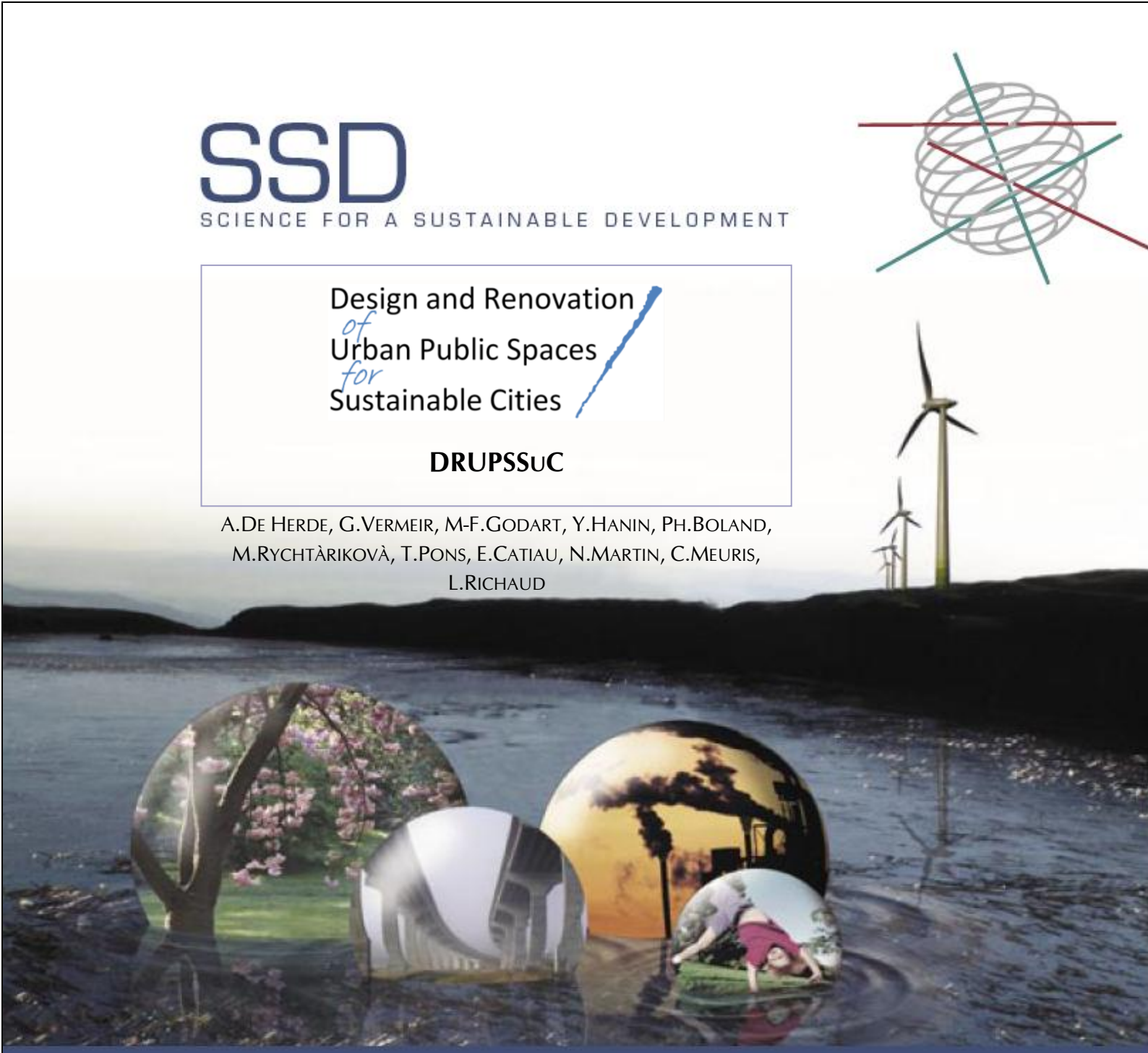
SSD

SCIENCE FOR A SUSTAINABLE DEVELOPMENT

Design and Renovation of Urban Public Spaces for Sustainable Cities

DRUPSSuC

A.De Herde, G.Vermeir, M-F.Godart, Y.Hanin, Ph.Boland, M.Rychtàrikovà, T.Pons, E.Catiau, N.Martin, C.Meuris, L.Richaud



ENERGY

TRANSPORT AND MOBILITY

AGRO-FOOD

HEALTH AND ENVIRONMENT

CLIMATE

BIODIVERSITY

ATMOSPHERE AND TERRESTRIAL AND MARINE ECOSYSTEMS

TRANSVERSAL ACTIONS

.be

SCIENCE FOR A SUSTAINABLE DEVELOPMENT
(SSD)

Transversal actions

FINAL REPORT

Design and Renovation of Urban Public Spaces for Sustainable Cities

DRUPSSUC
SD/TA/05

Promotors

André De Herde
Université Catholique de Louvain (U.C.L.)
Architecture et climat

Gerrit Vermeir
Katholieke Universiteit Leuven (K.U.Leuven)
Afdeling Bouwfysica en Laboratorium Akoestiek en Thermische Fysica

Marie-Françoise Godart
Université Libre de Bruxelles (U.L.B.)
Institut de Gestion de l'Environnement et d'Aménagement du Territoire

Yves Hanin
Université Catholique de Louvain (U.C.L.)
Centre d'Etudes en Aménagement du Territoire – CREAT

Authors

Philippe Boland (UCL - Architecture et Climat)
Monika Rychtàrikovà (KULeuven - Afdeling bouwfysica)
Thaïs Pons (ULB – IGEAT)
Etienne Castiau (ULB – IGEAT)
Nicole Martin (UCL – CREAT)
Coralie Meuris (UCL – CREAT)
Laurent Richaud (UCL – CREAT)

D/2011/1191/39
Published in 2011 by the Belgian Science Policy
Avenue Louise 231
Louizalaan 231
B-1050 Brussels
Belgium
Tel: +32 (0)2 238 34 11 – Fax: +32 (0)2 230 59 12
http://www.belspo.be

Contact person: Marc Van Heuckelom
+32 (0)2 238 35 55

Neither the Belgian Science Policy nor any person acting on behalf of the Belgian Science Policy is responsible for the use which might be made of the following information. The authors are responsible for the content.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without indicating the reference :

A.De Herde, G.Vermeir, M-F.Godart, Y.Hanin, Ph.Boland, M.Rychtàrikovà, T.Pons, E.Catiau, N.Martin, C.Meuris, L.Richaud, ***Design and Renovation of Urban Public Spaces for Sustainable Cities***. Final Report. Brussels : Belgian Science Policy 2011 – 101 p. (Research Program Science for a Sustainable Development)

TABLE OF CONTENT

0. ABSTRACT-SUMMARY

0.1 Context

Despite its crucial role in the implementation and functioning of the societal structures of the city, public space, increasingly privatized and invaded by the car, is becoming more synonymous with nuisance than with well-being. This state of affairs contributes to the exodus of a significant proportion of those urban populations who possess the necessary resources to an extra-urban residential environment that they perceive as offering more advantages.

As well as the loss of inhabitants from the most well-off sectors of the population, which is prejudicial to the city in terms of both finance and image, the process of urban spread that results from their move to the suburbs involves considerable consumption of space and energy, loss of landscape amenity, and a weakening of the social fabric.

These trends run contrary to the need to move to a more sustainable model of development, which, it must be remembered, meets the needs of the present without compromising the ability of future generations to meet their own needs

0.2 Objectives

Faced with the process of peri-urban spread, it is essential to re-evaluate public intra-urban spaces, not only in districts where there is a concentration of deprived populations but also in more affluent areas. The aim of this re-evaluation is to maximise the conviviality, comfort and attractiveness of these urban areas, not only to maintain their level of use but also to initiate a return to them. The city and its layout thus appear to be vital issues in the social, environmental and economic equilibrium of how this land is occupied.

With regard to the necessary transversality of town planning and the principles of sustainable development, a transversal multidisciplinary approach to urban development projects appears to be a key to sustainable urban design.

The design of public spaces should not be limited to simple considerations of aesthetics or functions. It requires a multidisciplinary approach, incorporating urban needs and issues that are as much physical, physiological and psychological as they are social, cultural, political, economic or environmental, and this must take place in a transversal manner in order to bring about “optimal compromises” within the processes involved in developing this type of space.

This transversal multidisciplinary approach is achieved in this study by means of eight non-exhaustive and non-exclusive research themes, namely: users (perception,

use, appropriation, and participation), mobility, urban density, microclimate and pollution, acoustic levels, vegetation and biodiversity, water, and artificial lighting.

0.2.1 Scientific approach

At the start of the scientific objective aimed for by the DRUPSSuC study, a grid of objectives common to the various research themes being handled is proposed. Improvement of the quality of life in the urban environment constitutes the basic objective. Meeting the objective regarding the quality of city life, it involves interventions that combine the eight fields of action dealt with as part of this research programme. This basic objective is then broken down into four strategic objectives for the design and renovation of urban public spaces within a perspective of sustainable development of urban areas. This four strategic objectives are:

- Developing urban public spaces as places of sociability
- Developing planning and supporting the uses of public spaces which limit the harmful environmental effects and improve the beneficial environmental effects
- Developing urban public space as structuring elements of our urbanisations
- Developing natural spaces and preserving natural cycles within urban public spaces

0.2.2 Practical aim

The practical aim of DRUPSSuC is the creation of methodological and technical tools to assist decision-making in procedures for the design or renovation of urban public spaces. These deliverables are aimed at being distributed to a wide public via a website : www.drupssuc.be (French speaking).

0.3 Conclusions

The DRUPSSuC study was carried out in two phases: an initial phase devoted to the theoretical approach to the subject, and a second phase involving its validation through confrontation with the realities on the ground.

A course of bibliographical research, fed by exchanges of knowledge between researchers from varied disciplines, resulted at the end of the first phase of the study in the production of a body of theory. This, drawn up on the basis of a common typology of public spaces and shared objectives, sets out, in the transversal manner required for the various themes, global issues and theoretical recommendations with regard to the development of these spaces.

The second phase was devoted to the validation of the theoretical approach by means of case studies. This testing of criteria and recommendations for the development of public space arising from the body of theory made it possible to validate them and ensure their ease of use within the tools assisting in decision-making and design, also developed during this second phase of the study.

0.3.1 Transversal structuration

The respective fields of action of the eight themes initially envisaged overlap. In effect, the disciplines and parameters involved in urban development projects reinforce or weaken each other. Urban needs and issues, physical, physiological and psychological as well as social, cultural, political, economic and environmental, come together, clash, and interlock, depending on the nature and content of public spaces. Adding to this the fact that the eight initial themes are neither exhaustive nor exclusive, it appeared necessary to perfect a structure for the transversal approach to public spaces.

The structure selected will still remain imperfect with regard to the complexity of the question of public space and the impossibility of responding to it in an exhaustive and absolute manner. Going beyond this assessment, the structure proposed, in the form of an arborescence, aims to be both adaptable and re-adaptable. In fact, its main objectives are legibility and an ability to evolve.

The first level of the arborescence highlights three scales of analysis and action: context, morphology and usage. The context represents the framework within which the space exists, from the adjoining built-up area to the networks and fabric of the city. The morphology corresponds to the physical characteristics and components of the space. ‘Usage’ deals with all that is immaterial yet nevertheless creates the space and how it is occupied. The meeting point of these three scales is the public space, envisaged transversally. The principle is shown in figure 0.

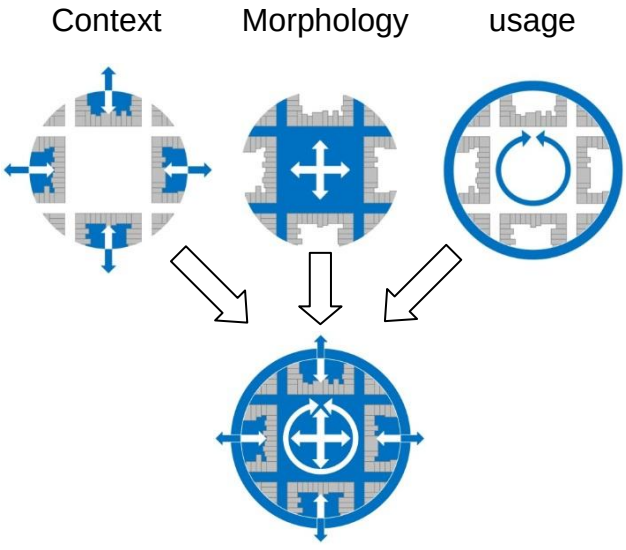


Figure 0: Arborescence first level

0.3.2 Tools

The tools resulting from the DRUPSSuC research program are presented as a set of files, both theoretical and practical available on www.drupssuc.be (French speaking). These diverse files implement the transversal arborescence based on the three scales: context, morphology, and usage.

0.4 Contribution of the project in a context of scientific support to a sustainable development policy

In addition of the tools available on the web, some recommendations are a more specific contribution of the project in a context of scientific support to a sustainable development policy:

Defining a global vision of the roles of the city and public spaces : The design and renovation of urban public spaces require the definition of a global vision of the roles which the town and its public spaces are called upon to fulfil. Among these roles, the town as a place for living and the public space as a place for sociability and socialisation for its residents appear to be two essential and inseparably linked roles. At public space level, these fundamental roles are accompanied by a reversal of priorities in terms of mobility by prioritising the movement, stopping and lingering of pedestrians, children, persons of reduced mobility, cyclists and users of public transport. Complementing these priorities, proactive policies aimed at a quantitative and qualitative reduction in motor vehicles circulating and parking in the city must also be developed, both for the movement of persons and goods.

Defining the networks: Depending on its location, public spaces can contribute to the networks of external spaces dedicated to leisure (parks and other greened spaces), cycle routes and surface public transport routes, which are easily accessible. Planning a public space also contributes to the green and blue ecological networks. These various networks should be defined in advance, at the neighbourhood and city level.

Understanding organisation and dimensioning from basic priorities: The fundamental priority to be attached to pedestrians, children and persons of reduced mobility, and to cyclists and public transport, must be translated into appropriate dimensioning, and the remainder can be allocated to other users and uses. Designing for appropriate dimensioning is also important for certain types of fixtures like trees. In many public spaces, the available area is limited, a further argument in favour of the development of share amenities, whether in residential streets, squares or multifunctional places...

Understanding the choice of components for a sustainable end-result: Whether elements of planting, ground coverings, urban furniture or lighting, each component

plays a role in the economic end-result, but also the environmental end-result. In this regard, each element must be dealt with by planning it over its entire lifecycle. In addition to the dimensioning implemented, the choice of plant species must be defined in line with the urban environment in which the plants must survive. Water management in the public space warrants particular attention in order to respect its natural cycle as far as possible. Since permeable ground coverings are rarely appropriate given the activities to be hosted in the public space, this cycle must be met as far as possible by a range of measures favourable to water retention, infiltration and evaporation, in addition to drainage systems.

Acquiring information on the needs of residents and users: Residents are recognised as being the essential players in the sustainable town... They needs are manifold: in terms of security, mobility, leisure, nature, social interaction, stimulation, belonging... In order for residents to play to the full their role as essential players in the town, it is important that they develop a sense of belonging to the town, to the neighbourhood, to the public spaces and to the community. This sense is founded on symbolic dimensions and dimensions of usage and appropriation. Therefore, the development of the town and its public spaces must stimulate the urban identity.

Interacting with residents and users: Within the context of a study of the development of a public space, acquiring information on the needs of residents and those of users more broadly can take particular forms. Of these, satisfaction surveys and the participative processes constitute two advantageous approaches which are to be encouraged, in coordination with the work of the project designer.

Convergent actions: Although non-exhaustive, the recommendations given above should assist in developing complementary and convergent actions in the fields of land-use planning, urban planning, architecture, mobility and environment, to build towns and public spaces where residents will take pleasure in living, staying, lingering and meeting one another. The implementation of these actions involves social support throughout the process, to ensure that the renovation of public spaces, in neighbourhoods populated by residents in precarious situations in particular, avoids marginalising these populations or prompting them to leave these places for others which are equally sensitive.

0.5 Keywords

Transversality, Sustainable cities, Public spaces, Urban planning, Multicriteria aiding tools, Methodology, Conception guidelines, Urban living, Urban microclimate, Urban acoustics, Urban biodiversity, Urban water cycle, Urban density, Urban sociology, Participation, Mobility, Public lighting

1. INTRODUCTION

This document constitutes a summary of the research on “Design and renovation of urban public spaces for sustainable cities (DRUPSSuC)”, financed by the Belgian Federal Science Policy within the framework of its program “Science for a Sustainable Development – SSD”. This research focused on the creation of transversal tools to aid in decision-making and in the design of urban public spaces, with a view to maximizing their conviviality, comfort and attractiveness, all within a perspective of sustainability, at the level of the public space itself and also at the more global level of the city.

1.1 Research Context

1.1.1 Context in terms of disciplines

The design of public spaces should not be limited to simple considerations of aesthetics or functions. It requires a multidisciplinary approach, incorporating urban needs and issues that are as much physical, physiological and psychological as they are social, cultural, political, economic or environmental, and this must take place in a transversal manner in order to bring about “optimal compromises” within the processes involved in developing this type of space.

1.1.2 Social context

Despite its crucial role in the implementation and functioning of the societal structures of the city, public space, increasingly privatized and invaded by the car, is becoming more synonymous with nuisance than with well-being. This state of affairs contributes to the exodus of a significant proportion of those urban populations who possess the necessary resources to an extra-urban residential environment that they perceive as offering more advantages.

As well as the loss of inhabitants from the most well-off sectors of the population, which is prejudicial to the city in terms of both finance and image, the process of urban spread that results from their move to the suburbs involves considerable consumption of space and energy, loss of landscape amenity, and a weakening of the social fabric.

These trends run contrary to the need to move to a more sustainable model of development, which, it must be remembered, meets the needs of the present without compromising the ability of future generations to meet their own needs [105].

1.2 Definition of the public space for a sustainable town

Long viewed as a residual space of a town, the public space is experiencing a resurgence in interest among public authorities. A number of issues are now attached to it, including that of the town's viability.

Definitions are numerous, evolving and frequently called into question. It is hard to go over the wealth of these debates in just a few lines, but we will dwell in particular on the most frequently heard definitions, those citing the fragility of the strict division between 'private' and ‘public'.

Thus, according to Jean Rémy [120], public space is an open space, somewhat indeterminate, permanently accessible to all without discrimination, providing general rules of behaviour are observed. Chadouin [28] has a similar idea, by defining it *"as an open space, access to which is not limited to the use of a group or community but rather relies on social conventions capable of governing shared, ephemeral gatherings of persons, objects and values."* As shown by Ervin Goffman [28], the conventions of access to public space constitute both procedures for interaction and a means of communication. *"From this point of view, public space establishes a certain normality of behaviour which is based less on adherence to given values than on observance of appearances, on a "harmony" of "faces" or self-presentation which goes beyond the heterogeneity of the players."* However, since they are always established within more or less distinct social complexes, public spaces rarely attract a definition of entitlement which makes them freely accessible spaces. Pierre Sansot [00], for example, has shown that they are, to a greater or lesser extent, devoted to certain categories of population and that they present barriers which are more or less surmountable according to social status, wealth, colour, sex etc. For Paquot [107], the expression, as has recently found favour among urban design professionals and elected representatives, is gradually losing its meaning. In fact *"the residential gated community, the shopping mall, the urban motorway all have the outer appearance of public spaces, but they are not so."* These questions are based on the observation of a gradual privatization of urban spaces.

Beyond this debate, public space is also defined by the functions generally attributed to it and which refer, in practice to seven major categories of town user need:

- The role of protection, meets the need for security against accidents and criminality. It also corresponds to the physical comfort of individuals.
- The role of mobility, meets the need to move around. Public space must allow accessibility to all types of user: those with reduced mobility, pedestrians, cyclists, motorists, skaters, bus passengers etc.
- The role of well-being, comfort and recreation; this corresponds to the capacity to sit, stop, take shelter, park, eat, read, write, converse, rest, slide, play, climb,

scribble, hide, play games. In terms of health in our industrialized countries, public spaces are important elements for the practice of a sport or physical activity.

- The role of sociability meets the need for social interaction.
- The role of education, of lifestyle, meets the need for discovery of nature, offering a place of education, for raising awareness of nature, of other people, of art...
- The role of identity. Some spaces may meet the need for belonging to a place, that it has a soul, a referential link.
- The role of public uses, to meet the need for stimulation, a venue for short-lived happenings or consumer goods events.

Public spaces which offer a response to these different categories of user need, which are managed and developed with a sustainable perspective - that is to say, those which meet the needs of current users without compromising the needs of future generations – would constitute the framework of the sustainable town, a town which incorporates all the economic, environmental and social factors to be viable and fit to live in over the long term.

In the interests of clarity, we will adopt the reference with the three basic pillars – social, environmental and economic – into which the main themes guiding our research are interwoven.

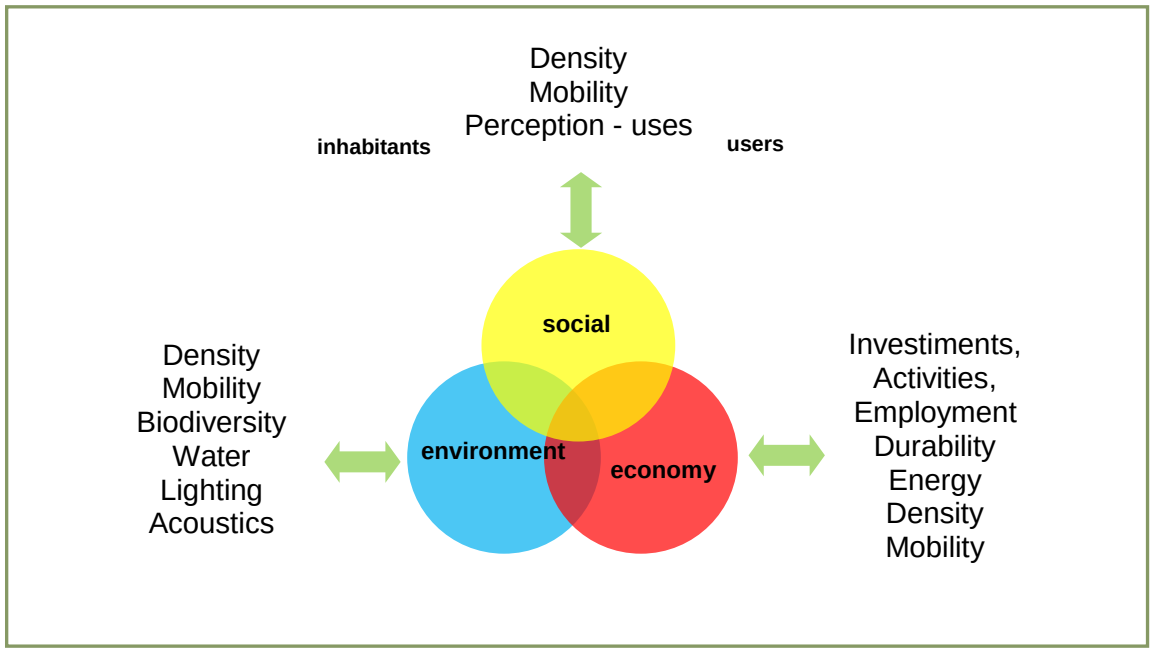


Figure 1: Links between public spaces main themes and the sustainability three pillars

Public spaces managed and developed from a sustainability perspective and offering a response to the needs of users would be the vector for an ecological concept of our relationship with the world and a formal expression of these profoundly ethical choices.

1.3 Scientific project

1.3.1 Transversality

The key to the proper management of urban development projects lies in the multidisciplinary but above all transversal approach that must be adopted. This involves comprehending that the design of public spaces does not consist of segregated sectors that may satisfactorily be managed separately. In reality, all the parameters involved are interwoven and impact on each other.

It is therefore a case of moving from the multidisciplinary approach to the transversal, just as the transverse element of a structure provides triangulation and ensures its stability. Transversality corresponds to a move from simple, sometimes contradictory maxima to an optimal compromise.

1.3.2 Strategy

Faced with the process of peri-urban spread, it is essential to re-evaluate public intra-urban spaces, not only in districts where there is a concentration of deprived populations but also in more affluent areas. The aim of this re-evaluation is to maximise the conviviality, comfort and attractiveness of these urban areas, not only to maintain their level of use but also to initiate a return to them. The city and its layout thus appear to be vital issues in the social, environmental and economic equilibrium of how this land is occupied.

With regard to the necessary transversality of town planning and the principles of sustainable development, a transversal multidisciplinary approach to urban development projects appears to be a key to sustainable urban design.

This transversal multidisciplinary approach is achieved in this study by means of eight non-exhaustive and non-exclusive research themes, namely: users (perception, use, appropriation, and participation), mobility, urban density, microclimate and pollution, acoustic levels, vegetation and biodiversity, water, and artificial lighting.

1.3.3 Scientific objectives

At the start of the scientific objective aimed for by the DRUPSSuC study, a grid of objectives common to the various research themes being handled is proposed. Improvement of the quality of life in the urban environment constitutes the basic objective. Meeting the objective regarding the quality of city life, it involves interventions that combine the eight fields of action dealt with as part of this research programme. This basic objective is then broken down into four strategic objectives for the design and renovation of urban public spaces within a perspective of sustainable development of urban areas; these are shown in figure 2.

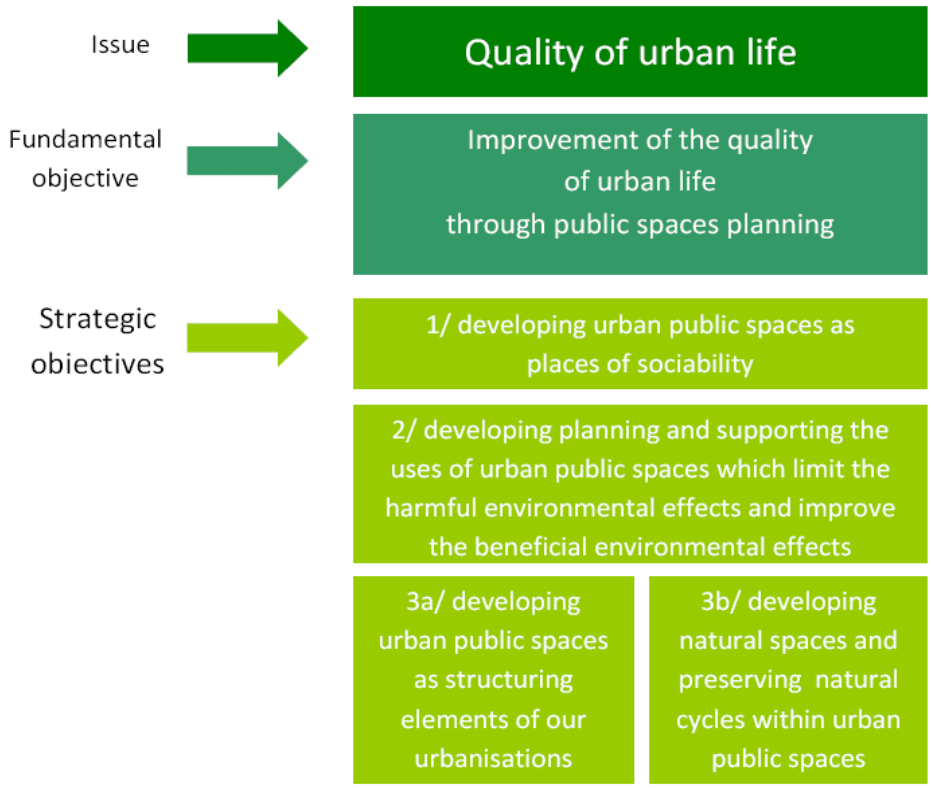


Figure 2: Objectives of the design/renovation of urban public spaces

1.3.4 Constraints and limits

In order to achieve the most transversal and least hierarchical approach possible, it is preferable to deal with all the present themes on an equal footing. Unfortunately, such diverse items as people and bulbs for public lighting are only rarely handled in a similar way.

What is more, since time and resources are unfortunately not limitless, the subject being dealt with here cannot be tackled in an exhaustive manner. Indeed, the scope of the question of public space and the related issues do not allow a full response to be made here – even though such a hypothetical and absolute response could only be less than perfect in view of the complexity of the subject being studied.

DRUPSSuC has consequently been designed as an initial transversal approach, open, legible and evolving, in order to facilitate its (re-)appropriation and to open additional scientific perspectives and strive towards a certain level of exhaustive study into public spaces.

1.3.5 Practical aim

The practical aim of DRUPSSuC is the creation of methodological and technical tools to assist decision-making in procedures for the design or renovation of urban public spaces. These deliverables are aimed at being distributed to a wide public.

2. METHODOLOGY

2.1 Organisation of research

The DRUPSSuC study was carried out in two phases: an initial phase devoted to the theoretical approach to the subject, and a second phase involving its validation through confrontation with the realities on the ground.

A course of bibliographical research, fed by exchanges of knowledge between researchers from varied disciplines, resulted at the end of the first phase of the study in the production of a body of theory. This, drawn up on the basis of a common typology of public spaces and shared objectives, sets out, in the transversal manner required for the various themes, global issues and theoretical recommendations with regard to the development of these spaces.

The second phase was devoted to the validation of the theoretical approach by means of case studies. This testing of criteria and recommendations for the development of public space arising from the body of theory made it possible to validate them and ensure their ease of use within the tools assisting in decision-making and design, also developed during this second phase of the study.

2.2 Common typology

The use of a common typology when describing urban public spaces was rapidly established, in order to ensure the transversal consistency of the study, and consequently the dialogue between the various groups concerned (researchers, designers, decision-makers, users, etc…).

In order to define this common vocabulary, the choice was made of a typology with two dimensions.

The first dimension taken into consideration refers to the types of public space defined according to their morphological structure, their built-up or non-built-up limits, and the nature of said limits. Three types of morphological spaces were thus defined:

- The “street” type covers any space with a linear morphology, namely streets, avenues, boulevards, quays, promenades, etc…
- The “square type” covers any space with a large surface, namely squares, forecourts, esplanades, public car parks, etc…
- The “green space” type includes all spaces dominated by vegetation, such as parks, public gardens, enclosed squares, cemeteries, etc…

The second dimension of the typology categorises the different types of urban area, on the basis of the period when the city was constructed (from the centre towards the periphery) and the criteria of density and extent of mixed use. Three types of zone were highlighted:

- The “centre” zone corresponds to the historic centre of the city and the former village centres swallowed up by the town, the most densely built-up central areas, which accommodate a mosaic of functions and a varied residential structure; to sum up, a distinct space covering a small surface area.
- The “urban” zone concerns built-up areas characterised by continuous or intermittent buildings constructed between the second half of the 19th century and the First World War. This area is less dense than the central zone and may comprise significant areas of activities and facilities as well as businesses and services.
- The “suburban” zone, developed between the wars, is characterised by a more extensive use of land, for both industrial and other purposes.

Table 1 below sets out the common typology of urban public spaces according to the two dimensions selected, defining nine types.

Common classification of public spaces to be studied		**Types of public spaces**		
		Street (street, boulevard, quay, …)	**Square** (place, esplanade, square, …)	**Green space** (park, public garden, interior of blocks, cemetery, …)
Types of urban zones	**Centre** **Strong density and strong mixed-use** (closed blocks with raised buildings, high buildings together, …)	***1***	***2***	***3***
	Urban **Average density and average mixed-use** (closed blocks with relatively low buildings, …)	***4***	***5***	***6***
	Suburban **Low density and low mixed-use** (open blocks, aligned bars, insulated buildings, waste land, …)	***7***	***8***	***9***

Table 1: Common typology of urban public spaces

3. RESULTS

3.1 Arborescence

The respective fields of action of the eight themes initially envisaged overlap. In effect, the disciplines and parameters involved in urban development projects reinforce or weaken each other. Urban needs and issues, physical, physiological and psychological as well as social, cultural, political, economic and environmental, come together, clash, and interlock, depending on the nature and content of public spaces. Adding to this the fact that the eight initial themes are neither exhaustive nor exclusive, it appeared necessary to perfect a structure for the transversal approach to public spaces.

The structure selected will still remain imperfect with regard to the complexity of the question of public space and the impossibility of responding to it in an exhaustive and absolute manner. Going beyond this assessment, the structure proposed, in the form of an arborescence, aims to be both adaptable and re-adaptable. In fact, its main objectives are legibility and an ability to evolve.

The first level of the arborescence highlights three scales of analysis and action: context, morphology and usage. The context represents the framework within which the space exists, from the adjoining built-up area to the networks and fabric of the city. The morphology corresponds to the physical characteristics and components of the space. ‘Usage’ deals with all that is immaterial yet nevertheless creates the space and how it is occupied. The meeting point of these three scales is the public space, envisaged transversally. The principle is shown in figure 3.

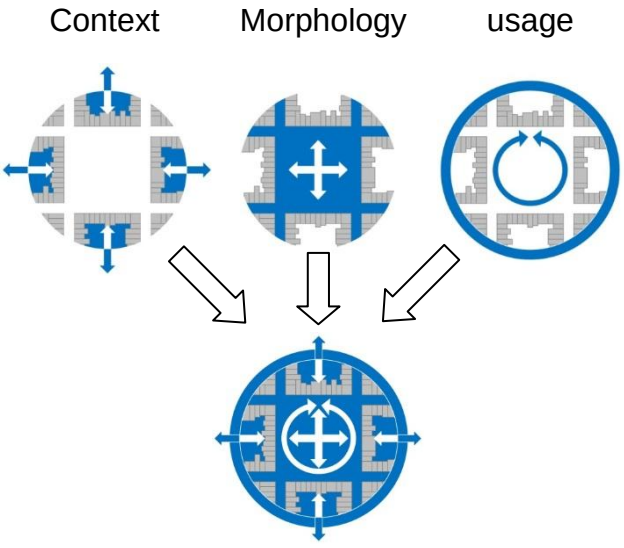


Figure 3: Arborescence first level

3.2 Tools

The tool resulting from the DRUPSSuC research programme is presented as a set of files, both theoretical and practical. These diverse files implement a transversal arborescence based on three scales: context, morphology, and usage.

3.2.1 "00" files

The "00" files form the second level of the arborescence. They provide a summary of a number of files dealing with related transversal themes. They also draw the reader's attention to subjects that we have not been able to tackle in an exhaustive manner within the framework of DRUPSSuC.

3.2.2 Theoretical files – recommendations

The theoretical files present in summary form the body of theory drawn up during the initial phase of research, supplemented by information arising from the validation by case studies carried out during the second phase.

Each file deals with a specific subject forming part of the general arborescence. A common structure shared by all files makes it possible to retain the same reading guides across the whole arborescence.

Two large chapters provide the basic structure for each file. The first gives an introduction to the importance and impact of the subject of the file with regard to public space and the sustainable city. The second, at the heart of the file, develops in detail the principal recommendations for the benefit of the reader.

Depending on the situation, additional chapters also appear in certain files. These chapters develop particular theoretical foundations. When necessary, files are also supplemented by examples drawn from case studies or elsewhere.

Links to other theoretical and practical files from the arborescence are highlighted. Likewise, a short bibliography is provided for the reader who wishes to learn more.

3.2.3 Practical files – analysis criteria

Each practical file describes an indicator or criterion for the analysis of urban public spaces. The indicators and criteria explained in these practical files are operational supports for the theoretical files.

In order to avoid producing an endless amount of criteria, the research network focused on the technical and use-based issues on which stakeholders know how to act on the scale of the subject of the study, while avoiding those aspects that fall outside the sphere of action of the decision-maker or developer.

Practical files are structured in three parts. Firstly the target of the criterion is highlighted, and the justification for this target is developed. Next, the body of the file, the methodology for the criterion is detailed. The methodology deals with both the

nature of the parameters to be known as well as the means of obtaining and handling them. Finally, key to the analysis procedure, details are given of the interpretation of the data obtained. This interpretation forms part of a benchmarking system that measures the discrepancy between the case being analysed and the theoretical optimum.

Beyond the intrinsic nature of each criterion, and in order to facilitate final transversal reading, interpretation of all criteria complies with the same qualitative ten-level scale as presented in table 2.

Score	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Interpretation	Nil	Very poor	Poor	Unsatisfactory	Fairly unsatisfactory	Average	Fairly good	Good	Very good	Optimal

Table 2: Common qualitative ten-level scale

3.2.1 Arborescence synthetic table

Transversal trinome	Conception guidelines – Recommendations files		Practical tools – Analysis criteria	
CONTEXT	**C.P-00**	**Defining priorities and policies for action**		
	C.P-F1	Which role, which category, which function to favor?		
	C.P-F2	Defining priorities in terms of mobility		
	C.I-00	**Making public space part of the urban fabric**		
	C.I-F1	Including the space in networks for non-motorized mobility and outdoor spaces	C.I-C1	Accessibility to green spaces
	C.I-F2	Making the space part of public transport networks	C.I-C2	Continuity of the progress in public transport
	C.I-F3	Including the space in ecological networks	C.I-C3.1	Planting trees along streets for a green urban network
			C.I-C3.2	Diversifying the capacity of green spaces to accommodate wildlife
	C.I-F4	Making public space part of urban socio-economic space	C.I-C4.1	Proximity of facilities and complementary services to housing
			C.I-C4.2	Proximity of places of study and employment to public transport stops
	C.B-00	**Developing the built and non-built environment**		
	C.B-F1	Optimizing occupation of land and sharing out of functions	C.B-C1.1	Density of human activity
			C.B-C1.2	Number of inhabitants per Ha
			C.B-C1.3	Density of green spaces
	C.B-F2	Developing a high-quality built-up environment	C.B-C2.1	Architectural quality
			C.B-C2.2	Quality of facades
			C.B-C2.3	Occupation of built-up areas
	C.B-F3	Developing a morphology favorable to microclimatic conditions and high-quality acoustics	C.B-C3	Diurnal visual conditions
M	**M.D-00**	**Sizing and organizing spaces**		
	M.D-F1	Sizing spaces for pedestrians to walk in	M.D-C1	Adaptation of pedestrian facilities
	M.D-F2	Sizing cyclable spaces	M.D-C2	Adaptation of cyclable facilities
	M.D-F3	Sizing spaces dedicated to public transport		
	M.D-F4	Organizing multimodal spaces		
	M.D-F5	Sizing areas and elements of vegetation	M.D-C5	Following rules on sizing of trees

S S U C	MORPHOLOGY	**M.M-00**	**Choosing materials**		
		M.M-F1	Choosing vegetation	M.M-C1	Adaptation of species of trees for planting in public spaces
		M.M-F2	Choosing materials that favor physiological comfort		
		M.M-F3	Choosing materials that respect the environment and natural cycles	M.M-C3	Run-off coefficient
		M.E-00	**Brightening up public space with facilities and furniture**		
		M.E-F1	Equipping space for the increased comfort of pedestrians and cyclists	M.E-C1	Providing elements that make people stop and stay
		M.E-F2	Laying out space for efficiency and attractiveness of public transport	M.E-C2	Facilities offered to pedestrians, persons of reduced mobility, and cyclists at public transport stops
		M.E-F3	Fitting out the space for high-quality microclimatic and acoustic ambience	M.E-C3	Visual conditions at night
		M.E-F4	Enhancing the space with elements providing contact with nature		
		M.E-F5	Choosing equipment that respects the environment	M.E-C5.1	Energy consumption of public lighting
				M.E-C5.2	Light nuisances from public lighting
	USAGE	**U.G-00**	**Managing, maintaining and administering public space**		
		U.G-F1	Managing meteoric water	U.G-C1	Mechanisms for drainage and infiltration
		U.G-F2	Maintaining trees in public spaces	U.G-C2	Sympathetic trimming of trees
		U.G-F3	Ensuring the safety of people and possessions	U.G-C3.1	Safety in relation to moving about within a sensitive area
				U.G-C3.2	Safety/surveillance
				U.G-C3.3	Safety/feeling
		U.L-00	**Stimulating the urban identity and social links**		
		U.L-F1	Rooting the public space in space and time	U.L-C1	Valorization of natural water points
		U.L-F2	Promoting the discovery of, and contact with, nature	U.L-C2	Space for discovery
		U.L-F3	Enriching the public space with microclimatic and acoustic benchmarks	U.L-C3	Acoustic conditions
		U.L-F4	Initiating activities that generate social links		
		U.P-00	**Interacting with neighbors and users**		
		U.P-F1	Getting to know users in order to know potential needs and uses	U.P-C1	Overall satisfaction
		U.P-F2	Involving residents and users in the approach to the project	U.P-C2	Participative process

3.3 Summary of the theoretical content of the arborescence

3.3.1 Context

A public space may not be dealt with in an isolated manner, independent of neighbouring urban spaces with which it maintains mutual links. The various surrounding functions (services, facilities, businesses, housing, etc.) and the users that these functions attract (older people, schoolchildren, workers, etc.) participate in its characterisation. The study of a public space from both a technical and sociological point of view obliges us to take it out of its own morphological framework. This is why, before envisaging a more detailed analysis of the public space as such, it is necessary to deal with its context.

The context of a public space can be studied from many angles: political, ideological, cultural, religious, socio-economic, the built environment, the non-built environment, landscaping, historical etc. Each influences the characteristics of the site to a greater or lesser degree. It is important to be aware of all these facets in order to design/renovate a public space which is integrated into its surrounding environment.

According to the tree structure developed, the approach to context is structured into three sub-sets. First of all, policies for action are planned. Then, the position of the space within the urban tissue is dealt with. Finally, the built and non-built landscape with which the space interacts is developed.

CP-00 Defining priorities and policies for action

Before designing or renovating a public space, it is necessary to determine within which political lines the project lies. Have the decision-makers defined a vision or any clear objectives that influence the design/renovation of the public space being studied?

Experiments in the field of sustainable “eco-districts” show that a strong initial policy is a determining factor in making the project a reality [77]. This assessment may also be applied as part of the renovation/design of a public space for a sustainable city. The policy and objectives regarding this subject will have to take account of the role, category and functions that it is hoped to develop there.

Connected to the definition of political lines, we propose four points requiring attention, prior to the design/renovation of the public space, to assist in the definition of its role, category, and function:

- Scope of the public space.
  From an international scope, such as the Grand Place in Brussels, for example, to the highly localised, such as a district square, this brings highly varied challenges for the public space, as for the responses to be made.

- A public space for which users?
  One of the recurring criteria for sustainable development is diversity of function and social diversity. To encourage these options, it is necessary for public spaces publics to respond to various functions and users.
  One route to determining users is a prior analysis of the socio-economic context. Depending on this analysis, two principal solutions may be proposed. Either the analysis highlights a need – such as, for example, a community with a significant number of older people – then in this case, the layout of the public space in question may aim to fulfil the needs of this population category, or the development of the public space is an opportunity to affect another category of the population, and thus to encourage a new demographic mix.
- How is it integrated into a network?
  A public space is influenced by its context and in particular by the interconnection of the public spaces that surround it. Therefore, it is necessary to think about the place of this space within the networks of public spaces, whether from the point of view of mobility (does it involve an interchange, a break, or simply an extension of an existing network for public transport, cyclists, pedestrians, or cars?) (CP-F2), from an environmental point of view (forming part of a green and blue ecological network), from a sociological point of view (is it an extension of the ambiances provided in adjoining public spaces, or does it, on the contrary, mark a separation?), or from a technical point of view (extension of the drainage or lighting systems, etc.)
- What resources are available?
  Designing a public space is not the whole story; it must be planned for the long-term. What financial and human resources will be available for the ongoing management of the space?

Even if these questions seem something of a caricature, they have the merit of adopting clear options that will be decisive in the choice of development.

Once these objectives are defined, it is important to pass them on to the various players: (political authorities, technicians and users) so that everyone may, at their own level, incorporate them in this overall vision.

With the policy defined and shared with the various players, mechanisms for implementation can now be put in place.

CI-00 Making the public space part of the urban fabric

According to our definition of a public space for a sustainable city, it is supposed to be open to all. In order to facilitate access, it is necessary to integrate it into the scale of the city so as to place it in relation to existing public spaces. It is therefore

necessary to make it part of the urban fabric, from the point of view of mobility, landscape and biodiversity.

Journeys on foot, by bicycle, by public transport, etc., take place within interconnected networks. For each of these modal networks, the public spaces used play different roles, from which a hierarchy is organised (C.P-F2), for example, into principal (or structuring) main routes, paths or spaces, or those for secondary or transport service use. This hierarchy may result from the current practices of the various users and may be more or less influenced by the dimensions (width) of the spaces being visited and the organisation of movements (route and management) that is proposed there, or by the information provided by signs.

As part of the drawing up of regional or (inter-)community plans dealing with all modes of travel or with any specific one, a hierarchy of public spaces and their specific allocation(s) to one or more means of transport must be confirmed or defined. This hierarchy is based on the collection of information relating to the roles, hierarchical levels, and also the status of public spaces, information that is itself linked to *in situ* observations (not exhaustive).

The principles for layouts to be developed in connection with the hierarchical status of the travel network, namely the relative treatment of users (priority, separation, mixed use, etc…), expected speeds[1], etc., must provide a useful complement to the different modal networks while giving users public spaces with varied ambiances that promote surface public transport as well as the concept of shared spaces, and at the same time allowing controlled car parking (C.P-F2).

As well as making it part of a hierarchy of mobility, it is appropriate to set it within a green and/or blue ecological network. As a complement to the private spaces of gardens and other green properties, it will therefore be vital to incorporate all public spaces whose dimensions or usage allow significant levels of vegetation into an ecological network (C.I-F3). This consists of a network of green or blue corridors or chains (wide avenues, watercourses with semi-natural banks, “greened” road links, green squares and other small spaces, etc…) interlinking them with other spaces managed in such a way as to allow the development of biodiversity (parks and larger semi-natural zones). Where possible, this network will penetrate more central districts, along broad openings of the “Haussmann” type, for example. Numerous cities, in Europe and elsewhere, have implemented such policies, favourable to the development of biodiversity in their very heart [23].

[1] More particularly, the operating speed of public transport and of motor vehicles.

CB-00 Developing the built and non-built landscape

When one talks of the sustainable town, the management of the urban spread is a necessity. 'Density' is one of the means frequently cited to counter this spread. However, the collective image devalues density. High densities are commonly associated with a lack of security, problems of pollution, noise etc. [102].

Actual density is an important indicator, but it is not sufficient [in itself] to take account of the "impression of density". It is of paramount importance to introduce the notion of perceived density which refers to more sociological approaches to space and which does not necessarily correspond to physical variables.

Apart from the technical aspects, such as measurements of actual densities in order to assess the viability of certain amenities, retail outlets and services (C.B.-F.1), it is also necessary to take into account the psychological and sociological dimensions of density and to offer high quality built and non-built spaces.

There a many factors influencing perception of the built landscape: the age of the individual, their ethnic or sociocultural affiliations, their origins and social life-history, types of social relationship, the characteristics of the physical environment [Duhayon, Page and Prochasson 2002]. Not all of these factors are quantifiable or easily measurable. More specifically, we approach the quality of the built landscape via three criteria for the analysis of the built environment: the architectural quality within the local area (C.B-C2.1), the quality of the facades (C.B-C2.2) and the occupation of the buildings (C.B-C2.3).

The built landscape and its morphology also influence the local microclimatic and acoustic conditions. Depending on the profile of public spaces and of the buildings adjoining them, the luminous (C.B-C3) and acoustic environments can become altered, sometimes substantially. Similarly, these same profiles alter aerodynamic velocities and turbulences which influence not only respiratory and thermal comfort but also their conditions of security where tall buildings are present.

3.3.2 Morphology

MD-00 Sizing and organising spaces

The public spaces must response to many functions. Furthermore, some of these functions have requirements in regard of their nature. Then, it is necessary to size and organize the public space in regard of all its needed functions and their requirements. In any case, all the public spaces must not necessary respond to all possible functions.

It is important to propose public spaces with comfortable places to meet other citizens. These places are also simply places to play, to read, to stay… to live.

The public spaces are also places for mobility. At the urban scale, the mobility priorities are first the pedestrians, children and PRM (M.D-F1), secondly the cyclists (M.D-F2), thirdly the public transportation (M.D-F3) and finally the personal motorized locomotion. Particularly, the promotion of the walking and biking requires that the spaces offered to the pedestrians, children, PRM and cyclists present adapted morphological qualities. These qualities concern in particular criteria of width, consideration of the speed of the motorized vehicles, horizontal and vertical continuities of courses, treatment of the pedestrian and cycle crossings, etc. In a more general way, shared and multimodal spaces (M.D-F4) are interesting to give right and casual place to each mobility mode.

The vegetation, introduced into the public place for its ecological and social role, requires optimal conditions for its growth and its survival in a good sanitary state (M.D-F5). This is particularly the case of trees, major vegetal element in the non-natural public spaces, for which investments are granted for the plantation. Trees need enough space, so underground as on-surface. So, it is mainly a question (M.D-C5) of respecting distances between trunk and facade as well as between trunk and road and of guaranteeing a sufficient permeable surface in foot of tree.

The surfaces and the elements constituting the public spaces must be sized and organized to durably coexist in response of the needs of the uses and of the users.

MM-00 Choosing materials

Thinking on the sustainability of public spaces brings up the question of the materials used when laying out public spaces in cities. During the course of this research, two types of material have been highlighted: plant material and ‘hard’ construction type or ‘inorganic’ material. Indeed, these choices play respective parts in the environmental and human problems involved in sustainable development.

Environmental issues are present depending on the introduction and conservation of urban biodiversity, and the type of management of the city’s natural water cycle.

As for human issues, these are dealt with through the physiological qualities engendered by the construction materials used.

The accommodation and development of biodiversity in the city makes it necessary to conserve vegetation while preserving areas of green space, and also by introducing it into the heart of the road network. Trees constitute the principal material suitable for this function in streets and squares, on condition that they can survive here. It is vital that we manage to preserve them in a good state of health

throughout their lives, in such a way as to avoid costly interventions for their well-being and in order to obtain the desired shape in their mature years.

To achieve this, plant material must have a good level of adaptability to climatic factors and poor, overcrowded soils that are subject to compression, as well as the various forms of pollution that characterise the urban environment.

What is more, their development must not hinder the use or stability of the transport network by being detrimental to the physical qualities of the public space, nor must it cause a nuisance for neighbouring occupied areas.

The same applies when selecting inorganic material. This must suit the function of the public space, but also its immediate environment (climate, natural environment and pollution), and its indirect environment (minimum environmental impact).

The primary function of the public space is to satisfy the user. Whether this is a pedestrian, a child, a person with reduced mobility, a cyclist, or even a motorist, the public space must be able to accommodate them under optimum conditions, especially in terms of high-quality physiological comfort.

This comfort varies according to the light reflection factor of the materials and the quantity of shimmering surface, the thermal capacity of the materials and also their acoustic characteristics. The environment brings a sensation of comfort, when the user wishes to see surrounding objects clearly and effortlessly, when the temperature can be adapted to suit living things, and when external intrusions, such as excessive noise, are absent.

The choice of materials must also form part of a thought process with regard to natural climatic cycles, and allow meteoric water to recreate the water cycle, passing through the urban soil to rejoin the local groundwater. Not only does the choice of a surface material with a low runoff coefficient make it possible to promote the natural water cycle, it also makes it possible to reduce the risk of flooding by reducing the number of permeable surfaces.

Finally, with a view to sustainability, it is important when selecting materials that go to make up the public space to take account of the amount of energy contained in its eco-balance, as well as its capacity for recycling.

ME-00 Brightening up public space with facilities and furniture

According to the nature, the shape, the materials and the techniques of equipment, this will damage or on the contrary will protect the environment. The concerned environment recovers the immediate environment of the equipment as well as the environment taken in its global and universal sense. According to the second strategic objective of DRUPSSuC, develop and encourage uses of the public places which limit the nuisances and favour the environmental benefactions, it is important

of well choosing the equipment by analysing needs, constraints, and effects on all the life cycle of the equipment.

Concerning the pedestrian mobility uses, it is important to equip the spaces with “stop and stay” elements. It is also interesting to place wanderings protected from the rain and other architectural elements to encourage the walking whatever the weather situation. In a more general way, any element which improves the physiological and psychological comfort of the pedestrians and cyclists in public spaces is good for their sustainable uses. More specifically, the available services offered to the pedestrians, PRM and cyclists at the public transportation stoppings increase the modal part of the public transportation. In the same way, systems to give priority in the traffic to the public transportation are desirable.

All conditions being equals, lighting devices are indispensable to the night living of public spaces and cities. The public lighting must guarantee the objective and subjective security as well as the visual night comfort without generate luminous nuisance and energy wasting. Energy is precious and expensive, it is necessary to make a rational use of this. Besides the nuisances on the environment bound to the wasting, bad choice in term of equipment is also very economically unfavourable. To summarize, in a general and logical way, it is necessary to prefer a moderate lighting realized with highly capable equipment and rather situated near the object to be enlightened to control the energy consumptions and nuisances.

Anyway, it is crucial to not overload space in equipment. An overloading of the space “privatises" this one and decrease the liveability of it.

3.3.3 Usage

UG-00 Managing, maintaining and administering the public space

The design of a town’s public spaces cannot be compared with the manufacture of a product, to be delivered on a precise date. It necessitates continual efforts to manage and maintain the space, and continuous in-depth thinking on the implementation of security measures which promote the well-being of its users. In the tree structure, these themes are tackled from a practical standpoint, dealing with the management of precipitation, the maintenance of vegetation and measures to ensure the security of persons and property.

The in-depth thinking on the management of precipitations deals with systems for the collection of run-off water, that is to say drainage and infiltration systems.

With a sustainability approach, the management of precipitations aims to minimise the negative impact of precipitations by limiting immediate outfall into the drains while

at the same time enhancing the replenishment of the water table by infiltration on-site, thereby more effectively managing water consumption.

In this way, depending on on-site constraints, designers can store water on the site and recycle it, replenish local water tables or slowly reintroduce it into a drainage system designed to collect run-off water.

The question of plant maintenance, and particularly that of trees, focuses on their size. The use of an appropriate pruning technique is paramount because it is intended not only to limit discomfort (light, circulation etc.) and hazards (falling branches) but it also prevents the occurrence of irreversible situations such as rot in the roots and trunk, massive branch breakage or even the partial or total death of the tree. Light pruning, carried out for training a young plant and for the maintenance of an adult plant, requires a high level of skill, but from a technical and biological standpoint it is the best solution. Hard, structural pruning will be limited to certain sites where it is essential to maintain the heritage and historical character.

Whereas the first two themes listed provide concrete focuses for work, the feeling of insecurity encompasses a number of dimensions and cannot be resolved or assessed by the application of a simple measurement.

It is important to distinguish the feeling of insecurity from an actual lack of security. Lack of security is an objective situation presenting a risk of victimisation, while the feeling of insecurity is the subjective perception of this risk [91]. This involves a combination of factors which also require a combination of responses, in the light of the particular features of the location and of the people populating it.

The main factors determined relate to the fear of criminality and the hazards associated with road traffic, and also security as reflected in leisure facilities.

The fear of others and of criminality is, and remains, highly controversial and it is difficult to provide responses which elicit unanimity. The literature on the subject shows that the feeling of "criminal" insecurity is connected with many factors. This societal objective goes far beyond the scope of this research and a more global policy should underpin the management of urban spaces.

By contrast, solutions do exist to reduce the feeling of perceived insecurity regarding road traffic. For vulnerable users, it is in and around sensitive public spaces, that is to say those likely to attract a young and more vulnerable public, that this feeling is at its strongest. Interventions fall into four major configurations: protecting access zones, prohibiting access by motor vehicles, sharing the highway and reducing speed limits.

UL-00 Stimulating the urban identity and social ties

This point deals with the development of sites and the offer of activities there which - through the amenities they offer users - are likely to contribute to the urban identity of these spaces and to strengthen social ties within the populations frequenting them.

The identification and diversity of environments

According to the theories propounded by Jean Rémy [120], a public space only really becomes a 'place' when it induces a process of collective identification. Identity refers to the ability to identify an object, distinguish it from others and assign to it a specific nature all of its own. This [need] can in part be met by urban design which retains the visual, acoustic and climatic environments which express the sensory experience of a place and which promote its identification.

The current observed trend is towards a gradual polishing of spaces, to the point of making them uniform both within a town and between one town and another. However, towns and public spaces which present a choice of diversified atmospheres will create a feeling of enhanced comfort among users. It is therefore necessary to offer a range of spaces with a variety of functions (places for tranquillity, places for social encounter), each presenting their own distinctive environmental atmospheres (the proportion of the site's surface area which is in sunlight, acoustic atmospheres). The offer of daytime and night-time activities (by providing specific lighting) can enliven a space, but this should not turn the place into a theatrical, commercial or festival venue. In fact, if this is done to satisfy the demand of investors or of a certain public, in the long term the staging of such events risks divesting the site of any identity and, in the end, no longer meeting the aspirations of the population.

The relationship with the context

Another fundamental element to be taken into consideration: how the space fits into its context and the context-space relationship. The expectations of citizens will vary according to the urban context. For example, it will be necessary to differentiate between central spaces and local neighbourhood spaces. The latter offer a favourable scale, a scale at which a feeling of identity and differentiation can develop. This is not the case for town centres, places of anonymity and impersonal relationships. The town centre must therefore be analysed according to its symbolic role and not only through the prism of satisfying material needs. Beyond adapting the space in accordance with how it fits into the town, its climatic context (seasonal) and acoustic landscape (perceived positively or negatively) must be incorporated into the design process in order to avoid creating an impression of excessively abrupt contrast.

The naturalness of the place

The naturalness of a place constitutes an essential characteristic for the individual's comfort. Modern life is increasingly isolating individuals from the natural elements, a problem of growing significance given the expansion of urbanization. Two corollaries go hand in hand with this assertion. On the one hand, we should increase the natural elements in our towns. On the other, spaces should be designed to offer characteristics which are similar to those offered by natural spaces.

Several criteria have been developed to promote an improvement in the social green network and a stimulating offer within spaces (the density of green space per resident, accessibility to green spaces, the offer of elements of nature and discovery).

Spaces of sociability

Finally, the public space must be a place for sociability, by definition and societal expectation in this respect. This assertion is not so evident today and it is widely recognized that the ascendency of private spaces (shopping centres for example) has become more marked, and access control (railings, cameras) for reasons of security is becoming widespread. This need to appropriate places is also demonstrated by specific signs, such as decorative plantings, cafe terraces, parking. In short, spaces presenting the image of a public place, of openness and unrestricted access, are in reality closed and socially selective. Let us also remember that the development of a public space demonstrates an intention to encourage a particular form of public sociability. But the history of these places shows that this role can only be temporary; rather than a place intended to direct social behaviours, the space must be considered as a setting which suggests such practices and which operate according to distinct rules of usage which evolve over time.

UP-00 Interacting with neighbours and users

The first to be affected by urban developments, neighbours and users of public spaces deserve particular attention.

In order to engage in a dialogue and better understand the social characteristics of the inhabitants, it is necessary to carry out a study of existing data on the scale of the context. Using data from the socio-economic survey of 2001, this analysis is interested in the socio-economic profile of the inhabitants (division by age classes, level of education, proportion of active population), and the description of the quality of the environment, both objective (proportion of the population without access to a private garden) and subjective (appreciation of tranquillity, air quality, cleanliness, green spaces, and the aesthetic appearance of constructions).

In order to obtain a more accurate vision of users and their needs, a quantitative and qualitative survey is then necessary, focusing on the ways and customs connected with the space or even the surrounding district.

Amongst other things, the survey makes it possible to evaluate the global level of satisfaction with a space, translated into the form of a practical file, and to provide a stream of information that may be compared to the objective measures connected with facilities for comfort and to the noting of environmental parameters (noise, wind, quality of facades, etc…).

Promoting exchanges with the players concerned and allowing them to participate actively during the project represents an essential objective in order to ensure the sustainability of urban districts. It makes it possible to respond to an increasing demand on the part of the population to be involved in decisions concerning the space being (re-)developed. Their knowledge and experience means that users of the space are privileged spokespersons, so they may stick as close as possible to the constraints of the piece of land. What is more, the various experiences noted show that this involvement makes it possible to achieve a better appropriation of the places concerned, and above all the creation of social links, vectors for an improved quality of life. The practical file proposed for evaluating the quality of participation attempts to go beyond the traditional distinction between information, consultation, cooperation and co-production by proposing first and foremost an evaluation of the intensity of the participative approach implemented. It is important properly to consider here that not all citizens have the same codes of communication. During the opinion survey and the related exchanges, multiple channels of communication must be used in order to guarantee real mutual comprehension.

3.4 Examples of analysis criteria

By way of example, a selection of criteria is listed below. The selection given here is an attempt to demonstrate the diversity of the factors analysed and their treatment and interpretation. This selection has no purpose other than to serve as an example in the context of this report.

CI-C1 Accessibility to green spaces

The availability of green spaces is a necessary precondition in urban planning. The benefits associated with the presence of green spaces in a town have long been propounded by a large number of studies, whether at a physical, emotional or social level.

A balanced spatial distribution of these green spaces is essential if wide accessibility is to be achieved, in terms of distance to travel, across the whole area of study (and across the urban territory). This criterion does not take account of the presence, or

otherwise, of the influence of amenities which may affect the distance/attractiveness trade-off.

Other criteria will play a role in the assessment of quality and the consequent attractiveness of the spaces.

Method

To determine the area of attractiveness, standards have been adopted in several European countries, notably in the Flemish Region in its long term Green Amenities Plan (Lange Termijnplanning Groenvoorziening). These classify green spaces according to their functional level (functieniveau), defined by the size of the space, to which a maximum accessibility distance is assigned (cf. Table 3). Small greened spaces known as "residential" (woongroen), of at least one hectare, play a dual aesthetic and social role and contribute to the quality of the living environment. They may take a diversity of forms: small community gardens in social districts, a single tree in a small square... Their area of influence is smaller than that of the larger green spaces (parks, woods etc.), that is to say those at a higher functional level (green spaces known as neighbourhood, district, municipal, agglomeration, outer suburban spaces) for which the maximum accessibility distance is expected to increase as one moves up the levels.

Functional levels	Minimal area (ha)	Maximal distance (m)
Végétation résidentielle - Woongroen	-	150
Espace vert de voisinage - Buurtgroen	1	400
Parc de quartier - Wijkpark	5	800
Parc d'arrondissement - Stadsdeelpark	10	1600
Parc d'agglomération - Stadsgewestpark	60	3200
Bois (péri)urbain - Stadsbos	200	5000

Table 3: Distance of attractiveness of green spaces according to their functional level [Van Herzele et al., 2000].

The green spaces in the context of the study, and those included outside its scope but whose area of influence has reached the context of the study, are identified on the map (NGI and ground occupation) and by the site surveys. Cartography software (ArcGis for example) will facilitate calculation of the areas of influence corresponding to the maximum distance, which is non-dissuasive and crossable by pedestrians to reach the green space (games space). On the basis of the standards listed in the

Mira Plan 2006 [95], two non-dissuasive distances to be travelled, according to the size of the green space, have been defined:

- small, local green spaces of less than 1 hectare will have an area of influence of 150m;
- green spaces of 1 hectare or more will have an area of influence of 400m.

The cartography reveals areas not covered by the buffers, that is to say located beyond the maximum distances considered to be non-dissuasive.

We consider here that the distance of influence of a green space is dependent not only on its size but also on the number of accesses on the public highway, on the morphology of the road network and any physical barriers present in the setting, such as water courses, railway lines or urban motorways. These elements must be considered in the interpretation of the results. For this reason, two methods are to be envisaged: "as the crow flies" buffers and isochrone curves linked to the road network, that is to say the distances actually travelled according to the constraints of the fabric of the roads connecting to access routes for the green spaces under consideration.

All the areas covered by green spaces and their buffers are then merged and this new layer intersected by the boundaries of the setting under study. The surface area of the green space-buffer group is then related to the total surface area of the setting under study, so as to obtain the proportion of the setting under study which benefits from good accessibility to green spaces

Interpretation

The rate of coverage by the buffers of the setting under study (accessibility area) is transferred to a scale of 1 to 10, presented in Table 4.

Score	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Interpretation	Nil	Very poor	Poor	Unsatisfactory	Fairly unsatisfactory	Average	Fairly good	Good	Very good	Optimal
Rate of coverage by the buffers	<20%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79%	80-89%	90-99%	100%

Table 4: Qualitative interpretation of the criteria CI-C1

CB-C1.1 Density of human activity

The development of hypotheses, established or confirmed by examination of studies and the body of information on urban density, leads us to pose the following hypothesis: the greatest density is tolerated in the "centres". Out of concern for sustainability, we would add that these centres are characterised by a concentration of property, services and a good public transport service. If they are to be accepted and encouraged, these high densities must be accompanied by a high-quality living environment, real urban animation created by a range of populations and activities and a certain architectural quality both in built and non-built spaces.

The density of human activity (DHA) is a measurement which incorporates the intensity of use of the surface area and the notion of urban animation [54]. It establishes the relationship between residents and uses over the urbanised area, that is to say over the net surface.

When this parameter is applied transversally with the theme of mobility, studies [54] [100] [143] show that the greater the density of human activity, the greater the modal split of public transport, cycles and walking in comparison with the car. This measurement is therefore also involved in the calculation of the potential use of public transport.

Method

On the basis of statistical data, the relationship is calculated between the sum of the number of jobs and residents (E+H) over the net urban surface, which is the analysis surface without non-urbanised areas: (E+H)/urbanised ha.

Interpretation

To define the scale for appraisal of this criterion, reference is made to studies by [100] and the Agence d'Urbanisme et d'Aménagement du territoire [8], the French agency for town planning and land use management.

Centre

The hypothesis is posed that in the centres, the optimum is achieved where the threshold value allows an alternative modal split to the dominance of the car and a structuring underground network, which is approximately between 150 and 250 (H+E)/urbanised hectare.

The score remains positive if the central area offers sufficient density for the development of at least a tram network.

Finally, the rating is minimal if the density of human activity does not permit buses with reserved busways.

Score	1	2	3	4	5	6	7	8	9	10
Interpretation	Nil	Very poor	Poor	Unsatisfactory	Fairly unsatisfactory	Average	Fairly good	Good	Very good	Optimal
DHA (E+H)/ha	<70	85 > x ≥ 70	100 > x ≥ 85	110 > x ≥ 100	120> x ≥ 110	120 > x ≥ 135	135 > x ≥ 150	150 > x ≥ 200	≥ 200	-

Table 5: Qualitative interpretation of the criteria CB-C1.1 – Central area

Urban area

The score is considered to be optimal where the density of human activity permits the development of an underground system, which is above approximately 150 (H+E)/urbanized ha.

The average score is equal to the value for a rubber-tyred tram network (means of transport in terms of capacity between the bus with reserved busways and the rail tramway).

Finally, the minimum score is equal to the values put forward by Newman and Kenworthy [100] below which the modal share for the car becomes predominant.

Score	1	2	3	4	5	6	7	8	9	10
Interpretation	Nil	Very poor	Poor	Unsatisfactory	Fairly unsatisfactory	Average	Fairly good	Good	Very good	Optimal
DHA (E+H)/ha	<50	70 > x ≥ 50	85 > x ≥ 70	100 > x ≥ 85	110> x ≥ 100	120 > x ≥ 110	135 > x ≥ 120	150 > x ≥ 135	≥ 150	-

Table 6: Qualitative interpretation of the criteria CB-C1.1 – Urban area

Suburban area

The optimum score corresponds to the development of a rail tramway.

The average score takes the value for a bus line with reserved busways.

Finally, the minimum score corresponds to the values put forward by Newman and Kenworthy [100] below which the modal share for the car is largely predominant.

Score	1	2	3	4	5	6	7	8	9	10
Interpretation	Nil	Very poor	Poor	Unsatisfactory	Fairly unsatisfactory	Average	Fairly good	Good	Very good	Optimal
DHA (E+H)/ha	<25	37 > x ≥ 25	50 > x ≥ 37	60 > x ≥ 50	70 > x ≥ 60	85 > x ≥ 70	100 > x ≥ 85	120 > x ≥ 100	≥ 120	-

Table 7: Qualitative interpretation of the criteria CB-C1.1 – Suburban area

MD-C1 Adaptation of pedestrian amenities

If proximity between housing and its complementary facilities and services (C.I-C4.1) is an essential element in the choice of walking between them, then the amenities provided for pedestrians, children and persons of reduced mobility have to have appropriate morphological qualities, of which the width of thoroughfares (M.D-C1.1) constitutes a basic reference (basic criterion).

In addition to the width of thoroughfares, various morphological criteria put forward may enhance the attractiveness of walking, for adult pedestrians and/or children and/or persons of reduced mobility:

- the interaction between the width of thoroughfares and the speed of motor vehicles (M.D-C1.2),
- the horizontal continuity of the paths (M.D-C1.3),
- the treatment of pedestrian crossings (M.D-C1.4),
- guiding for the visually impaired (M.D-C1.5),
- the vertical continuity of the paths (M.D-C1.6),

The six criteria (M.D-C1.1 to M.D-C1.6) are aggregated and by assigning to the basic criterion (M.D-C1.1) a weighting equal to the advanced criteria M.D-C1.2 to M.D-

C1.6. The score for the aggregated criterion is therefore found by applying the following operation:

Score M.D-C1 = [(5 x score M.D-C1.1) + (score M.D-C1.2 + score M.D-C1.3 + score M.D-C1.4 + score M.D-C1.5 + score M.D-C1.6)] / 10

In this report, only the basic criterion relating to the width of thoroughfares is detailed. According to the width of the thoroughfares provided to pedestrians, children and persons of reduced mobility, walking may appear more or less attractive and therefore competitive in relation to other means of travel [4] [56] [69] [92] [117]: the more comfortable the width of thoroughfares provided to pedestrians, children and persons of reduced mobility, the more adapted it is to the ergonomic features of users (pedestrians, children and persons of reduced mobility) and to the numbers present at the same time in the same public space and to their co-existence with motor vehicles, the more attractive walking becomes. Furthermore, pedestrians, children and persons of reduced mobility may adopt varying speeds of travel or even stop here and there to talk to someone they have met, to look in a shop window, to play etc.

Method

The method consists in measuring the width of thoroughfares provided to pedestrians, children and persons of reduced mobility.

For ease of observation, analysis and documentation of the results of the local morphology criteria relating to pedestrians, children and persons of reduced mobility, a street incorporating several crossroads may be divided into sections, one section being equal to the portion of the street which is located between two crossroads. However, since routes for pedestrians, children and persons of reduced mobility are only rarely limited to a single section of the street, it is also necessary retrospectively to consider the whole street, its connecting crossroads and... beyond, in order to ensure the best through-route conditions for pedestrians, children and persons of reduced mobility over their entire route.

In the case of a green space, we consider accessible paths and grassed areas to be thoroughfares provided to pedestrians, children and persons of reduced mobility and therefore as a reference for observing widths. This item is also observed in front of the accesses to the green space under study.

Within the public space under study, extended to connecting crossroads, the width of thoroughfares provided to pedestrians, children and persons of reduced mobility is measured in several places.

The width of the thoroughfares is measured excluding occasional obstacles. In fact, occasional obstacles may be the subject of additional measurements (removal, relocation away from thoroughfares etc.) in order to clear the thoroughfares.

Interpretation

Of the various measurements taken, the one most commonly provided to pedestrians, children and persons of reduced mobility in their thoroughfares is retained.

Depending on whether the space is located in a central, urban or suburban area, the width adopted is compared to threshold widths of 3.50m to 0.70m in central areas, and 2.50m to 0.70m in urban and suburban areas.

Score	1	2	3	4	5	6	7	8	9	10
Interpretation	Nil	Very poor	Poor	Unsatisfactory	Fairly unsatisfactory	Average	Fairly good	Good	Very good	Optimal
Central area	-	0,70 m > Lm	-	1,50 m > Lm ≥ 0,70 m	-	2,50 m > Lm ≥ 1,50 m	-	3,50 m > Lm ≥ 2,50 m	Lm ≥ 3,50 m	-
Urban and suburban area	-	0,70 m > Lm	-	1,40 m > Lm ≥ 0,70 m	-	2,00 m > Lm ≥ 1,40 m	-	2,50 m > Lm ≥ 2,00 m	Lm ≥ 2,50 m	-

Table 8: Qualitative interpretation of the criteria MD-C1

MM-C1 Adaptation of tree species in road-side plantings.

The choice of species adapted to road-side plantings, within the context of road development and renovation, is essential if an optimum result is to be achieved. Managing to keep a tree in good health throughout its lifetime, to achieve the desired shape when mature, necessitates the selection of species and varieties or cultivars which are specially adapted to the often harsh conditions (sub-soil, various kinds of damage etc.) or demanding conditions (no obstruction to users) imposed by the urban environment.

Method

According to the way they are planted – in a planting trench or in a planted island – the trees present are scored 10, 5 or 1:

- 10 for trees having been planted in a trench (irrespective of the planting method observed) or trees requiring to be planted in a planted island, and are in effect so planted.
- 5 for trees requiring to be planted in a planted island which are currently planted in a trench (generally disappointing result);
- 1 for trees reserved for green spaces, irrespective of the planting method observed.

Each tree present in the analysed space is judged on its ability to withstand planting on the road according to the evaluation assigned to it in the Dutch guide *Stadsbomen Vademecum*. *Deel 4: Boomsoorten en gebruikswaarde* [69] which characterises over 420 different species (species, hybrids, varieties and cultivars).

Interpretation

The score for this criterion in the space analysed corresponds to the average marks allocated to each of the trees present. It falls into a scale from 1 (extremely poor) to 10 (optimum)

ME-C5.1 Energy consumption of public lighting

Whilst guaranteeing optimum lighting, it is possible to opt for some systems and public lighting appliances which are more energy efficient than others

Energy is a precious and expensive commodity and it should be used carefully and rationally. Apart from reducing the financial burden borne by public bodies, controlling the energy consumption of public lighting has a positive impact on the conservation of natural resources and reduced emissions of pollutants of all kinds.

In the first place, rational energy use can be achieved by only lighting those areas which require it, and only during essential time intervals and to the appropriate intensity and no more. Then, as a second stage, in limiting the energy consumption of public lighting, energy-efficient bulbs and accessories should be opted for, that is to say, those with a high light emitting efficiency. The types of lamps and accessories and their spatial positions are key elements for the lighting system and the electrical power consumed.

Method

It may be that different lit areas are clearly differentiated either in terms of equipment or in terms of intensity of illumination. In some cases, it will be advantageous to differentiate these areas in the criterion study.

The main parameter in the analysis of limiting energy consumption of public lighting is the specific installed power, that is to say the electrical power consumed per m² per 10 lux given out (W/m²*10lux). At the same intensity of illumination per unit of surface and therefore at the same level of comfort and security, this reveals how energy consuming the lighting installation is.

The specific installed power is calculated using a series of data collected in the field or requested from the system manager operating in the space under study. The data required is:

- The bulb ratings = [PI]
- The power consumed by the accessories = [PA]
- The number of lights/bulbs of each type present = [NB]
- The surface to be lit = [SU]
- Average intensity of illumination = [EM]

[PI] and [PA] should be requested from the system manager. These parameters provide information about the energy consumption of each light. [PI] + [PA] = effective power [PE].

[NB] should also be collected from the manager or if necessary taken in the field or from plans. By multiplying the number of lights of each type by the total power it effectively consumes (light + ballast + other accessories), one obtains the total power consumed by the entire installation under study.

[SU] is measured from plans or on-site. By dividing [PE] by the lit surface, one obtains the effective power per unit of surface (m²).

[EM] is the value taken/calculated in the nocturnal visual comfort analysis carried out for criterion M.E-C3. [EM] can be determined either by using a luxmeter or through a simplified tool, based on the reading and/or determination of a series of data relating to the lighting installation present. Knowing the value for [EM] makes it possible to relate to 10 lux the effective power consumed per unit of surface.

The criterion for analysis of control of energy consumption is characterised using the following specific power [PS] calculation:

[PS] = [NB] * [PE] / [EM] / [SU] * 10 Where [PE] = [PI] + [PA]

Interpretation

According to the DRUPSSuC qualitative reading grid, interpretation of the criterion "energy consumption of public lighting" is:

Score	1	2	3	4	5	6	7	8	9	10
Interpretation	Nil	Very poor	Poor	Unsatisfactory	Fairly unsatisfactory	Average	Fairly good	Good	Very good	Optimal
Specific power	[1 ;oo] W/m²/10lux	]0,9 ;1[W/m²/10lux	]0,8 ;0,9] W/m²/10lux	]0,7 ;0,8] W/m²/10lux	]0,6 ; 0,7] W/m²/10lux	]0,5 ;0,6] W/m²/10lux	]0,4 ;0,5] W/m²/10lux	]0,3 ;0,4] W/m²/10lux	]0,2 ; 0,3] W/m²/10lux	[0 ;0,2] W/m²/10lux

Table 9: Qualitative interpretation of the criteria ME-C5.1

UG-C1 Device of sewer network and infiltration

In urban environment, the extended waterproofed surfaces concentrate instantaneously the surface waters in the sewer network. The evacuation of these surface waters is unfavourable with many regards. It limits the filling of the local ground water and causes floods by saturating the sewer network. It decreases the efficiency of the wastewater treatment plant by diluting wastewater rich in organic matters. And finally, it does not allow its recycling (watering plantations, cleaning of the streets, public toilets…), while increase the energy cost in the drinking water purification cycle (from collecting, to consumption and its treatment after rejection).

The stake is to minimize the negative impacts of rain water (floods) by limiting their instantaneous evacuations to the sewers while developing the filling of the ground water by infiltration on site and to increase the water consumption management (by recycling).

Method

Analysis parameters

We evaluate this criterion into the local perimeter. For all type of urban spaces, street, place, or City Park, the evaluation is identical. It consists to define the type of sewer network:

- To determine if the sewer network size is able to drain the totality of surface waters [RE];
- To determine the presence of a separative sewer network system [ITS];
- To determine the presence of a water tank in order to develop recycling water (watering, public toilets, cleaning of public spaces…) [The RER];
- To determine the presence of a water tank connected to a draining network (storm-water basin, tank, roadway system tank,…) [REE];
- And to determine the presence of permeable storm-water basin, allowing to refill the local ground water by direct infiltration (valley, draining ditch, natural storm-water basin,…) [REP].

Measurements and sources of data

The harvest of data is done by observations on the field, by requesting information to the communal concerned services, by collecting information to the climate institute, by questioning to the managers of the local sewer network.

Data manipulation

The 5 data [RE], [ITS], [the RER], [REE] and [REP] correspond to a binary variable, 0 or 1. If the required element is found, the variable equal 1, if the required element is absent, the variable equal 0 and the end value of the criteria is equal to the sum of the five variables.

Interpretation

The variation of the criteria value `device of sewer network and infiltration' is function of a sum of binary variable, the choice of the judgment scale is thus a linear function. The more the sewer network is diversified in its surface waters management solutions, the more the score is good.

Score	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Interpretation	Nil	Very poor	Poor	Unsatisfactory	Fairly unsatisfactory	Average	Fairly good	Good	Very good	Optimal
Score of the variables	If sum of points =1	-	-	If sum of points =2	-	If sum of points =3	-	If sum of points =4	-	If sum of points =5

Table 10: Qualitative interpretation of the criteria UG-C1

UP-C2 Participative process

The last criterion, for what should be the first stage in the project for the development and rehabilitation of the public space, concerns the quality of the participative process implemented when the space is redeveloped.

Indeed, the residents are the primary experts in the evaluation of their district and they often ask to be kept informed and associated with decisions concerning their urban environment.

Method

This criterion attempts to identify the quality of the participative process put in place. Our intention here is not to reduce this complex and constantly evolving approach down to a few rapid qualitative assessments. This criterion is therefore not closed and does not constitute a quality label because external factors can influence the quality of the process undertaken. It nevertheless has the advantage of determining the public authority's degree of willingness to involve the local community in the procedure for improving their living environment.

The expressed wish in respect of this point is to go beyond the simplistic assessment generally made between the four major levels of participation (information, consultation, concertation, joint management), which previous experiences show are not hermetically sealed and may have differentiated content depending on the project.

In order to communicate with the population effectively, the municipality cannot be content merely to fulfil legal obligations. The variables used in the assessment are guides, above all, which can encourage each individual to respond fully. Self-assessment is not easy and must be carried out prudently in order to make it as objective as possible.

Table 11 gives the questions put to project sponsors responsible for participation. Once filled in, the investigator completes the information by means of a telephone or face-to-face interview.

Assessment criteria	**Score**
Degree and form of participation **Information/awareness raising** → fill in boxes I and II **Consultation** → fill in boxes I to III **Concertation/ involvement** → fill in boxes I to IV **Coproduction/empowerment** → fill in boxes I, II and V	
Box I Representativeness of the population involved in the participative process. Objective: Legitimacy and equity in representativeness	

➔ Measurement: Is this a representative sample in terms of geography (area covered)? *From the assertions below, choose those which have been applied and use their scores.* Write a personalised letter to the residents of the street(s) directly concerned by the planned developments. *(1.5 points)* Send a standard letter to residents of the street(s) directly concerned by the planned developments. (*1 point*) Write a personalised letter to residents within a 150m radius. (2 points) Standard letter within a 150m radius. (*1 point*) Publication in the local press (*1 point*) Open days (*2 points*) Information at the information desks of the local council building or town hall (*1 point*) Notices posted (*1 point*) Other (*1 point*) ➔ In socio-demographic terms? (type of population at different times in the participation [process]) Has contact been made with the various socio-demographic profiles (young people, vulnerable groups, older people) concerned by the project, through various channels to inform them and raise awareness (*examples below*)? Create a meeting point in the space concerned by the renovation in order to make contact with users. Involvement of associations working with young people. Involvement with local community associations. Presence of a local district committee. Involvement of trade associations. Representatives of the various profiles.	/10 /15
Box II. Quality of information Objective: quality of the dissemination of information and of its content. Ensure transparency.	
To spread the message, the information has to be ➔ accessible (website, information at the municipality, publication in the local press, public meeting, liaisons) ➔ readable and digestible (is the information provided in a language accessible to the public and not just to experts?)	/5 /5
Box IIII. Procedural rules of the consultation-concertation Objective: the quality of the consultation will depend on the means employed	
Has an inventory been made of the actual and expected uses, through interviews and round tables which reach a broad section of the community concerned?	/5
Credibility/legitimacy of the process Clear definition of what is negotiable. Definition of the points on which public input is sought?	/5

Organisation of a tender process among design offices and participation of the public in the selection?	/4
What is the degree of citizen control over the agenda, the establishment of the rules, the selection of experts, the information?	/1
Who is listening? Presence of influential members or junior staff? Of the public players, presence of representatives of the various services which will manage the space (police, maintenance, sports service etc.), experts for opposing viewpoints? Presence of a sociologist or other type of mediator to ensure fairness in the debates?	 /3 /4 /3
When? Objective: Participation can take place at different stages in the project process	
(in advance) Was the community involved at the inventory stage, before programming? Was the community involved in the formulation of goals and the action plan?	 /4 /4
(mid-project) Is the participative process continuous, does the community have a voice whilst work is in progress?	/2
(Post-project) Was there (planned) monitoring upon completion of the work? Assessment of the quality of the facilities. (appropriation, user numbers).	/5
Box IV Results/decisions/concertation/deliberation Objective: an exchange of points of view in order to reach agreement which leads to improvements in the project and in the quality of decision making.	
Degree of consensus achieved (reaching a common position).	/15
Has provision been made to incorporate or implement the recommendations in the decision making process?	/10
Box V Coproduction Objective: Collective project design from the outset and project management by users	
Is the project based on cooperation, involving either coproduction, joint management or self-management?	/65

Table 11: Participation assessment criteria

Interpretation

Interpretation of the criterion is obtained by rounding the result of dividing by 10 the score out of 100 obtained from the analysis grid.

3.5 Case study

3.5.1 Methodology of case studies

The common typology throws up nine types of urban public space, clearly defined and representative of morphological diversity, a more or less 'green' character and the structural position of urban public spaces. However, to study, design and renovate a public space taken in isolation, without making it part of a broader plan, would be classed as an over-restrictive approach. Indeed, a public space only exists through being incorporated into this larger scale, made up of the city and its network of public places.

It is therefore a case of having a spatial approach demarcating an analytical context that goes beyond the space considered in isolation. It is necessary on the one hand to comprehend the public space considered together with its context, and on the other, to make this space part of the chain of public spaces on a city-wide scale. In order to respond to this delicate question of scale, we introduce two important concepts: the urban route and short journeys.

The urban route

A public space is never isolated; it is always in contact with a number of other spaces which themselves are linked to other spaces, and so on. This sequence of public spaces is envisaged in this study in the form of urban routes. Within the framework of this research, the route should be understood as an element of the space's consistency.

An urban route uses a succession of public spaces covering several types contained in our typology and linking strategic points within the city. It contains in its very definition a concept of time linked to its use. The time of use to which we refer here is an element of the public space that incorporates the components of the latter into a global system of how it is used and visited.

The relevance of a route for analysis demands that the principal places structuring the city, liable to enhance this type of approach, should be the subject of prior study. Routes defined in connection with a station or a centre obviously have a more lasting connotation. There will therefore be frequent reference to this type of place in determining an urban route.

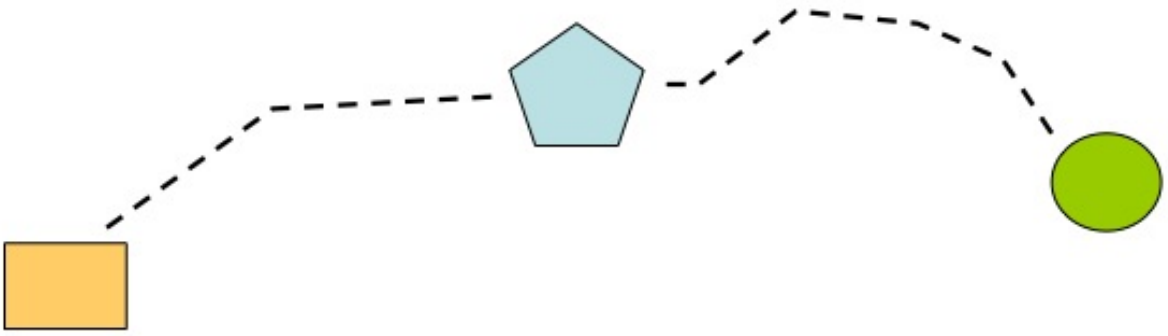


Figure 4: Urban route illustration

Short journeys

The context of a public space may be approached from a succession of perimeters of accessibility: perimeters accessible on foot, by bicycle, by car, etc…The DRUPSSuC research programme aims to define recommendations and tools for the development of public spaces with a view to the sustainability of the city. It is therefore important that the distances between the different types of public space, various amenities (crèches, businesses, pharmacy, etc…) take into account the "concept of short journeys". This principle gives central points their structure as local centres offering easy accessibility on foot or by bicycle to various services and basic facilities.

We also put forward the principle that, for a city to be sustainable, it is necessary to encourage non-motorised mobility, and to return to what is generally defined as a "walkable neighbourhood". In connection with the urban route that we are putting in place, we are therefore taking into consideration the distance known as "*pantoufle*" (walkable in slippers); in other words a distance covered on foot in 5 minutes, which corresponds to approximately 300 metres[2]. The concept of short journeys thus takes the form of an isochronous curve that demarcates an initial perimeter, reflecting a ground truth.

For a number of analytical criteria, the public space being considered includes the awareness of statistical measurements. We take into consideration the statistical sectors that are bisected by the isochronous curve of the urban route.

Analytical file

Our methodology for analysis on the ground leads us to consider two principal perimeters of the study. The first, called the 'global' perimeter, arises from two concepts of the urban route and short journeys as defined above; it takes into

[2] This is a distance that can be comfortably covered by everyone to reach the nearest public transport stop, at an average of 3.6 km/hour.

consideration the public space and a context of reciprocal influences. The second focuses on the public space in itself and therefore on its immediate limits, both built and unbuilt; for example, the public space in itself, extended to the facades of the buildings that demarcate its perimeter.

Thus, prior to each on-the-ground analysis, the research program has produced a sort of 'signpost' file reiterating the demarcation of the perimeters under consideration.

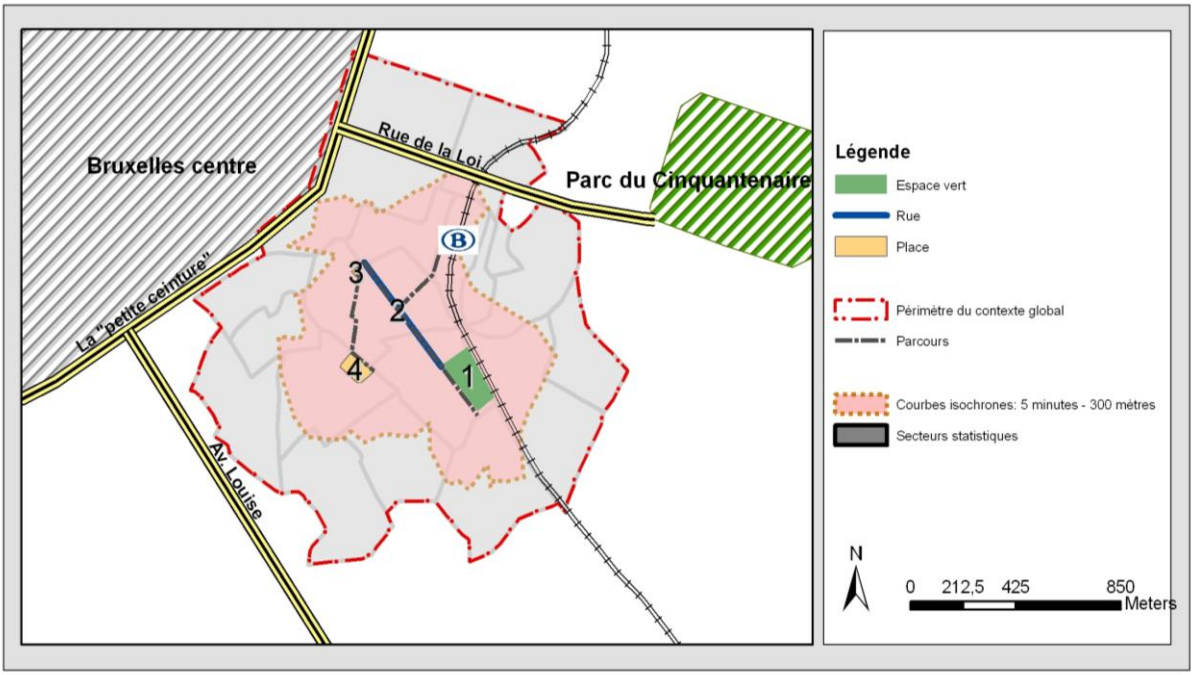
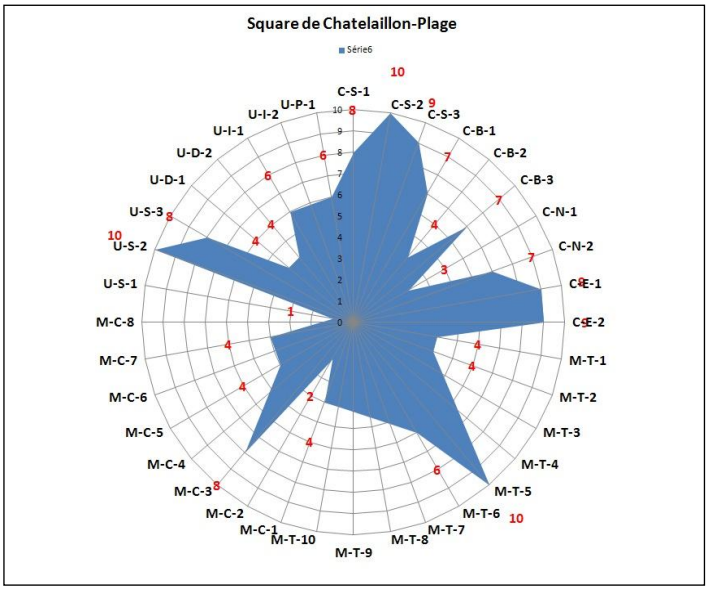


Figure 5: Example of analytical file – Ixelles urban route

3.5.2 Expression of the results



A radar representation of all the studied criteria permits an easy reading of the quality level of each criterion with a global vision.

When all the studied criteria meet their optima, the disc is full.

Unfortunately, such representation leads to a bias of reading when good criteria is surrounded by less efficient criteria or when some criteria are not available.

A graphical solution is to work with radar working not with nodes of the net but with meshes of the net.

Another solution was chosen. The graphical representation of the multicriteria studies is a kinde of horizontal histogram. An example of final expression is available in section 3.5.4, figure 6.

3.5.3 List of performed study cases

Case studies were done in Brussels, Leuven and Namur, one city in each Belgian Region. Leuven and Namur have an unquestionable interest within the framework of this study because their sizes are comparable with many of other Belgian cities. Brussels is interesting from its status, its size and the presence of the three urban areas defined in our typology.

For each city, a choice of one (or several) "walk" was conducted. This walk must have a sociological (socio-economic) and urban interest in connection with the history of the city, its life and its inhabitants.

With a respect to obtain the best and deepest solutions related to transversal interactions between the research fields, some spaces are selected in each urban walk for their urban and social interest by taking into account the perimeters of actions and interactions with broader context such as district or city as such. Moreover, attention is paid towards obtaining a sample of typical cases to each discipline in the total sample of selected spaces.

	Central area		**Urban area**	**Suburban area**
	Leuven	Namur	Brussels	
			Ixelles	Woluwé-Saint-Lambert
Street type	Bondgenotenlaan	Rue de Fer Quai Ferdinand Courtoy	Rue du Trône	Rue des Vaillants Boulevard de la Woluwe
Square type	Grote Markt	Place d'Armes	Place de Londres Square de Chatelaillon-Plage	Place Saint-Lambert
Green space	Stadspark	Parc Louise-Marie	Parc du Viaduc	Parc René Pechère

Table 12: Typology of the studied spaces

3.5.4 Example of case study : Ixelles

In order to illustrate the methodology, this section presents the example of Ixelles, and more particularly the results obtained for the public spaces at the Parc du Viaduc.

The Ixelles case falls into an "urban" context in a first ring suburb in the Region of Bruxelles-Capitale. This is a fabric of high density in terms of buildings and population, relatively deprived and having been the subject of recent measures to renovate some public spaces under several Neighbourhood Agreements (C.Q. Blyckaerts, Malibran and Sceptre), scheduled for the periods 2002-2006 and 2009-2013.

Three public spaces concerned by the above-mentioned Neighbourhood Agreements were chosen - the Parc du Viaduc, the Place de Londres and the Square de Chatelaillon-Plage – and a road which was not involved in the above, namely the Rue du Trône, taken in three quite distinct sections. This road falls under the responsibility of the regional authority of Brussels and not under the municipality of Ixelles. Of the first three spaces mentioned, only the Place de Londres has been renovated (during 2008-2009); the renovation of the other two remains at the planning stage.

Example of the space 'Parc du Viaduc' in the municipality of Ixelles

The Parc du Viaduc is a green space located at the centre of a residential block. Formerly a private property, the space was laid out as a park and opened to the public in March 2004. It was refurbished under the Blyckaerts and Sceptre Neighbourhood Agreements.

Lying between the Brussels-Luxembourg railway line to the east, the back gardens of houses on the Rue du Sceptre to the south and those on the Rue du Trône to the west, this park is open to the public during the day. The entrance is on the Rue du Viaduc to the north. The house of the former owners has been converted into communal and association spaces.



A study of the Parc du Viaduc using the DRUPSSuC criteria grid produces the results presented in Figure 6. Each cursor presents the interpretation of one criterion on the

quality scale from 1-extremely poor to 10-optimum. The absence of a cursor for any criterion means that this is not relevant to the case in point.

Scrutiny of Figure 6 shows an overall satisfactory result for the Parc du Viaduc. It fits into its setting and has obtained a number of positive results for the usage component.

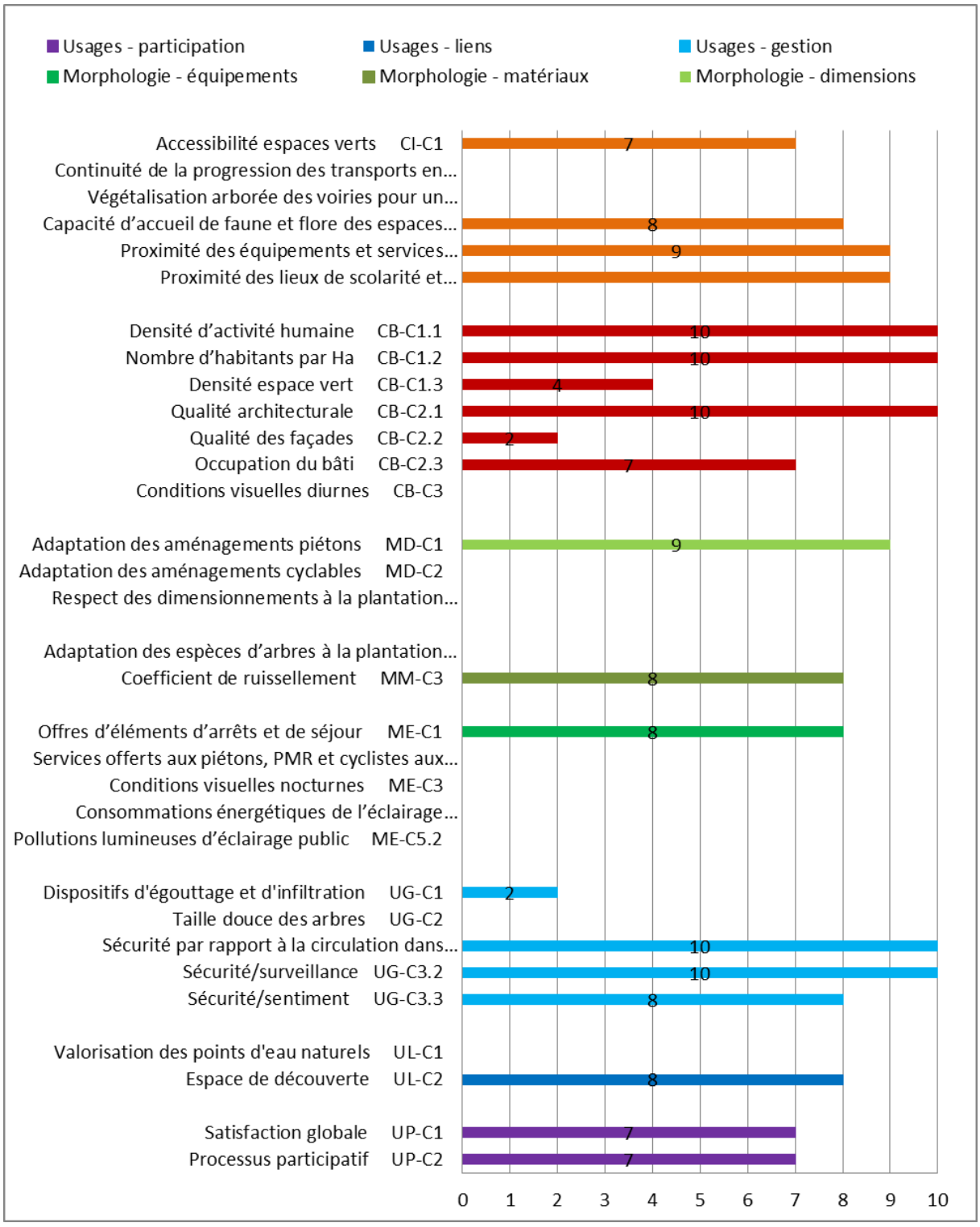


Figure 6: Results of the Parc du Viaduc case study

(Criteria codes correspond with the English written arborescence of pages 17 and 18)

One also notes that a number of questions are not applicable. Among other things, this is explained by the location of this green space within a residential block. Consequently, the question relating in particular to continuity in the advancement of public transport and road-side planting are not relevant. Similarly, the fact that this space is closed at a certain time of day means that the study of nocturnal visual conditions, and other questions relating to public lighting, are not applicable.

On the other hand, one detects two main gaps in the criteria studied, namely the quality of the facades and the drainage and infiltration system, which allowed us to make adapted recommendations.

The Parc du Viaduc is bordered by a number of dilapidated facades (peeling paintwork, dirt, cracks etc.) which contribute to a negative impression of the public space. During the design-renovation of the space, it would be appropriate to put in place certain encouragement levers (renovation bonus, for example) for private owners or to work on a renovation of the space which moves from facade to facade, thereby not restricting the project to the public space alone.

We also note that although it scored highly, the criterion M.D-C1 is accompanied by a recommendation to place the Parc du Viaduc on certain daytime routes, namely to provide a second pedestrian access from the Rue du Sceptre.

Its intimate aspect makes this a convivial place, used in particular by families with children at the weekend and by students and workers during lunch breaks on weekdays. A park warden is in attendance permanently following the application of component 4 of the Neighbourhood Agreement which also provided for several developments (agora space etc.). These developments have not been realised due to budgetary and time constraints, which seems to have suited the various project managers and users who were of the opinion that the site would have lost its character.

Finally, we note that since this park is at the centre of a residential block and is not accessible 24 hours a days, it can be considered as a “weak” public space, but one which brings real added value in terms of quality of life for the residents of this district which is particularly lacking in “natural” public spaces. Indeed, the study context offers only 5m² of green space per resident.

3.6 Survey

The better to gain an insight into the practices and perceptions of users of the public spaces studied, in addition to an observation and qualitative interview phase, a quantitative survey was conducted among users and non-users of the spaces making up the urban routes (Ixelles and Woluwe-Saint-Lambert in June and July 2009, Namur in June 2010). Information was initially collected face-to-face in the spaces themselves, and then by telephone calls to people living less than 300m from the public spaces studied, irrespective of whether or not they were users. It proved relatively difficult to find people who were prepared to be involved in this procedure. In spite of everything, 433 questionnaires from users and 45 from non-users were collected. The SPSS programme was used to analyse chi squared, ANOVA tests and a PCA (principal component analysis).

The questionnaire was structured into several components:

- The quality of accessibility to the space
- The frequency of use
- The activities practiced
- The feeling of security (traffic, buildings, maintenance, people, lighting, vegetation) (9 Q- 41 items)
- The level of physiological comfort (acoustic, wind, building, sun) (5 Q)
- The level of satisfaction (2 Q)
- The proposals for amenities (furniture, mobility, social, physiological comfort, nature)
- The feeling of belonging
- The profile

We will cover here only a few of the most eloquent results, which show how a survey of this kind can assist designers in acquiring information on the social practices associated with the spaces and how this subjective analysis can corroborate the objective results for the sustainability of the space measured using practical sheets.

3.6.1 The practiced activities

A graph such as the one given below provides us with a number of pointers likely to alert decision-makers to the strengths and weakness of the spaces.

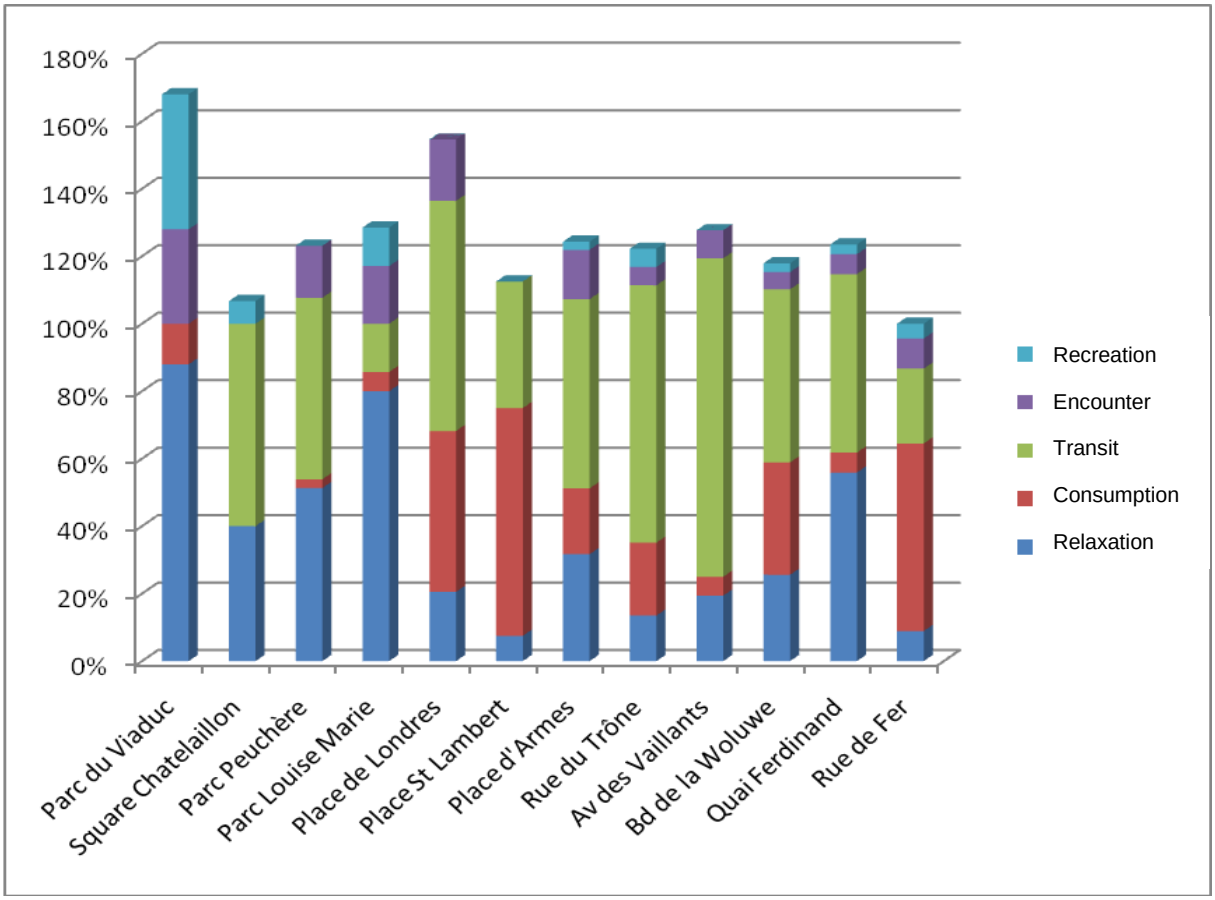


Figure 7: Practiced activities in study cases

The Parc du Viaduc consummately fulfils its function as a space for leisure. By contrast, it is striking to note that the Square Chatelaillon-Plage, likened to a green space, is principally used as a through-route. It was also very difficult to gain the residents' collaboration in giving their opinions on this place.

The Parc Pechère is also frequently used as a through-route, since it is extensively open to the roads surrounding it.

The recently refurbished Place de Londres emerges as the most multi-functional space, consumption and transit representing between them a large proportion of activities practiced. The Place Saint Lambert, on the other hand, is seldom considered as a place for leisure and is primarily used for consumption, due to the restaurants which border it. The Place d'Armes is also seldom used for leisure in spite of the recent improvements made. The absence of benches and trees, which is complained about in the survey, is doubtless one explanation.

3.6.2 The feeling of security

An overall criterion for the feeling of security in the space is obtained by adding together the scores assigned to each of the questions specifically posed. The ANOVA test, calculated from the statistical software SPSS, shows a significant variation in averages in our example studies. Figure 8 gives the questions which attempted to identify the feeling of security in relation to the space studied.

Do you feel safe in the space?:

- ☐ Always 61%
- ☐ Often 28%
- ☐ Sometimes 10%
- ☐ Never 1%

Did you feel safe on your way to this space?

☐ Yes 91% ☐ No ….. 9% If not, why?…….

Do you feel unsafe in relation to

	Always	Often	Sometimes	Never	I don't know
Traffic	2%	6%	20%	70%	2%
the cleanliness of the surroundings	0%	3%	12.1%	84,2%	1%
the state of the buildings	0%	2%	6%	90%	2%
public lighting	1.2%	4.7%	10%	50%	36%
Vegetation	1%	1.4%	4.4%	88%	5.8%
the maintenance of the space	1%	2%	9.5%	84%	4%
the people who frequent the space	1%	10%	24%	61%	4%

Figure 8: Questions which attempted to identify the feeling of security, and results

Although every city and space creates its own feeling of insecurity, for information we present the percentages of the results obtained from all questionnaires and for all spaces taken together. It emerges that insecurity in relation to people who frequent the space is the highest, followed by insecurity associated with car traffic. The detail of the studies of course colours the global figures given here.

Figure 9 highlights the proportion of people feeling very insecure per space. It can clearly be seen that the Rue du Trône is considered the least safe space, but being under 10% it is necessary to put this assertion into perspective.

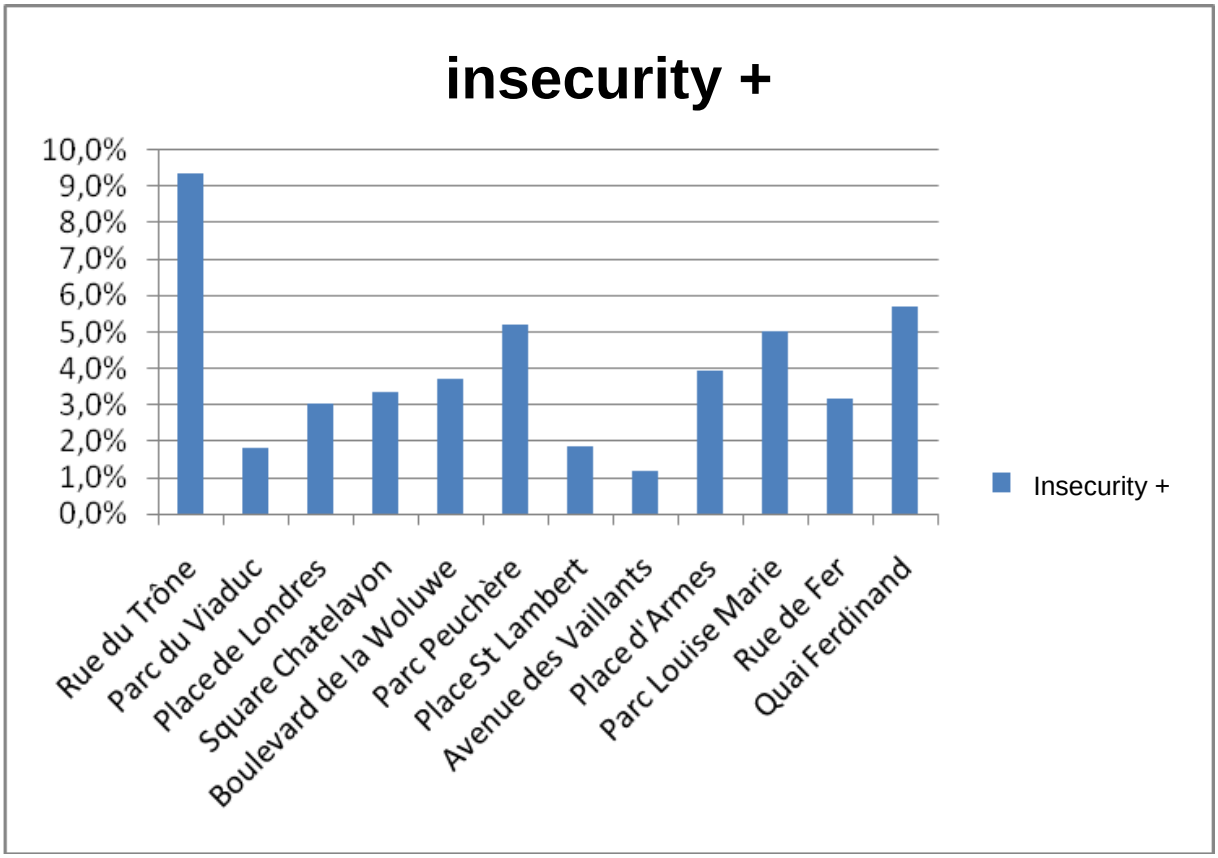


Figure 9: Percentage of people feeling very insecure

3.6.3 Physiological comfort and built landscape

Not surprisingly, the most frequently cited discomfort factors are the air quality and the noise level, which affect users of the Rue du Trône, the Boulevard de la Woluwe and the Rue de Fer.

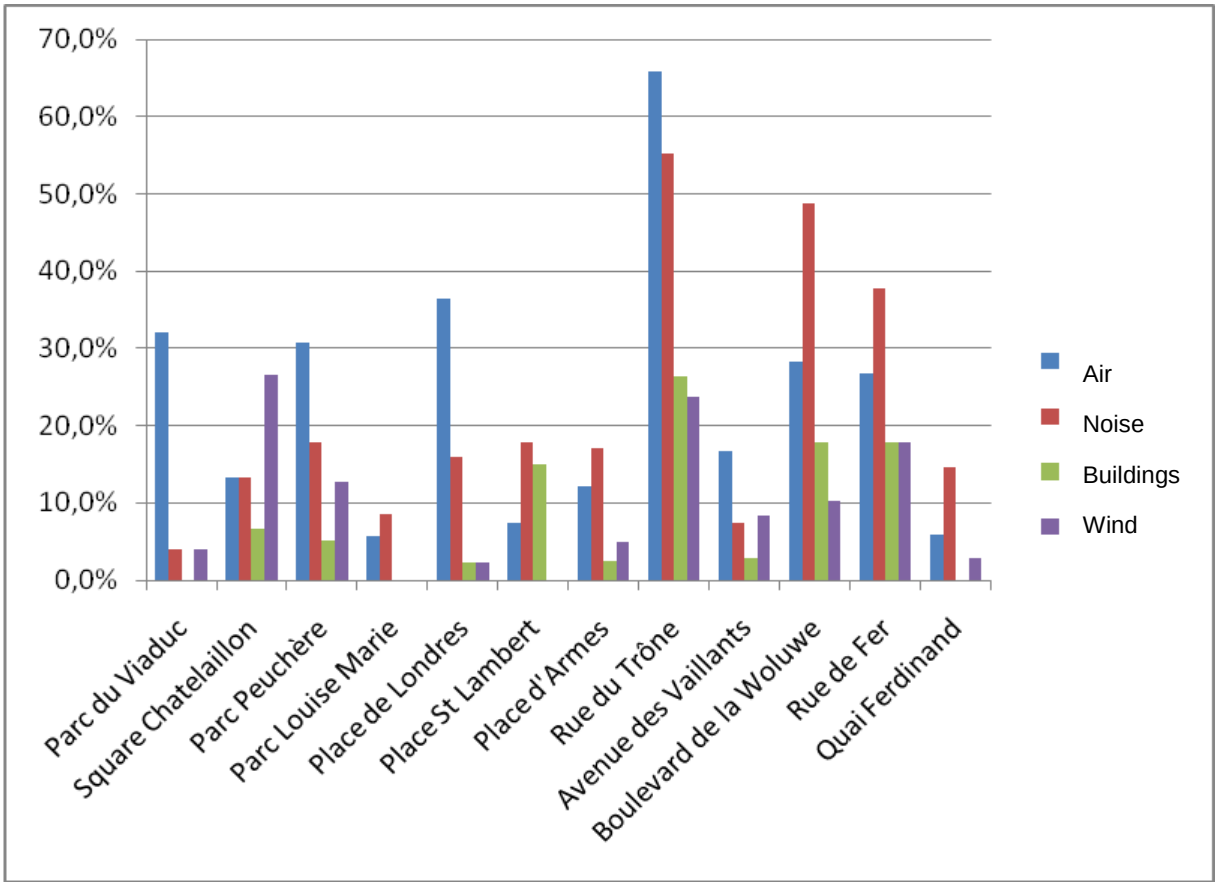


Figure 10: Discomfort factors for physiological comfort

Air quality and acoustics

For these two themes, we will take the example of the analysis of the Rue du Trône.

In respect of air quality, the objective analysis shows that the relationship between the width of the road and the height of the buildings does not allow for efficient air circulation; the high traffic level also gives an average to negative assessment depending on the section. This concurs with the general negative feeling expressed by respondents to the survey.

In respect of the acoustics, measurements were taken in the field on the days on which the surveys were conducted. The relationship between the expressed level of discomfort and the objective measurements is generally consistent. Table 13 gives the example of the results of readings for the Rue du Trône and, by way of comparison, for the Parc du Viaduc which is rather less concerned by a feeling of acoustic discomfort. The clusters corresponding to the analyses are presented in Table 14.

place	More description	cluster	Sound-mark	Keynote sound	Sound signals
Troonlaan	Wide main street with : path close to the road	4 (D)		Traffic noise	Different sound signals from cars such as door blast, horns and sound coming from car breaks
	path behind the trees	3 (D)		Traffic noise mixed with neutral sound of in wind moving leaves	
Viaduct park	Park hidden behind buildings, preventing direct sound from cars to be heart inside. Park is close to rail road.	1 (E) 2 (D)		natural sounds of park with seasonal character, distant trains, airplanes, no car sound	Sound of machines for park maintenance, such for cutting the grass

Table 13: Examples of acoustical analysis

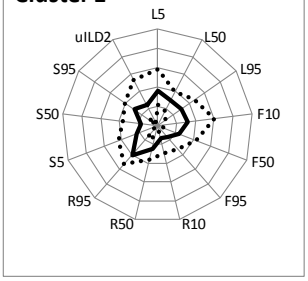
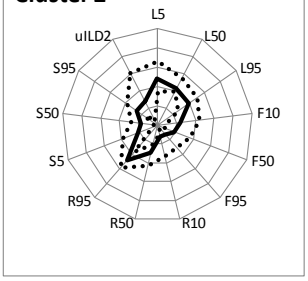
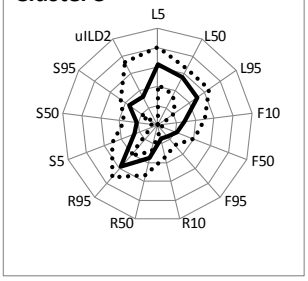
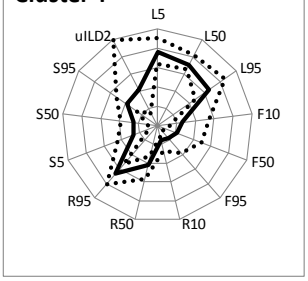
Cluster No.	Explanation		L_5	L_{50}	L_{95}
Cluster 1 	**STREETS** - side roads in the city centre or urban zone in the evening (evening-E), typical speed limit 30 km/h - residential areas (apartment blocks) in the city centre or urban zone, (E), typical speed limit 30 km/h - shopping areas when shops are closed (e.g. evenings and Sundays), without or little traffic **SQUARES** - squares with limited traffic - squares with parking places, day (day-D), (E) **PARKS** - bicycle pads in the parks, (D)	max	69.8	54.5	51.8
		mean	60.3	50.1	44.8
		min	54.0	44.7	36.3
Cluster 2 	**STREETS** - residential areas in the urban zone, apartment blocks, (D), typical speed limit 30 km/h **SQUARES** – small squares in city centre with little function (pub etc.) (D), (E), typical speed limit 30 km/h. **PARKS** – small parks in the city centre, close to road with typical speed limit 30 km/h, (D)	max	73.3	61.1	53.3
		mean	65.8	56.3	49.0
		min	59.8	54.6	43.1
Cluster 3 	**STREETS** – main roads in the city centre, typical speed of traffic 30-50 km/h, (E) - Side roads in the city centre, typical speed of traffic 30-50 km/h, (D) **SQUARES** – with traffic (but limited speed) in urban and suburban zone, (D) and (E). **PARKS** –parks close to main roads, separated form road by trees only, (D)	max	79.5	66.3	59.5
		mean	72.1	61.8	53.2
		min	62.8	52.9	41.5
Cluster 4 	**STREETS** – main roads in the city centre and urban zone (50km/h), (D)	max	84.1	73.7	67.9

Table 14: Overview of the proposed clusters with a short explanation

Wind comfort

Again by way of example, let us take the case of the Square de Chatelaillon-Plage. The square is marked by a greater degree of discomfort linked to the wind. Once again, this result is comparable with the objective analysis, because the assessment of the 'wind comfort' focus of attention is negative.

In fact, the example study establishes that the square is enclosed between two long residential buildings 30 metres high, while the average height of nearby cornices is 13 metres. High buildings of this kind create aerodynamic problems at their base, namely high wind speeds and turbulence. These two types of problem generate discomfort for soft users [not in cars] who are lingering in the square, but also for those crossing it.

By contrast, this space does not generate excessive discomfort in respect of air quality, which is also assessed positively in the analysis of microclimatic atmospheres. The space is very largely open and bordered by high residential buildings generating major aerodynamic disturbances which generate intensive wind activity in the square. Nearby roads are all local roads. No particular pollution load is reported. Assessment of this focus for attention is positive here.

Built landscape

The buildings along the Avenue du Trône are also a source of discomfort. This finding also matches the objective analysis conducted by means of the criteria C.B-C2.1 (architectural quality) and C.B-C2.2 (quality of the facades).

For the first, the overall score is average. In fact, one observes an excessive disparity and inconsistency in reading the built landscape, which contributes to a spatial incomprehension and a negative impression of the public space.

As for the second, this varies according to the sections. In general, the quality of the facades varies from "unsatisfactory" for the third section of the Rue du Trône to "extremely poor" for the other sections. The public spaces studied are bordered by a number of dilapidated facades (peeling paintwork, dirt, cracks etc.) which contribute to a negative impression of the public space. During the design-renovation of the space, it would be appropriate to put in place certain encouragement levers for private owners (renovation bonus for example) or to work on a renovation of the space which is not restricted to the public space alone.

3.6.4 The overall level of satisfaction

The overall level of satisfaction is summarised in figure 11. The line is forced here, because only the proportions of very positive and very negative responses are represented, in blue and red respectively. This amplification of the results nevertheless gives a good general overview of the assessment of the sites studied. The lowest scoring spaces are the Square Chatelaillon-Plage, the Rue du Trône**,** the Rue de Fer and the Quai Ferdinand Courtois.

It is interesting at this point to go back to our overall view of the criteria, by comparing the targets (cf. Figure 12) which illustrate the scores for all criteria for two very different cases: the Square de Chatelaillon-Plage and the Parc du Viaduc. It is clearly apparent that the overall feeling expressed by users is closely reflected.

The results of the PCA show these same spaces within the least appreciated group, for reasons which are specific to them.

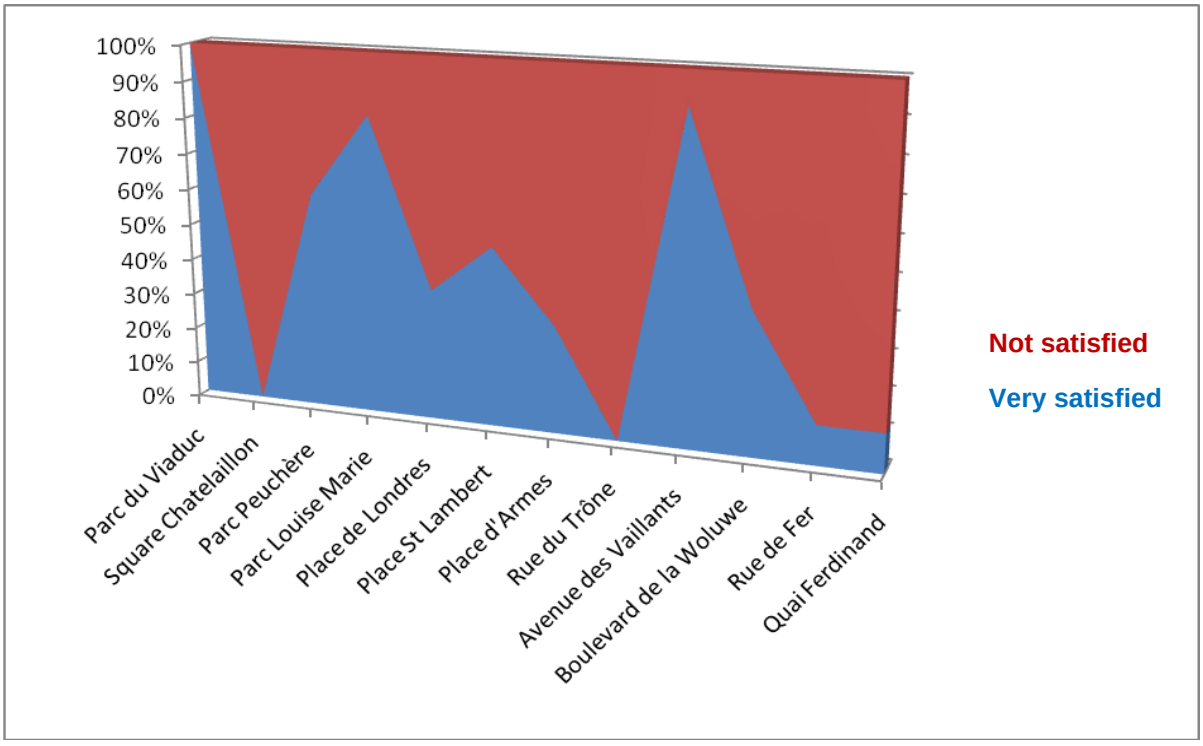


Figure 11

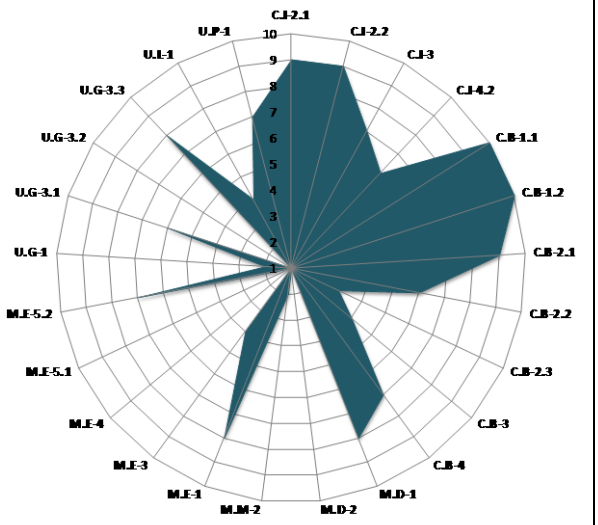
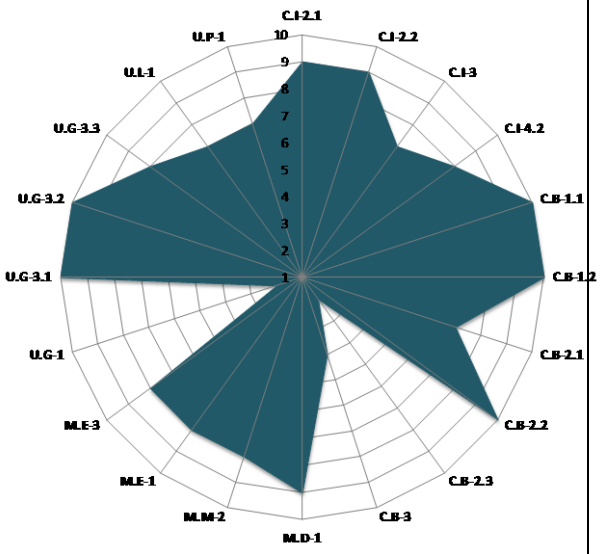
Square Chatelaillon-Plage	Parc du Viaduc
	

Figure 12

3.6.5 Proposals for improvement

The proposals for improvement put forward by the people questioned show a clear demand in connection with the following elements:

- comfort: more benches (40%), less noise (18%), higher air quality (19%), shelter from the rain (16%)
- nature: more trees (34%), more fountains (13%)
- sociability: more organised activities (games, festivals (14%)).

So, for example, among the proposals for improving the quality of the Parc du Viaduc, it would appear necessary to provide aquatic elements (pond 28%, fountain 40%) and install games (32%), a rain shelter (36%) and a kitchen garden (26%). In this respect, the development of a kitchen garden was planned under the Neighbourhood Agreement, but few people volunteered to manage it. The idea of aromatic plants, less labour-intensive, is envisaged instead.

For the Rue du Trône the most common demand is linked to providing more greenery (more trees 42%), and also more organised activities offering greater conviviality (more terraces 29%) or more organised activities for children (18%).

3.6.6 Conclusion from the survey analysis

The survey constitutes a very useful tool for assessing the quality of a space according to its users and nearby residents. Overall, the subjective study of the variables approximates to the objective analysis conducted by means of measurable criteria.

Although not all themes linked to the sociological approach can be "measured" using criteria or closed questions, it remains paramount for designers to immerse themselves in the place and its users in order to gain an insight into these essential notions.

We should finally point out that, in view of the results obtained, a space assessed overall as sustainable seems to be the preference of users.

3.7 Other results

3.7.1 Implementing a network of competences

Due to its transversal nature, the DRUPSSuC study made it necessary for each of the researchers involved to step outside the framework of the discipline for which they were responsible. In this way, the intensification of the exchanges of knowledge between researchers offered each of them the opportunity to increase their skills in terms of a multidisciplinary approach to a set of problems, and, more broadly, to put in place a real network of inter-university skills capable of handling future urban planning studies of the transversal type, incorporating components of a sociological, architectural, environmental and engineering nature.

3.7.2 Training students

During the preliminary phase of the study, two social ecology students from the Brussels *Haute Ecole Libre* were supervised by *IGEAT* (Institute for Environmental Management and Land-use Planning) and trained in the typological approach to the urban public space and its incorporation into the city.

As a result, during the case study phase, 6 students from the *Ecoles des Ingénieurs de la Ville de Paris* (Paris engineering college) were in their turn accommodated within the *IGEAT* structure, as part of a 3-month course. They were able to receive training in the use of the cartographic tool ArcGis, carrying out surveys, and setting up databases (Access), and were made aware of the concepts of public spaces and the sustainable city.

3.7.3 Elaboration of new techniques

A novel approach to acoustical categorization of urban public places, based on objective analysis of binaural sound recordings in situ has been outlined. The objective clustering is found to be consistent with subjective expectations on the basis of the typology of the recording locations and activities.

The definition of clusters by multiparameter analysis (by using the optimized set of the 13 parameters: L_5, L_{50}, L_{95}, F_{10}, F_{50}, F_{95}, R_{10}, R_{50}, $R_{95,}$ S_5, S_{50}, S_{95} and $uILD_2$.) performed on in situ recordings is thus useful for categorization of the recording in terms of expressing “how an acoustic scenario sounds like”. The 20 clusters identified in this study reflect typical acoustical situations in particular urban public spaces as well as special sound events. New clusters will be added in future, as new records will be added to the database.

It has been demonstrated to what detail the differentiation between particular urban public space or sound events can be successfully performed by using only objective acoustical parameters. However, it is obvious that a single value assessment can be hardly applied when speaking about soundscape as whole. Extension of the current approach to a hybrid clustering method that is based on the current acoustic measures, enriched by a semantic description, in terms of e.g. Soundmark, Sound signals and Keynote Sound in the urban public space, can be expected to give a full and comprehensive impression of the evaluated soundscapes.

A strong advantage of the proposed method is the use of the well known and generally used objective acoustical parameters for physical quantification of noise, i.e. sound pressure level, together with known psychoacoustical quantities that directly relate to human perception of sound and that have been thoroughly tested in acoustical laboratories.

In this way, locations measured through our approach can still be evaluated by data from classical approaches that deal with statistical noise levels only if necessary (since L_p is one of our similarity measures). In this case, further discrimination on the basis of clusters can be used for more detailed specification of the soundscape in a given place.

The proposed classification algorithm focuses on a categorisation of sound samples that have been binaurally recorded in urban public places, i.e. streets, squares and parks, during so-called “soundwalks (SW)” that last for 15-20 minutes. The recordings were stored to an M-Audio® solid state recorder in wave format.

The calibrated binaural recordings were performed by means of in-ear microphones so as to gather the sound in the ear of a city user. The sound samples were later on analysed in the acoustical laboratory, where thirteen acoustical parameters were calculated. In a next step, the acoustical parameters were normalized and used as

similarity measures in a clustering analysis that sorted locations with similar values into 20 different clusters. Finally, the clustering-based categorization was verified by identifying systematic analogies between acoustical as well as non-acoustical properties of different elements within the clusters, and by identifying systematic differences between different clusters.

More detailed description of the clusters and the newly proposed method can be found in the publication: M.Rychtarikova - G.Vermeir : Soundscape Categorization on the Basis of Objective Acoustical Parameters, accepted for a publication in Applied Acoustics, 2011.

4. SCIENTIFIC PERSPECTIVES

4.1 Additional implementation of arborescence

Due to limited time and resources, the full set of results from the DRUPSSuC study are only a part of the thinking with regard to the highly complex question of public spaces. Implementation of the arborescence, a notch higher, on the joint basis of the eight initial themes and a number of new themes, can only reinforce the transversal approach introduced. It is in this perspective of potential evolution that the structure of the arborescence was drawn up.

4.2 Correlative analysis using a wider sample of data

The ambition of the DRUPSSuC study was to highlight potential correlations between characteristic parameters of public spaces. The number of case studies carried out and therefore the amount of data gathered for each criterion, however, are not sufficient to carry out such statistical work.

In fact, when moving from phase 1 to phase 2 of the project, the international experts in charge of its evaluation judged that it was indeed too ambitious for the time and resources allowed. The number of case studies was therefore revised drastically downwards. Although expert opinion was judicious with regard to the time spent on case studies, the fact remains that the sample of data is insufficient to be subjected to correlative analysis; this would constitute an error of judgement.

Consequently, it would be advantageous to continue with a campaign of case studies on the basis of the same analytical criteria as those developed within this research programme. Such a process of collecting additional data would make it possible to carry out the correlative analysis that was initially hoped for, and which would be a potential source of scientific advances.

4.3 Construction of a multicriteria method - *Prométhée*

The multicriteria approach, such as that developed within DRUPSSuC, follows the routes used in benchmarking. This type of approach has the merit of presenting an estimate of the discrepancy between a solution and its theoretical optimum. However, when such an approach becomes aggregative, it forces the addition of factors that are sometimes very different, while losing many of their nuances. The aggregative approach, aiming at comparison between possible solutions, also has the weakness of engendering problems of indifference, incomparability, and compensation, truncating any conclusions that we might draw from it.

It is for these reasons of bias that the aggregative route, although attempted within DRUPSSuC, was finally rejected. There exists, however, a means of partially or totally comparing and ranking projects concerning spaces that are *a priori* very

different over a certain number of criteria. Multicriteria methods are the expression of this type of approach. They work with flows of preferences between possible solutions. Through their way of integrating every type of factor for what they are, these methods make it possible to move from simple isolated maxima to a judicious multidisciplinary compromise.

Among the multicriteria methods presented in literature [12][129][130], we will select the PROMETHEE I and II methods [18]. Promethee is an acronym meaning Preference Ranking Organisation Method for Enrichment Evaluations. Promethee methods construct outranking relationships depending on the intensity of preference. The Promethee I method deduces a partial ranking system on the relative rankings of different incoming and outgoing flows. An incoming flow is the measurement of the way in which one action outranks all other actions. An outgoing flow is the measurement of the way in which an action is dominated by all other actions. A partial ranking takes account of the fact that certain actions cannot be completely ranked, since they are not comparable. Promethee II is a method that takes other routes. It determines a total ranking system; that is to say thanks to the technique of distinct flows it ranks all actions, even if they are not comparable. These two versions of Promethee complement each other: one allows complete ranking, and the other makes it possible to qualify it by highlighting instances of incomparability. The potential existence of such cases of incomparability is not negligible, given the highly varied options possible when it comes to public space.

There is a definite advantage in tackling the design of public spaces while simultaneously implementing the two approaches, benchmarking and Promethee methods. The benchmarking approach makes it possible to confront absolute performance levels. The ranking approach allows us to measure the level of transversal preference for a solution in the face of others without being simplistic in our treatment of the factors present, since it does not iron out specific features.

4.3.1 New formulation of criteria

In order to perfect a Promethee method, it is necessary to define the criteria in accordance with a particular format. Promethee compares actions two by two and measures the intensity of preference “H(d)” of one compared to the other for each criterion according to the difference in appreciation “d” between actions for this criterion. The expression of this intensity H(d) is called the function of preference. The function H(d) may take different forms and depend on certain parameters. Six formal families or “generalised criteria” are highlighted. The parameters relating to functions of preference are three in number, to be considered or not depending on the generalised criterion selected:

- " q " is the indifference threshold. This is the highest value of "d", below which it is considered that there is indifference between two actions for the criterion being considered.
- " p " is the threshold of strict preference. This is the lowest value of "d", below which it is considered that there is a strict preference between two actions for the criterion being considered.
- " σ " is the parameter equivalent to the standard deviation in a Gaussian distribution.

The six generalised criteria used in the Promethee methods, as well as the parameters to be defined, are as repeated in figure 13. Type I corresponds to the "true criterion", type II to the "quasi-criterion", type III to the "linear preference criterion", type IV to the "criterion with levels", criterion V to "mixed criteria", and finally type VI to the "Gaussian criterion".

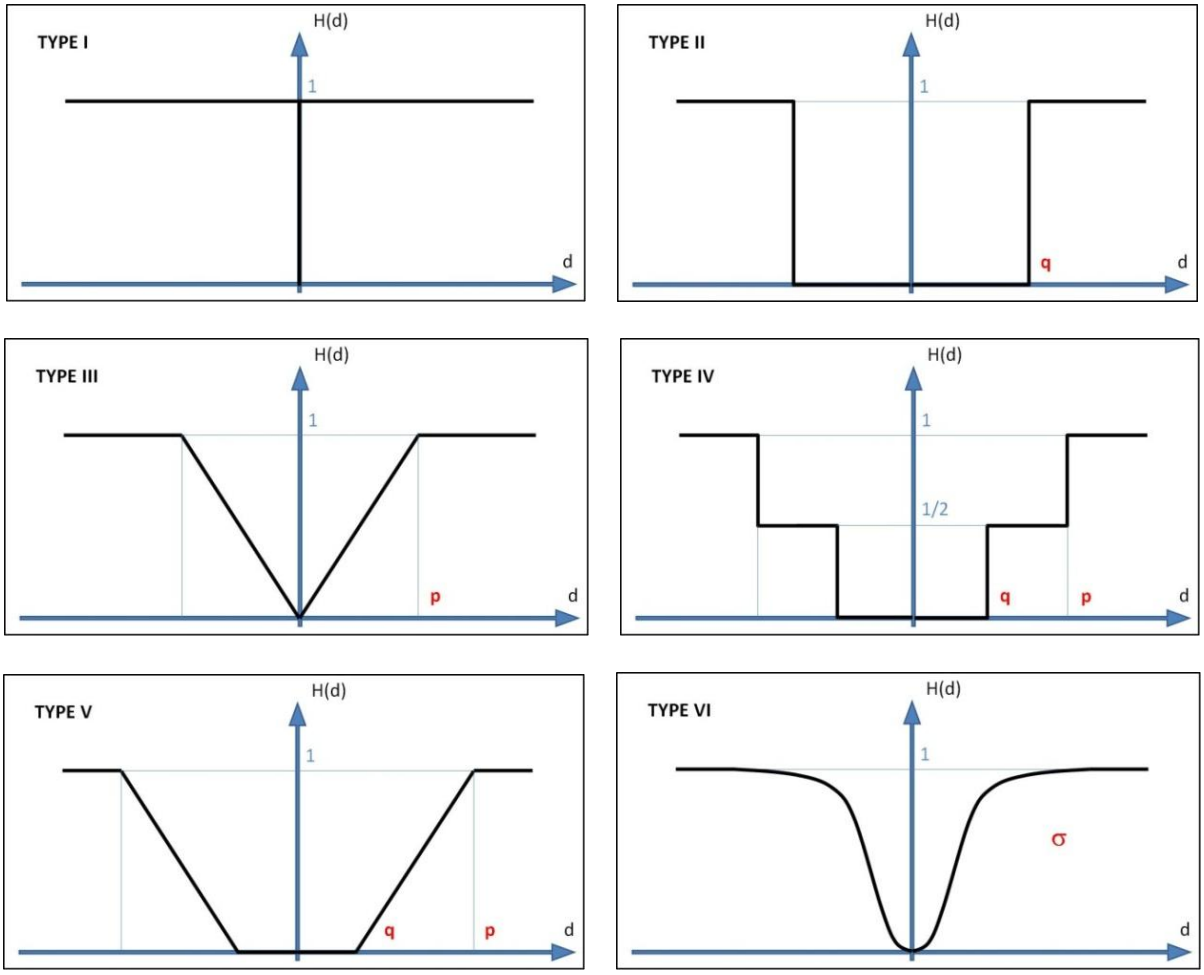


Figure 13: Generalized criteria for Prométhée methods

Depending on the nature of the criteria to be dealt with, it is a matter of choosing the appropriate generalised criterion and setting its parameters.

4.3.2 Organisation into method and sub-methods according to the arborescence

The number of criteria relating to the design of public spaces is substantial. Thus, the use of Promethee is impossible as things are. The general multicriteria method must be sub-divided into sub-methods. The framework of the arborescence will guide this process of division. In this structure consisting of sub-methods, the flows of preferences arising from primary methods must take the form of type III criteria, with p = 2. This choice of generalised criteria and the associated parameter preserves the integrity of the data obtained previously.

4.3.3 Devising a weighting system

The adoption of a transversal approach by means of multicriteria methods necessitates the allocation of weighting relative to the different criteria. This is the most sensitive stage of a multicriteria method, or an aggregative benchmarking approach, if one were ever to risk it. This is the part that is *a priori* subjective within a process that aims to be as objective as possible, so it is therefore important to devote particular attention to it. The method that we propose for devising a weighting system is derived partly from the Delphi method partly from Saaty's Analytic Hierarchy Process [126].

The postulate of the Delphi method is that forecasts made by a structured group of experts are generally more reliable than those made by non-structured groups or individuals. In the case of questions relating to public spaces, it therefore involves having at one's disposal a panel of experts dealing with the different issues present. The network of researchers working on the DRUPSSuC project is a good example of a panel. The method consists of bringing together the proposed weighting systems that each expert, working in isolation, has allocated to each criterion. These proposals must be accompanied by the necessary justification. Next, having rendered them anonymous, a coordinator forwards them to each member of the group. There then follows a second stage during which each member reviews their weighting system with regard to the opinions stated by the other experts. After a certain number of repetitions, we generally observe a convergence of values.

Despite its favourable results, the increased time taken by the Delphi technique proves to be a handicap to itself. Consequently, for the expression of opinions and once they have become sufficiently convergent in the eyes of the coordinator, we propose to opt for a mechanism close to the one drawn up by Saaty. The methodological details of this step of devising weighting systems for the various criteria are developed in the publication: Boland, Ph. (2010): Elaboration of multicriteria decision-aiding tools for the conception of urban public spaces - Proposed methodology, Accepted for PLEA2011 Conference.

The methodology for obtaining weightings is to be produced for each branch or sub-branch of the arborescence showing the trinome “context-morphologies-uses”.

5. POLICY SUPPORT

5.1 Defining the political, guiding and founding lines

The transversal approach, adopted with the perspective of creating a decision support tool for the design and renovation of urban public spaces which contribute to a sustainable town, reminds us of the intrinsic complexity of any public space and the consequent complexity involved in defining its every component. Although some can be reflected relatively easily by quantifiable and quantified reference thresholds, others cannot be transposed into figures.

This section presents a summary of the political, guiding and founding lines which will lend the most appropriate meaning to the indicators and criteria.

5.2 Defining a global vision of the roles of the city and public spaces

In terms of context, the design and renovation of urban public spaces for sustainable towns require the definition of a global vision of the roles which the town and its public spaces are called upon to fulfil. Among these roles, the town as a place for living and the public space as a place for sociability and socialisation for its residents appear to be two essential and inseparably linked roles.

At public space level, these fundamental roles are accompanied by a reversal of priorities in terms of mobility by prioritising the movement, stopping and lingering of pedestrians, children, persons of reduced mobility, cyclists and users of public transport. These new priorities are formalised in a particularly relevant way in an offering of public spaces with varied atmospheres, combined with the application of the concept of development of the public space into a “shared space” in which visual contact between individuals guides their reciprocal interactions.

Complementing these priorities, proactive policies aimed at a quantitative and qualitative reduction in motor vehicles circulating and parking in the city must also be developed, both for the movement of persons and goods. Of these polices, a move from the Highway Code to a Street Code should be pursued, for example by reversing the reference logic for parking: parking should be prohibited everywhere except in those places where it is authorised and conditions have to be observed.

The juxtaposition of these two essential roles is, moreover, accompanied by the definition of encouragement policies aimed at private owners, in terms of constructions and surroundings (functions, forms, materials, operations, management, vegetation, permeability, lighting systems etc.), and policies on the occupation of the built environment, the choice of means of travel etc. so that all human activities and their public and private expressions are harmonised within the town, in its central, urban and suburban areas, by living neighbourhoods.

5.3 Defining the networks

The planning per se of a public space falls within the urban fabric and in this regard it must contribute to developing a pedestrian friendly approach.

Depending on its location, it can also contribute to the networks of external spaces dedicated to leisure (parks and other greened spaces), cycle routes and surface public transport routes, which are easily accessible. These various networks should be defined in advance, at the neighbourhood and city level. Only then should a structural network relating to the routes for the movement of traffic and parking areas for private motor vehicles be defined, being sure to prioritise the interests of pedestrians and the other networks.

Planning a public space also contributes to the green and blue ecological networks, the global vision for which should also be defined in advance, complementing the presence and quality of urban plant and aquatic elements in streets, squares and green spaces.

Finally, the urban socio-economic context is an essential key to the sustainable city: in central, urban and suburban areas, the relative proximity of urban functions (housing, amenities and services, educational establishments, employment centres) by foot, bicycle and/or public transport is a decisive factor in the choice of means of travel and consequently of the potential of public spaces as places for sociability and socialisation in particular.

Public spaces enhanced as structuring elements, significant and meaningful, hierarchized and structured into networks, must guide the judicious location of attractive functions of transportation in terms of compatibility and even synergy of proximity between attractive function and structuring space.

In addition, the actual planning of public spaces can and must contribute to the legibility of the city structure.

5.4 Optimising the quantitative and qualitative relationships between demand and supply

The distribution of functions in the town can also be expressed in terms of densities: density of human activities, of jobs-housing, of residents or even of green spaces... Their optimisation assists an overall balance between the needs of residents (demand) and the responses to these (supply).

An architecture which is of high quality and at a human scale (layout, outlines, volumes, the composition of facades), retaining residential occupation, and a morphological framework which is favourable in terms of microclimatic (wind, sunlight etc.) and acoustic conditions are also essential components for the viability, attractiveness and animation of the city.

5.5 Understanding organisation and dimensioning from basic priorities

A study of the planning of a public space leads to determination of the organisation of activities pursued there and to the dimensioning of a series of elements relating to the movements of the various users.

Therefore, the fundamental priority to be attached to pedestrians, children and persons of reduced mobility, and to cyclists and public transport, must be translated into appropriate dimensioning, and the remainder can be allocated to other users and uses. In many public spaces, the available area is limited, a further argument in favour of the development of share amenities, whether in residential streets, squares or multifunctional places...

Designing for appropriate dimensioning is also important for certain types of fixtures; trees in particular can constitute an inconvenience (obstacle, source of excessive shadow etc.) for users and neighbouring residents if certain planting distances are not observed.

5.6 Understanding the choice of components for a sustainable end-result

Whether elements of planting, ground coverings, urban furniture or lighting, each component plays a role in the economic end-result, but also the environmental end-result. In this regard, each element must be dealt with by planning it over its entire lifecycle.

In addition to the dimensioning implemented, the choice of plant species must be defined in line with the urban environment in which the plants must survive, in particular in the light of activities pursued in the public space and the pollution associated with the management of infrastructures and energies used by the various means of travel.

Water management in the public space warrants particular attention in order to respect its natural cycle as far as possible. Since permeable ground coverings are rarely appropriate given the activities to be hosted in the public space, this cycle must be met as far as possible by a range of measures favourable to water retention, infiltration and evaporation, in addition to drainage systems.

As regards urban furniture, certain components which contribute to enhanced comfort for pedestrians, children, persons of reduced mobility and users of public transport must be anticipated at the level of routes - daytime and night-time - which link different public spaces. This concerns both the quantitative and qualitative offer of elements for stops, stays and/or facilities at public transport stops and elements of acoustic, visual and microclimatic comfort.

5.7 Acquiring information on the needs of residents and users

Residents are recognised as being the essential players in the sustainable town... They needs are manifold: in terms of security, mobility, leisure, nature, social interaction, stimulation, belonging... Acquiring information on these, although important, is nevertheless not easy since these needs are not all tangible. Of these, the need for security, first, and of belonging, second, warrant subtle definition.

The need for security of persons and property forms the basis for road safety systems in most public spaces. It also justifies the multiplication of technical and human surveillance systems. But deployment of these security elements must be defined quantitatively and qualitatively, taking the feeling of security expressed by users into account.

In order for residents to play to the full their role as essential players in the town, it is important that they develop a sense of belonging to the town, to the neighbourhood, to the public spaces and to the community. This sense is founded on symbolic dimensions and dimensions of usage and appropriation. Therefore, the development of the town and its public spaces must stimulate the urban identity:

- through activities which generate a variety of social links,
- through the enhancement, discovery and contact with nature: water, plants, fauna and flora etc.
- through the existence of sensory markers: visual and also acoustic, olfactive, even tactile and gustatory.

5.8 Interacting with residents and users

Within the context of a study of the development of a public space, acquiring information on the needs of residents and those of users more broadly can take particular forms. Of these, satisfaction surveys and the participative processes constitute two advantageous approaches which are to be encouraged, in coordination with the work of the project designer.

Face-to-face, telephone and other surveys constitute a useful tool for assessing the quality of an existing space according to residents and users. They provide a means of collecting a variety of useful information such as

- the needs of the various categories of age, education level etc.
- the needs of users and non-users
- the means of access to the public space
- visitor numbers at the public space
- the activities practiced
- the feeling of security (buildings, traffic, vegetation, lighting, maintenance, people etc.)

- appraisal of comfort (air, noise, sun, buildings)
- the overall level of satisfaction and additional suggestions for improvement
- the sense of belonging
- The participative processes must meet a number of conditions such as:
- geographical and socio-economic representativeness of the population involved in the process
- the quality of information: accessible, legible, digestible
- the clear definition of the margin for manoeuvre of the various players
- the presence and responsiveness of influential players
- the exchange of points of view with the aim of reaching an agreement

They must also allow the necessary time for observation of the space and plan for a post-project assessment.

5.9 Convergent actions

Although non-exhaustive, the recommendations given above should assist in developing complementary and convergent actions in the fields of land-use planning, urban planning, architecture, mobility and environment, to build towns and public spaces where residents will take pleasure in living, staying, lingering and meeting one another.

The implementation of these actions involves social support throughout the process, to ensure that the renovation of public spaces, in neighbourhoods populated by residents in precarious situations in particular, avoids marginalising these populations or prompting them to leave these places for others which are equally sensitive.

6. DISSEMINATION AND VALORISATION

6.1 Distribution of practical tools

Tools to aid decision-making and design, such as those drawn up during the research programme, will be the subject of an official presentation during a workshop. This workshop, aimed at both decision-makers and designers, will be organised during May 2011 in Brussels. What is more, the whole set of results will be distributed to a wider public via a special Internet site that is currently under construction and which will go on line to coincide with the workshop.

6.2 Scientific communications

As well as the publications mentioned in chapter 7, and those yet to appear, the network of researchers has been, and is still is, taking care to share the knowledge from the DRUPSSuC research programme, both in scientific circles and also in the widest possible sense.

Thus, within the framework of DRUPSSuC, a number of presentations and seminars have been given by different researchers on various occasions throughout Europe.

- Cambridge Workshop on Universal Access and Assisted Technology. 2008.
- Seminár Akustika. October 2008, Česká republika.
- Séminaire Art and Build. 2009, Brussels, Belgium.
- Applied Soundscapes Symposium. 2009, University of Salford, Manchester, UK.
- Rencontre écologique d'été. 2009, Belgium.
- Symposium "Stemergonomie. Een nieuwe kijk op stem". 2010, Netherland.
- Colloque tours et densité à Bruxelles et dans les grandes villes européennes. November 2010, Brussels, Belgium.
- Workshops Belspo at IBGE/BIM « Design and renovation of urban public spaces towards sustainable cities », 2008 and 2011, Brussels, Belgium.
- …

Likewise, the DRUPSSuC study has been presented in part or in its entirety on four occasions to urban development consultants as part of continuous training programmes for these local authority players, entrusted by the *Région wallonne* (Walloon region) to the *Conférence permanente du développement territorial* (Standing Conference on Territorial Development) which brings together the three Brussels universities (ULB - Guide), Liège (ULg-Lepur) and Louvain-la-Neuve (UCL-Creat).

7. PUBLICATIONS

7.1 Peer-reviewed publications

- Rychtáriková, M., Vermeir, G. (2010): Use of Psychoacoustical Parameters for Soundscape Categorization. Accepted with minor changes for publication in Applied Acoustics 2011.
- Boland, Ph. (2010): Elaboration of multicriteria decision-aiding tools for the conception of urban public spaces - Proposed methodology, International conference on Passive and Low Energy Architecture 2011- Architecture and sustainable development, 13-15 July 2011, Louvain-la-Neuve, Belgium.
- Rychtarikova, M., Van den Bogaert, T., Vermeir, G., Wouters, J. (2010): Perceptual Validation of Virtual Room Acoustics: Localization and Speech Understanding. Applied Acoustics, Volume 72, Issue 4, March 2011, Pages 196-204, ISSN 0003-682X.
- Rychtáriková, M., Vermeir, G. (2010): Acoustical Assessment of Urban Public Places, In Proceedings of the Institute of Acoustics & Belgium Acoustical Society-Noise in the Built Environment, Gent, 29-30 April 2010, Belgium, ISBN: 978-1-906913-02-1
- Rychtáriková, M., Vermeir, G. (2010): Determination of the context related sound level in an urban public place by using a sound-masking procedure, In Proc. DAGA 2010 - 36. Jahrestagung für Akustik Berlin 15.-18. March 2010, ISBN: 978-3-9808659-8-2.
- Vermeir, G., Rychtarikova, M. (2010): Invloed van de ruimteakoestiek op de spraakinspannig en op het Spraakverstaan. In Proceedings: Bridging voice professionals, Stemegonomie een nieuwe kijk op stem, (Jong, F. (Eds.)). Symposium “Stemergonomie. Een nieuwe kijk op stem”. 4-5 February 2010, Leuven, Oss: Ipskamp, Nijmegen, p.31-47. ISBN: 978-90-808846-2-5. (in Dutch)
- Rychtáriková, M., Vermeir, G.: (2010) Acoustical Categorisation of Urban Public Places by Clustering Method. In Proceedings of the International conference on Acoustics NAG/DAGA 2009 23-26 March, Rotterdam 2009, Paper No. 000114, pp.988-991. ISBN : 978-3-9808659-6-8 and ISBN:978-2-9521105-409, EAN: 9782952110549.
- Rychtáriková, M., Vermeir, G., Wouters, J. (2010): Overenie softvéru Odeon pre testovanie zrozumiteľnosti reči v dozvukovej miestnosti, In Proceedings of MAP 2010, pp.111-114, Zvolen, 8-10 September 2010, Slovakia, ISBN: 978-802282121-6.
- Jedovnicky, M., Rychtáriková, M., Vermeir,G.: Prediction of statistical noise values in an urban square by using auralisation, In Proceedings of Euronoise 2009, 26-28 October 2009 Edinburgh, UK, paper No. 0228

- Rychtarikova, M., Van den Bogaert, T., Vermeir, G., Wouters, J. (2009): Binaural Sound Source Localization in Real and Virtual Rooms. Journal of Audioengineering Society, Vol. 57, No. 4, p. 205-220. ISSN: 0004-7554.
- Rychtáriková, M., Vermeir, G. (2008): Acoustical Categorisation of Urban public places. In Proceedings of the 4th International Symposium “MAP ‘08”. Zvolen, September, Slovakia. ISBN 978-80-228-1911-4.
- Rychtáriková, M., Boland, Ph., Castiau, E., Godart, M-F., DeHerde, A., Hanin, Y., Martin, N., Meuris, C., Pons, T., Vermeir, G., Xanthoulis, S. (2008): Assessment of the Urban Public Places in Multidisciplinary Context – Proposed Methodology. In Procceedings of Building and Environment – Sustainable Development. Bratislava, November 2008. p. 69-72, ISBN 78-80-227-2981-9..
- Haesendonck, D., Rychtáriková, M., Vermeir, G. (2008): Qualitative assessment of the urban public spaces by using the psycho-acoustical parameters and semantic description. In Proceedings of the Building Physics Symposium in honor of Professor Hugo Hens (eds. S.Roels, G.Vermeir, D.Saelens), Laboratory of Building Physics, Catholic University Leuven, Leuven, Belgium, 29-31. October 2008, Leuven. p.219-222. ISBN: 978-90-5682-991-9.
- Rychtáriková, M., Vermeir, G., Domecká, M. (2008): The Application of the Soundscape Approach in the Evaluation of the Urban Public Spaces. In Proceedings of the Acoustics ’08. Paris, (Euronoise 2008) 29 June – 4 July. Paper No. 001649, p. 5533-5538, ISBN: 978-2-9521105-7-0, EAN: 9782952110570.
- Rychtáriková, M., Heylighen, A., Vermeir, G. (2007): Architecture for Every listener. In Proceedings of Symposium KVIV, “Mooi bedacht, nuttig toegepast”. November 2007, KMS Brussel. p.33-37.

7.2 Other publications

- VERMEIR and RYCHTÁRIKOVÁ (2010), Luisteren naar de geluidomgeving. KARAKTER – Tijdschrift van wetenschap. No.32, p. 12-14.
- BOLAND (2010), Elaboration d’une méthode multicritère d’aide à la décision en matière de projets d’aménagements urbains durables, TFE DES Management, ICHEC Entreprises, Bruxelles.
- MEURIS (2009), Densité vécue, densité perçue, in *Mouvement communal*, Juin-Juillet 2009, UVCW, pp. 278-287
- HAESENDONCK (2008), Soundscape in de stad, Master thesis (promotor. Prof. Vermeir, begeleider: Monika Rychtarkova), K.U.Leuven, 2008.
- Reiter (2007), Elaboration d’outils méthodologiques et techniques d’aide à la conception d’ambiances urbaines de qualité pour favoriser le développement durable des villes, Doctoral thesis, Université catholique de Louvain (UCL), June 2007, 643 p.

8. ACKNOWLEDGMENTS

Project DRUPSSuC - Design and Renovation of Urban Public Spaces for Sustainable Cities – was performed thanks to the financial support of the Belgian Federal Science Policy (Belspo) within the framework of its program Science for a Sustainable Development.

We thank the Belspo program administrators for their confidence and support:

- Marc Van Heuckelom
- Marie-Carmen Bex

We thank the researchers who worked with us during the first phase of the research:

- Sigrid Reiter (Architecture et Climat – UCL)
- Sandrine Xanthoulis (CREAT – UCL)

We also thank all the members of the follow-up committee for their guidance:

- Vincent Carton (Institut bruxellois de la Gestion de l'Environnement)
- Mireille Deconinck (Ministère de la Région Wallonne and ULB)
- Kristiaan Borret (Stadsbouwmeester – Antwerpen)
- Arnold Janssens (Vakgroep Architectuur en Stedenbouw – RUGent)
- Michèle Guillaume (Institut Belge pour la Sécurité Routière)
- Peter Hofman (Vlaamse Overheid)
- Pieter Van Vooren (Ministerie van de Vlaamse Gemeenschap)
- Hans Tindemans (MObiliteirsRAad van Vlaanderen)

more especially, for their high level of support:

- Serge Kempeneers (Institut bruxellois de la Gestion de l'Environnement)
- Isabelle Janssens (Institut Belge pour la Sécurité Routière)
- Pierre Vanderstraeten (LOCI – UCL and CERAA)
- Michel Delcorps (Ministère de la Région de Bruxelles-Capitale)

Finally, we thank all the people who helped us during case studies and people who took time to respond to surveys.

9. REFERENCES

[1] ADAMS (2005), Street and the culture of risk aversion, in What are we scared of ? The value of risk in designing public space. Cabe Space. London.

[2] ADAMS et al. (2006), Sustainable soundscapes: Noise policy and the urban experience, Urban Studies. 43, (2006)2385-2398.

[3] ASSOCIATION FRANCAISE DE L'ECLAIRAGE - AFE (2002), Eclairage des voies publiques. Association Française de l'éclairage.

[4] ARCHITECTURE LA CAMBRE (2004), La dimension accessible, -, Bruxelles.

[5] ARCHITECTURE ET CLIMAT (2010), Energie+ 6.1, Architecture et Climat, Louvain-la-Neuve.

[6] ATSMA (1990), Stadsbomen Vademecum. Deel 1: beleid en planvorming. Ministerie van Landbouw, Natuurbeheer en Visserij, Wageningen 527 p.

[7] ATTENBOROUGH et al. (1976), Background Noise-Levels in United-Kingdom, Journal of Sound and Vibration. 48, (1976) 359-375.

[8] AUAT (2007), Guide méthodologique pour la mise en œuvre des contrats d'axe, Toulouse

[9] BASSAND et al. (2001), Vivre et créer l'espace public, science, technique, société, Presses Polytechniques et universitaires Romandes, Lausanne, 223 pages.

[10] BELL et al. (2007), Mapping research priorities for green and public urban space in the UK, Urban Forestry & urban Greening 6 pp103-115.

[11] BELLEFONTAINE et al. (2010), Thème de recherche 5 : les écoquartiers, rapport de juillet 2010, annexe I, CPDT, DGO4

[12] BEN MENA (2000), Introduction aux méthodes multicritères d'aide à la décision, dans Biotechnol. Agron. Soc. Environ, 4(2), 2000, pp.83-93.

[13] BERGLUND and NILSSON (2006), On a tool for measuring soundscape quality in urban residential areas, Acta Acustica United With Acustica. 92 (2006) 938-944.

[14] BOTTELDOOREN et al. (2006), The temporal structure of urban soundscapes, Journal of Sound and Vibration. 292 (2006) 105-123.

[15] BOTTEMA (1993), Wind climate and urban geometry, Technische Universiteit Eindhoven, Eindhoven.

[16] BOUTAUD and BRODHAG (2006), Le développement durable, du global au local, Une analyse des outils d'évaluation des acteurs publics locaux, dans Natures Sciences Sociétés 14, 2006, pp.154-162.

[17] BOUTEFEU (2005), La demande sociale de nature en ville, Enquête auprès des habitants de l'agglomération lyonnaise. PUCA-CERTU, France.

[18] BRANS et al. (1984), PROMETHEE : A New Family of Outranking Methods in MCDM, in Operational Research #84, North Holland, 1984, pp.477-490.

[19] BRES (2007), De la voirie à la rue : riveraineté et attrition. Des stratégies d'inscription territoriale des mobilités périurbaines, Flux n°66-67, pp. 87-95, Métropolis. www.cairn.info (F)

[20] BRES et al. (2008), Le potentiel de densification autour des pôles et des axes de transport en commun, Paris, DREIF (Direction générale de l'équipement en Ile-de-France) – http://www.ile-de-france.equipement.gouv.fr

[21] BRODHAG (2003), Genèse du concept de développement durable : dimensions éthiques, théoriques et pratiques, dans Développement durable et aménagement du territoire, Presses polytechniques et universitaires romandes, Lausanne, 2003, pp.29-45.

[22] BROWN and GILLESPIE (1995), Microclimate Landscape Design, creating thermal comfort and energy efficiency. Canada: John Wiley & Sons.

[23] BRUXELLES ENVIRONNEMENT - IBGE, (2000). Maillage vert et bleu. IBGE, Bruxelles, 10p.

[24] BRUXELLES ENVIRONNEMENT - IBGE (2007), Guide pratique pour la construction et la rénovation durable, Problématique et enjeux de l'eau, www.ibgebim.be

[25] BUNTING et al. (2009), Instrument for soundscape recognition, identification and evaluation (ISRIE): technology and practical uses, In Proceedings of Euronoise 2009, 26-28 October 2009, Edinburgh.(2009)

[26] BUREAU FÉDÉRAL DU PLAN - TASK FORCE DÉVELOPPEMENT DURABLE (2002), Un pas vers un développement durable ? Rapport fédéral sur le développement durable, Bureau fédéral du Plan, Bruxelles.

[27] CASTIAU et al. (2008), Guide pratique pour un urbanisme durable, Sus-Cit, DAU-Région wallonne, Namur.

[28] CHADOUIN (2004), La ville des individus, sociologie, urbanisme et architecture, propos croisés. L'Harmattan, France.

[29] CHAÏB (1997), Les guides pratiques Ecologie Urbaine : les eaux pluviales-Gestion intégrée, ed. Sang de la Terre.

[30] CHRISTALLER (1933), Die zentralen Orte in Süddeutschland, université d'Iéna, Iéna.

[31] COLLECTIF (SOS Jeunes – Quartier Libre, Samarcande, IEB, et Julie Cailliez (ULB)) (2008), Jeunes en ville, Bruxelles à dos. L'appropriation de l'espace urbain bruxellois par des jeunes de différents quartiers. Bruxelles.

[32] COLLECTIF (2008), Stedelijke Ecologische Verbindingszones in Den Haag 2008-2018, (2008). Concept. 87p.

[33] COMPAGNON and GOYETTE-PERNOT (2004), Visual Comfort in Urban Spaces. In: CEE, Designing Open Spaces in the Urban Environment: a bioclimatic approach, Centre for Renewable Energy Sources. Grèce.

[34] CONSEIL FÉDÉRAL DU DÉVELOPPEMENT DURABLE (2003), Etude pour le Conseil fédéral du développement durable, Mesurer le développement durable en Belgique : quels rôles pour les processus participatifs ?

[35] COLLES and CASEIRO (2001), Social criteria for the evaluation and development of urban Green space – Development of urban green spaces to improve the quality of life in cities and urban regions , URGE, UK, October.

[36] CROW-KENNISNET, (-), Kindvriendelijke Straten, Kinder Straat Scan (KiSS), www.crow.nl (NL)

[37] DAVIES et al. (2007), The Positive Soundscape Project, In Proceedings of the 19th International Congress on Acoustics, Madrid, 2-7 September 2007.(2007)

[38] DAVIES et al. (2009), Measuring and mapping soundscape speech intelligibility, In Proceedings of Euronoise 2009, 26-28 October 2009, Edinburgh, U. K.(2009)

[39] DE COENSEL et al. (2008), Clustering outdoor soundscapes using fuzzy ants, 2008 Ieee Congress on Evolutionary Computation, Vols 1-8.(2008) 1556-1562.

[40] DE HAECK (2005), Kiezen voor bomen langs lanen en straten. In HERMY M., SCHAUVLIEGE M. and TIJSKENS G. (eds). Groenbeheer, een verhaal met toekomst. Velt, Berchem, pp. 387-429.

[41] DE HERDE et al., (2009), Design and Renovation of Urban Public Spaces for Sustainable Cities, Final Report Phase 1, Belgian Science Policy, Bruxelles.

[42] DE MYTTERAERE (2006), Vers une Architecture Soutenable, thèse de doctorat, Architecture et Climat, Université catholique de Louvain, Louvain-la-Neuve, Belgium.

[43] DECONINCK (1983), Les espaces verts publics à fonction sociale de l'agglomération bruxelloise. Fondation Roi Baudouin, Bruxelles.

[44] DECUYPERE et al. (2005), Parken, ver en dichtbij. In HERMY M., SCHAUVLIEGE M. and TIJSKENS G. (eds). Groenbeheer, een verhaal met toekomst. Velt, Berchem, pp. 467-506.

[45] DEHAIBE (2010), Projections démographiques bruxelloises 2010-2020, Région de Bruxelles-Capitale, Bruxelles.

[46] DEMANET and MAJOT (1995), Manuel des espaces publics bruxellois. Editions Iris, 163p.

[47] DUBOIS et al. (2006), A cognitive approach to urban soundscapes: Using verbal data to access everyday life auditory categories, Acta Acustica United With Acustica. 92 (2006) 865-874.

[48] ELSLEY (-), Outsiders ! Children and Young People and Their Use of Public Space.

[49] ERNST (2002), Cultures urbaines et développement durable, Ministère de l'Aménagement du territoire et de l'Environnement, Paris.

[50] ESCOURROU (1995), Les particularités du climat urbain, Journée du CUEPE 1995 « Energie et climat urbain », Genève.

[51] EURIDICE92 (-), Réconcilier l'Eau et la Ville par la maitrise des eaux pluviales, ed. STU.

[52] EUROPEAN UNION (2002), EU directive, EU directive on environmental noise 2002/49/EC,(2002)

[53] FONDATION ROI BAUDOUIN (2006)., A l'écoute du sentiment d'insécurité, rapport général. Bruxelles.

[54] FOUCHIER (1997), Les densités urbaines et le développement durable, le cas de l'Ile-de-France et des villes nouvelles, Paris, éd. du SGVN

[55] FRENAY (1994), Transport de personnes : éléments de choix modal. Réflexions pour la recherche d'un usage plus sélectif de l'automobile, ULB - Institut d'urbanisme et d'aménagement du territoire, Bruxelles (B)

[56] GAMAH (-), Groupe d'action pour une meilleure accessibilité aux personnes handicapées, www.gamah.be -, (B).

[57] GANDEMER (1976), Inconfort dû au vent aux abords des bâtiments : concepts aérodynamiques, Cahiers du centre scientifique et technique du bâtiment n°170, Paris.

[58] GAUDIN (2006), Murs après murs : Les jeunes face aux politiques de rénovation urbaine. L'exemple de la démolition dans deux quartiers d'habitat

populaire bretons. Espaces géographie et société, université de Rennes 2. http://sejed.revues.org/document823.html.

[59] GODARD (1996), Le développement durable et le devenir des villes ; bonnes intentions et fausses bonnes idées, dans Futuribles, 209, 1996, pp.29-35.

[60] GODEFROID and KOEDAM (2007), Urban plant species patterns are highly driven by density and function of built-up areas. Landscape Ecology, 22, pp. 1227-1239.

[61] GRELA et al. (2004), Convention d'étude de méthodes et d'outils d'aide à la décision pour la planification et la mise en œuvre de systèmes d'épuration individuelle ou groupée, Guide pratique, Région wallone DGRNE

[62] GRIFFITH (1968), A Note on Traffic Noise Index and Equivalent Sound Level, Journal of Sound and Vibration. 8 (1968) 298-&.

[63] GUINAUDEAU (2010), L'arbre en milieu urbain. Choix, plantation et entretien. Guide Pratique Aménagements urbains durables, CSTB, 144p.

[64] GUSTAVSSON et al. (2005), Management of urban woodland and parks. Iin KONIJNENDIJK C. , NILSSON K., RANDRUP T. and SCHIPPERIJN J. (eds.). Urban Forests and Trees. A Reference Book. Springer, Berlin and Heidelberg, pp. 369-397.

[65] HECQ W. et al. (-), Elaboration et application d'un set d'indicateurs pour un développement durable des transports en Belgique. Approche conceptuelle et méthodologique, Services fédéraux des affaires scientifiques, techniques et culturelles, Bruxelles (B)

[66] HERMAN (2008), Méthodes multicritères, Module 2 Logistique et production, cours DES en management, ICHEC Entreprises, Bruxelles.

[67] HRABOVSKA (1999), Klasifikácia a rozhodovacie stromy pre lubovolne merané premenné, In Proceedings of the 8th International seminar on computational statistics, 2-3 december 1999, Bratislava.

[68] HUBERT et al., (2008), Etats généraux de Bruxelles. La mobilité à, de, vers et autour de Bruxelles (Note de synthèse n°1), Brussels Studies (B)

[69] JANSON (2006), Stadsbomen Vademecum. Deel 4 : Boomsoorten en gebruikswaarde. IPC Groene Ruimte, Arnhem, 423p.

[70] JOLY (2005), L'allocation du temps de transport de l'observation internationale des budgets-temps de transport aux modèles de durées, Thèse pour le doctorat en Sciences Economiques mention économie des transports, Université Lumière de Lyon 2, Faculté des sciences économiques et gestion.

[71] KANG and ZHANG (2010), Semantic differential analysis of the soundscape in urban open public spaces, Building and Environment. 45 (2010) 150-157.

[72] KRIJNDERS et al. (2009), Sound event identification through expectancy-based evaluation of signal-driven hypotheses, Accepted for publication in Pattern Recognition Letters, doi: 10. 1016/j. patrec. 2009. 11. 004.(2009)

[73] KRYTER (1984), Physiological, psychological and social effects of noise,(1984)

[74] KRYTER (1985), Noise and Hearing Damage - How Much Is Too Much, Impact of Science on Society. 35 (1985) 197-205.

[75] KULL (2006), Natural and urban soundscapes: The need for a multi-disciplinary approach, Acta Acustica United With Acustica. 92 (2006) 898-902.

[76] LAIN (2005), Stimulating the sense in the public realm, in What are we scared of? The value of risk in designing public space. Cabe Space. London.

[77] LAMBERT and DEWART (2006), *Quartier durable pistes pour l'action locale*, Etude n°1, décembre 2006, Etopia,

[78] LAMBOTTE et al. (2010) Expertise spécifique 1 implantations commerciales annexe 7 relative aux propositions de critères relatifs aux implantations commerciales, CPDT, mai 2010.

[79] LIEBARD and DE HERDE (2005), Traité d'architecture et d'urbanisme bioclimatiques. Concevoir, édifier et aménager avec le développement durable. Observ'ER, Baume-les-Dames.

[80] LITTLEFAIR et al. (2000), Environmental Site Layout Planning : Solar Access, Microclimate and Passive Cooling in Urban Areas, Building Research Establishment, London, 2000.

[81] LÖSCH (1954), The Economics of Location, Yale Univ. Press, Yale.

[82] MAGALON N (2005), S'organiser pour aménager l'espace public. Démarches et processus d'organisation. CERTU, Lyon.

[83] MAHAUT (2010), Comment l'eau traverse-t-elle la question de d'architecture ; suivant quel processus l'eau est un média d'architecture et d'urbanisme ?, Thèse de doctorat en science de l'ingénieur, Université Catholique de Louvain, Belgium.

[84] MANUSSET et al. (2007), Pour une approche des inégalités écologiques à travers les définitions de la « qualité du cadre de vie », Développement durable et Territoire n°9.

[85] MARQUIS-FAVRE et al. (2005), Noise and its effects - A review on qualitative aspects of sound. Part 1: Notions and acoustic ratings, Acta Acustica United With Acustica. 91 (2005) 613-625.

[86] MATHIEU and GUERMOND (2005), La ville durable, du politique au scientifique, Indiscipline, Cemagref, Cirad, Ifremer, INRA, Paris.

[87] MAYSTRE (1997), Une démarche pour négocier les décisions relatives à l'aménagement des territoires et la gestion de l'environnement, dans Biotechnol. Agron. Soc. Environ, 1(4), 1997, pp.248-256.

[88] MEMOLI et al. (2008), Testing the acoustical corrections for reflections on a facade, Applied Acoustics. 69 (2008) 479-495.

[89] MERCIER and BETHEMONT (1998), La ville en quête de nature, Centre Jacques Cartier, Québec, 256 pages.

[90] MERLIN and CHOAY (1996), Dictionnaire de l'urbanisme et de l'aménagement, ADAGP, Paris.

[91] MINCKE (2010), Insécurité et sentiment d'insécurité à Bruxelles. Les enseignements du Moniteur de sécurité. Brussels Studies

[92] MINISTERE WALLON DE L'EQUIPEMENT ET DES TRANSPORTS (2006), Guide de bonnes pratiques pour l'aménagement de cheminements piétons accessibles à tous, les Manuels du MET n°10, Ministère de l'équipement et des transports, Namur (B)

[93] MINISTERE WALLON DE L'EQUIPEMENT ET DES TRANSPORTS (2007), Mobilité douce et déplacements quotidiens, Ministère de l'équipement et des transports / la Cemathèque n°22, Namur (B)

[94] MINISTERE DE L'INTERIEUR LUXEMBOURGEOIS (2004), Pour une mobilité alternative. Analyse et réflexions, Ministère de l'Intérieur. Aménagement communal et développement urbain, Grand-Duché de Luxembourg (L)

[95] MIRA PLAN, (2006) Mileurapport Vlanderen, achtergronddocument, Thema Stedelijk milieu. www.milieurapport.be.

[96] NARBONI (1995), La lumière urbaine, éclairer les espaces publics, Collection techniques de conception, Le Moniteur, Paris.

[97] NIKOLOPOULOU and STEEMERS (2000), Thermal comfort and psychological adaptation as a guide for designing urban spaces. In Proceedings of PLEA 2000. Cambridge.

[98] REGION NORD - PAS DE CALAIS : MISSION GESTION DIFFERENCIEE (2001). Mieux comprendre la gestion différenciée des espaces verts. Région Nord – Pas de Calais.

[99] MORMONT et al. (2006), La participation composante du développement durable : quatre études de cas. Revue électronique VertigO, Vol 7 n°2.

[100] NEWMAN and KENWORTHY (1999), Sustainability and cities – Overcoming automobile dependence, New York, Island Press.

[101] NIJS (1989), The Increase and Decrease of Traffic Noise-Levels at Intersections Measured with A Moving Microphone, Journal of Sound and Vibration. 131 (1989) 127-141.

[102] OBSERVATOIRE DE LA VILLE (2007), Les français et leur habitat, Perception de la densité et des formes d'habitat, principaux enseignements du sondage réalisé pour l'Observatoire de la Ville du 10 au 12 janvier 2007, Observatoire de la ville, Paris.

[103] OECD (2008), Guidelines for Multinational Enterprises.

[104] OGULLARI and DORATLI (2004), Measuring accessibility and utilization of public spaces in Famagusta, Cities, Vol 21, n°3, pp 225-233.

[105] ONU - COMMISSION MONDIALE SUR L'ENVIRONNEMENT ET LE DÉVELOPPEMENT (1987), Rapport de la Commission mondiale sur l'environnement et le développement de l'ONU présidée par Gro Harlem Bruntland, Nairobi/Genève.

[106] ONU-HABITAT (2010), State of the World's Cities 2010/2011 - Cities for All: Bridging the Urban Divide, rapport 2010/2011 de l'agence ONU-Habitat, ONU-Habitat.

[107] PAQUOT (2009), L'espace public, La Découverte, Paris pp 92-111.

[108] PASAOGULLARI and DORATLI (2004), Measuring accessibility and utilization of public spaces in Famagusta; Cities, Vol. 21, No. 3, p. 225–232.

[109] PAULEIT and KALISZUK (2005), An ecological approach to green structure planning - Green structure patterns. In WERQUIN et al. COST Action C11: Green structure and urban planning – Final repport. Office for Official Publications of the European Communities, Luxembourg, pp. 137-140.

[110] KOROSEC-SERFATY (1998), La sociabilité publique et ses territoires. Places et espaces publics urbains. Architecture Behavior., vol 4 n°2 pp 111-132.

[111] POLACK et al. (2008) Perceptive relevance of soundscape descriptors: a morpho-typological approach, In Procceedings of the Acoustics '08, 29th June - 4th July, 2008, Paris (2008)

[112] POUYANNE (2004), Des avantages comparatifs de la ville compacte à l'interaction forme urbaine-mobilité. Méthodologie, premiers résultats, Les cahiers Scientifiques du Transport N°45/2004, IERSO, IFReDE-GRES université Montesquieu – Bordeaux IV

[113] PUMAIN et al. (2006), Dictionnaire, la ville et l'urbain, Collection Villes, Economica, Anthropos, Paris.

[114] RAIMBAULT and DUBOIS (2005), Urban soundscapes: Experiences and knowledge, Cities. 22 (2005) 339-350.

[115] RANDALL (2008), Sustainable urban design an environmental approach, ed. Spon press.

[116] RAULIN (2007), Anthropologie urbaine, Armand colin, Paris pp 163-198.

[117] REGION WALLONNE, (-), Code wallon de l'aménagement du territoire, de l'urbanisme et du patrimoine. Articles 414 et 415 (B)

[118] REITER (2003), L'influence du microclimat sur le confort des piétons pour des espaces publics durables, mémoire de DEA, Architecture et Climat, Université catholique de Louvain, Louvain-la-Neuve, Belgium.

[119] REITER (2007), Elaboration d'outils méthodologiques et techniques d'aide à la conception d'ambiances urbaines de qualité pour favoriser le développement durable des villes, Thèse de doctorat, Architecture et Climat. Université Catholique de Louvain , Louvain-la-Neuve, Belgium.

[120] REMY and VOYE (1992), La ville vers une nouvelle définition, L'Harmattan. Paris.

[121] REYBURN (2002), le cadre de vie et les jardins potagers communautaires à Montréal. Vertigo, Vol 3 No 2 Revue en ligne.

[122] ROGERS PARTNERSHIP, (1996-2000), Masterplanning London. Urban task force, <www.rsh-p.com>, (GB)

[123] ROY (1985), Méthodologie multicritère d'aide à la décision, Economia, Paris.

[124] RUOCCO (1974), Background noise, Environmental Health.(1974) 6-11.

[125] RUROS (2002), Rediscovering the urban Realm and Open Spaces, Fifth framework Programme 1998-2002. co-financé par l'Union Européenne.

[126] SAATY (2000), Fundamentals of the Analytic Hierarchy Process, RWS Publications, Pittsburgh.

[127] SANTAMOURIS et al. (2001), Energy and climate in the urban built environment, ed : Santamouris, London, 2001.

[128] SCHAFER (1977) The tuning of the world, The Soundscape,(1977)

[129] SCHÄRLIG (1985), Décider sur plusieurs critères, panorama de l'aide à la décision multicritère, Presses polytechniques et universitaires romandes, Lausanne.

[130] SCHÄRLIG (1996), Pratiquer Electre et Prométhée : un complément à décider sur plusieurs critères, Presses polytechniques et universitaires romandes, Lausanne.

[131] SCHMITT et al. (2006), Réussir un projet d'urbanisme durable, ADEME, ed. Le Moniteur.

[132] SCHULTE-FORTKAMP and DUBOIS (2006), Recent advances in soundscape research - Preface, Acta Acustica United With Acustica. 92 (2006) V-VIII.

[133] SCHULTE-FORTKAMP and LERCHER (2003), The Importance of soundscape research for the assesment of noise annoyance at the level of community, In proc. of Techni Acustica, Bilbao.(2003)

[134] SEDJARI (2007), Les politiques de la ville: intégration urbaine et cohésion sociale, l'Harmattan, Paris.

[135] SEMIDOR (2006), Listening to a city with the soundwalk method, Acta Acustica United With Acustica. 92 (2006) 959-964.

[136] STEEMERS et al. (2004), Urban morphology, In: CEE, Designing Open Spaces in the Urban Environment: a bioclimatic approach, Centre for Renewable Energy Sources. Grèce.

[137] TEMPERIO et al. (2006), Is availability of public open space equitable across areas ? Health and Place 13.

[138] THEYS and EMELIANOFF (2001), Les contradictions de la ville durable, dans Le Débat, 113, 2001, pp.122-135.

[139] THOMAS (2005), Les trajectoires de l'accessibilité, A la croisée, Bernin,

[140] TIPLER (1995), Physics For Scientists and Engineers,(1995).

[141] TOPOZYM (2009) Mesurer le développement durable en Belgique : quel rôle pour le processus participatif ? Etude réalisée à la demande du conseil fédéral de développement durable, Belgique. Politique scientifique fédérale (2009)., Topozym, Dashboard aimed at decision-makers and citizens in place management, within Sustenable developpement principles.

[142] TOUSSAINT and ZIMMERMANN (2001), User, observer, programmer et fabriquer l'espace public, Presses Polytechniques et universitaires Romandes, Lausanne, 290 pages.

[143] UITP (2006), Le rôle du transport public dans la réduction du changement climatique et l'amélioration de l'efficacité énergétique, position sur le programme européen sur le changement climatique et le livret vert sur l'efficacité énergétique, European Union in http://www.uitp.com/eupolicy/

[144] URBAN TASK FORCE (1999), Towards an urban renaissance, London, Spon Press,

[145] VRANCKX (1967), Le calcul des réseaux d'égouts-Guide pour le calcul des conduites d'écoulement,éd. La Charte S.A.

[146] WIPLIER and GRAZIANI (2002), Jeu et détente. Prise en compte dans l'aménagement de l'espace public. CERTU, France.

[147] WORLD HEALTH ORGANIZATION (1999), Guidlines for Community Noise, www. who. int/peh.(1999)

[148] YU and KANG (2009), Modeling subjective evaluation of soundscape quality in urban open spaces: An artificial neural network approach, Journal of the Acoustical Society of America. 126 (2009) 1163-1174.

10. ANNEXES

ANNEX 1: COPY OF THE PUBLICATIONS
ANNEX 2: MINUTES OF THE FOLLOW-UP COMMITTEE MEETINGS

THE ANNEXES ARE AVAILABLE ON OUR WEBSITE

http://www.belspo.b/belspo/ssd/science/par_transversal_en.stm