

1. Introduction

1.1. Leisure-time physical activity promotion among urban dwellers for public health improvement

Non Communicable Diseases (NCD) such as cardiovascular diseases, diabetes, cancers, and chronic lung diseases account for approximately 70% of deaths worldwide (WHO, 2018). The burden of cardiovascular diseases among other NCD has been increasing rapidly in high-income countries where they are responsible for 44% of all NCD deaths (WHO, 2002, 2009). Epidemiological studies suggest that most cardiovascular diseases are attributable to lifestyle and particularly to a significant increase in sedentary behaviours associated with rapid urbanization (Goryakin, Rocco, & Suhrcke, 2017; The Lancet Diabetes & Endocrinology, 2017; WHO, 2002, 2009). This implies that interventions designed to increase physical activity among urban dwellers are paramount for preventing cardiovascular diseases and improving public health.

Physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure, including activities undertaken while working, playing, carrying out household chores, travelling, and engaging in leisure pursuits (WHO, 2019). Among the different types of physical activity, in the context of this thesis we focused on leisure-time physical activity (LTPA), defined as "physical activity by choice", which are not performed for the sake of exercise only, but also for its meaningful and enjoyable quality. It includes activities such as walking, bicycling, jogging, practising sports, playing, gardening and being in contact with nature (Sallis et al. 2006, p. 308). Reason behind this choice was twofold. First, LTPA is the largest contributor to total physical activity in high-income and urbanized countries (Bauman et al., 2012). Secondly, LTPA presents the greatest potential for interventions to increase physical activity participation and maintenance over time (Godbey, Caldwell, Floyd, & Payne, 2005).

1.2. Green environments as key contributors to public health promotion: the strategic role of urban stream corridors

Green Environments (GE) in urban areas have a central role for health and wellbeing promotion since they provide opportunities for LTPA (Hartig, Mitchell, de Vries, & Frumkin, 2014; Nieuwenhuijsen et al., 2014; Vert et al., 2019). GE include natural surfaces as well as urban greenery, additionally they can also comprise blue spaces i.e. water elements ranging from ponds to coastal areas (Finlay, Franke, McKay, & Sims-Gould, 2015; WHO Regional Office for Europe, 2016). The use of urban GE for LTPA is determined by different factors including proximity (Annerstedt et al., 2012; Gascon et al., 2016; Jilcott, Evenson, Laraia, & Ammerman, 2007; Stessens, Khan, Huysmans, & Canters, 2017), greenness (Sarkar et al., 2015), size (Banzhaf, de la Barrera, & Ieee, 2017; Baran et al., 2014; Stessens et al., 2017) green space area per-capita (Cradock, Melly, Allen, Morris, & Gortmaker, 2009), accessibility (Baran et al., 2014; Edwards, Giles-Corti, Larson, & Beesley, 2014), physical (Baran et al., 2014; Cradock et al., 2009; Edwards et al., 2014; McGinn, Evenson, Herring, & Huston, 2007) and social characteristics of the surrounding neighbourhoods (Baran et al., 2014; Cradock et al., 2009; Gobster & Westphal, 2004). However, it has been also showed that differing uses and health outcomes dependent on demographic factors, including gender, age, ethnicity and socioeconomic status (WHO Regional Office for Europe, 2016).

Although most studies on urban GE impacts on health and wellbeing have focused on public parks (Coutts & Miles, 2011), urban greenways deserve a special attention because of their unique benefits. Urban greenways are linear open-space areas equipped with trails and developed along natural corridors such as river valleys. Their popularity has grown to the point that they are now defined as ‘corridors of benefits’ due to the environmental and social functions they can serve (Moore & Moss, 1998). As a matter of fact, greenways along natural corridors can be managed to protect any assets of natural, cultural and historical significance, provide an outdoor laboratory for environmental education, create habitat for wildlife migration, reclaim brownfields, secure water quantity and quality, and last but not least, they also provide attractive settings for recreation (Coutts & Miles, 2011). Recreational greenways allow significant use from people who perform multiple forms of LTPA or look for relaxation, challenge, adventure, family togetherness, but also from those who aim at increasing their own awareness of nature, sense of place, and sustainable mobility options (G Lindsey & Nguyen, 2004; Greg

Lindsey, Wilson, Yang, & Alexa, 2008; Moore & Moss, 1998). Moreover, recreational greenways in urban settings have the potential to interconnect parks, nature reserves, cultural features or historic sites and neighbourhoods with variable social features (Coutts & Miles, 2011). In sum, recreational greenways provide a large number of urban dwellers with a wide range of opportunities of leisure activities and living in contact with nature (Coutts, 2008).

The present thesis focused on a particular type of recreational greenways: the urban stream corridors. After decades of intensive urbanisation and environmental neglect, the restoration of urban waterways in European metropolitan regions has received considerable investments to recreate functional floodplains integrated into attractive parkland landscapes (EEA, 2016; Findlay & Taylor, 2006). The general approach aims at decreasing local flooding and water pollution while achieving an additional integrated set of cultural and educational benefits concerning biodiversity, microclimate, leisure, tourism and basic facilities. Said benefits contribute collectively to regenerate riparian areas and underpin human health and wellbeing (Findlay & Taylor, 2006; Vert et al., 2019). However, research on how LTPA enhancement in restored recreational greenways and in urban stream corridors impact on health and wellbeing is presently sparse although it is slowly growing (Coutts & Miles, 2011; Gascon, Zijlema, Vert, White, & Nieuwenhuijsen, 2017; Reynolds et al., 2007; Wolch et al., 2010).

1.3. Understanding the factors influencing Leisure-time physical activity experiences in urban stream corridors: toward a qualitative ecological approach

Understanding the factors that influence LTPA experience in urban stream corridors is vital to promote LTPA in urban dwellers' daily routines. However, the majority of the studies on LTPA in GE have been based on quantitative approaches their aim being to define determinants (causal factors) and correlates (statistical associations) of LTPA through objective measures of large population samples. Consequently they tend to draw conclusions about generic human responses rather than understand people's perceptions of GE and how these perceptions affect the GE use for a given LTPA (Gobster & Westphal, 2004). On the other hand, several studies have proved that objective measures and subjective perceptions of the factors influencing LTPA are the two sides of the same coin, thus deserving the equal

consideration (Jilcott et al., 2007; Kothencz & Blaschke, 2017; Lee et al., 2017; McGinn et al., 2007). Further research is needed to comprehensively understand LTPA experiences and, in particular, how and why different types of users experience the GE while practicing LTPA (Andrews, Hall, Evans, & Colls, 2012; Bell, Phoenix, Lovell, & Wheeler, 2015a; Thomas, 2015). With this in mind, combining qualitative and ecological approaches, which have been gaining momentum in the contemporary scientific debate on LTPA behaviour, could prove to be a significant advance (Brymer, 2010; Dashper & Brymer, 2019; Öztürk & Koca, 2019).

Qualitative approaches to LTPA behaviour have been receiving increasing attention since they provide a deep insight into LTPA experience (Bell, Phoenix, Lovell, & Wheeler, 2015b; Foley & Kistemann, 2015). More specifically, qualitative research based on phenomenology seeks the essential structure of human experiences to understand human behaviours. The central focus is that people exist in relation to their environment, forming an indissoluble unit (Stewart & Mickunas, 1990, p. 9). Accordingly, LTPA experience is the result of a complex, ever-changing series of interactions between the individual and the physical and social living environments (Figure 1). These interactions characterise a place and the individual's own psychological features which manifest externally through particular behaviours (Buttimer & Seamon, 1980). Thus, people's behaviour become a critical variable for understanding the way people experience a place and the task of qualitative research is to delve into the variety of ways which people behave in and experience their everyday world. To this end, experience patterns are used as a tool to unbury, describe, and thematise particular routines that people usually take for granted and conduct in their day-to-day existence without paying constant conscious attention (Buttimer & Seamon, 1980). To carry out this process, qualitative methodologies take researchers into the real worlds to produce results 'grounded' in the empirical world and generate theories inductively (Glaser & Strauss, 1967; Welch & Patton, 1992).

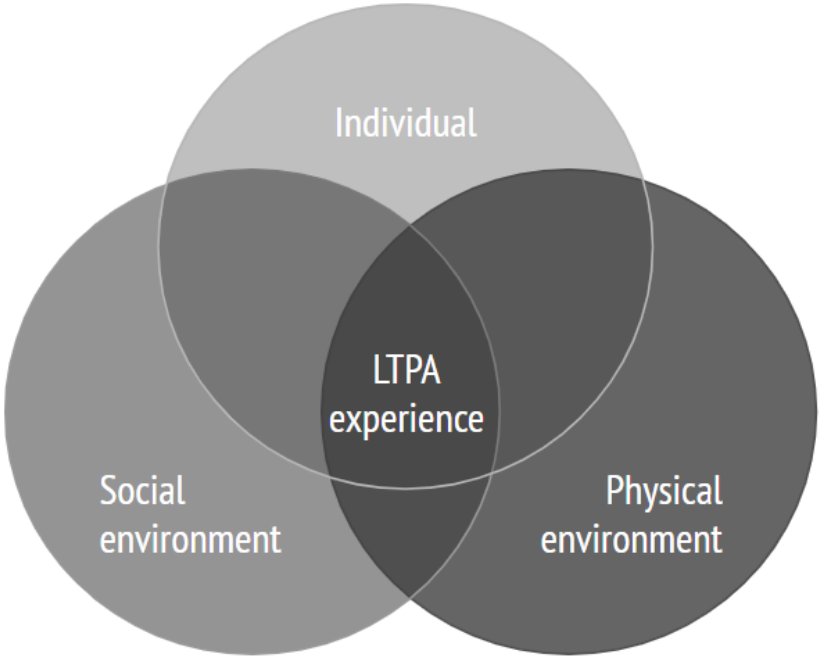

Figure 1: Factors influencing LTPA experience analysed in this thesis. Source: own elaboration

The ecological approach provides a comprehensive model of the multiple factors that influence LTPA and has been recognized as the most effective approach for LTPA promotion. The core principle of ecological models is that human behaviours result from interactions between the individual and the physical and social environment. Due to the complexity of LTPA experience, the ecological models suggest that mutual interactions between multilevel factors at individual, social, physical and institutional levels contribute to physical activity behaviour (Stokols, 1996). In order to be effective, LTPA promotion strategies should therefore be based on multi-level and multi-sectorial approaches which require the trans-disciplinary contribution of public health and behavioural sciences along with social, urban planning transportation, leisure, public policy, economics, and political sciences (Sallis et al., 2006; Sallis, Owen, & Fisher, 2008). Psycho-social factors have received greater attention by researchers and the interventions supported at individual scale (or on small groups) have been shown to have moderate and temporary effects (Glanz, Rimer, & Viswanath, 2008). Contrarily, physical and social environmental factors still remain under-researched although they are expected to have widespread population-level effects on LTPA promotion (Bauman et al., 2012).

Despite their potentialities, qualitative and ecological approaches have rarely been applied in a thorough and comprehensive manner (Brymer, 2010; Dashper & Brymer, 2019; Öztürk & Koca, 2019). To our

knowledge, no study has adopted an integrated approach to understand the social and physical environmental factors that influence LTPA experience in urban stream corridors and to reflect on the implications of this understanding on LTPA promotion enhancement.

1.4. The use of qualitative Geographic Information System in the analysis of Leisure-time physical activity experiences

Map-based approaches are long-standing methods that human geographers, planners, and environmental psychologists use to understand how people experience places. Translating people's thinking into a tangible map may be an effective method to understand the interactions between individuals and the environment. This method has been utilized to identify a range of community concerns, to understand people's preference, perception, knowledge or behaviour, and in general to reveal otherwise invisible landscapes (J. W. Curtis, 2016) .

With the emergence of Geographic Information Systems (GIS), these map-based approaches have evolved into what is currently known as qualitative Geographic Information System (qGIS). Concretely, qGIS combines qualitative methods with conventional quantitative GIS technologies and has shown a great potential in providing insights into the diverse and subjective ways in which people experience, relate, and value places (Cope & Elwood, 2009; Mitra, Siva, & Kehler, 2015). Therefore, the greatest merit of this mixed methodology is to allow researchers to collect subjective (qualitative) data associated with objective (spatial, quantitative) data (A. Curtis et al., 2015). Given its versatility, several authors have used qGIS with very different objectives (Table 1).

Authors	Research goals	Qualitative data collection techniques							
		Participatory mapping	Sketched maps	GPS mapping	Focus groups	Interviews	Participant observations	Environmental Audits	Guided tours
Alarasi et al. (2016)	To explore youths' perceptions of their city center	x			x	x			x
Bagheri (2014)	To gather insights from women in Tehran socio-spatial behaviours					x	x		
Battista and Manaug (2018)	To develop user oriented walkability framework that incorporates social and personal factors mediating spatial engagement					x			
Boschmann and Cubbon (2014)	To explore perceptions of fear and safety in public spaces among LGBTI communities		x			x			
Curtis (2012, 2016)	To explore perceptions of fear and safety in public spaces		x						
Curtis et al. (2014)	To explore youths' perceptions of their neighbourhood		x						
Curtis et al. (2015)	To understand the neighbourhood context of a patient's life in order to improve education and treatment					x			
Garcia et al. (2018)	To spatially identify and describe conflicts in an urban stream corridor	x				x			
Harman (2015)	To explore women access to resources, agricultural practices, and knowledge and perceptions in the context of food security and soil conservation	x		x	x	x			
Keddem et al. (2015)	To support health-related strategies based on the understanding of the environmental factors that affect asthma control					x			
Kelley et al. (2012)	To explore youths' perceptions of urban nature		x						
Kwan (2008)	To explore perceptions of fear and safety in public spaces among Muslim women		x			x			
Maclaurin (2011)	To explore perceptions of fear and safety in public spaces among university students	x				x			
McCray and Brais (2007)	To assess the role that transport plays in fostering social exclusion		x		x				
McQuoid et al. (2018)	To support health-related strategies based on the understanding of the environmental factors affecting substance use					x			
Schoepfer and Rogers (2014)	To delve into people's images and perceptions of their neighbourhood					x			
Sloan et al. (2016)	To understand the environmental factors affecting avoidance behaviour in university students		x						
Topmiller et al. (2015)	To gain youths' local knowledge of neighbourhood environments	x	x		x			x	
Wridt (2010)	To explore youths' perceptions of their neighbourhood	x							

Table 1: qGIS approaches to explore people's perceptions of places.

Three main methodological merits of qGIS emerged from these studies. By portraying participant's narratives and highlighting the spots where similar participants' perceptions clustered qGIS 1) offers countermapping perspectives, 2) generates detailed spatial information from individuals, and 3) facilitates interpretation of the results. Moreover, qGIS approaches have the capacity to translate

individual perceptions into spatial indicators, even though this opportunity has been rarely sized (Kothencz & Blaschke, 2017). In order to capture well measurable and quantifiable physical place attributes and to support urban planning, macro-scale spatial indicators have been extensively used in traditional GIS analysis (Kothencz & Blaschke, 2017). However, the integration of macro-scale spatial indicators with micro-scale users' perceptions is less known and the strengths of this integrated perspective for LTPA promotion still need to be addressed.

2. Hypothesis and objectives

The research gaps, identified in the previous section and summarized in Figure 2, serve as starting point for formulating the hypothesis and objectives of this thesis.

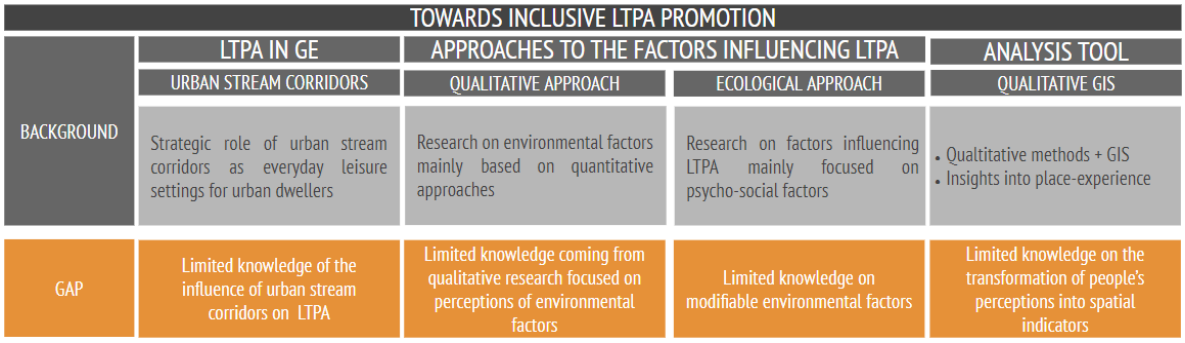

Figure 2: Research gaps addressed by this study. Source: own elaboration

Hypothesis

Urban stream corridors report important benefits to health and wellbeing by enhancing opportunities for LTPA among urban dwellers. The assessment of users' perceptions of the environmental factors which influence LTPA experiences in urban stream corridors provides relevant insights to inform the strategies intended to support inclusive LTPA promotion.

General objectives

1. To assess users' perceptions of the environmental factors influencing LTPA in urban stream corridors (Paper 1).

2. To explore the relationship between environmental factors and perceptions of safety among women (Paper 2).

Specific objectives

<u>Paper 1</u>

1.1 To categorize the different types of LTPA users in the Caldes Stream corridor according to their characteristics and motivations for LTPA.

1.2 To identify the social and physical environmental factors influencing LTPA.

1.3 To assess the role of environmental factors as either barriers or facilitators to LTPA for each type of stream user according to their perceptions.

Paper 2

2.1 To identify the physical and social environmental factors related to women's perceptions of safety/fear in the Caldes Stream corridor.

2.2 To design an analytical tool that allows the integrated assessment of micro-scale women's perceptions of safety with macro-scale spatial indicators of the identified environmental factors.

3. Methodology

3.1. Case study research methodology

This work was developed using a single case study research methodology. By definition, case study based methods consist in selecting a small geographical area and/or a limited number of individuals as the subjects of study, thus exploring contemporary real-life phenomenon through detailed contextual analysis of limited numbers of events or conditions and their relationships (Yin, 2017). Such methodology allowed a holistic and in-depth understanding of LTPA experiences in GE and, on the basis of this specific knowledge, it enabled the researchers to examine data within a particular context and to understand which mechanisms behind LTPA experience in urban stream corridors may be validated in other GE (Lijphart, 1971).

More specifically, given the relevance of place in LTPA experiences, the case study research approach allowed the qualitative ecological exploration of the relationships between users and their environment in a specific real-life situation. In relation to the specificities of the context, the methodology adopted enabled the thorough examination of how and why LTPA was conducted as well as the combination of qualitative and quantitative data through a qualitative Geographic Information System (Zainal, 2007).

3.2. Description of the case study : the Caldes Stream in the Metropolitan Region of Barcelona

This study took place in the corridor of the Caldes Stream, an urban watercourse in the Metropolitan Region of Barcelona, Spain. Together with the Mogent, the Congost, the Tenes, the Ripoll and the Besòs, the Caldes Stream belongs to the Besòs River basin which runs mostly through the Vallès depression, between the Litoral and Prelitoral mountain chains (Figure 3). After years of overexploitation the environmental and social rehabilitation of the basin is requiring the efforts of administrations and local entities which during the last three decades had worked to control the water quantity, enhance environmental quality, and involve the citizen in the maintenance of the river landscape (Benages-Albert & Vall-Casas, 2014).

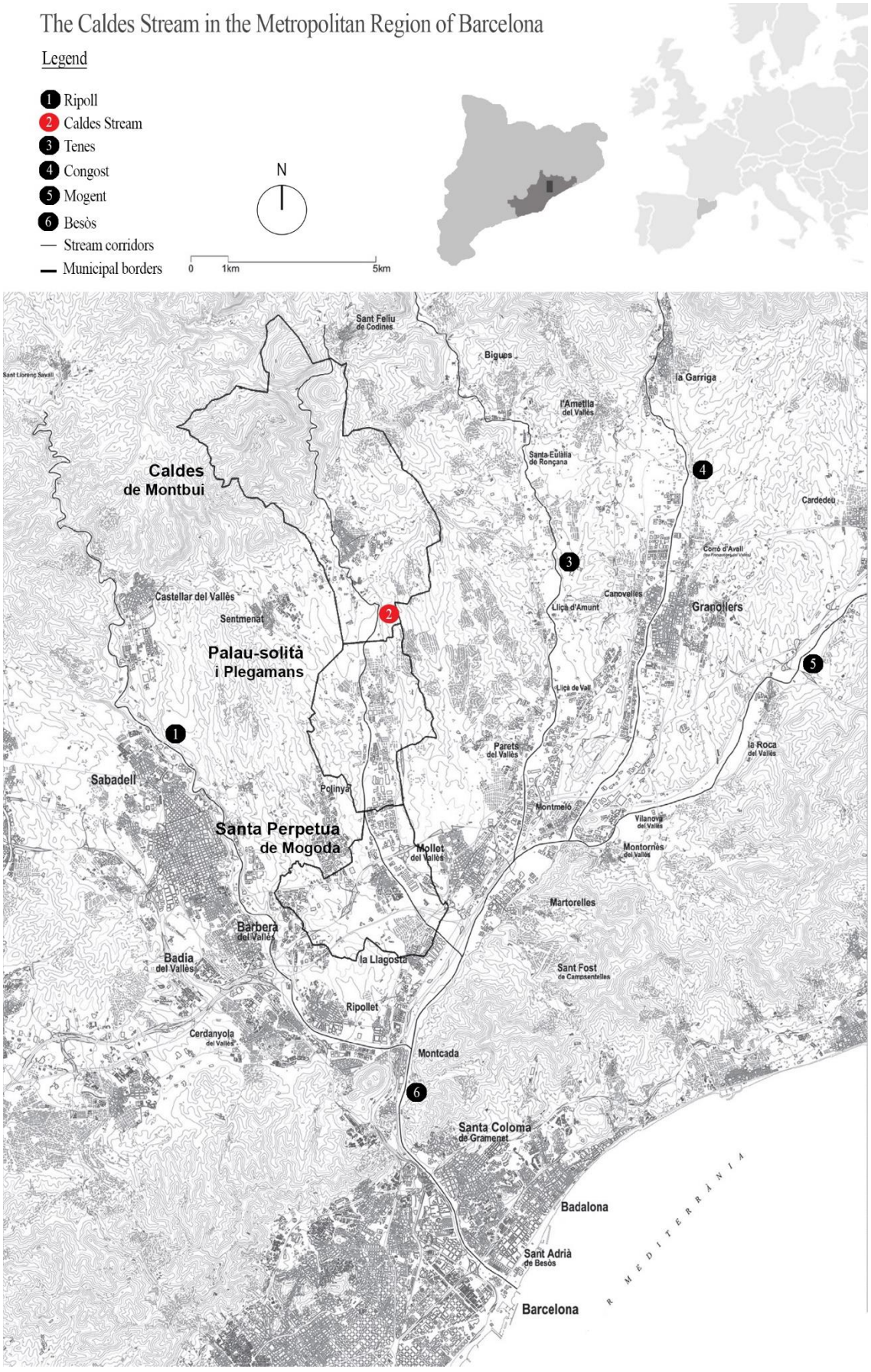

Figure 3: The Caldes Stream in the Metropolitan Region of Barcelona. Adapted from Benages-Albert et.al. (2015)

Since the 1950s, the traditional agricultural use of water and land resources had been gradually replaced by an intense land occupation aimed at supplying the growing population and the industrial demands. The consequent suburban sprawl in this industrial area resulted into a low-density urban development along the stream corridor which did not show the typical concentration of a traditional compact city (Vall-Casas et al., 2019). In the period from the 1960s to the 1970s the relocation of factories from the city of Barcelona and the growing popularity of second homes fostered a rapid and scattered development. Between the 1980s and the 1990s medium-to large-scale international companies in the electronic, IT and pharmaceutical sectors settled in the area attracted by the proximity of the metropolitan market and the availability of a cheap but quality industrial land. Between 1980 and 2000 a low-density residential growth affected the area supported by an improved metropolitan road system connecting the agrarian municipalities of Barcelona's hinterland to the city. Said urbanization process was marked by degradation and oblivion to the extent that it spoiled the traditional human-environment relationships of the relevant communities. Since the 2000s the rehabilitation of the corridor has been carried out. On the one hand, the consolidation of agricultural parks has been applied in order to counteract the impacts derived from the diffuse urban development (Vall-Casas et al., 2019). On the other hand, public administrations and citizen associations promoted an -at times unplanned- protection, an environmental improvement and a social use of the remaining open spaces within this area (Benages-Albert & Vall-Casas, 2014).

As a result, the Caldes Stream corridor is today a strategic green infrastructure which organizes a significant urban area of the Metropolitan Region of Barcelona interconnecting components with environmental and social values (Vall-Casas et al., 2019). The urban stream corridor performs multiple functions at local, regional, and national scales, including the promotion of certain ecosystem services (e.g., protection of the natural habitats, clean air, extreme weather mitigation, human mental and physical well-being) and the enhancement of local development (Feira Toribio & Ramos, 2017). Moreover, the accumulation over time of public spaces, pathways and amenities along the Caldes Stream has led to the creation of an important recreational greenway with relevant influence on the health and well-being of many metropolitan dwellers (Benages-Albert & Vall-Casas, 2014).

The Caldes Stream crosses four main municipalities: Caldes de Montbui, Palau-Solità i Plegamans, Santa Perpètua de Mogoda and La Llagosta. Of its 22 km length, the study focused on the 19-kilometre stretch flowing through the first three municipalities, where about 60,000 inhabitants live (Institut d'Estadística de Catalunya, 2019). The main reasons behind this choice were related to the recreational value of this stretch as well as its physical conformation. Given that the stretch is a key leisure setting for local urban dwellers, it eased recruitment of a heterogeneous sample of stream users, and thus the identification of a whole variety of LTPA experiences. On the other, the complex riparian landscape made up of forestry and agro-forestry areas, low-density residential areas, and industrial estates (Figure 4) enabled the identification of multiple environmental factors (Benages-Albert & Vall-Casas, 2014). With regard to specific objective 2.2 (Paper 2), the study area was framed within the 0.5-kilometre wide buffer around the 19-kilometre stretch, since it included all the itineraries frequented on a daily basis by the women interviewed. The two most frequented itineraries (6.5 km and 3.8 km long respectively) were selected for the spatial analysis (see Figure 2, Paper 2).

Figure 4: The Caldes Stream landscape. From the upper left corner to the bottom right corner: forestry, agroforestry, low density residential, and industrial areas. Source: own elaboration.

3.3. Sequential mixed-model design: Qualitative Geographic Information System approach

The combination of both quantitative and qualitative approaches in a single research project has become steadily more recognised by academics since it provides a complete and comprehensive understanding of an issue. Among several mixed method typologies, this study adapted the sequential mixed model design of Tashakkori and Teddlie (2003) showed in Figure 5. The model is sequential because qualitative and quantitative studies are set out in consecutive order and because one set of data provides a sound basis for collecting the other one. Each study includes data collection, data analysis and inferences. The final meta-inferences are made on the basis of the inferences from the qualitative and quantitative studies (Tashakkori & Teddlie 2003).

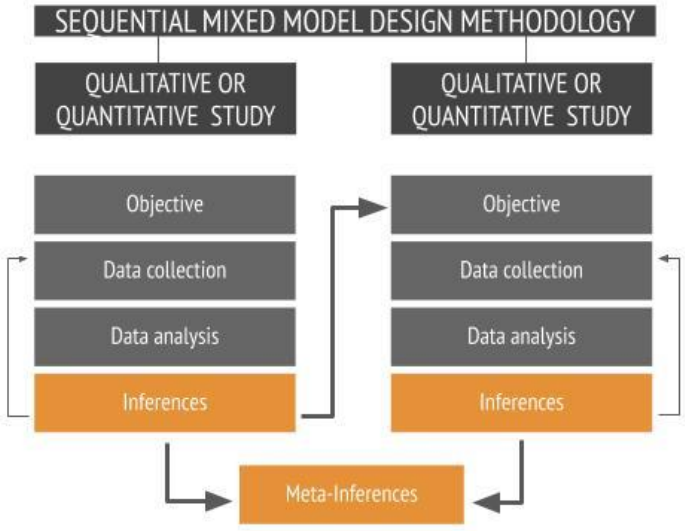

Figure 5: Sequential mixed model design. Source: own based on Tashakkori and Teddlie (2003)

Figure 6 shows the application of the sequential mixed model design to this research. Concretely, phase I took a qualitative approach whereas phase II took a quantitative approach. Phase I was developed throughout two sub-phases (sub-phase I.I and I.II), which are sequential themselves. The sub-phase I.I (paper 1) adopted the qualitative ecological approach for the purpose of analysing users' characteristics and perceptions of the environmental factors which influence LTPA in the Caldes Stream corridor. The process of data collection lasted from January to November 2016 and served both sub-phases of the

qualitative study. An early exploratory fieldwork conducted a documentary research and participant observations which included interviews with local experts to gain familiarity with the context being studied. This process prepared the ground for the main fieldwork, during which in-depth map-based and go-along interviews gathered extensive insights into the subjective LTPA experiences of a heterogeneous sample of stream users. Interviews were analysed with Computer Assisted Qualitative Data Analysis (CAQDAS) in order to 1) categorize the different types of stream users according to their characteristics and motivations for LTPA, 2) identify the social and physical environmental factors influencing LTPA, and 3) assess factors' role as either barriers or facilitators to LTPA for each type of stream user according to their perceptions. This research process enabled the assessment of people's LTPA experiences from a holistic and sensitive perspective, which facilitated the development and analysis of the emergent themes in the following phases (Buttimer & Seamon, 1980).

More specifically, the safety issue emerged as a key factor influencing women LTPA in the Caldes Stream corridor. Consequently, through an iterative process, sub-phase I.II (paper 2) focused on women's in-depth interviews and applied a second qualitative content analysis to 1) identify the environmental factors related to women's perceptions of safety or fear in the stream corridor, 2) translate the environmental factors into spatial indicators, and 3) geo-locate women's perceptions. Although the process of analysis was non-linear it progressed towards the successive phases through steps moving backward and sideward before moving on. Such research path was highly effective in creating a feeling for the whole, grasping subtle nuances of meaning, pulling together divergent information and switching perspectives (Cameron, 2009; Neuman, 2006).

During phase II, these qualitative data was integrated into GIS in order to conduct a quantitative spatial analysis. The spatial indicators were weighted according to their capacity to convey safety and were successively combined into a composite safety index that measured women's general perception of safety. Inferences from each phase complemented each other into final meta-inferences resulting in a safety map that combined safety index values with individual perceptions (paper 2).

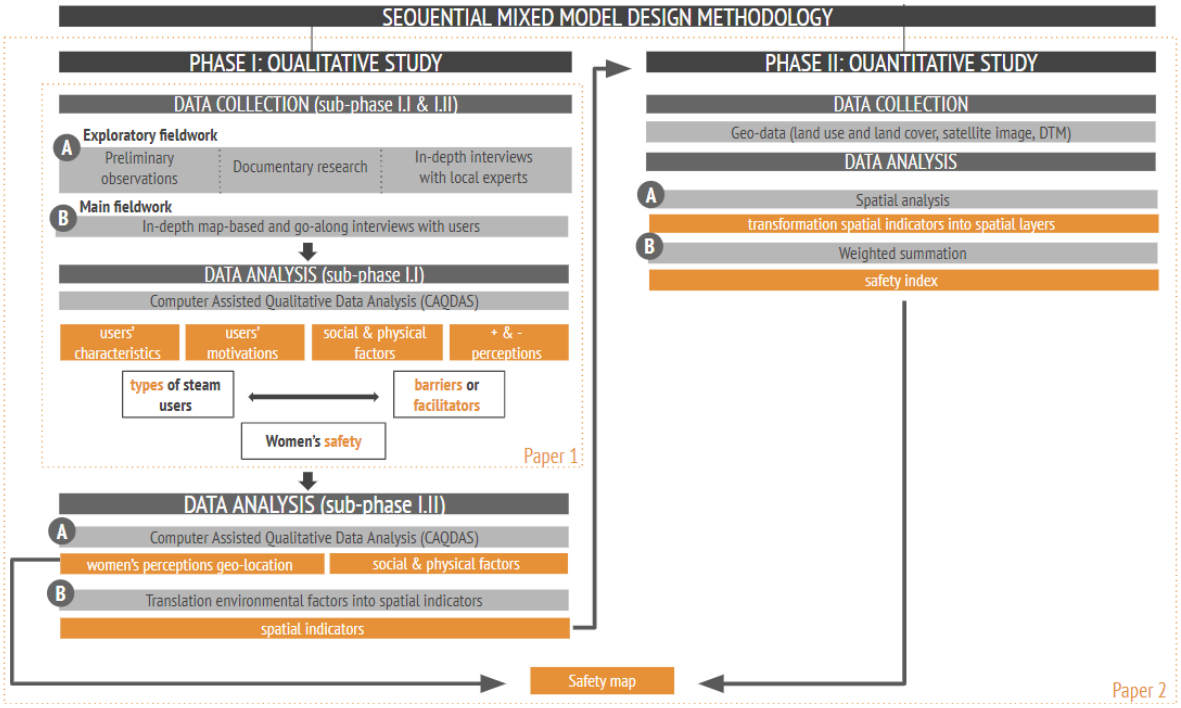

Figure 6: Application of the sequential mixed model design methodology. Source: own elaboration

3.4. Data collection and analysis.

Table 2 provides general information on the process of data collection and analysis. Due to the mixed-method research design, the table informs on the objective or subjective nature[1]of the data collected and on the type of sources (primary or secondary[2]). Moreover, it specifies whether data is analysed with qualitative or quantitative approaches. Besides, the table informs on the period of time in which both data collection and analysis took place and also on the sample they used. Concretely, the sample included 16 local experts in LTPA and public spaces from the three municipalities as exploratory fieldwork and 30 participants, 14 women and 16 men, aged between 27 and 81 as main fieldwork. Given that this research involves human participation and personal data, the study gained approval from the Committee for Research Ethics of the Universitat Internacional de Catalunya (ref: ARQ-2018-01) (See Appendix

[1] Objective data is the information that we can gather using a measurement or an observation. It reflects reality deprived of personal elements from the interviewee. Subjective data is gathered from the interviewees and it belongs to their perspective and expresses their particular experience.

[2] Primary sources provide raw information and first-hand evidence. Secondary sources provide second-hand information and commentary from other researchers.

Committee **for Research Ethics approval**).

	Data (Data source)		Objective/ subjective	Primary/ secondary	Timeline	Sample
Data collection	**Exploratory fieldwork**					
	Documentary research		o	s	January-May 2016	local experts n=16
	Participant observations		s	p		
	In-depth interviews					
	In-depth map-based interviews (16)		s	p	May 2016-April 2017	n=30
	In-depth go-along interviews (14)		s	p		
	Spatial data collection					
	Digital Terrain Elevation Model (DTM) of Catalonia (ICGC, 2018a)		o	s	March-May 2018	-
	Land use and land cover of Catalonia (CREAF, 2009)		o	s		
	Streetlights within 500 m buffer from the Caldes stream (Google Earth, 2018) and urban planning services		o	s		
	Streets included in the topographic base map of Catalonia (ICGC, 2018b)		o	s		
	Abandoned areas and discotheques within 500 m buffer around the Caldes Stream(Google Earth, 2018)		o	s		
			Qualitative (QL)/quantitative (QT)			
Data analysis	CAQDAS with Atlas.ti software	Sub-phase I.I	QL		October 2016 – June 2017	n=30
		Sub-phase I.II	QL		June-October 2018	Only women n=14
	Translation of environmental factors into spatial indicators		QT		June – October 2018	-
	Spatial analysis with GIS		QT			
	Weighted summation		QT			

Table 2: Data collection and analysis.

4. Results

4.1. Perception assessment of environmental factors related to Leisure-time physical activity in an urban stream corridor (Paper1)

TABLE OF CONTENT

Abstract

Leisure-Time Physical Activity (LTPA) in green environments is influenced by various social and physical environmental factors. A better understanding of how green environment users perceive these factors may have important implications for health and wellbeing promotion among urban dwellers. This research explores LTPA environmental factors and related perceptions in a Barcelona metropolitan stream corridor case study. We analysed the information collected by means of 30 in-depth interviews using a qualitative ecological approach. We identified the main social (free-time availability, intergenerational exchanges, association membership, presence of other people) and physical (naturalness, accessibility, maintenance, facilities) factors related to LTPA, and assessed their perception for six types of stream corridor users (Athletes, Nature-lovers, Custodians, Cholesterol route users, Weekenders, Allotmenteers). According to their characteristics and motivations in relation to LTPA, each type perceived factors as either barriers or facilitators with coincidences and divergences. Safety concerns stand out for being the main cause of divergent perceptions.

Keywords: leisure-time physical activity; ecological models; environmental factors; perceptions; urban streams

1. Introduction

Increasing physical activity among the population is a priority for public health authorities. Regular practice of physical activity helps prevent non-communicable diseases (cardiovascular diseases, diabetes and cancers) and associated risk factors (excess weight, high blood sugar and high blood pressure) (WHO, 2013). Physical activity further contributes to physical and mental wellbeing, including stress reduction, and improved quality of life and social connectedness (Das & Horton, 2012). However, one-third of the worldwide adult population remains inactive (Hallal et al., 2012).

This study intends to contribute to research aimed at increasing physical activity participation and maintenance over time. More specifically, it focuses on Leisure-Time Physical Activity (LTPA), that is 'physical activity by choice', engaged for its meaningful and enjoyable quality (Sallis et al., 2006, p. 308). LTPA interventions have proven to be more effective than in physical activities related to transport, occupation, and household (Godbey, Caldwell, Floyd, & Payne, 2005).

Among city-dwellers, green environments are fundamental for LTPA (Hartig, Mitchell, de Vries, & Frumkin, 2014). In particular, urban stream corridors are large-scale green environments that have deserved special attention (Moore & Moss, 1998; Moore & Shafer, 2001). Aware of the opportunities that they provide for LTPA such as walking, bicycling, jogging, practising sports, and gardening, in the last decades public authorities have equipped urban stream corridors with trails, parks, gardening areas, and facilities (Henderson & Bialeschki, 2005; Lindsey, Wilson, Yang, & Alexa, 2008).

Understanding the interactions between the individuals and stream corridors is crucial for LTPA promotion. To this end, combining ecological models with qualitative research methods is valuable (Dashper & Brymer, 2019; Humbert et al., 2008; Öztürk & Koca, 2019). The ecological models provide a comprehensive theoretical framework for understanding the environmental factors that influence LTPA that is, those factors that vary by context and setting (Sallis et al., 2006). The qualitative research methods serve to reveal hidden meanings related to individual experiences behind factors (Brymer, 2010). Therefore, based on a qualitative ecological approach, this study explores the perceptions that multiple types of stream users have of environmental factors according to their characteristics and

motivations in relation to LTPA. Although LTPA in green environments has attracted particular attention in leisure studies, there is little research to show how environmental factors relate to LTPA in urban stream corridors from this approach.

2. The Qualitative Ecological Approach

It could be speculated that LTPA promotion has met with limited success to date as it has focused on a narrow range of psychological and biological individual factors, with just moderate and temporary effects on small groups (Glanz, Rimer, & Viswanath, 2008). The necessary understanding of how environmental factors influence LTPA is making ecological models more prominent. Ecological models provide holistic understanding of LTPA behaviour by acknowledging that complex interactions between individuals and their social, physical, and policy environments shape LTPA (Bauman et al., 2012). According to this approach, interventions operating at individual as well as environmental level are the most effective for inducing lasting, population-wide changes as regards LTPA (Dollman, 2018).

Factors influencing LTPA	
Individual factors	Demographic, biological, psychological, family structure
Social factors	Interpersonal modelling, social capital, social identity, social support, social climate, crime, programmes, norms, culture, place attachment, advocacy by individuals and organizations
Physical factors	Built environment: - access and characteristics of neighbourhood (presence of facilities, aesthetics, traffic safety) - access and characteristics of recreational spaces such as parks, and trails (views, connectivity, type, quantity per-capita) Natural environment: - weather, topography, open space, air quality
Policy factors	Health care policies/incentives, zoning codes, development regulations, transport investments and regulations, public recreation incentives, park policies, transport policies, land use policies)

Table 3. Factors influencing LTPA from an ecological perspective. Adapted from Sallis et al. (2006).

Based on the ecological perspective, this study focuses on the social and physical environmental factors that facilitate or hinder LTPA. These factors are the least understood but the most important to be targeted through interventions aimed at increasing LTPA (Owen, Leslie, Salmon, & Fotheringham, 2000). Following Sallis and colleagues (2006), social environmental factors are those depending on the cultural meanings of the activities as well as the social interactions between individuals, while physical

factors refer to both the built and the natural environment (Table 1).

Studies of the associations between physical and social environmental factors and LTPA in green environments have mainly relied on quantitative research underpinned by objective measures, statistical methods and large samples (Kaczynski & Henderson, 2007). However, quantitative studies tend to draw conclusions about generic human responses. In other words, they seek to establish how people, understood as a relatively undifferentiated category, behave in relation to LTPA. Consequently, they neglect how multiple types of green environment users perceive environmental factors differently, which might influence LTPA practice in various ways. Despite the general validity of the associations found through quantitative research between LTPA and environmental factors, this one-size-fits-all approach is insufficient fully to explain LTPA behaviour.

In fact, several studies proved that objective measures and individuals' perceptions of environmental factors are not coincident and that they relate to physical activity with discordant results. For example, Lee et al. (2017) found that perceptions of attractive aesthetics, diversity of and access to destinations, and lower residential density were significantly related to physical activity, whereas the objective measures of the same factors were not. McGinn and colleagues (2007) found associations between physical activity and perceptions of weather and presence of hills, but not between physical activity and objective measures of the same factors. These mismatches challenge the capacity of quantitative-based research alone to handle the complexity of the interaction between users and green environments.

Against this backdrop, several authors have called for a comprehensive understanding of LTPA experience that is, how and why LTPA is practised in particular places (Bell, Phoenix, Lovell, & Wheeler, 2015; Foley & Kistemann, 2015). LTPA experiences are subjective and diverse by definition. They vary depending on the individuals' motivations for LTPA and perceptions of physical and social environmental factors (Buttimer & Seamon, 1980; Calogiuri & Chroni, 2014; Öztürk & Koca, 2019). In order to address the complexity of LTPA experience, qualitative oriented approaches have gained momentum in the recent decades (Dashper & Brymer, 2019; Dobbels et al., 2014; Roberson & Babic, 2009).

These precedents suggest that qualitative research based on ecological models can serve to explore the unequal effects of the same environmental factors on LTPA for different types of green environment users. To our knowledge, however, this field remains under-researched, and its implications for customized LTPA policies need to be addressed.

This article develops a qualitative ecological approach to explore the diverse ways in which users of an urban stream corridor in the Metropolitan Region of Barcelona perceive the environmental factors that influence LTPA. More specifically, this study aims to: (1) identify types of stream users, (2) identify the social and physical environmental factors related to LTPA, and (3) assess their role as either barriers or facilitators, according to perceptions and motivations for LTPA practice.

3. Methodology

3.1. Methodological Approach

Qualitative data collection and analysis was undertaken to explore how people interact with an urban stream corridor while engaging in LTPA (Buttimer & Seamon, 1980). This approach served to identify different types of users according to their motivations (i.e. reasons for practicing LTPA in the stream corridor), and characteristics of both LTPA (i.e. detailed information regarding how and why LTPA is practised) and of users (i.e. socio-demographic information).

3.2. Case Study Context

The study took place in the Caldes Stream, a tributary of the Besòs River Basin, in the Metropolitan Region of Barcelona, Spain. More specifically the 19-kilometre stretch flowing through the municipalities of Caldes de Montbui, Palau-Solità i Plegamans and Santa Perpètua de Mogoda (Figure 1), with about 60,000 inhabitants, was analysed. Reasons behind this choice were related to the recreational value of the stretch as well as its physical conformation. On the one hand, the accumulation over time of public spaces, pathways and amenities along the riverbanks has resulted today in a large-scale open space system for recreation that allowed the identification of a wide range of users. On the other, the complex riparian landscape made up of forestry and agro-forestry areas, low-density residential areas, and industrial estates (Figure 2) enabled the identification of multiple environmental

factors (Benages-Albert & Vall-Casas, 2014; Garcia et al. 2018).

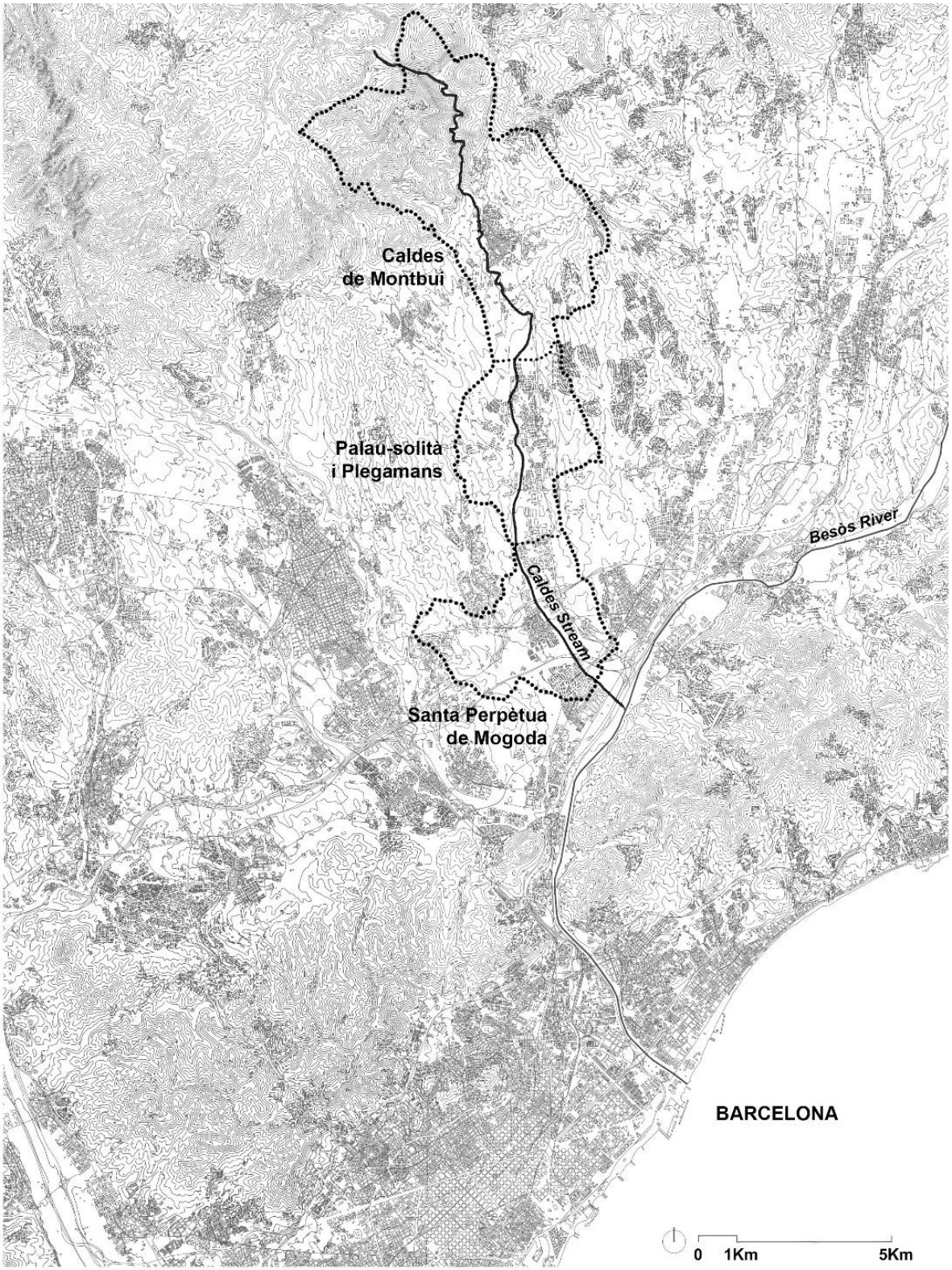

Figure 1. The Caldes Stream within the Metropolitan Region of Barcelona. Source: Institut Cartogràfic i Geològic de Catalunya

Figure 2. River spaces and social uses. From left to right: Forestry, agroforestry and industrial area. Source: Author

3.3. Data Collection

One trained interviewer collected the data in two phases from January to November 2016. Early exploratory fieldwork made use of participant observations to gain familiarity with the context and make contact with potential participants. In the second phase, in-depth interviews gathered data from participants identified in the exploratory phase, and new participants were included by means of the purposive sampling detailed below (Denscombe, 2007).

3.3.1. Exploratory Fieldwork

Participant observations served to witness at first hand and in intimate detail users' interactions with the Caldes Stream corridor. Adopting an open role, the researchers participated in the daily use of the stream corridor for LTPA, observed things that happen, listened to what is said, and asked questions (Denscombe, 2007).

With the aim of getting an overall feel for LTPA practice in the Caldes Stream corridor, preliminary holistic observations were conducted. During this early phase, the researcher entered the field without pre-established hypotheses to be tested (Denscombe, 2007), following the stream itineraries by bike and on foot. As things emerged which appeared to have particular significance, observations shifted from the broad canvas of LTPA in the Caldes Stream corridor towards specific areas along the itineraries where particular LTPA took place. Here, observations were conducted at different times and on different days of the week in order to document critical aspects such as characteristics of users, types of LTPA, and places where it occurred by means of field notes and photographs. In order to back up the information gathered, observations included chats with the stream users and the local experts in sport and public spaces. In particular, conversations with municipal decision-makers, technicians, and

representatives of local associations related with the stream corridor served to explore actions taken to encourage LTPA. Besides, local experts provided a list of stream users potentially interested in participating in the study, and identified the main places and social networks for the recruitment of new participants.

3.3.2. In-depth Interviews

The potential participants suggested by local experts were contacted, and complementary strategies of purposive sampling were applied in order to achieve a representative sample of the Caldes Stream corridor users. First, a direct on-site approach to the riverbanks at the places identified during exploratory fieldwork provided new participants. Second, using the snowball sampling technique, interviewees named other potential participants suitable for the purposes of research. The recruitment process extended to the analytical phase. In parallel with the interviewing process, transcriptions were analysed and recurrent themes (Denscombe, 2007) emerging from the text were categorized (see section 3.4). The recruiting process ended when the point of data saturation was reached (Glaser & Strauss, 1967) that is, when no new categories related to social and physical environmental factors and motivations emerged. A diverse sample of 30 stream users including adults of different age, gender, municipality of residence and years of residence was interviewed (see Table 2).

Variables	Categories	*n*
Age	Adults (27 – 44)	8
	Middle-aged (45 – 64)	13
	Elderly (≥ 65)	9
Gender	Female	14
	Male	16
Municipality of residence	Santa Perpètua de Mogoda	11
	Palau-Solità i Plegamans	6
	Caldes de Montbui	11
	Other municipalities	2
Years of residence	≤ 9	3
	10 - 25	8
	≥ 26	17
	Non-resident	2

Table 2. Socio-demographic descriptors of the participants.

Two complementary techniques for conducting in-depth interviews were applied: map-based interviews (14) and go-along interviews (16). Both techniques ensured extensive insights into stream corridor users' perceptions and motivations. Map-based interviews used maps at different scales as elicitation

tools to stimulate the identification of the places where LTPA was practised as a preliminary step before detailing participants' perceptions (Curtis, 2016). This technique allowed participants to reflect on their experiences in different places and place them in relation to the larger scale, though it provided limited small-scale spatial information. Go-along interviews consisted in interviewing and observing at the same time, while accompanying the participants on outings to their familiar places (Carpiano, 2009). This technique served to collect detailed characteristics of the interview place and enrich the oral content by speech-spatial integration, though more in-depth experiences of other places was limited. Given the greater involvement required by the go-along interview technique, both interviewing options were offered to participants, who chose according to their schedules and physical abilities.

At the beginning of each interview, the interviewer explained the purpose of the study and ensured that participants gave verbal informed consent. The map-based interviews lasted about one hour, and the go-along interviews between 20 minutes and five hours. The interview guideline was adapted from the Active Living Research surveys database on trails and greenways (Robert Wood Johnson Foundation, 2017). This source used fixed-choice answers aimed at measuring self-reported perceptions, and covered the main areas of inquiry related to the environmental factors associated with LTPA from an ecological perspective. However, this kind of questions left little room for the thorough interpretation typical of qualitative approach. To address this gap, exploratory inquiries based on qualitative methods tested in health geography research were applied to broaden data-gathering to the whole environmental experience (Bell et al., 2015; Thomas, 2015; Völker & Kistemann, 2013). Accordingly, the final guideline consisted of three sections. The first section contained open-ended questions structured according to LTPA characteristics to obtain: 1) extensive descriptions of the types of LTPA practices (What?); 2) interactions with others while practising LTPA (With whom?); 3) duration, constancy, and frequency of LTPA (When?); and 4) places where LTPA occurs (Where?). A transversal Why? Section complemented the foregoing with open-ended questions aimed at exploring further the motivations behind every answer. A final set of close-ended questions served to gather users' socio-demographic data (Who?). The use of the interview guideline facilitated comparison of interviews transcripts, while the open-ended questions allowed for a reflective conversation, offering the researcher the opportunity

to delve deeper into a topic or let the discussion flow on to the next point depending on each interviewee. In doing so, the interviewer adopted the stance of 'stranger' by temporarily suspending existing suppositions about the phenomenon before undertaking the interviews or interpreting the text (Denscombe, 2007). Respondents to the map-based interviews were invited to sketch the places mentioned with markers on a paper-based topographical map of the stream corridor; whereas for those interviewed on site, the interviewer marked the path travelled at the end of each interview.

Characteristics	Questions	
What	• What kinds of LTPA do you practice, and particularly in the Caldes Stream corridor?	**Why?**
With whom	• Do you prefer to practise LTPA alone or accompanied? • Are you a member of an organization that promotes LTPA in the Caldes Stream corridor?	
When	• In summer/winter, how often do you practise LTPA in the Caldes Stream? • For how long on working days/weekends? • When during the day?	
Where	• Where do you like/don't like to practise LTPA in the stream area? • Can you describe what you usually do when you go there?	
Who	• Gender, age, address, years of residence, civil status, number of children, educational level, job position	

Table 3. In-depth interview guideline.

3.4. Data Analysis

The transcriptions of the interviews were managed and processed by qualitative content analysis using ATLAS.ti software version 8 (Scientific Software Development, 2017). A refining process of reading, coding, and verifying was recursively carried out in two iterative stages (Friese, 2014). A first descriptive stage explored characteristics of LTPA and of users' motivations for practising LTPA, social and physical environmental factors involved, and corresponding perceptions. In a preliminary coding phase, the text was segmented into thematic units according to the LTPA characteristics considered as main categories (i.e. What, With whom, When, Where, and Why). A second coding phase served to identify the subcategories and prioritize recurrent themes arising from the data itself. The themes shared among the interviewees were regarded as significant, and therefore were associated with descriptive codes. As the analysis advanced, interpretative codes also defined categories and subcategories of motivations, environmental factors, and perceptions. Codes were partly adapted from literature reviews

and partly defined inductively.

Subsequently, a conceptual analytical stage looked for patterns and relations in the processed data, assisted by several ATLAS.ti tools. The transcripts were named according to the participant's socio-demographic characteristics (Table 2). To identify the types of users, transcripts were grouped using communal motivations for LTPA as an initial distinctive feature. The network view tool highlighted the links between each group of transcripts, dominant user characteristics, and secondary motivations. Once the pertinence of the codes with the associated quotations was checked, motivations and characteristics were used to define inclusion and exclusion criteria for a transcript to be part of the group, and initial groups were modified accordingly. The resulting groups of transcripts corresponded to the types of stream users. The research team agreed on labelling each type of users with a conceptual name associated with the identified motivations for LTPA. As such, each group served as filters for inquiries during the following stages. Then the ATLAS.ti query tool retrieved all the text segments where negative or positive perceptions matched social and physical factors for assigning barrier or facilitator codes, respectively. Afterwards, the scope tool served to assess barriers and facilitators for each type of stream user. Coincidences and divergences among types of user perceptions of environmental factors were thereby identified. In addition, transcripts were grouped according to users' socio-demographic characteristics, and the scope tool highlighted coincidences and divergences in perceptions of factors among users belonging to the same type. Finally, the code-document table served to analyse the weight of the environmental factors by cross-calculating how many times each factor resulted in either a barrier or a facilitator for each type of stream user.

4. Results

4.1. Types of Stream Corridor Users and Influential Environmental Factors

Six types of stream corridor users were identified according to LTPA characteristics (What, With whom, When, and Where), users' characteristics (Who), and motivations for practising LTPA (Why) in the Caldes Stream corridor (Figure 3). Motivations included: (1) Mental wellbeing (relaxation, stress relief), (2) Physical wellbeing (excess weight, high cholesterol, and high blood pressure reduction), (3) Achieving goals (kilometres covered, speed, vegetable production), (4) Contact with nature (sensorial interactions), (5) Sharing (interpersonal relationship reinforcement), (6) Commitment (riparian stewardship), and (7) Enjoyment. The types of stream corridor users were labelled: (1) Athletes, (2) Nature-lovers, (3) Custodians, (4) Cholesterol route users, (5) Weekenders and (6) Allotmenteers Types are described in Supplementary Table S1. The users' groups were not mutually exclusive; so each participant may belong simultaneously to multiple types.

Eight social and physical environmental factors influenced LTPA practice in the Caldes Stream corridor: (1) Free-time availability, (2) Intergenerational exchanges, (3) Association membership, and (4) Presence of other people, for the social; and (1) Naturalness, (2) Accessibility, (3) Maintenance, and (4) Facilities, for the physical. Factors are described in Supplementary Table S2.

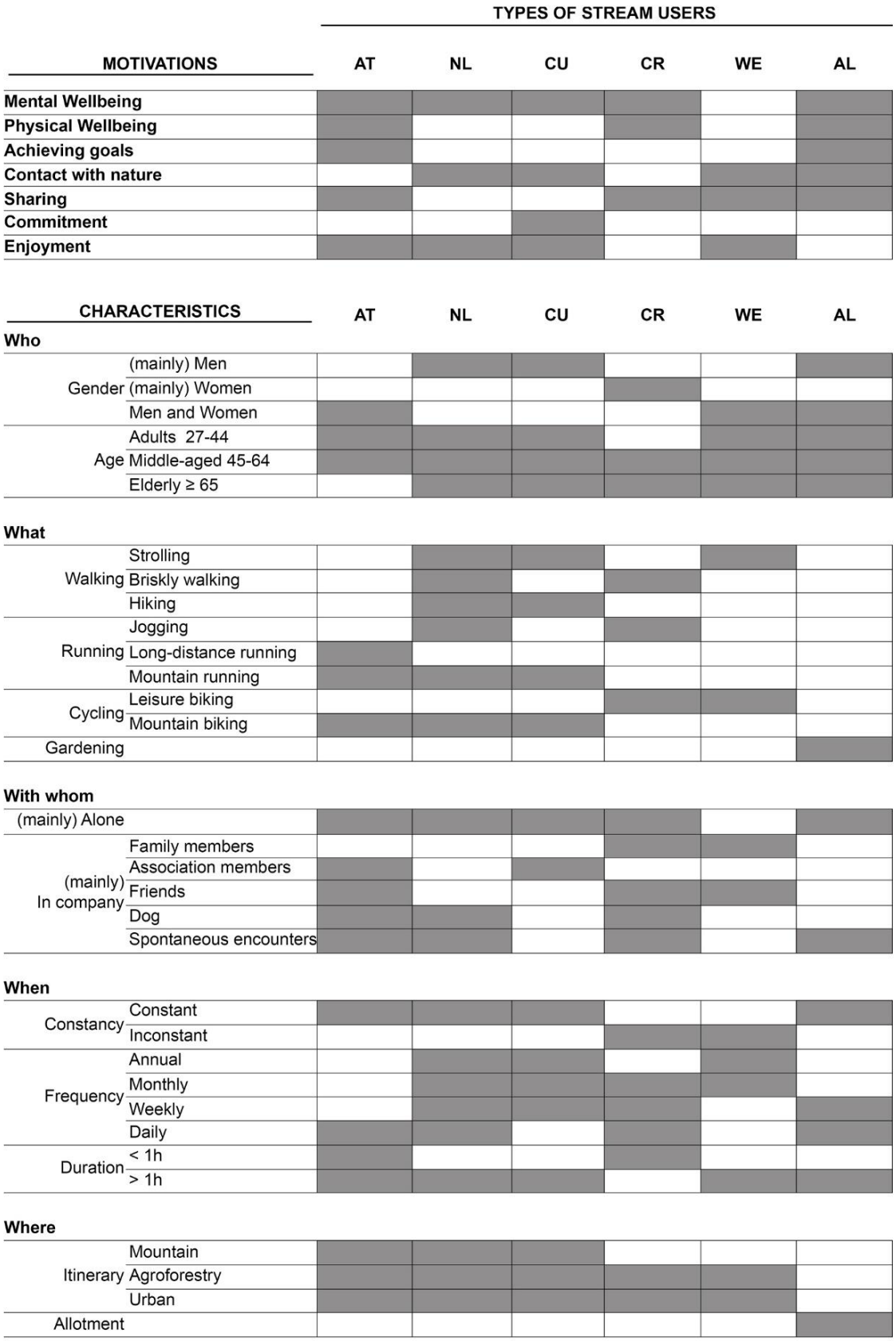

Figure 3. Types of stream users: motivations and characteristics. Source: Own elaboration using ATLAS.ti software.

4.2. Perception of Environmental Factors

The perception of social and physical environmental factors varied according to the types of stream users. Each type perceived these factors as either having no influence (0), being barriers (B), or facilitators (F), with varying intensity, bringing to light coincidences and divergences in perception of different factors (Figure 4). Coincidences and divergences were identified based on the distribution of barriers and facilitators, while neutral perceptions were overlooked.

		TYPES OF STREAM USERS										
SOCIAL FACTORS		**AT**		**NL**		**CU**		**CR**		**WE**		**AL**
		m	w	m	w	m	w	m	w	m	w	m
Free-time availability	Time at work	0	0	F	F	F	F	F	F	F	F	F
	Time doing housework	0	0	0	B	0	B	0	**B**	0	**B**	0
Intergenerational exchanges	From older to younger	0	0	0	0	**F**	**F**	0	0	0	0	F
	From younger to older	0	F	0	0	0	0	0	0	**F**	**F**	F
	From past PA	**F**	**F**	0	0	0	0	**F**	0	0	0	0
Association membership	PA-related	**F**	**F**	**F**	**F**	F	F	0	0	F	0	**F**
	Environment-related	0	0	0	0	**F**	**F**	0	0	0	0	0
Presence of other people	Company	0	F	**B**	B	**B**	0	B	**F**	0	F	0
	Attendance	B	F	B	B	B	0	B	F	0	F	0
	Threat	B	**B**	B	B	B	B	B	**B**	B	**B**	B
PHYSICAL FACTORS		**AT**		**NL**		**CU**		**CR**		**WE**		**AL**
		m	w	m	w	m	w	m	w	m	w	m
Naturalness	Presence of nature	F	F	**F**	**F**	**F**	**F**	F	F	**F**	**F**	F
	Vegetation density	F	B	F	F	F	F	F	**B**	F	B	0
Accessibility		**F**	**F**	F	F	F	F	**F**	**F**	**F**	**F**	F
Maintenance		F	F	F	F	F	F	F	F	F	F	F
Facilities	Lighting (lack of)	0	**B**	B	B	0	0	B	0	0	0	0
	Surface (paved)	**B**	**B**	B	B	B	0	F	F	**F**	**F**	0
	Signposting	F	F	0	0	F	F	0	0	F	F	0

Legend:
AT Athletes, NL Nature Lovers, CU Custodians, CR Cholesterol route users, WE Weekenders, AL Allotmenteers
m/w Men/Women
F Facilitator
B Barrier
0 No influence
Divergent perceptions across types of stream users
Divergent perceptions by gender

Figure 4. Coincidences and divergences in types of user perception of factors as barriers, facilitators or no influence. Source: Own elaboration using Atlas.ti software

(*) No women allotmenteers could be interviewed due to their scant presence in the study area.

(**) Bold (B and F) letters highlight the factors with greatest impact on a given type of users.

4.2.1. Coincident Perceptions of Environmental Factors

Figure 4 shows that, across types of users, perception coincided as regards free-time availability, intergenerational exchanges, association membership, and threat related to presence of other people

regarding social factors; and in presence of nature, accessibility, maintenance, and lighting and signposting facilities concerning physical factors. However, various nuances came to light in the way coincident perceptions of factors enabled LTPA.

As regards social factors, free-time availability determined participants' choice of itinerary, duration, constancy, and time of day to do LTPA. Lack of available free time from work to devote constantly to LTPA was a general concern. In particular, the lack of free time due to housework inhibited almost all women's LTPA. Whether working or retired, women Cholesterol route users and Weekenders prioritized family duties over their own leisure activities. In this case, according to an ethic of care model, social pressure on women to be good mothers and wives may hamper leisure engagement, perceived as challenging structured gender relations and social expectations of women (Day, 2000).

> 'I love walking, but I don't have time for myself. I have a husband and a daughter. I work. I clean the house, go to the supermarket, and cook, while my husband sits on the sofa.' (Weekender, woman, 61)

With regard to intergenerational exchanges, results confirmed that a physically active life style and the preference for green environments for LTPA practice are likely to be inherited and begin in early childhood (Telama, 2009). Custodians and Allotmenteers traced their preference for natural settings for LTPA back to their past family routines. Exchanges from younger to older were crucial among Weekenders and Athletes, who stressed the importance of their children's extracurricular activities to constancy in their own LTPA practice and discovering new places. Finally, male Cholesterol route users and Athletes attributed constant LTPA practice during adulthood to regular LTPA practice as youths.

> 'I've always liked it. I think it comes from my father; he loves the mountains and used to take me with him.' (Custodian, woman, 50)

> 'Our children joined an after-school club and we go together on excursions of the area on paths that we didn't even know existed.' (Weekender, man, 43)

As for association membership, being part of LTPA-related associations encouraged LTPA by finding companions for LTPA practice, promoting constancy, providing insurance for unforeseen emergencies, and allowing the exploration of unknown surroundings. Athletes, older Nature-lovers and Allotmenteers benefit from association membership inasmuch it enhances sense of belonging, strength positive bonding among individuals with shared values and interests, and propels the feeling of being accepted. This mirrors previous findings that point to social cohesion as one of the strongest facilitators of LTPA (De Vries, van Dillen, Groenewegen, & Spreeuwenberg, 2013). Furthermore, when scheduling simultaneous training sessions for parents and children, belonging to LTPA-related associations might improve free-time management, thereby increasing opportunities for women's LTPA.

> 'S: "Thanks to the running club, we've made lots of friends. We formed a group of parents and children who like the same things; we are like one big family."
>
> R: "The club is also useful because they organize training sessions for kids and adults at the same time."' (Athletes, women, 39 and 42)

Similarly, belonging to environmental associations facilitated Custodians' LTPA. Through promoting pro-environmental group activities such as litter picking, re-greening, and care of riparian areas, these associations fostered opportunities for LTPA (Husk, Lovell, Cooper, Stahl-Timmins, & Garside, 2016).

> 'Once a year we clean the stream of rubbish. We planted trees, because streams like this one have been logged in the past.' (Custodian, man, 59)

With regard to threats, presence of other people may constrain users' LTPA by inducing fear of both accidents and crime. On the one hand, the coexistence of conflicting activities along the same path raised perceptions of overcrowding and risk of accidental injuries (Godbey et al., 2005). Groups of Cholesterol route users or Weekenders walking along the same itinerary where Athletes run or cycle impeded Athletes' proper training. In turn, Cholesterol route users and Weekenders considered Athletes as hazardous when riding bikes.

> ‘I don’t like it there, there are too many people walking and running. Sometimes it looks like the high street!’ (Athlete, man, 43)

On the other hand, the presence of disorderly people in particular sites, behaving antisocially, provoked fear of crime (Taylor & Hale, 1986). This is the case of truck drivers resting, drinking, and smoking near industrial estates. With their comments and catcalls, they induced fear of harassment in women Cholesterol route users and Athletes.

> ‘It’s a lonely place, and there are lots of truck drivers who make comments. Once I ran into a few, and I got scared and ran away!’ (Athlete, woman, 42)

Speaking of physical factors, the presence of nature was the most appreciated quality for visiting the stream greenway, thus an important facilitator to LTPA practice for all types of users. Practising LTPA in contact with nature is known to provide psychological benefits (Hartig et al., 2014) that have been shown to increase due to the perception of naturalness (Van den Berg & Ter Heijne, 2005). Mental relief, disconnection from everyday problems and connection with oneself were the most reported outcomes.

> ‘This is my time for being outdoors, listening to the wind, seeing the changing seasons. It makes me feel connected and relaxed; it’s walking for the mind rather than the walking itself.’ (Nature-lover, woman, 53)

Moreover, participants indicated stream accessibility as an important facilitator for LTPA practice. Consistent with the literature, the availability of green environments within walking distance of home promotes health by increasing opportunities for daily LTPA (Gascon et al., 2016).

> ‘This is a paradise for runners, really! When you leave the house, you can go running to the mountains, plains, hills.’ (Athlete, man, 56)

There was also a widespread demand for better maintenance of the stream area. Acts of incivility and signs of neglect, particularly near the industrial areas, might spoil users' experiences by inducing anger, displeasure and insecurity (Taylor & Hale, 1986).

> 'If you go past the industrial estates, it's horrible, dirty, seedy and almost dangerous. People drop litter and dump rubbish, not to mention the indecency of the graffiti.' (Nature-lover, man, 66)

In response to the public administration's neglect of stream maintenance, Custodians showed a deep sense of responsibility in the form of pro-environmental participation, either self-organized or mediated by associations.

> 'I pick up broken glass and bottles every day so that dogs don't get hurt. What if children go and play there? The stream belongs to the people you know?' (Custodian, woman, 40)

As regards facilities, lack of itinerary lighting restricted LTPA primarily for women Athletes who train after dark and for Nature-lovers and Cholesterol route users who walk the dog at night. Conversely, male Athletes were not concerned about training in the dark. Gender differences may be traced back to perceptions of safety, more specifically to the lack of visibility that increases the feeling of risk of victimization or injury (Skår, 2010).

> 'Alone here at dark, no. I run through the town centre first, and end up here when the sun has risen. Because there is no lighting here.' (Athlete, woman, 36)

Regarding signposting, the lack of clearly signposted itineraries deterred visits to the mountain and agroforestry areas. Weekenders and Athletes stressed the need for an improved orientation system to discover places they would not currently visit out of fear of getting lost. It may also be reasonable to consider signposting a facilitator for Custodians, since they practise LTPA while maintaining and signposting trails.

> ‘I don’t train in the mountains because I don’t know the way. It would be great if the trails were signposted for people who aren’t familiar with the area.’ (Athlete, woman, 42)

4.2.2. Divergent Perceptions of Environmental Factors

According to Figure 4, in the case of social factors, perceptions of company and attendance diverged between users, as well as perceptions of vegetation density and path surfaces for physical factors. Perceptions also diverged by gender in Athletes, Cholesterol route users and Weekenders.

Regarding social factors, the presence of other people in terms of company and attendance have generally been identified as a source of support and encouragement of LTPA (Eyler et al., 1999). However, results highlighted that users’ experiences differed depending on whether the presence of people conveys safety. In the case of women Cholesterol route users, Athletes and Weekenders, when the presence of others is a safety matter, company and high attendance are more likely to be preferred (Maruthaveeran & van den Bosch, 2014). According to the literature, fears of crime, injury and their potential consequences typically affect women more than men, inducing changes in their habits and restricting their freedom to use public spaces. Therefore, among women, company, either of other people or dogs, and high attendance enable LTPA insofar as they reduce the perception of danger (Krenichyn, 2006; Richardson & Mitchell, 2010). Conversely, Nature-lovers and Custodians, both men and women, and male Cholesterol route users and Athletes were the most unaccompanied users. In line with Gordon et al. (2004), Nature-lovers and Custodians also stood out for longer relationships with the stream or longer involvement in LTPA. This might explain why they showed less concern about safety in the natural environment, to the point that they preferred solitude to achieve their desired place experience.

> ‘I never come here alone, because I’m scared. You never know what might happen!’ (Cholesterol route user, woman, 46)

> ‘I like it here. If something happens, or someone attacks you, you can ask for help and someone can hear you, because there are always people going up and down.’ (Weekender, woman, 61)

> ‘The fewer people I meet, the better I feel. I listen to music and I am happy! Everyone knows me and says hello; I don’t like it. I put my sunglasses on and look straight ahead.’ (Cholesterol route, man, 49)

Turning to physical factors, perceptions of vegetation density and path surface diverged among types of users. Males in general, and Nature-lovers and Custodians of both genders in particular favoured dense, more natural and vegetated areas, and considered urban itineraries less pleasant. Conversely, women Athletes, Cholesterol route users and Weekenders described urban itineraries as lush and verdant, and forested areas as dangerous. Again, for women Athletes, Cholesterol route users and Weekenders, the perception of safety played a key role in determining dense vegetation as either a barrier or a facilitator. If perceived as a barrier, locations with built features and visible from roads may be favoured over highly wooded areas due to greater visibility and the possibility of calling for help in the event of aggression or accidents (Loewen, Steel, & Suedfeld, 1993).

> ‘I usually run through the woods. That’s the part I like the most! When I need to be quicker I go south, but you have to go through factories, it’s horrible.’ (Athlete, man, 43)

> ‘I prefer this to the woods. There are more people, I feel safer. I feel lonely there. There’s only woods and I don’t like it.’ (Cholesterol route user, woman, 41)

Finally, with regard to path surfaces, previous studies have indicated that paved trails are positively associated with LTPA (Starnes, Troped, Klenosky, & Doehring, 2011). Accordingly, Cholesterol route users and Weekenders, and particularly elderly people and parents with children, welcomed paved trails since they facilitate pushing the stroller and allow children to cycle and skate. Contrarily, Athletes favoured dirt tracks to avoid joint injury, and Nature-lovers preferred them for their natural connotation.

> ‘I like it because I can bring the stroller.’ (Cholesterol route user, woman, 41)

> ‘There is a narrow dirt track. I always use that. I try to run on asphalt as little as possible to avoid joint problems.’ (Athlete, woman, 39)

A number of key divergences arose principally from perception of safety, which concerned mostly women Athletes, Cholesterol route users and Weekenders. Safety referred to both social and physical risks perceived in green environments. In terms of social risk, perceived crime is regarded as a significant issue in green spaces, associated with a wide range of experienced emotions rather than the actual crime incidence, though it is still responsible for modifying people's habits and eroding their quality of life (Maruthaveeran & van den Bosch, 2014). Regarding physical risks, accidental injuries while practising LTPA became the main concern (Gobster & Westphal, 2004).

5. Discussion

This paper explored the diverse perceptions of physical and social environmental factors influencing LTPA for different types of stream corridor users. Research findings posed three fundamental challenges to LTPA promotion: 1) social-oriented LTPA promotion, 2) customized LTPA promotion, and 3) qualitative ecological approach to LTPA promotion.

5.1. Social-oriented LTPA Promotion

Interventions supporting LTPA in green environments run the risk of focusing excessively on the provision of physical infrastructures. Many cities worldwide have implemented urban streams rehabilitation plans (Foley & Kistemann, 2015; Vert et al., 2019). The traditional approach adopted consists in the progressive integration of urban streams in cities' park systems, improvement of their environmental quality, and development of trails and facilities for public access and social use (Prominski, Stokman, Zeller, Stimberg, & Voermanek, 2012). In the specific case of the Metropolitan Region of Barcelona, major efforts have been made to provide support and guidance to appealing trail development. Guides on trail design offer precise indications as to physical characteristics, layout and public facilities that these infrastructures should present in order to guarantee their use for LTPA (Diputació de Barcelona, 2018). However, a significant number of people are still not using them. In other words, by focusing on physical dimensions, decision makers and practitioners overlook other aspects that could be just as significant in dictating whether people will end up practicing LTPA in green environments (Hitchings, 2013).

Against this backdrop, ongoing educational and motivational programmes focused on the social environmental factors that influence LTPA should exist alongside the enhancement of physical infrastructure. For example, availability of free time from work and housework determined users' choice of itinerary and LTPA duration. Particularly in the case of women, housework took up most of their spare time since an ethic of care prevailed. In this respect, programmes aimed at changing gender roles, which still associates women and men with different jobs, physical and sensorial capacities, models of freedom, and places, are paramount (Day, 2000). Moreover, participants with a physically active life style attributed a key role to LTPA practised in green environments since early childhood. Therefore, the early acquisition of this habit among children should be promoted at homes and schools, where the basic attitudes of personal care are taught (WHO, 2018). Support should also be given to local associations that organize group walks and guided activities to promote LTPA while reinforcing community ties (Husk et al., 2016).

5.2. Customized LTPA Promotion

The effects of environmental factors on different types of green environment users have traditionally been studied according to user's socio-demographic characteristics or types of LTPA practised (Dollman, 2018; Gobster, 1995). Moving a step forward, this study focused on LTPA experiences, depending on individuals' perceptions of environmental factors and motivations for LTPA. Motivations biased the perception of the environmental factors that depicted the green environment as either supportive or hindering (Calogiuri & Chroni, 2014), thus adding a greater degree of complexity to strategies aimed at increasing LTPA. Moreover, diverse perceptions of environmental factors related to gender among members of the same type of users were observed. In particular, the restricted use of the urban stream corridor by women related to perceptions of fear may entail serious implications for their health and wellbeing.

The resulting complex picture of coincident and divergent perceptions of environmental factors suggested the need for customized LTPA promotion to meet the needs of different types of green environment users. Coincident perceptions showed prevalent domains of intervention, whereas divergent perceptions offered information about user specificities in controversial domains. Many users

would welcome efforts to provide accessible, well maintained green environments, with lit and signposted itineraries that allow LTPA at night and easy orientation. Conversely, divergent perceptions of surface, presence of others and vegetation density, invite reflection on nuanced strategies. In this regard, urban stream corridors are particularly suitable for planning an inclusive network of specialized itineraries. Actually, stream corridors contain trails within environments with very different characteristics, which may meet multiple, and sometimes conflicting, recreational needs (Moore & Moss, 1998). For example, separate trails could be provided; dirt for Nature-lovers, Custodians, and Athletes, and paved for Cholesterol route users and Weekenders. Likewise, itineraries with enhanced visibility and higher attendance, together with pruning of dense vegetation and provisioning of areas of assistance in case of need could be provided to promote women's LTPA practice. In addition, removing land uses that generate insecurity near the itineraries, such as parking areas, could also mitigate women's fear of crime.

However, these strategies based on physical changes should be complemented by policies to mitigate adverse socio-cultural environments and reduce antisocial behaviours. For instance, promoting women's use of mountain itineraries so that they can enjoy the benefits in nature would require major changes in the way women and men are educated in terms of the use of public space. According to Hillman (1990), boys are usually allowed to go out alone, go further and return home later, whereas girls are given warnings about being careful when outside, particularly when alone and in the dark, conveying fear. Likewise, when specialized itineraries are not possible and different types of users have to coexist, awareness-raising programmes organized by schools, media, and local associations could promote respectful co-use of green environments, thereby reducing the threat of injury.

5.3. Qualitative Ecological Approach to LTPA Promotion

The qualitative ecological approach applied in this study showed that complex interactions between the environment (social, physical, policy) and the individuals shape LTPA. Decision-making processes for LTPA promotion should therefore take into account all factors influencing LTPA from an ecological perspective: social (free-time availability, intergenerational exchanges, association membership, presence of other people), physical (naturalness, accessibility, maintenance, facilities), and policy (open

space regulations, land use policies, educational programmes); as well as individual (perceptions and motivations, gender, age). In this web of factors, the social and the physical deserve special attention, since through their modification, lasting population-wide effects on LTPA behaviour can be achieved (Bauman et al., 2012; Nieuwenhuijsen, 2016).

However, the enhanced understanding of physical and social factors through objective measures unconnected with personal experiences has proven to be insufficient. The same environmental factors can induce divergent perceptions according to the different motivations of each type of green environment user, thus questioning the efficacy of the current one-size-fits-all approach to LTPA promotion. The qualitative ecological approach, centred on personal LTPA experience, served to overcome this limitation and to better connect policies with people's needs and expectations. We argue that the qualitative ecological perspective offers the appropriate theoretical framework for customized LTPA promotion that solves conflicts and addresses gender inequalities. In this line, future studies should explore interactions between the environment and the individuals by means of multidisciplinary experts' teams. For example, urban planners could involve psychologists and anthropologists in the design of open space regulations based on an understanding of how each type of user chooses and relates to green environments.

6. Conclusions

This article relates an in-depth analysis of personal LTPA experiences in an urban stream corridor of the Metropolitan Region of Barcelona. Using a qualitative ecological approach, it explores the coincident and divergent perceptions of social and physical environmental factors related to LTPA for different types of users. It demonstrates that factors are perceived as either barriers or facilitators, with different nuances and importance, depending on each type of user. Moreover, for the same type of user, factors perception also depends on gender.

This research shows that the qualitative ecological approach is required for customized LTPA promotion that serves to anticipate and deal with conflicts, and prevent inequalities in the access to and use of green environments by understanding people's perceptions.

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Supplementary material

Role	Municipality of reference
Public administration	
Councillor for Public space and sustainability	Caldes de Montbui
Sport technical	Caldes de Montbui
Councillor for Public space	Palau-Solità i Plegamans
Councillor for Sport	Palau-Solità i Plegamans
Councillor for Environment	Santa Perpètua de Mogoda
Councillor for Sport	Santa Perpètua de Mogoda
Supra-municipal body	
Consorcio Rio Besos	
Local associations	
Camping el Pasqualet	Caldes de Montbui
Centre Excursionista	Caldes de Montbui
Esplai Gent gran	Caldes de Montbui
Esplai la Olla	Caldes de Montbui
Club fondistas El calderi	Caldes de Montbui
Amics del sender	Caldes de Montbui
Hortes de baix	Caldes de Montbui
Asociación dels veins del Bugarai	Caldes de Montbui
Club els 10 de Santa	Santa Perpètua de Mogoda

Table 1: Local experts' interviewed during the exploratory fieldwork.

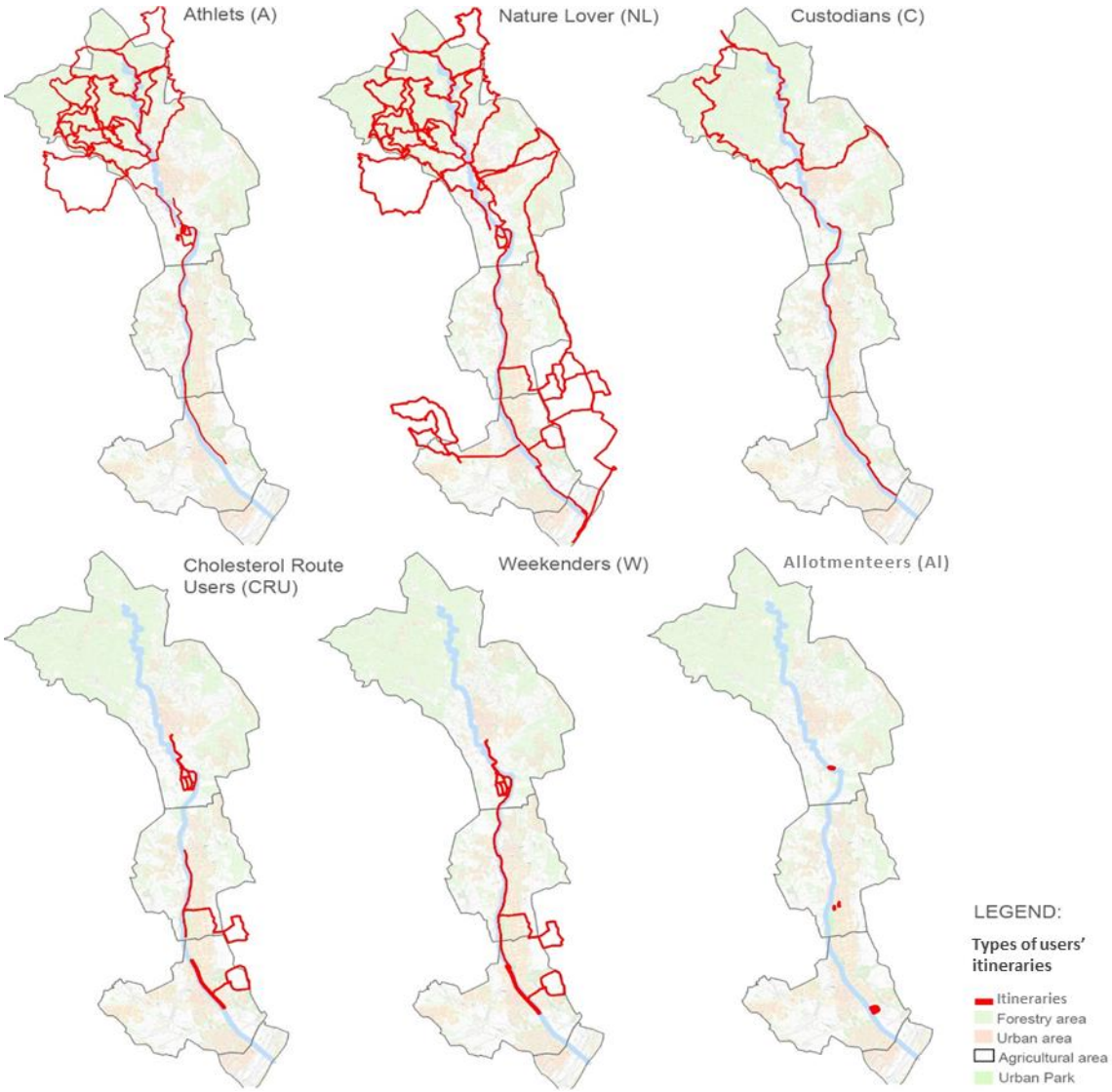

Figure 1: Types of users' itineraries. Source: own elaboration.

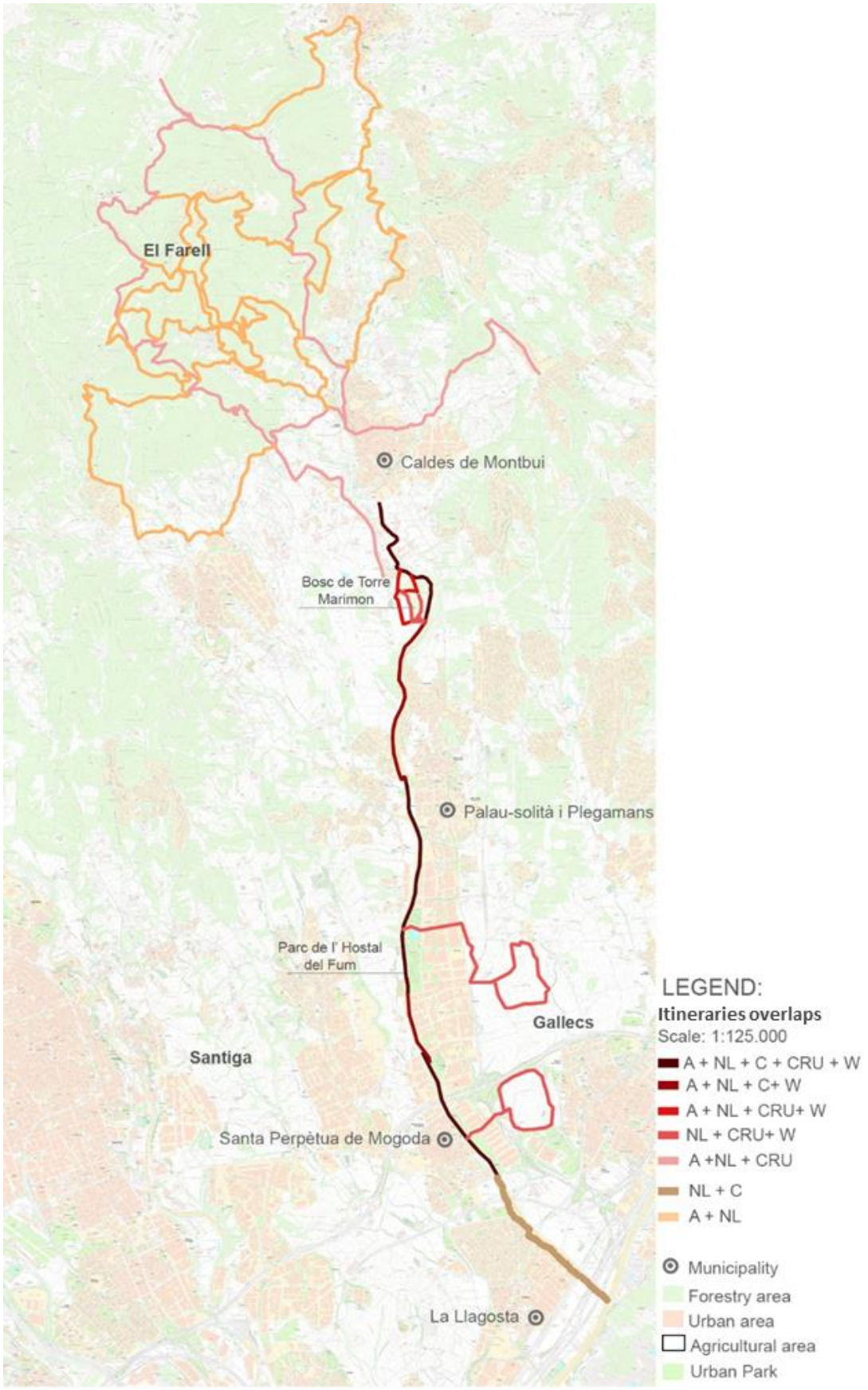

Figure 2: Overlaps of types of users' itineraries. Source: own elaboration.

4.2. Women's safety perception assessment in an urban stream corridor: developing a safety map based on qualitative Geographic Information System (Paper 2)

TABLE OF CONTENT

Abstract

Perceived safety influences women's use of green environments (GE) for physical activity with considerable implications on health. In order to address gender inequality in GE use, the effects of physical and social environmental factors on women's perception of safety must be assessed. To achieve this, a pilot study designed and implemented a safety map based on a qualitative Geographic Information System (qGIS) methodology, in an urban stream corridor of the Metropolitan Region of Barcelona. Fourteen in-depth interviews with women users of the stream corridor were conducted to identify influencing environmental factors (i.e., lighting, vegetation density, visibility, and presence of streets, residential areas, industrial areas, parking areas, green areas, abandoned areas and discotheques, for the physical; and presence of truck drivers and vandals, and user density, for the social). These factors were translated into four spatial indicators (visibility, vegetation density, lighting, and land use) to allow for generation of safety index values. The safety map combined the safety index values with individual perceptions. The integration of qualitative and quantitative methods served to compare and contrast micro-scale individual perceptions with general perceptions of safety at the GE macro-scale. The safety map pointed out the importance of providing "eyes on the GE" and provided a nuanced understanding of how perceptions are mediated by women's background (patriarchal vision of public space, criminal stereotypes and vulnerability of women) and everyday practices (recurrent use of GE). The map identified the areas that merit decision-makers' attention to develop strategies for reverting gender inequality in GE use.

Key words: physical activity; environmental factors; women's safety perception; qualitative GIS; safety map; green environments

1. Introduction

Green environments (GE) are essential for promoting urban dwellers' health and wellbeing (WHO Regional Office for Europe, 2016). Practising physical activity in GE facilitates stress relief, restoration and interpersonal exchange (Hartig, Mitchell, de Vries, & Frumkin, 2014), and helps to prevent noncommunicable diseases associated with sedentary behaviours such as depression, obesity, cardiovascular diseases, diabetes or cancer, which have a significant impact on public health worldwide (WHO, 2013).

However, claiming that GE availability implies better public health would be an oversimplification. Multiple studies have demonstrated that GE may evoke fear, including: (1) fear of physical dangers such as accidental injuries (Gobster & Westphal, 2004) and nature-based threats (i.e., getting lost, encountering wild animals) (Van den Berg & Ter Heijne, 2005), and (2) fear of social dangers, such as crime (Pain, 1997). Fear, understood in the wider sense, is often irrational and related to personal experience in GE (i.e., perceived rather than actual safety or risk). People who experience fear tend to change their habits, avoiding the GE in general or in specific places (Skogan, 1986), thus reducing their physical activity and contact with nature. In short, fear influences how people use the GE which may, consequently, affect their health.

Previous research has highlighted a limited presence of women in GE, gender being a consistent predictor of fear of crime in urban green spaces (Langemeyer, 2018; MacBride-Stewart, Gong, & Antell, 2016; Richardson & Mitchell, 2010). From most women's viewpoint, GE such as parks and forests often do not comply with their safety expectations. They tend to perceive these environments as not facilitating easy orientation and recognition of elements, seeing and being seen, hearing and being heard, and the chance of running away and receiving assistance if necessary (Eurocultures, Fopa, Groupe Cadre de Vie, Praxis, & Seirov-Nirov, 1994; Kolektiboa, 2010). Thus, fear may compromise women's accessibility to GE and become a leading cause of health inequality between genders (Koskela & Pain, 2000).

In order to provide inclusive open spaces for physical activities, it is essential to widen the concept of accessibility to GE beyond the traditional terms of geographical proximity (Levesque, Harris, & Russell, 2013) and to pay attention to fear as a significant barrier. Concretely, understanding the effect of environmental factors (i.e., factors that vary by context and setting) on women's safety perception is paramount to supporting decision-making intended to enhance accessibility to GE for women and addressing gender-related health inequalities. For this purpose, the ecological models that encompass individual, physical and social environmental factors provide a comprehensive theoretical framework (Glanz, Rimer, & Viswanath, 2008). However, to our knowledge, no studies have addressed safety perception of GE using ecological models from a gender perspective.

Furthermore, previous studies have employed a qualitative Geographical Information System (qGIS) methodology to explore the subjective perception of the environment (Mitra, Siva, & Kehler, 2015). However, in spite of the spatial and qualitative nature of fear, to date qGIS has received limited attention in research into women's safety perception in large-scale GE. This paper aims to contribute to this field by providing qGIS methodological guidelines by means of a pilot study (Yin, 2017). Based on ecological models, the pilot provides methodological foundations for in-depth examination of the relationship between women's safety perception and environmental factors. More specifically, the study intends to: (1) identify the physical and social environmental factors related to women's perception of safety in an urban stream corridor case study, and (2) map their effects on safety perception.

2. Background

2.1 Theoretical background

Studies on the relationship between safety perception and environmental factors developed during recent decades owe a debt to the seminal "eyes on the street" theory developed by Jacobs (1961). The logic is simple: the greater the number of people around, the safer a place becomes, as their eyes on the street provide informal surveillance. In this respect, visibility and use of public spaces become fundamental when assessing safety perception. The visual control of places improved by lighting systems, together with constant urban activity supported by mixed uses, is recommended for achieving a safe atmosphere. A number of authors have explored the influence of physical and social environmental factors associated with the visual perception and use of GE (Bedimo-Rung, Mowen, & Cohen, 2005; Beebeejaun, 2009; Fitzpatrick, 2014; Jorgensen, Hitchmough, & Dunnett, 2007; Reis, Lay, Muniz, & Ambrosini, 2005; Schroeder, Anderson, & Daniel, 1984; Taylor & Hale, 1986; Topmiller, 2013; Varona Martínez, 2015). These factors are strategic because they can be modified by inclusive GE design and planning, thereby inducing lasting population-wide changes (Nieuwenhuijsen, 2016). Likewise, intervention in physical and social environmental factors has been demonstrated to be more cost-effective than addressing behaviours and choices at the individual level (Pain, 1997; Rivas, 2009).

In order to identify the environmental factors related to women's perception of safety, the pilot study draws on the ecological models that serve to understand the complex web of factors that influence human behaviour. Behaviours are shaped by the individual's interactions with the social and physical environments in which he or she lives, works, or practises an activity (Stokols, 1992, 1996). Great attention has been paid to ecological models in research on health behaviours and education (Glanz et al., 2008), yet few studies have used them to tackle fear in GE. By means of a literature review, Maruthaveeran and van den Bosch (2014) identified the physical, social, and individual factors that may evoke fear of crime for GE users, physical factors being the most studied (Table 1).

Factors influencing fear in GE	
Individual factors	Socio-demographic, Previous experiences (direct or indirect victimization)
Social factors	Social cohesion, trust, familiarity, frequency of visit, company, presence of people, and social incivilities
Physical factors	Physical incivilities, lighting, landscape design, maintenance, vegetation density, open/long distance views with unrestricted prospects, signs of development (built features), dark areas, surveillance, location, and access

Table 1. Factors influencing fear in GE. Adapted from Maruthaveeran and van den Bosch (2014)

Maruthaveeran and van den Bosch (2014) found that with regard to physical factors, most individuals feel safer in GE that incorporate built features and are close to residential areas under the watchful eyes of other people. The perception of safety decreases in industrial areas, car parks, and bars, which are generally associated with crime or incivility (e.g., litter, unmaintained properties, graffiti). In contrast, open views and spaces with good all-round visibility ensure safety, whereas high and thick vegetation evokes fear as it obstructs the view to and from buildings and streets, creates dark hiding spaces and blocks escape. Likewise, good lighting is paramount to ensure safety, since risks are thought to increase at night. As regards social factors, poor social integration understood as a low level of mutual knowledge, trust and active interaction among neighbours leads to increased fear. In addition, visiting GE alone versus going with others, or visiting an unfamiliar place versus going to a place regularly serve to amplify or attenuate fear. Furthermore, safety perception can be reinforced by the presence of other people engaged in acceptable uses, whereas it can be weakened by the presence of disorderly people who violate social norms or act in a threatening manner (e.g., vandalism, public drinking, drug dealing). Finally, as for the individual factors, previous experiences of direct or indirect fear (e.g., reported by media or interpersonal communication) can heighten fear in GE. Likewise, there are certain groups of people (e.g., the elderly, women, racial and ethnic minorities) who tend to be more fearful because of actual or perceived physical vulnerability to crime or the risk of accidents. In particular, gender was seen to be a significant predictor of fear in GE. Based on this body of knowledge, compiled in the literature review of Maruthaveeran and van den Bosch (2014), the pilot study tackled the factors that specifically trigger women's fear.

2.2 Methodological background

Map-based approaches are a long-standing method for human geographers and environmental

psychologists to understand how people perceive the environment and to propose changes. However, only recently have they been converted into qGIS approaches (Table 2). In a specific geographic context, qGIS integrates spatial data and people's perceptions to explore how the two dimensions interact (Steinberg & Steinberg, 2006). This mixed methodology combines different qualitative data collection methodologies with conventional quantitative Geographic Information System (GIS) technologies (Cope & Elwood, 2009).

	Qualitative methodologies							
Authors	**Participatory mapping**	**Sketched maps**	**GPS mapping**	**Focus groups**	**Interviews**	**Participant observations**	**Environmental audits**	**Guided tours**
Author (2016)	x			x	x			x
Bagheri (2014)					x	x		
Battista and Manaug (2018)					x			
Boschmann and Cubbon (2014)		x			x			
Curtis (2012)		x						
Curtis et al. (2014)		x						
Author (2018)	x				x			
Harman (2015)	x		x	x	x			
Keddem et al. (2015)					x			
Kelley et al. (2012)		x						
Kwan (2008)		x			x			
Maclaurin (2011)	x				x			
McCray and Brais (2007)		x		x				
McQuoid et al. (2018)					x			
Schoepfer and Rogers (2014)					x			
Sloan et al. (2016)		x						
Topmiller et al. (2015)	x	x		x			x	
Wridt (2010)	x							

Table 2. Qualitative data collection methodologies integrated with GIS to understand people's perceptions of the environment. In bold, those that explored safety from a gender-related perspective

Relatively few of these research projects used qGIS to explore safety in association with gender perspective. Three studies considered safety and gender as variables, but neither gender nor safety were their focus (Alarasi, Martinez, & Amer, 2016; Battista & Manaugh, 2018; Wridt, 2010). McCray and Brais (2007) focused on gender and used qGIS to explore women's perceptions of social exclusion, including safety. Alternatively, Maclaurin (2011) looked at perceptions of safety in a mixed-gender sample. Only Kwan (2008) focused on both safety and gender, considering how Muslim women's fear of hate crimes influenced behaviours before and after 9/11.

The different qGIS approaches of the above-mentioned studies provided methodological insights for exploring participants' perceptions of places. Their coding processes helped identify the environmental factors related to these perceptions. In these studies, the codes associated with the environmental factors were geolocated and described as either dangerous or safe for each participant. Battista & Manaugh (2018), Kwan (2008), and McCray & Brais (2007) used the coding process to portray participants' geo-narratives, whereas Author (2016), Maclaurin (2011), and Wridt (2010) used the coding process to highlight the spots on the map where similar participants' perceptions clustered. Furthermore, Wridt (2010) compared results with data about reported risk. However, these studies did not explore the capacity of qGIS to map identified characteristics through spatial indicators, thereby integrating perceived safety at the macro-scale with micro-scale individual perceptions, in order to inform policy-makers in a holistic yet nuanced way.

Apart from the methodological gaps identified, there are also shortcomings as regards the scale of the GE studied. According to the available literature, approaches have been restricted to medium- and small-scale GE, from city and neighbourhood parks (Maclaurin, 2011; McCray & Brais, 2007; Wridt, 2010) to small open spaces with natural features such as water, trees and flowers (Alarasi et al., 2016). Moreover, only Maclaurin (2011) considered the relationship between safety and parks, with parks being the places where participants felt most at danger of mugging due to poor lighting and dark hiding places. To our knowledge, no study has comprehensively analysed women's safety perception in large-scale GE. In order to contribute to this body of knowledge, this research aims to develop a safety map by applying a novel qGIS approach that combines conventional quantitative GIS with qualitative data to assess women's safety perception in an urban stream corridor.

3. Methodology

3.1 Methodological approach

In order to explore the relationship between women's safety perception and environmental factors in an urban stream corridor, research design was based on a sequential mixed model (Tashakkori & Teddlie, 2010) (Figure 1). First, a qualitative study served to: (1) identify the relevant environmental factors

related to safety; (2) assess their positive or negative effect on safety; (3) translate the environmental factors into spatial indicators, and (4) geolocate individual women's perceptions. Second, a quantitative spatial analysis was conducted. This consisted in weighting the spatial indicators according to their capacity to convey safety and further combining them into a composite safety index that measured women's general perception of safety. Finally, a safety map was created, combining safety index values with individual perceptions. The combination of qualitative and quantitative methods served to compare and contrast micro-scale individual perceptions with general perceptions of safety at the GE macro-scale.

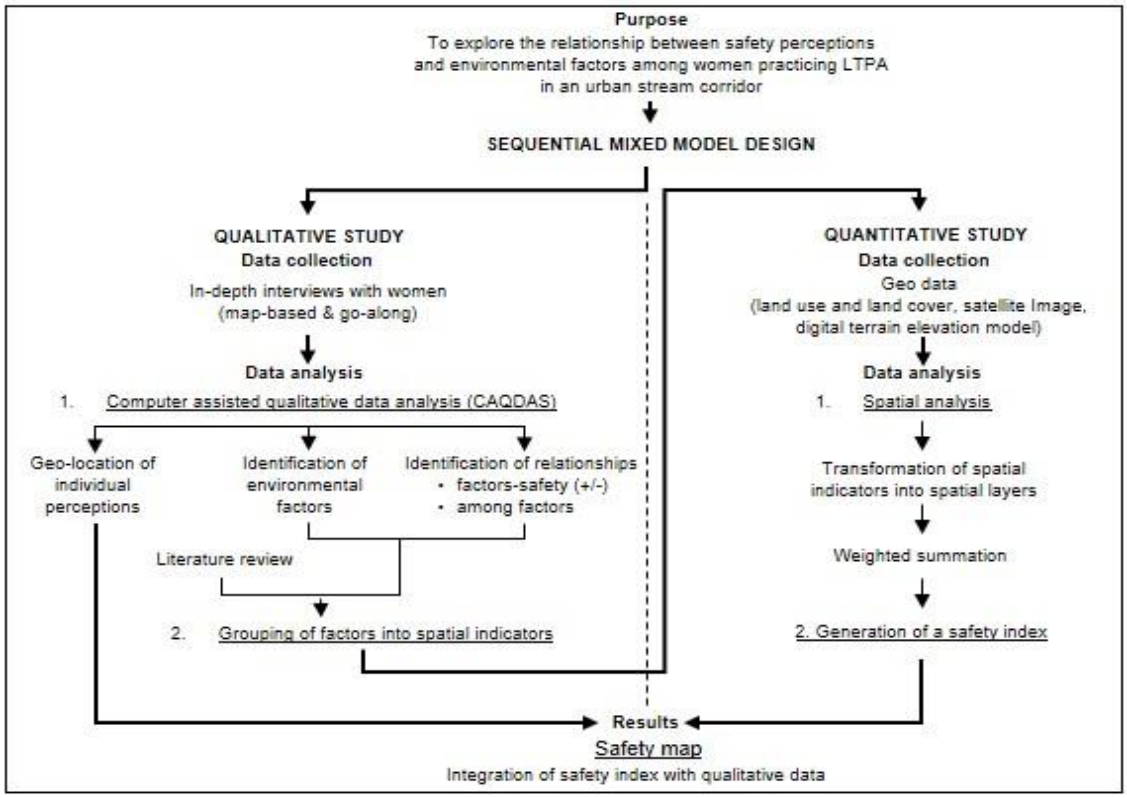

Figure 1. Methodological approach: sequential mixed model design. Own elaboration

3.2 Study area

The study was developed in an urban stream corridor in the Besòs River Basin, in the Metropolitan Region of Barcelona. Urban stream corridors are large-scale GE that represent key leisure settings for urban dwellers (Panareda-Clopés, 2009). More specifically, the study focused on a 0.5-kilometre wide, 19-kilometre long stretch of the Caldes Stream corridor that runs through the municipalities of Caldes de Montbui, Palau-Solità i Plegamans and Santa Perpètua de Mogoda, inhabited by approximately

60,000 dwellers (Figure 2). Reasons for this choice were threefold. First, the riparian landscape of this stretch is characterised by a mix of agro-forestry areas with low-density residential and industrial areas (Benages-Albert & Vall-Casas, 2014). Frequent urban-to-rural transitions served to explore a rich array of environmental factors. Second, the accumulation of public spaces, pathways and amenities along the riverbanks in this stretch has resulted in a large-scale open space system for recreation, suitable for the recruitment of a heterogeneous sample of women practising a whole variety of physical activities (Vall-Casas et al., 2019). Third, the 0.5-kilometre distance includes all the itineraries frequented on a daily basis by the women interviewed. Among them, the two most frequented itineraries (6.5 km and 3.8 km, respectively) were selected for the spatial analysis.

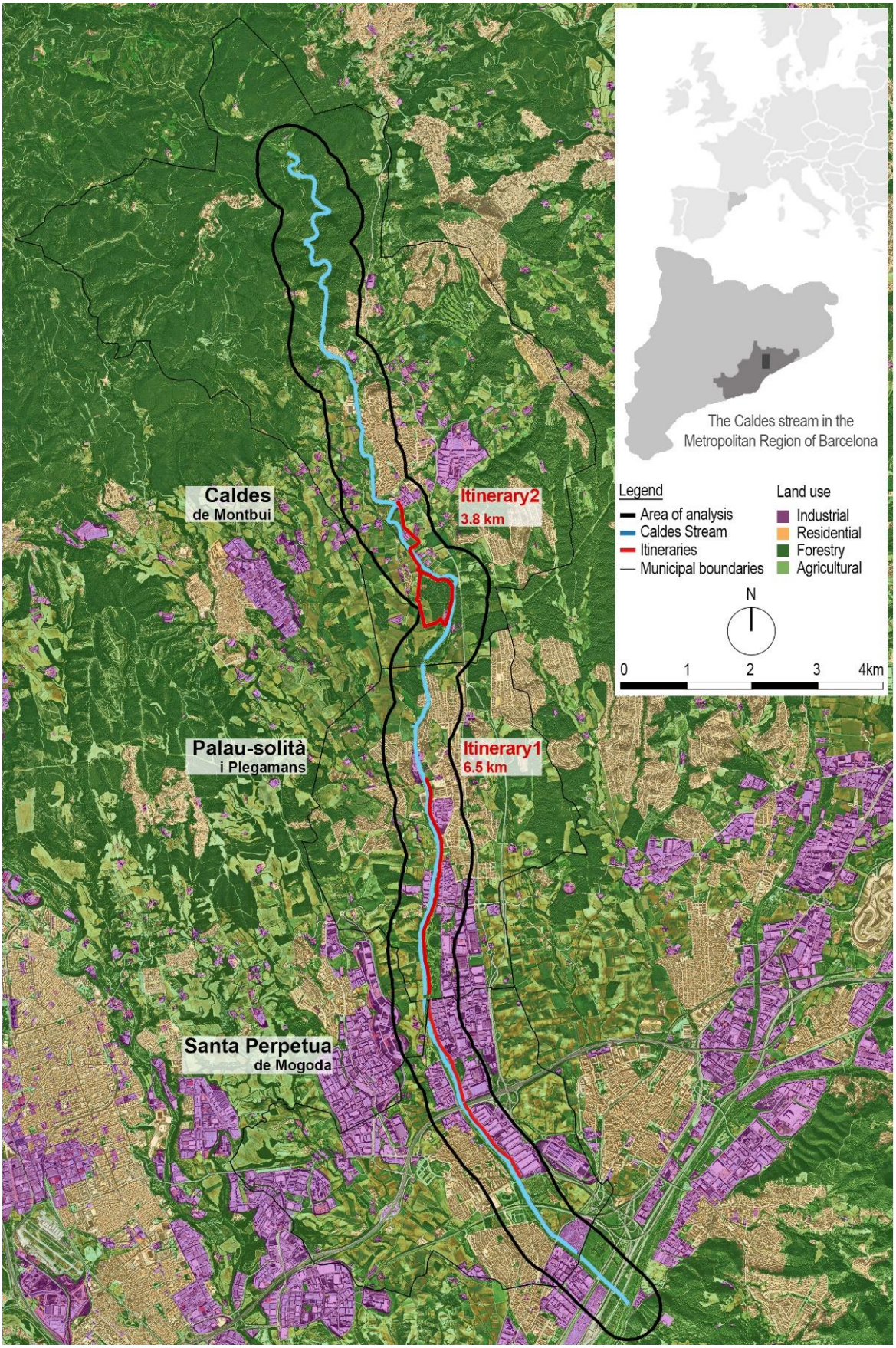

Figure 2: Area and itineraries of analysis. Own elaboration with GIS software. Based on Topographic Map of Catalonia 1:50000 (ICGC, 2018)

3.3 Qualitative study

3.3.1 Data collection

A sample of 14 participants (Table 3), including adult and older women who walk, run and cycle along the riparian itineraries, was recruited by means of snowball sampling and direct on-site approach techniques until data saturation was reached (Glaser & Strauss, 1967). The collected viewpoints illustrated the array of existing relationships between women and the studied GE.

In-depth interviews (six map-based and eight go-along) reported on women's safety perception. In the former, women sketched the frequented itineraries with markers on a paper-based topographical map of the stream (1:50,000), and on detailed maps of each municipality (1:15,000) while externalizing their experiences in different places (Curtis, 2012). The go-along technique consisted in interviewing and observing while accompanying women on outings along the frequented itineraries. In this case, the interviewer marked the path travelled and geolocated the places at issue (Carpiano, 2009).

The interviews followed a guideline consisting of open-ended questions plus a set of closed-ended questions to gather socio-demographic data. The topics addressed the types of physical activity practised, with whom, when during the day, and where. The reasons for every answer were explored for a reflective conversation (see Supplementary Material). This approach allowed the topic of safety to arise from the flow of the interviews as influencing the practice of physical activity, enabling further exploration.

Variables	Categories	N
Age	Adult 27 - 44	5
	Middle-aged 45 - 64	6
	Elderly ≥ 65	3
Municipality of residence	Santa Perpètua de Mogoda	5
	Palau-Solità i Plegamans	3
	Caldes de Montbui	6
Types of physical activities	Walking	11
	Running	3
	Cycling	2

Table 3: Socio-demographic data of the sample and physical activities practised

3.3.2 Qualitative data analysis

Data analysis consisted of: (1) identifying the physical and social environmental factors related to safety, and (2) grouping and translating environmental factors into spatial indicators. Transcriptions of the women's interviews were analysed with computer-assisted qualitative data analysis using ATLAS.ti™ software, version 8 (see Supplementary Material). A refining process of reading, coding and verifying was recursively carried out in two stages (Friese, 2014). During a coding stage, descriptive codes were assigned to safety-related themes and the corresponding quotations were geolocated on a Geo-document that is a digital map of the area of analysis. As shown in Figure 3, for each theme, categories and subcategories of (i) social and physical environmental factors, and (ii) safety perceptions were further identified. Afterwards, an analytical stage served to identify the relationships (Table 4): (i) between factors and safety, both positive and negative, and (ii) among the factors themselves. Safety increased for positive relationships and decreased for negative ones (Malczewski, 1999).

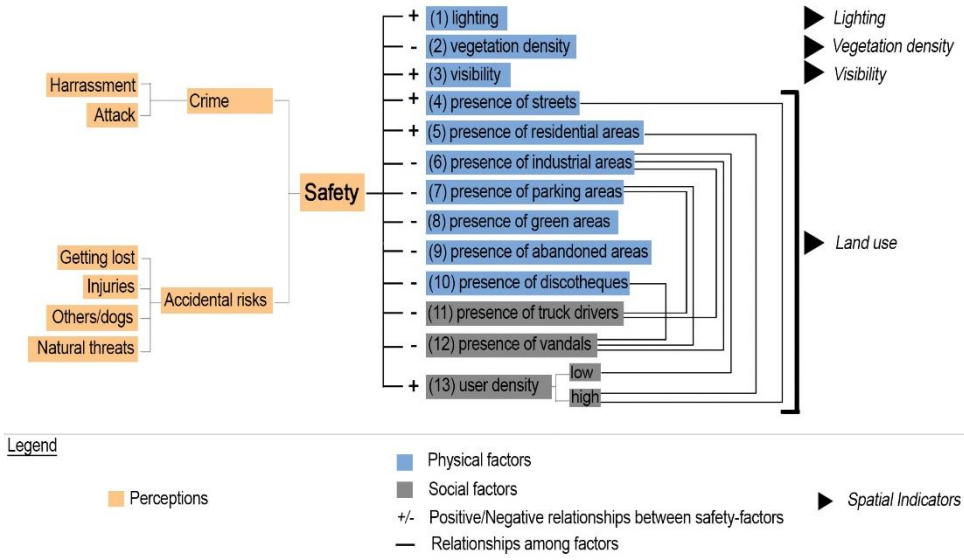

Figure 3. Perceptions of safety, social and physical environmental factors and spatial indicators. Own elaboration with Computer Assisted Qualitative Data Analysis Software (CAQDAS)

Environmental factors	Relationships		Rationale
Physical	**Between safety- factors**	**Among factors**	
(1) visibility	+	(2) (4) (5)	Open views and spaces were perceived as safer as they mean you can be seen in case of need. Conversely, areas with limited prospects and high concealment evoke fear as they limit this possibility.
(2) vegetation density	-	(1)	Dense vegetation such as overgrown and excessive trees, shrubs, and bushes evokes fear as it tends to obstruct visibility from and to the path.
(3) lighting	+	(1)	Path lighting facilitates physical activities among women who want to train in the dark as it enhances visibility.
(4) presence of streets	+	(1) (13)	Open views in streets enhance safety, as they are associated with increased user density.
(5) presence of residential areas	+	(1) (13)	Open views in built-up residential areas enhance safety, as they are associated with increased user density.
(6) presence of industrial areas	-	(1) (13) (11)	Views of industrial areas induced fear as they are related to low user density and antisocial behaviours such as those of truck drivers and vandals.
(7) presence of parking areas	-	(1) (11) (12)	Views of parking areas induced fear as they are related to antisocial behaviours such as those of truck drivers and vandals.
(8) presence of green areas	-	(1)	Most participants felt exposed to higher risks of injury and attack when in green areas, despite recognising the positive effect on health and wellbeing.
(9) presence of abandoned areas	-	(1) (6) (12)	Views of abandoned areas make the industrial areas appearing neglected, besides becoming a breeding ground for vandals.
(10) presence of discotheques	-	(1) (12)	Views of discotheques induced fear as they are related to the presence of vandals.
Social			
(11) presence of truck drivers	-	(6) (7)	Truck drivers usually rest in the parking spaces of the industrial areas near the stream, provoking fear of harassment in the form of catcalls and comments.
(12) presence of vandals	-	(7) (9) (10)	Vandals use the riverbanks for littering and fly tipping. This is the case of young people who meet in the parking areas or at the discotheque and gather on the riverbanks to smoke and drink. Broken glass left on the ground is seen as a danger to dogs and children as well as to personal safety.
(13) stream user density	+	(4) (5) (6)	High user density improved the feeling of safety inasmuch as it increases the possibilities of assistance.

Table 4: Factors and relationships

Physical and social environmental factors were grouped and translated into spatial indicators to allow for spatial analysis (Table 5). Four main categories of spatial indicators were identified: visibility, vegetation density, lighting, and land use. More specifically, land use included seven subcategories referring to types of sites: streets, residential areas, industrial areas, parking areas, green areas, abandoned areas, and discotheques. These subcategories grouped physical factors (related to types of sites) and social factors (related to the stream users). On the other hand, visibility, vegetation density and lighting enhanced or mitigated the safety perception of the seven land-use subcategories. Finally, in accordance with the spatial relationships between safety and environmental factors, a positive value was assigned to visibility, lighting, streets and residential area indicators, whereas a negative value was

assigned to industrial areas, parking areas, green areas, abandoned areas, discotheques and vegetation density indicators.

Environmental factors		Spatial indicators			
Physical	**Social**				**+/-**
(1) visibility		visibility: raster layer containing the area visible from a path		1	+
(2) vegetation density		vegetation density: raster layer associated with dense vegetation		2	-
(3) lighting		lighting: raster layer associated with lit streets		3	+
(4) presence of streets	(13) stream user density (high)	land use: raster layers associated with land uses	LU/streets	4	+
(5) presence of residential areas	(13) stream user density (high)		LU/residential areas	5	+
(6) presence of industrial areas	(13) stream user density (low) (11) presence of truck drivers		LU/industrial areas	6	-
(7) presence of parking areas	(11) presence of truck drivers (12) presence of vandals		LU/parking areas	7	-
(8) presence of green areas			LU/green areas	8	-
(9) presence of abandoned areas	(12) presence of vandals		LU/abandoned areas	9	-
(10) presence of discotheques	(12) presence of vandals		LU/discotheques	10	-

Table 5: Translation of social and physical environmental factors into spatial indicators, and attribution of positive (+) or negative (-) relationships to safety

3.4 Quantitative study

3.4.1 Data collection

In order to map the spatial indicators and proceed with the spatial analysis, the following data was used. Visibility was mapped using a Digital Terrain Elevation Model (DTM) of Catalonia obtained from LiDAR (Light Detection and Ranging) data retrieved from the Cartographic and Geologic Institute of Catalonia (ICGC) (ICGC, 2018). Vegetation density as well as land uses such as residential areas, industrial areas, parking areas, and green areas were mapped from the land use and land cover of Catalonia dataset provided by the Centre for Ecological Research and Forestry Application (CREAF) (CREAF, 2009). Lighting was mapped by geolocating the streetlights within the 500 m buffer around the Caldes Stream based on Google Earth imaging and on data provided by the urban planning services of the four municipalities. Streets were mapped from the topographic base map of Catalonia provided by the ICGC. Finally, abandoned areas and discotheques were mapped using Google Earth. Table 6 describes the data collected.

Spatial indicators		Data	Data source
		Digital Terrain Elevation Model (DTM) of Catalonia	
visibility	1	• Year: 2008-2010 • Height of sight-obstructing vegetation > 0.15 metres, heights of buildings > 3 metres • Pixel size: 1 x 1 metre • UTM zone 31N projection coordinates • ETRS89 geodetic reference system • EGM08D595 orthometric and geoid heights	Light Detection and Ranging (LiDAR) (ICGC, 2018)
		Land use and land cover of Catalonia	
vegetation density	2	• Year: 2009 • Vector dataset: percentage occupied by vegetation in forested areas • Clear forests: vegetation density between 5% and 20% Dense forests: vegetation density higher than 20% • UTM zone 31N-UB/ICC coordinates	Centre for Ecological Research and Forestry Application (CREAF, 2009)
		Streetlights within 500 m buffer from the Caldes Stream	Own elaboration from Google Earth and from data provided by urban planning services
lighting	3	• Vector map: geo-location of the street lights on the topographic base map of Catalonia	
		Streets included in the topographic base map of Catalonia	
LU/ streets	4	• Raster map: lanes and pavements • Scale 1:25000 • Contour lines every 10 m • Accuracy: 2.5 m	Own elaboration from Institut Cartogràfic i Geològic de Catalunya (ICGC, 2018)
LU/residential areas	5	Land use and land cover of Catalonia	
LU/industrial areas	6	• Year: 2009 • Vector dataset: highly detailed thematic cartography of land covers and uses • UTM zone 31N-UB/ICC coordinates	Centre for Ecological Research and Forestry Application (CREAF, 2009)
LU/parking areas	7		
LU/green areas	8		
LU/abandoned areas	9	Abandoned areas and discotheques within 500 m buffer around the Caldes Stream	Own elaboration from Google Earth
LU/discotheques	10	• Raster maps: abandoned areas, discotheques	

Table 6: Data used to map spatial indicators

3.4.2 Spatial data analysis

The spatial analysis was conducted using Quantum GIS™ and GRASS GIS™ software, in two phases: (1) mapping of spatial indicators and formation of spatial layers (see Supplementary Material), and (2) generation of the safety index. A buffer of 500 m around the stream defined the area of spatial analysis.

First, in order to map visibility, a cumulative viewshed analysis was conducted using Advanced Viewshed Analysis (Cuckovic, 2016). This estimated the difference in elevation between observations points, set up at 5 m intervals along the two most frequented itineraries, and a target raster cell. The points were modelled for a 300 m visual distance limit, considered the representative threshold for human perceptions (Lynch, 1960), and for an observer height of 1.63 m, corresponding to the average female height in Spain (OECD, 2009). The analysis returned a 1 x 1 metre raster layer identifying the

total area of the landscape visible from the perspective of a woman moving along the itineraries (Brabyn, 2015).

Second, the land use subcategories were mapped using the attribute table of the land use and land cover vector dataset. For each subcategory, the relevant attributes were selected. Green areas included allotments, urban parks, greenways, forestry areas, agricultural areas, urban green cover and water bodies. Residential areas included mixed urban land, facilities and services. Industrial areas included industrial estates, waste and water supply plants, and energy infrastructures. The parking areas were selected to form the corresponding spatial layer. Streets, abandoned areas, and discotheques were digitalised. Finally, two researchers familiar with the case study checked the accuracy of the data and modified the polygons and their attributes accordingly. Each land use was saved as a single vector layer.

Third, the vegetation density layer was formed by selecting polygons with a percentage of forest coverage above 20% from the land use and land cover dataset.

Fourth, in order to determine the portion of the lit itineraries, the streetlights dataset and the streets layer were overlapped on the two itineraries to form the lighting spatial layer.

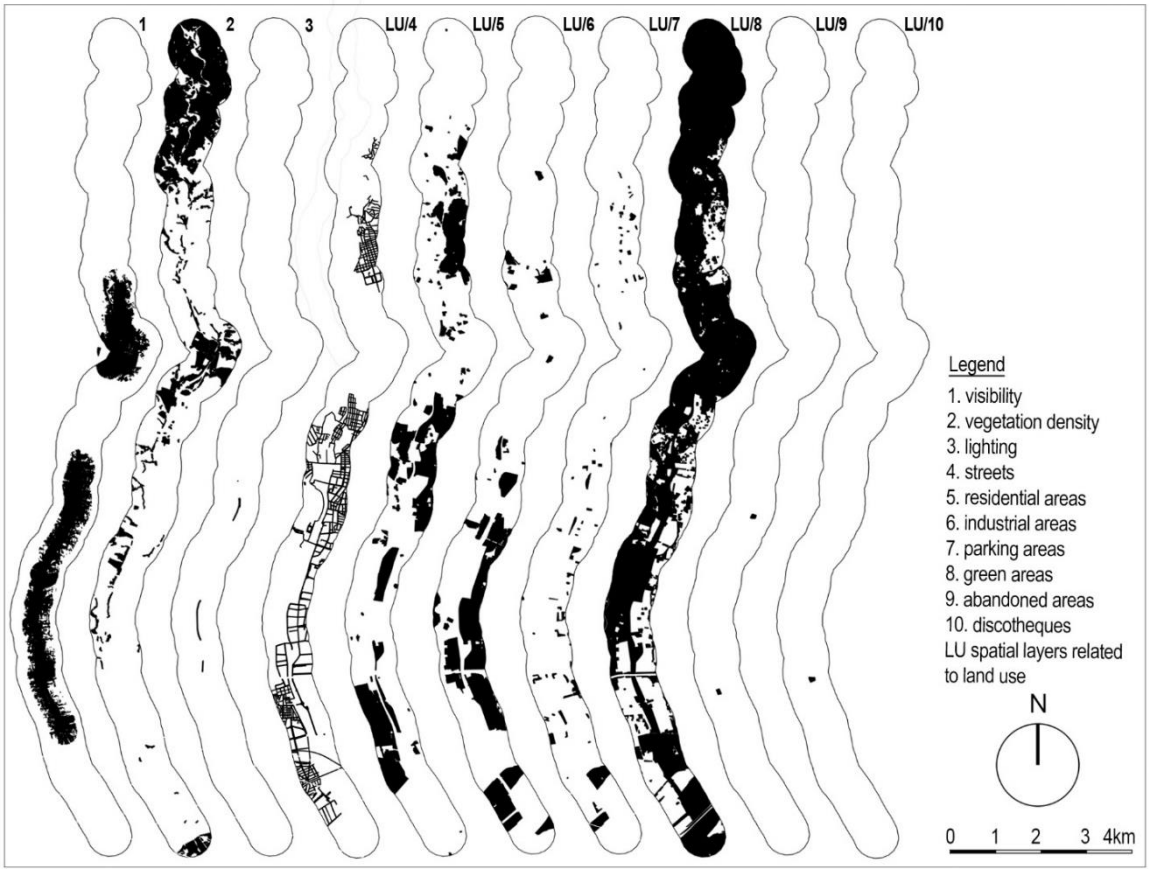

Figure 4. Spatial layers generated by computing the spatial indicators (in black): visibility (1), vegetation density (2), lighting (3), and land uses (LU 4-10). Own elaboration with GIS software

The spatial layers were then aggregated into a composite safety index, which models the capacity of the landscape to provide safe experiences for women travelling along the itineraries. More specifically, the map layers were combined using a weighted summation procedure (Wong, 2006). According to Table 3, layers were weighted by means of a binary scale: +1 for indicators with a positive relation with safety and -1 for those with a negative relationship. In this way, as the sum of positive indicators increased, the index value tended to go up as well. Conversely, when the sum of negative indicators went up, the index value tended to go down. To enable the weighted summation, all the vector layers were rasterised with a pixel size of 1 x 1 metre to reflect the human eye (Tomko, Trautwein, & Purves, 2009).

As for visibility, the viewshed was reclassified, assigning the value 1 for the visible cells and 0 elsewhere, and multiplied for the other layers. This ensured that only the areas visible from the

itineraries were included in the analysis. Afterwards, equal weights were assigned to the layers, and a weighted summation was carried out to form the composite safety index.

4. Results

A safety map (Figure 5) combining the general safety index values with individual perceptions was created. The index values ranged from -3 (perceived as very dangerous) to 3 (perceived as very safe). Each value was the result of combining multiple spatial layers (Table 7).

The overall perception was negative, given that 90% of the total visible area was rated from -1 to -3, which is logical given the prevalence of green areas associated with fear (Figure 4, LU8). The most dangerous areas (-3) resulted from the combination of three land uses perceived as adverse (e.g., a green spot in an abandoned industrial area) or of two of them with vegetation density (e.g., a parking area in a green space with dense vegetation). Moderately dangerous areas (-2) appeared when two adverse land uses overlapped (e.g., abandoned buildings in industrial areas); when one adverse land use was combined with vegetation density; or when three negative spatial indicators were mitigated by one positive indicator (e.g., a lit green spot in an abandoned industrial area). When a negative indicator stood alone, or when two were mitigated by a positive one (e.g., lit green areas with dense vegetation), the place appeared as slightly dangerous (-1). The map also showed areas with a neutral value (0), where positive and negative spatial indicators balance each other out (e.g., green areas located in residential areas). Most of the area with positive values was perceived as slightly safe (+1), being the result of a single positive indicator (e.g., streets) or the sum of two positive with one negative indicator (e.g., lit streets in industrial areas). The combination of two positive indicators (e.g., lit streets) resulted in a moderately safe environment (+2) while the highest positively rated areas (+3) included three positive indicators (e.g., lit streets in residential areas). In sum, the safety map mirrored the effects of environmental factors on safety, identified by the qualitative analysis and the literature review. Where there was proper lighting, open views not obstructed by vegetation, and nearby residential areas, safety perception increased. Conversely, where itineraries were not properly lit at night, with views of

industrial estates, abandoned areas or parking lots, and vegetation limited the viewshed, perceived safety decreased.

Itinerary 1						
Safety index value						
-3	**-2**	**-1**	**0**	**1**	**2**	**3**
(Area/Total area) ratio						
0%	**6%**	**66.9%**	**19.8%**	**6.9%**	**0.4%**	**0%**
Combinations of spatial indicators						
B+F+G	B+G	F+G+H	A+E+F+H	C+H+I	E+H	E+H+I
A+D+F	D+E+F+G	E+F+G	C+E	E+F+H	H+I	
	A+F	G	B+E	G+H+I		
	A+F+G+H	D	F+H	B+E+H		
	C+G	A+F+H	D+E	H		
	B+F+G+I	B+F+H	G+H	E+F+I		
	D+F+G+H	D+H+G	E+F	E		
	A+E+F+G	C+G+H		G+I		
	C+D	B+G+I		I+F		
	C+F	D+E+G				
	C+D+G+H	C+D+E				
	B+F	B				
	F+G	D+F+I				
	D+G	C				
	D+F	D+E+F				
		F+G+I				
		A+E+F				
		F				
		C+D+H				
		B+E+F				
		D+G+I				

Itinerary 2						
Safety index value						
-3	**-2**	**-1**	**0**	**1**	**2**	**3**
(Area/Total area) ratio						
0%	**16%**	**77.5%**	**4.5%**	**2%**	**0%**	**-**
Combinations of spatial indicators						
F+D+A	F+A	D	E+D	E	H+E	
G+F+A	F+D	F	F+E	H		
	G+D	F+E+A	G+E	H+G+E		
	G+F	F+E+D	H+F+G+E			
		G				
		G+F+E				
		H+G+F				

LEGEND:	NEGATIVE INDICATORS:		POSITIVE INDICATORS:
0% RESIDUAL VALUES - NO VALUE	A: VEGETATION DENSITY B: ABANDONED AREAS C: DISCOTHEQUES	D: PARKING AREAS F: GREEN AREAS G: INDUSTRIAL AREAS	E: RESIDENTIAL AREAS H: STREETS I: LIGHTING

Table 7: Combinations of spatial indicators and resulting safety index values

Besides showing the overall distribution of safety perception for the whole area from women's perspective, the safety map geolocated individuals' perceptions in four specific locations where data clustered. This integrated vision of spatial indicators and qualitative data raised several aspects that deserve consideration.

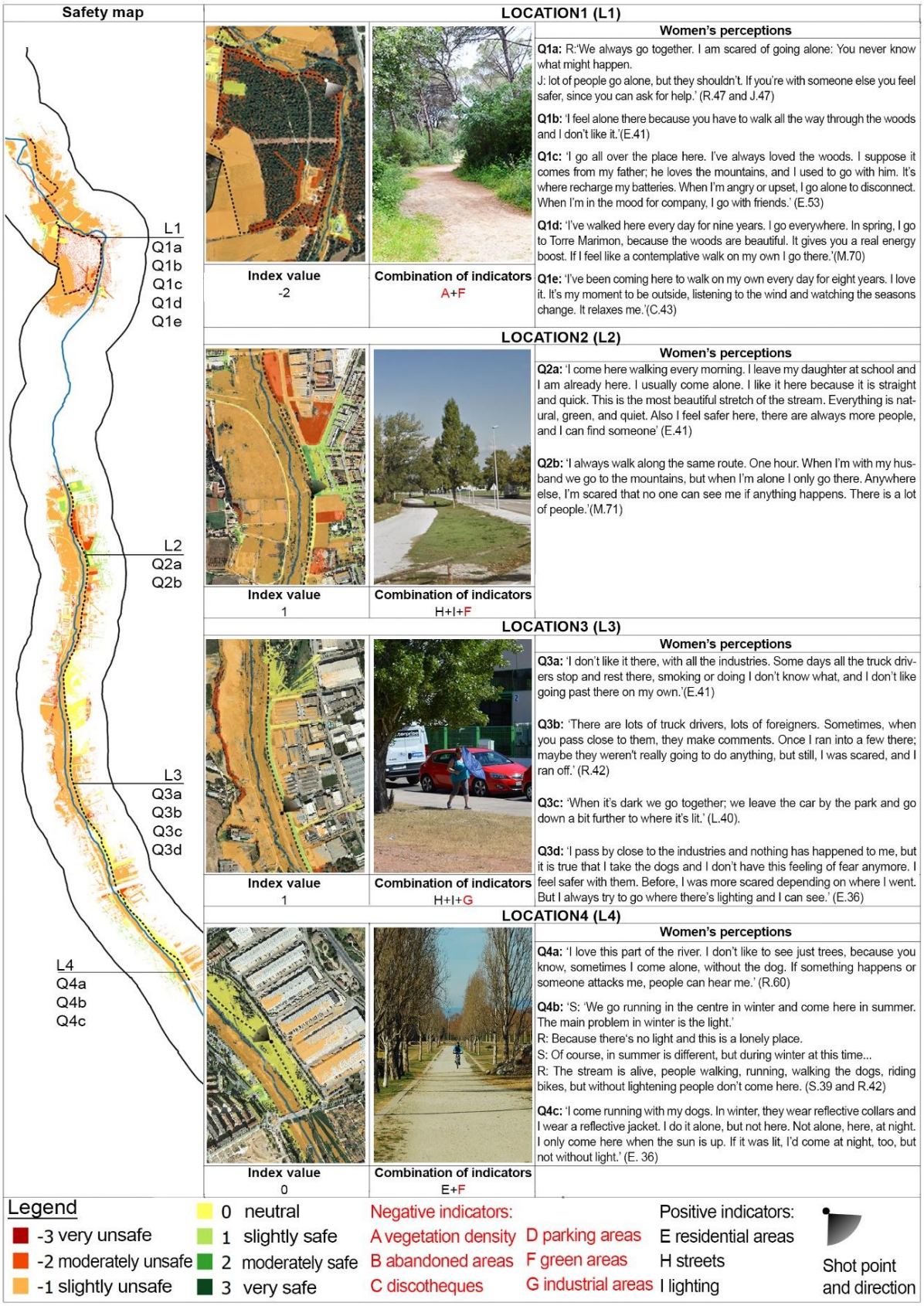

Figure 5: Safety map. Integration of the general safety index values with personal perceptions. Own elaboration

5. Discussion

5.1 Tangible factors: Eyes on the street

The safety map allowed an in-depth examination of the effect of the physical and social environmental factors associated with the visual perception and use of GE on women's safety perception. Findings from the pilot study supported the "eyes on the street" theory developed by Jacobs (1961).

Efficient lighting facilitates surveillance during the day and at night, so illuminated itineraries with views in residential areas and streets were perceived as the safest, as Loewen, Steel, and Suedfeld (1993), Atkins et al., (1991), and Painter (1996) found in their research. When streets and lighting came into play, women believed that the number of "eyes on the itinerary" increased, as did the possibility of receiving assistance even in a GE (Q2a, E.41, Figure 5). Maintenance and equipment also play a significant role in safety. According to Skår (2010) and Van den Berg and colleagues (2014), urban parks, inasmuch as they are more likely to be maintained and equipped, are suggestive of the presence of a friendly, caring environment, and are perceived as more welcoming and safer, especially if compared with wilder woodlands (Q4a, R., 60, Figure 5).

Conversely, stretches through the woods were recurrently considered as lonely places where women choose not to go alone. More wooded or wild settings may remind women of their own vulnerability (Skår, 2010) and be associated with negative index values. Women believed they were more exposed to crime in densely vegetated areas, marked by hiding spaces for possible attackers, fewer people using the riparian itineraries, and less chance of being seen from afar (Q1a, R.47 and J.47, Figure 5).

Likewise, stretches close to the industries were prone to generate fear, especially at night, since, as mentioned, they were related to low density of users and antisocial behaviours. However, lighting can balance out the perception of an undesired land use, such as the industrial, and is therefore very influential among the various indicators. In fact, lit stretches close to the industries were perceived as safer than unlit (Q4c and Q3d, E., 36, Figure 5).

Taken as a whole, the pilot's results confirmed Jacob's seminal intuition and were consistent with previous research. The "safety map" visualizes the interactions of the tangible (physical and social) environmental factors involved in the "eyes on the itinerary", i.e., factors influencing 1) the visual perception of places (lighting, maintenance and equipment, vegetation density) and 2) their use (land use, density of users, and types of users). However, the effect of such interactions was mediated by equally crucial intangible factors, thus leading towards a more complex understanding of women's safety perception.

5.2 Intangible factors: Women's background and everyday practices

Beyond the general validity of the tangible mapped factors involved in the "eyes on the itinerary", the study found that some intangible factors also played a crucial role, specifically in women's safety perception. These intangible factors overlapped and interacted with those associated with the "eyes on the itinerary", and included two types: 1) social factors associated with women's backgrounds (cultural norms and beliefs), and 2) individual factors related to personal everyday practices. The patriarchal vision of public space, as well as myths and beliefs about criminal stereotypes, and vulnerability of women belong to the first type. These factors, deeply rooted in women's backgrounds, may coincide and reinforce one another, turning the emotion of fear into a social concern (Varona Martínez, 2015).

The patriarchal vision of public spaces, derived from an ethic of care, may constrain women's leisure engagement and induce fear (Q1a, R.47 and J., 47; Q4a, R., 60, Figure 5). The ethic of care model is rooted in the ancestral concept of gender roles, which associates women and men with different jobs, physical and sensorial capacities, models of freedom, and places (Reguillo, 2000). Accordingly, taking care of family needs and sustaining relationships in the private sphere tends to be the highest priority for women, who put their family first, often to the detriment of fulfilling their own needs. A lack of a sense of entitlement to leisure appears to be unique to women, who feel the social pressure of fulfilling the role of being a good mother and wife, subordinating their own spare time to family and work responsibilities (Day, 2000). This leads to a patriarchal vision of public spaces, with men as protagonists of public life and women in the private sphere, and has prompted women to interiorise public space in

general, and GE in particular, as places that do not belong to them, thus increasing their perception of risk (Rivas, 2009). Moreover, this risk perception can be indirectly exacerbated (Doran & Burgess, 2012), and a number of studies show that women often fear victimization despite the absence of actual victimization experiences (the so-called fear paradox) (Varona Martínez, 2015). This absence of logic means that neither victimization surveys nor official statistics are able to reflect the extent of women's fear, which seems to be mostly related to media exposure and interpersonal communication about others' experiences of criminal victimization. Many examples of this paradox can be found in the interviews, where fear seems to be disconnected from experienced violent episodes (Q1a, R.47 and J., 47; Q4a, R., 60, Figure 5).

In accordance with established literature, criminal stereotypes intervened to exacerbate the fear paradox. For example, when expressing their concerns about the presence of truck drivers who park their trucks and rest where the stream runs close to the industrial estates, women pointed out their foreign citizenship (Q3b, R., 42, Figure 5). It has been demonstrated that ethnic diversity is significantly related to fear of crime. This could be explained by criminal stereotypes affecting specific ethnic minorities or groups of the population which are believed to be directly associated with specific forms of crime such as robberies, assaults or drug dealing, an association that is often inaccurate and reinforced by media reporting that emphasizes the involvement of a member of an ethnic minority group in certain forms of crime (Hooghe & de Vroome, 2016).

On the other hand, the popular thinking that women are "the weaker sex" also influenced women's perceptions of safety (Q4a, R., 60, Figure 5). The expression reflects the social belief that women are physically more vulnerable than men, and thus more likely to be victimised (Taylor and Hale, 1986). Accordingly, women feared that, if actually attacked, especially at night, they would suffer greater harm than men. The different education that men and women still receive in terms of safety in public spaces reinforces this dichotomy through hidden and unconscious messages. Boys are allowed to go out alone, go further and return home later, whereas girls are given warnings about being careful when out and not trusting people they don't know, particularly when alone and in the dark, that convey fear (Hillman, 1990).

Interestingly, the influence of the above-mentioned social factors related to women's backgrounds can be mitigated by individual factors such as the recurrent use of GE. Three women who described their activities as long-standing recurrent practices felt at ease in places considered moderately unsafe due to the presence of obstructing vegetation. Unlike those who tended to limit their movements, avoid certain routes or adopt precautionary measures (e.g., going with company), these women did not wonder whether to go or not: they simply went, walked, explored and decided autonomously what to do and what not to (Q1c, E., 53, Figure 5). In line with the findings of various studies (Benages-Albert, Di Masso, Porcel, Pol, & Vall-Casas, 2015; Kolektiboa, 2010), it turns out that recurrent use of GE stimulates a personal process of place attachment which ultimately helps users to overcome the fear associated with limiting environmental factors.

This complex interplay between tangible and intangible factors underlies any attempt to analyse women's perception of safety in GE. For this purpose, the use of an ecological model to address safety from a multilevel perspective, and the integration of tangible and intangible dimensions using a novel qGIS approach are significant contributions to this research. The systematic comparison and contrast of individual perceptions and the overall spatial distribution of fear ("eyes on the itinerary") by means of safety maps will serve to identify areas that merit decision-makers' attention and inspire strategies for reverting gender inequality in the use of GE.

6. Conclusions and implications for practice

To explore the relationship between women's safety perception and environmental factors in urban stream corridors, a safety map was created by integrating quantitative and qualitative data. Four spatial indicators (visibility, vegetation density, lighting and land use) were weighted according to their capacity to convey safety and combined into a safety index. Individual qualitative data for specific locations was also included. The combination of quantitative macro-scale and qualitative micro-scale approaches provided an across-the-board picture of the capacity of GE to enhance or mitigate women's perceptions of safety and also promoted a nuanced understanding of how these perceptions were mediated by women's backgrounds (patriarchal vision of public space, criminal stereotypes, vulnerability of women) and everyday practices (recurrent use of GE).

The purpose of this pilot study was to explore methods for mapping women's safety perception rather than to prove the validity of a specific tool, and the methodological findings are not meant to be conclusive. Given the complexity of the safety issue, which involves multifaceted tangible and intangible dimensions, further research is needed to overcome the limitations of this study and increase the accuracy of safety assessment. More specifically, based on the proposed methodology, future research should: (1) test the methodology in different GE and socio-demographic contexts, and on larger samples; and (2) tackle the perception variability of the environmental factors depending on different women's profiles.

Safety maps based on qualitative Geographic Information Systems (qGIS) serve to capture hidden projections of women's perception of safety and may be useful in supporting policies to promote physical activity in large-scale GE from a gender perspective. This exploration suggests the importance of efforts aimed at providing "eyes on the GE". In particular, improved lighting may remove fears related to certain existing land uses. However, actions taken to modify environmental factors should be accompanied by long-term educational programmes with the aim of supporting recurrent use of GE to stimulate the sense of belonging, and overcoming the socio-cultural barriers that inhibit women's access to GE.

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Supplementary material

This supplementary material aims to present the steps that have not been detailed in the manuscript for the realization of the Safety map. The following Figure 1, already presented in the manuscript, highlights these steps and relates them to the entire methodology.

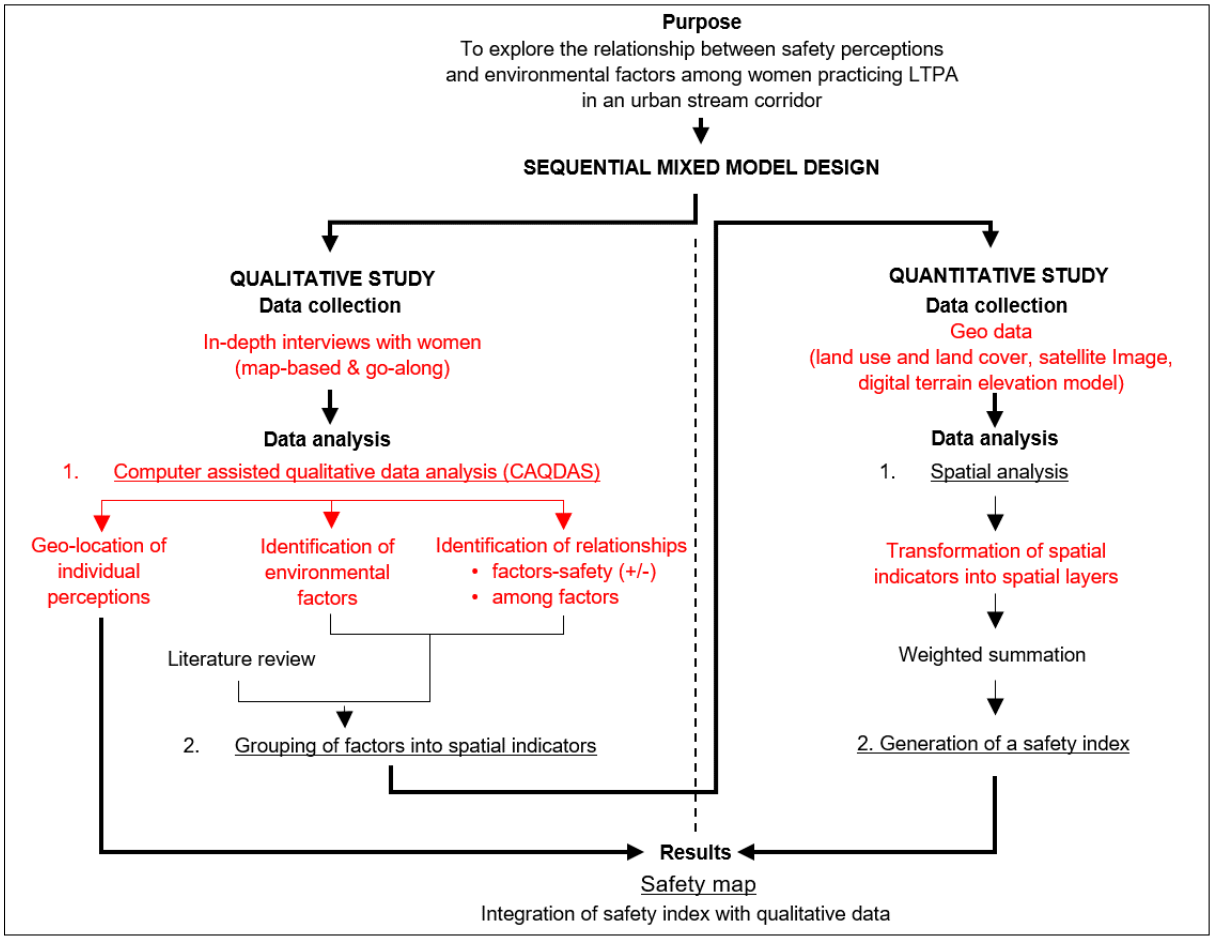

Figure 1: Steps detailed in the Supplementary Material (in red) in relation to the entire methodology.

1. Qualitative study

1.1 Data collection

Participants selected the interview technique according to their schedules. Six map-based and eight go-along interviews were conducted, as detailed in the following Table 1.

Name	Age	Municipality of residence	Types of physical activity	Type of in-depth interview	Frequented itinerary
J.	47	Caldes de Montbui	Walking	Map-based	Itinerary 2
R.	47	Caldes de Montbui	Walking	Map-based	Itinerary 2
C.	53	Caldes de Montbui	Walking	Map-based	Itinerary 2
R.	65	Caldes de Montbui	Walking	Go-along	Itinerary 2
J.	65	Caldes de Montbui	Walking	Go-along	Itinerary 2
E.	50	Caldes de Montbui	Walking, Cycling	Map-based	Itinerary 2
E.	36	Santa Perpètua de Mogoda	Running, Cycling	Go-along	Itinerary 1
L.	40	Santa Perpètua de Mogoda	Walking	Go-along	Itinerary 1
R.	61	Santa Perpètua de Mogoda	Walking	Go-along	Itinerary 1
R.	42	Santa Perpètua de Mogoda	Running	Map-based	Itineraries 1 and 2
S.	39	Santa Perpètua de Mogoda	Running	Map-based	Itineraries 1 and 2
M.	71	Palau-Solità i Plegamans	Walking	Go-along	Itinerary 1
M.	70	Palau-Solità i Plegamans	Walking	Go-along	Itinerary 1
E.	41	Palau-Solità i Plegamans	Walking	Go-along	Itinerary 1

Table 1: In-depth interview details.

At the beginning of each interview, the interviewer explained the purpose of the study and gave a definition of physical activity, meant as any bodily movement that requires energy expenditure, such as walking, riding a bike, running, gardening, walking the dog, playing, exercising, and sport. The interviewer also ensured that participants gave verbal informed consent. Both map-based and go-along interviews followed a guideline (Table 2) adapted from the Active Living Research surveys database on trails and greenways. These surveys covered the main areas of inquiry related to the environmental factors associated with physical activity from an ecological perspective (Robert Wood Johnson Foundation, 2017). In addition, exploratory inquiries tested in health geography research (Bell, Phoenix, Lovell, & Wheeler, 2015; Thomas, 2015; Völker & Kistemann, 2013) were included in order to broaden data-gathering to the whole environmental experience. The use of the interview guideline facilitated comparison of interviews transcripts during the analytical phase.

Characteristics	Questions	
What	• What kinds of physical activities do you practise, and particularly in the Caldes Stream corridor?	
With whom	• Do you prefer to practise physical activity alone or accompanied? • Are you a member of an organization that promotes physical activity in the Caldes Stream corridor?	**Why?**
When	• In summer/winter, how often do you practise physical activity in the Caldes Stream? • For how long on working days/weekends? • When during the day?	
Where	• Where do/don't you like to practise physical activity in the stream area? • Can you describe what you usually do when you go there?	
Who	• Age, address, years of residence, civil status, number of children, educational level, job position	

Table 2: In-depth interview guideline.

1.2 Computer-Aided Qualitative Data Analysis (CAQDAS)

ATLAS.ti was the software used for the CAQDAS of the interviews' transcripts. It helped managing large volumes of qualitative data in a systematic way. The logic of the software is built around a standardized and refining process of coding. At the most general level, the process consisted in two consecutive phases: 1) coding the data using the software to select, sort, and structure the data (descriptive analytical level), and 2) querying the data with the aim of discovering patterns and relations (conceptual analytical level) (Friese, 2014; Saldaña, 2015).

1.2.1 Descriptive analytical level

The aim of the descriptive analytical level was to create a code system for all transcripts. An iterative process of coding was developed. It consisted in marking quotations relative to the recurrent topics emerging from the interviews, writing comments on quotations, and attaching labels. The first stage of coding consisted in reading the transcripts of the interviews, noticing interesting information for the research purposes, segmenting the text in thematic units related to safety and geo-locating the relative quotations. Geo-locating was made possible by the hyperlink function that related quotations across documents. Quotations were assembled using a Google Earth document.

The second coding stage aimed to associate code categories and subcategories with environmental factors and safety perceptions. At first, the text segmented in thematic units was coded randomly, in

order to collect as many ideas as possible with regard to women's safety perceptions and environmental factors influencing them. At this point, the labels were descriptive and had a provisional character.

The first code list contained a massive amount of codes, too often redundant. Hence, codes were grouped to classify, prioritize and conceptualize themes. Accordingly, all the names that had a different label but appeared to have the same meaning were merged. Having cleaned up the code list in this way, the analysis moved on, adding more conceptual structure to the list by attaching interpretative codes partly retrieved from the literature. This resulted in a structured code list of categories and subcategories of social and physical environmental factors, and of safety perceptions. The list was applicable to the rest of the data during further cycles of coding until all the data was coded.

The final code list was structured by labelling the codes into two main families (environmental factors and safety perceptions). Capital letters were used to refer to each category (PF for environmental physical factors, SF for environmental social factors, and S for safety perceptions), followed by the name of the subcategory. A different colour was assigned to each category to facilitate visualization for the subsequent analytical phase. Code names are shown with their groundedness and density counts—that is, the number of links to quotations and to other codes, respectively (Figure 2).

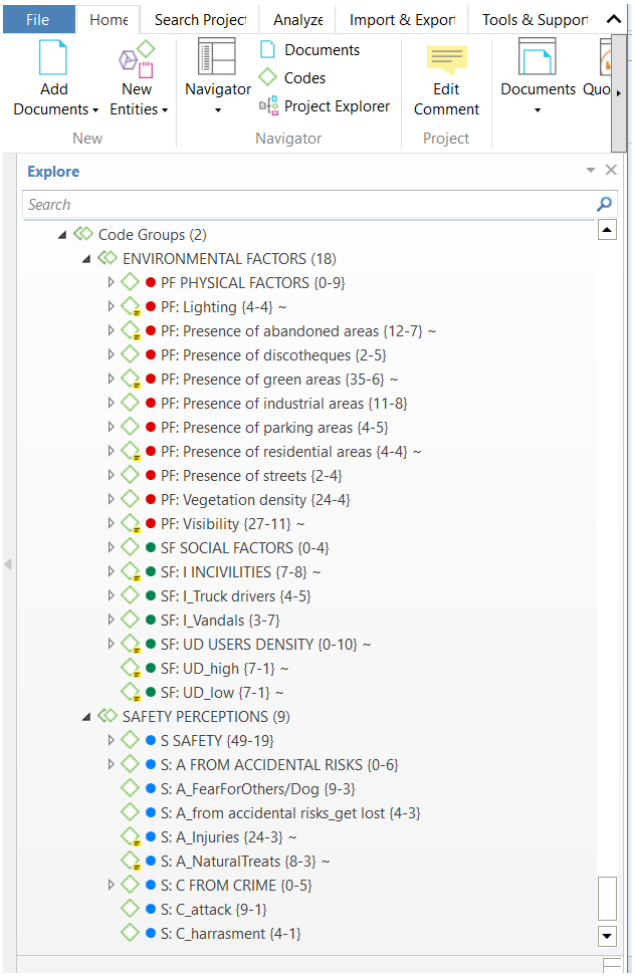

Figure 2: Code list and groups. Retrieved from the ATLAS.ti project

1.2.2 Conceptual analytical level

Once the code system was developed, it was interrogated using the ATLAS.ti analytic tools. This phase aimed to identify: 1) positive or negative relationships between factors and safety and 2) relationships among factors. A network view was used to integrate these relationships in order to gain a comprehensive understanding of the safety perception and to define a base model for the following phase (Figure 3). The network was progressively developed as the analysis advanced. First, it showed 'Is a' type relationships to link specific concepts to general ones, such as safety to specific safety issues extracted from the data exploration. Second, the quotations associated with each environmental factor were re-read in order to determine its role in increasing or decreasing safety perceptions, and a positive or negative relationship type was assigned accordingly. Third, in order to relate environmental factors with each other, 'Is associated with' type relationships were added. The Query tool was used to

determine these relationships by retrieving all the text segments where the environmental factors matched up (Figure 4).

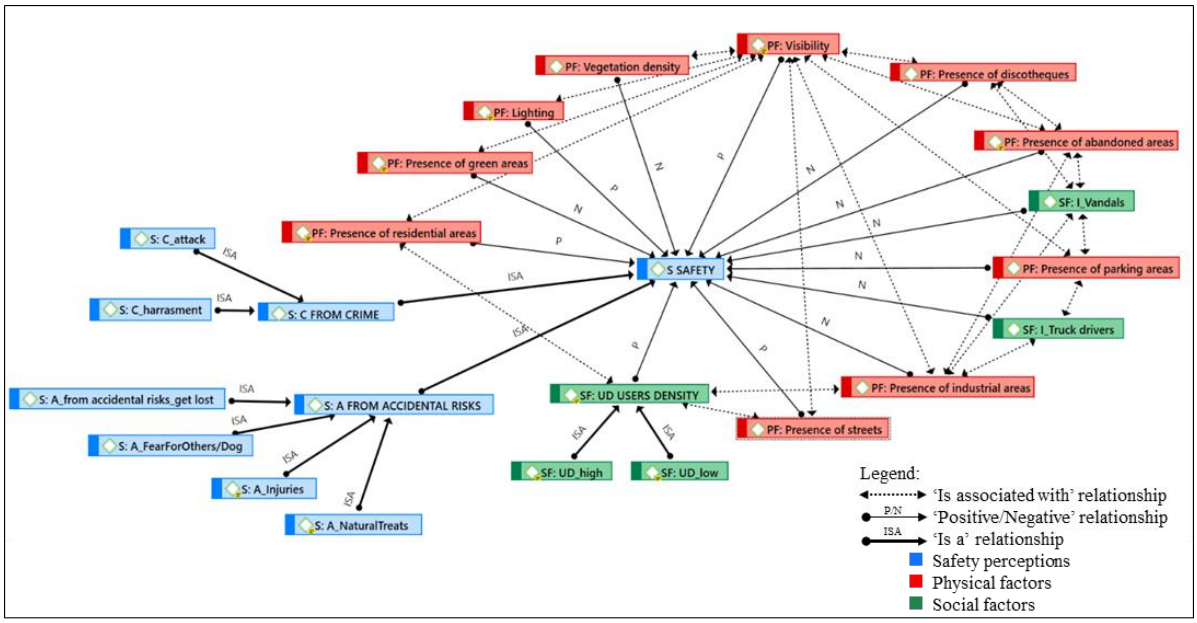

Figure 3: Network view. Retrieved from the ATLAS.ti project

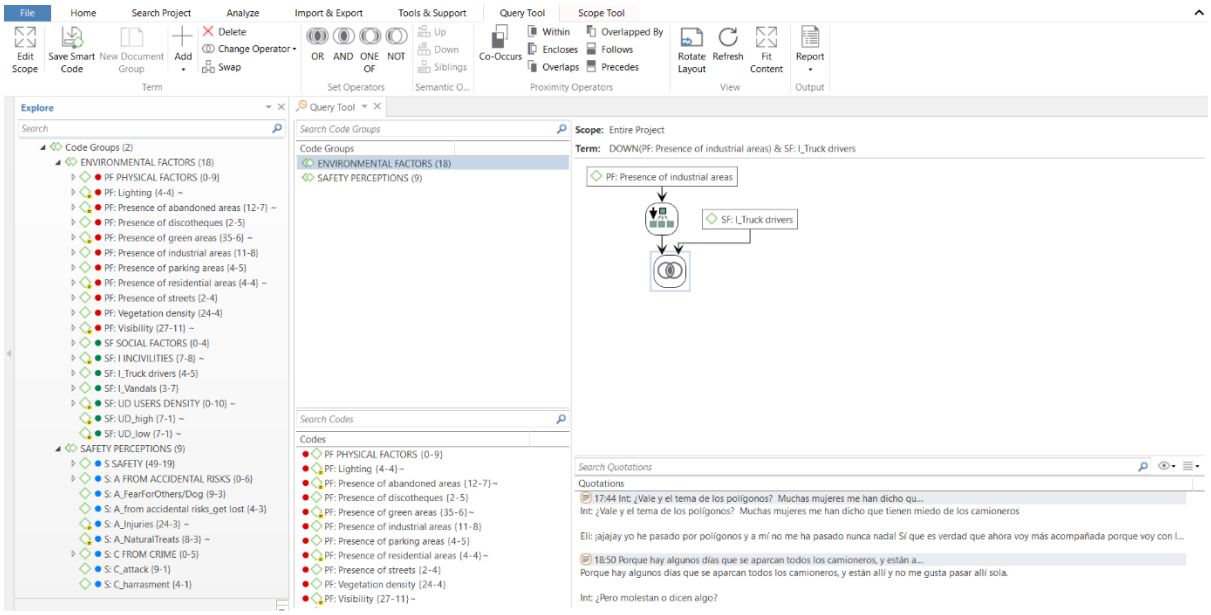

Figure 4: Query tool. Retrieved from the ATLAS.ti project

2. Quantitative study

2.1 Transformation of spatial indicators into spatial layers

Descriptive maps of the visible landscape (spatial layers) were produced by superimposing cumulative viewsheds and land-use data related to women's perception, following the examples of Egarter Vigl,

Depellegrin, Pereira, de Groot, & Tappeiner (2017), Robert (2018), and Yasumoto, Jones, Nakaya, & Yano (2011). Regarding visibility, LiDAR data was used to obtain the Digital Terrain Elevation Model (DTM). LiDAR is a surveying method that measures distance to a target land area by illuminating the area with laser light and measuring the reflected light with a sensor. Differences in laser return times and wavelengths are used to make digital 3D representations of the land surface. The data was taken between 2008 and 2010, and is distributed by blocks of 2 x 2 km, with a minimum density of 0.5 points/m^2, in LAS 1.2 format, UTM zone 31N projection coordinates, ETRS89 geodetic reference system, and orthometric heights in reference to the EGM08D595 geoid model. In order to be able to process LiDAR data, the QGIS las2dem tool from LAStools was used (Isenburg, 2010). The tool triangulates LAS 1.2 data temporarily into a triangulated irregular network (TIN) and then rasterizes the TIN onto a DTM format. The high-data density served to obtain a high-resolution DTM with a pixel size of 1 m. This resolution provided a correct topography of the study area and the heights of sight-obstructing vegetation taller than 0.15 metres and buildings taller than 3 metres. The DTM was clipped according to the 500-metre buffer around the Caldes stream.

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5. Discussion

As this research is based on the need to reconsider the current standardized approach to LTPA promotion in GE, it is useful to reflect on the results of the qualitative ecological approach applied to the Caldes Stream corridor case study as a baseline to support inclusive LTPA promotion. In general, four learning points can be elicited with the purpose of supporting future designs and the implementation and evaluation of LTPA-enhancing interventions (Figure 7). The first two learning points suggest two crucial topics on whom inclusive LTPA promotion in GE should be based: the thorough characterisation of users according to their motivations for practicing LTPA in the GE, and the gender perspective. The third learning point highlights the need of ad hoc toolkits for customised and inclusive LTPA promotion. The fourth one revolves around the improvement of LTPA promotion policies.

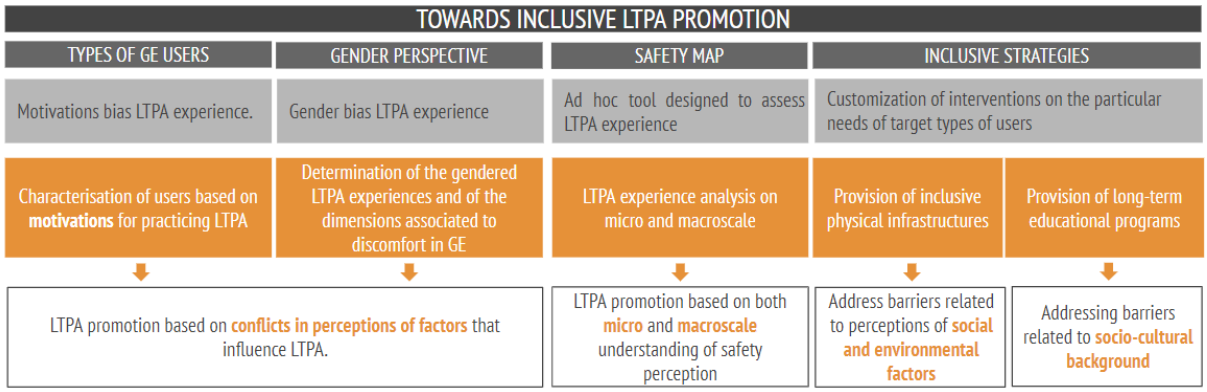

Figure 7: Guidelines for inclusive LTPA promotion. Source: Own elaboration

5.2. Characterisation of green environments users as crucial means for inclusive LTPA promotion

Inclusive LTPA promotion in GE should be based on a thorough characterisation of GE users which takes into account their motivations for practicing LTPA and how motivations influence their LTPA experience (Calogiuri & Chroni, 2014). Depending on motivations, users interpreted the GE and related to it in very different ways. Moreover, depending again on motivations, on the characteristics of the LTPA practiced and on the socio-demographic characteristics of the users, the stream corridor users

turned out to be similar one to another in their pattern of experience, allowing the definition of units of analysis (Hull, Stewart, & Yi, 1992), that is the types of users.

Types of users perceived the environmental factors influencing LTPA as either barriers or facilitators variously, giving rise to conflicts in some instances. For example, users who interpret LTPA as a sociable moment to be shared with friends or members of the family, along with those who feel safer in presence of other people may perceive high attendance as a facilitator. On the contrary, expert runners or cyclists with specific training goals or users in search for relaxation and contact with nature may perceive high attendance as a barrier since the presence of too many people can interfere with their goals and expectations. Therefore, conflicts in perceptions of factors are related to motivations interferences between one or more types of users. That may have important implications for LTPA promotion in GE since these motivation interferences can shape the users' decision to participate or not in LTPA (Godbey et al., 2005; Jacob & Schreyer, 1980).

LTPA intervention planning without placing emphasis on an in-depth understanding of such conflicts can have serious consequences. This is the case of the Besòs River park in the town of Santa Coloma de Gramanet, where a cyclist died after crashing into another and a woman was run over by a cyclist while walking with a friend (Gramenet 2.0, 2019; La Vanguardia, 2019a). These events have led the administration to take new measures to avoid accidents, including improved signalization, pedestrian crossings, separate trails, and speed limit rules (La Vanguardia, 2019b). However, this kind of accidents may have been avoided by anticipating potential conflicts among the different types of users coexisting in the GE. In this regard, a thorough understanding of types of users' specificities could be the backbone of a safer LTPA practice. In the light of a bottom-up approach, which is primordial for conflicts resolution, administrations should promote public participation and elicit appropriate solutions based on users' specificities.

5.3. Gender inequalities in green environments: women's safety perception as a barrier for Leisure-time physical activity

LTPA promotion should pay attention to gender perspective since, together with motivations, gender determine users' LTPA experiences. There is some evidence to suggest that both the meaning assigned to GE and its use are highly gendered. Women use GE in a different way from men (Richardson & Mitchell, 2010). This suggests that conflicts depend not only on motivation interferences between types of users, but also, for the same type, on gender differences in the perception of the environmental factors influencing LTPA.

Certainly, literature supports the idea that women are preoccupied with uncomforting feelings in GE. Safety, characteristics of the space, social roles and expectations, gendered norms of physical behaviour and gender regulation are among the various issues which might fuel such discomfort; women's participation to LTPA in GE is discouraged with important consequences on their health and wellbeing (MacBride-Stewart, Gong, & Antell, 2016). In this research, discomfort was highly associated with the perception of fear experienced by women practicing LTPA in the Caldes Stream corridor. For example, in contrast to men, who preferred more remote natural settings, women were more likely to favour familiar environments that guarantee lightening and views of the residential areas and streets; otherwise, they tended to project the place as dangerous. Besides, women reported feeling less safe than men in neglected areas marked by signs of physical and social incivilities. Due to perceptions of fear, women appeared to show a preference for highly attended GE or for visiting GE with friends or family. Apart from these environmental factors, perceptions of fear were attributable to intangible dimensions related to the socio-cultural backgrounds of women. Actually, they perceived the GE in ways that took into account victimisation beliefs, socio-ethnic prejudices, and ethic of care norms.

Therefore, the identification of the gendered LTPA experiences and of the dimensions associated to discomfort in GE emerges as a particularly important goal for public health. Although this is widely acknowledged (WHO Regional Office for Europe, 2016), poor consideration is given to the potential gender inequalities derived from current interventions addressed to promote LTPA in GE (Britton, Kindermann, Domegan, & Carlin, 2020). Gender perspective remains largely neglected in surveys and policies with practical effects on women's use of GE. For example, a recent guideline for the design of healthy peri-urban itineraries elaborated by the Diputació de Barcelona (2018) have not made reference

to the gender perspective. Similarly, no gender perspective has been included in the survey of the University of Brighton aimed at prioritizing strategies for inclusive health and wellbeing promotion through the enhancement of LTPA in a recreational greenway in England (Church, 2011). Although the survey shows that the rates of LTPA practice in GE are higher for men than women, no particular strategies to revert this situation are considered. Overall, practical and policy-relevant strategies for addressing the inequities related to GE use for LTPA remain still pending.

5.4. The safety map as an example of analytical tool for inclusive Leisure-time physical activity promotion

In the light of the above, strategies for inclusive LTPA promotion require an ad hoc toolkit purposely designed to meet the particular needs of specific types of GE users (Britton et al., 2020). Renewed analytical tools could support the customisation of interventions providing a competent knowledge on the tangible and intangible dimensions associated to LTPA experience of each type of GE user. The toolkit should include i) previous qualitative analysis of LTPA experiences and ii) qualitative GIS mapping. The former serves to elicit the types of users and to assess the barriers or facilitators to LTPA for each type based on their perceptions. The latter serves to map the influencing factors which take place in a specific context integrating tangible (social and physical environmental factors) and intangible (socio-cultural factors) dimensions (Golledge & Stimson, 1997).

The safety map based on qualitative GIS designed in this thesis contributes to this toolkit. The map offers a throughout representation of the place where LTPA occurs which goes beyond the purely geographic notion and reflects the subjective perception. When considering women LTPA experience in terms of “how” (that includes “what”, “with whom”, “when” and “where”), and “why”, it can rarely be reduced to some hard-coded information and analysed and mapped with regard to a single location. Indeed a more complex representations is required (Merschdorf & Blaschke, 2018). Accordingly, the map is able to create rich and multi-layered descriptions of the place combining physical, social, and individual information on LTPA. As for ‘where’, the map allows drawing conclusions on both micro and macroscale. On the one hand, it geo-locates individuals’ perceptions in specific locations (micro-

scale). On the other hand, it measures and maps the social and physical environmental factors influencing such perceptions through spatial layers which show the macroscale distribution of the safety perception. As for 'how', the spatial layers are charged with qualitative information through the assignation of a value based on women's perceptions, and are then combined into an index. The shading of the index represents the degree to which a perception occurs in a portion of space and provides some interesting trends, necessary for the general explanation and prioritisation of domains of intervention. As for 'why', once such information is compared to a narrative in a specific location, the map gives higher levels of understanding.

The safety map is therefore a powerful analytical tool which enhances understanding of places in a way that may differ from the dominant representations created by experts. For example, public administrations should be aware of the fact that the promotion of itineraries that cross forested areas runs the risk to exclude most women from their use; issue that appears not to be taken into consideration yet (Diputació de Barcelona, 2018). Therefore, the safety maps should draw the attention of policymakers who deliver practical advice about inclusive LTPA promotion based on user's LTPA experience.

5.5. Strategies for inclusive Leisure-time physical activity promotion in green environments

Inclusive LTPA promotion in GE which makes them more accessible and usable for the maximum types of users' profiles (Levesque, Harris, & Russell, 2013; Stessens et al., 2017), challenges academics and policymakers since it requires translating intangible and sometimes conflicting perceptions of the GE into practical and policy-relevant LTPA promotion strategies. These strategies should combine i) the provision of physical infrastructure suitable for the different types of users, and ii) long-term educational programs to overcome the limiting effects of certain socio-cultural backgrounds.

The provision of relevant physical infrastructure should result from a detailed analysis of the different relationships between types of users and GE which will be a guidance tool in terms of which factors should indeed be addressed to bring users into these spaces (Hitchings, 2013). For example, improved

accessibility, maintenance, lighting, and signposting resulted to be prevalent domains of interventions on which most types of users agreed. On the contrary, factors as surface, presence of others, and vegetation density were controversial domains of intervention among different types of users. Consequently, these factors would require diversified strategies able to meet the conflicting needs of the different types of users. In particular, in order to enhance women's perceptions of safety, the provision of physical infrastructure should guarantee 'eyes on the GE' (Jacobs, 1961), that is, itineraries with enhanced visibility and higher attendance together with pruning of dense vegetation and provisioning of areas of assistance in case of need. At the same time, itineraries immersed in nature, away from the crowd, which give the idea of a brief escape from the city, should be arranged with a view to satisfy the needs of the types of users who perceive these physical characteristics as facilitators to LTPA.

However, providing physical infrastructures only, does not tackle the fact that GE may be fully equipped and organized but still unused due to other reasons (Hitchings, 2013). Given that perceptions of factors have a deep intangible component related to people's individual life-experiences and related with socio-cultural backgrounds, LTPA promotion should begin by focusing on specific educational programs. Taking the example of women's use of GE, before proposing solutions based on physical infrastructure, practitioners need to face the gendered influence of life circumstances and the barriers that may arise in relation to victimization beliefs, socio-ethnic prejudices and ethic of care norms. For example, in relation to the unequal access to the GE for LTPA associated with the needs to care for children and significant domestic responsibilities (MacBride-Stewart et al., 2016), educational programs that promote gender-balanced roles might reduce the barriers for women LTPA practice in GE.

6. Conclusions

This work shows how the assessment of users' LTPA experiences in urban stream corridors can inform inclusive strategies intended to promote equal opportunities for LTPA for everybody. In order to analyse LTPA experiences, a mixed methodology based on qualitative ecological approach integrated with GIS was developed allowing for a comprehensive and thorough understanding of LTPA

experiences through: 1) the categorization of types of users, 2) the identification of environmental factors influencing LTPA, 3) the assessment of coincident and divergent perceptions that diverse types of users have of these factors, and 4) the spatial representation of perceptions on the micro and macroscale (Figure 8).

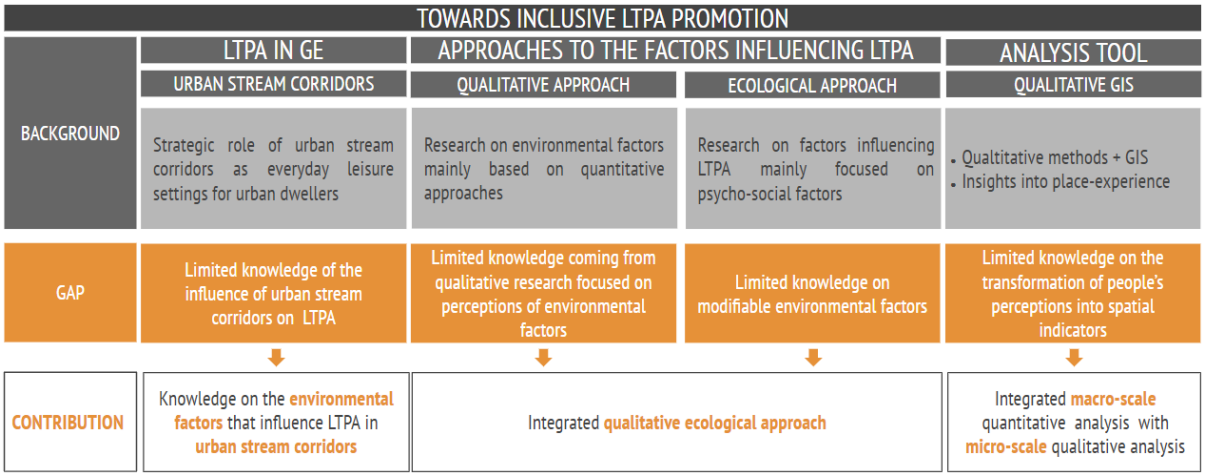

Figure 8: Main contribution of the study. Source: own elaboration.

First, the categorization of the types of LTPA users (Athletes, Nature-lovers, Custodians, Cholesterol route users, Weekenders and Allotmenteers) depending on 1) the characteristics of the LTPA practiced, 2) their socio-demographic characteristics, and 3) their motivations for LTPA provides a better understanding of the different ways through which different users interpreted and interacted with urban stream corridors when practising LTPA. This knowledge represents the basis for planning inclusive practices of LTPA promotion.

Second, motivations and gender bias LTPA experience. In fact, depending on motivations and gender, the distinct types of users perceived environmental factors influencing LTPA as either barriers or facilitators contradictorily or coincidentally. The comprehensive and thorough understanding of the coincident and divergent perceptions of environmental factors is paramount for inclusive LTPA promotion to identify and address potential conflicts that otherwise would not appear when interventions are based on generic human responses.

Third, principal conflicts related to divergent perceptions between genders depend on safety issues. Perceptions of safety among women are related to environmental factors, yet they are mediated by women's socio-cultural background and everyday practices. On the one hand, environmental factors can be measured and mapped on a macro scale. On the other hand, although related to deep intangible dimensions, women's socio-cultural background and everyday practices take place in a specific context thus it can be geo-located and represented on the micro-scale. This requires the development of an ad hoc analytical tool.

Fourth, the safety map based on qGIS provides the assessment of the macro-scale spatial indicators of environmental factors and the micro-scale narratives of women's perceptions of safety from an integrated perspective. The macro-scale perspective offers a general explanation of the phenomenon and helps visualise conflicting domains of interventions basing on women's perceptions. The micro-scale gives deeper and detailed understandings of the safety perception by comparing the big picture with women's narratives.

Given its pilot nature, this study focused on one case study and on a small sample. Future research would benefit of focusing on different GE, different socio-demographic contexts, and larger samples with multiple psychological and socio-cultural profiles. This would result in a more complex structure of the types of users. Moreover, this study assigned equal weights to the environmental factors influencing women's perceptions of safety, so as to get a composite index representing the perspective of the women's general perspective. This entails a limitation as the influence of each environmental factor might vary depending on the type of user. Therefore, in order to increase the sensitivity of the analytical tool (safety map), a nuanced weighing of said factors should be considered. Finally, future studies could test the applied methodology for phenomenon other than safety in order to draw the attention of policymakers on marginalized social phenomena that still remain invisible and require responses.

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Appendix

a. Committee for Research Ethics approval

CER Comitè d'Ètica de Recerca | Universitat Internacional de Catalunya

APROVACIÓ PROJECTE PEL CER/ APROBACIÓN PROYECTO POR EL CER

Codi de l'estudi / *Código del estudio*: ARQ-2018-01
Versió del protocol / *Versión del protocolo*: 1.0
Data de la versió / *Fecha de la versión*: 06/02/2018
Títol / *Título*: Perception assessment of environmental factors related to physical activity in an urban stream corridor.

Sant Cugat del Vallès, 19 de febrer de 2018

Investigadors: Pere Vall-Casas, Marta Benages-Albert,

Títol de l'estudi / *Título del estudio*: Perception assessment of environmental factors related to physical activity in an urban stream corridor.

Benvolgut/da,

Valorat el projecte presentat, el CER de la Universitat Internacional de Catalunya, considera que, el contingut de la investigació, no implica cap inconvenient relacionat amb la dignitat humana, tracte ètic per als animals ni atempta contra el medi ambient, ni té implicacions econòmiques ni conflicte d'interessos, **però no s'han valorat els aspectes metodològics del projecte de recerca degut a que tal anàlisis correspon a d'altres instàncies.**

Per aquests motius, el Comitè d'Ètica de Recerca, RESOLT FAVORABLEMENT, emetre aquest CERTIFICAT D'APROVACIÓ, per que pugui ser presentat a les instàncies que així ho requereixin.

Em permeto recordar-li que, si en el procés d'execució es produís algun canvi significatiu en els seus plantejaments, hauria de ser sotmès novament a la revisió i aprovació del CER.

Atentament,

Apreciada,

Valorado el proyecto presentado, el CER de la Universidad Internacional de Catalunya, considera que, el contenido de la investigación, no implica ningún inconveniente relacionado con la dignidad humana, trato ético para los animales, ni atenta contra el medio ambiente, ni tiene implicaciones económicas ni conflicto de intereses, ***pero no se han valorado aspectos metodológicos del proyecto de investigación debido a que tal análisis corresponde a otras instancias.***

Por estos motivos, el Comitè d'Ètica de Recerca, RESUELVE FAVORABLEMENTE, emitir este CERTIFICADO DE APROBACIÓN, para que pueda ser presentado a las instancias que así lo requieran.

Me permito recordarle que si el proceso de ejecución se produjera algún cambio significativo en sus planteamientos, debería ser sometido nuevamente a la revisión y aprobación del CER.

Atentamente,

Dr. Josep Argemí
President CER-UIC

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