Design of green spaces located below the urbanised level. Themes, problems and solutions applied to a case study

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Abstract

The design of green areas and landscape is often related to spaces with special features, which, due to their territorial peculiarities, require the adoption of appropriate design solutions. This category includes spaces located below the urbanised/street level (or on different levels), which may have various origins: areas derived from the regeneration of defensive ditches that, after having lost their original function, have become centres of urban aggregation (ancient city walls, castles moats); sites derived from the demolition of buildings or other structures; spaces created expressly sub-level as a result of design choices. This paper deals with some design issues concerning those places, in relation to orography, vegetation and the type of users expected. Moreover, the opinion of the population is taken into account to clearly define design choices; the issue is explored using special techniques to involve citizens in the design process, namely *focus groups* and surveys aimed at identifying their needs. The paper, finally, presents a design experience applied to a study area in the municipality of Abbiategrasso (Lombardy region, Italy) located under the urbanised level and currently used as urban park (the so-called *Fossa Viscontea*). This park (about 3.7 ha) occupies the area of the ancient defensive moat of the historical village (including the Visconti Castle - 13th century); design solutions are proposed for ensuring accessibility and fruition of this area such as leisure and aggregation centre.

Introduction

With reference to the design of sub-level green spaces the literature on the specific issue is very poor. In this section was investigated about the design themes particularly relevant to those areas, was then analysed the issue of the perception of sub-level spaces by an individual or a community of people, finally some design cases in various cities were described.

Design themes for sub-level green spaces

The following design themes can be considered, particularly significant to these spaces: connection with the urban area; width, difference in height and edges of the site; accessibility and paths; vegetation; micro-climatic conditions. As for *connection*, three different types of solutions can be considered: interventions *over*, allowing to overcome the sub-level space without entering it (for example, through elevated walkways); interventions *inside*, making it possible to cross the space after entering it (stairs or ramps); mixed interventions (Doronzo, 2003; Toccolini, 2015).

The width of the sublevel area characterises the activities and functions to be provided; limited widths not allow activities that require large spaces while an area developed in the longitudinal direction promotes fruition in motion; structures to play, socialise, walk and run can be realised (Jansson and Persson, 2010) but the morphology of the sub-level areas requires equipment with low visual impact, especially in historic sites (*e.g.*, ancient moat); the equipment height must not exceed the level difference, in order to maintain the landscape features and the perception of the place.

The ratio width of the area/height of the margins influences from the perceptual point of view, determining the sense of an open or closed space. According some authors (Greenbie, 1982; Motloch, 1991) in the case of ratio from 1:1 to 2:1 the space is perceived as closed. In the case of 3:1 ratio up to 4:1 one can speak of semi-open spaces; higher ratios characterise open spaces and allow views of the surrounding landscape. The edges of the area can be of different types: vertical, with a clear separation from the external environment; margins with terraces or wide steps ensuring more gradual separation; margins with natural slope and continuity with the surroundings (Lanzoni, 2006) (Figure 1).

As regards accessibility guidelines, they are the same as for any public space: guaranteeing accessibility and practicability to different types of users (pedestrians, cyclists, disabled) and creating a system of green areas, which can be accessed comfortably and safely by the population. The key problem is to overcome the height difference between the street and the green area; in addition to the stairs should be provided access ramps.

The possibility to reach the area from various districts of the city can be analysed through accessibility and proximity analysis implemented with geographical information systems (La Rosa, 2014; Reyes *et al.*, 2014).

As for *vegetation*, the choice of the plant component depends on the purpose to be achieved: enhancing elements of the site (historical buildings, monuments, places of significance) through rows of trees and groups of trees and shrubs (Booth, 1990; Arnold, 1992), improving the fruition of the place (shaded areas, noise barriers) through trees and hedges creating shade and comfort.

As for *microclimatic conditions*, in these contexts particular conditions may occur due to the morphology of the place: many shaded areas with high humidity, or zones with different temperatures (Erell *et al.*, 2011; LaGro, 2001). All those elements should be taken into account in the design choices.

Human perception of a place

This phase of the work analyses how an individual (or a community of people) perceives a given place, in particular a sub-level space.

The perception of a place is the ratio between: i) individual and space; ii) individual and other individuals; iii) individual and feeling of fear and security.

These three aspects certainly are related to the perception of an open space in general, but they are particularly significant in the case of green areas, where users seek features as the aesthetic quality of the landscape observed, relations with other people, a sense of well being and safety raised from the place. For sub-level green areas the particular morphology affects the visuals (often limited by scarps and gradients), the perception of space as *open* or *closed* (Greenbie, 1982; Motloch, 1991; Erell *et al*., 2011), and, in a positive way, the sense of safety and security.

Regarding the first point - the relationship between individual and space - the role of perspective and the three-dimensional vision of the human eye is very important.

The perception of a place is mainly due to three different types of perspective (Gibson, 1950): position, movement, atmospheric.

Perspective of position (related to distance and depth): it depends on the texture gradient; essentially the finer is the texture, the farthest objects and spaces are perceived, and vice versa.

Perspective of movement (related to moving objects), where speed is the key element; the speed of an object is perceived in relation to the distance between the object and the observer.

Atmospheric perspective, which depends on the weather of the context: the presence of fog or haze, for example, increases the perception of depth of a space.

Regarding the second point - the relationship between individuals - it is important to define relational spaces that are differentiated spaces where individuals can relate in different ways.

In this regard, four different types of relationship spaces can be identified (Lamure, 1982; Lynch and Hack, 1984): private spaces (within a distance of 0.50 m) for interactions between individuals through the five senses; personal spaces (between 0.50 and 1.20 m) for interactions through sight, hearing and touch; social spaces (between 1.20 and 3.60 m) for sometimes indirect interactions, mainly through sight and hearing; public spaces (over 3.60 m), for only indirect interactions.

Concerning point 3 - individual and feeling of fear and security - it is important to mention the *prospect-refuge* theory (Appleton, 1975). It describes the human-innate survival instinct, by applying it to the perception of a place (Bauman, 2005): a person must have control over the space around him, but at the same time he must be protected from the threats that space itself may contain.

Basically the individual, especially in urban areas, looks for places where he can relax without having to worry about what happens around him. However, in urban parks and green areas, it is often difficult to find places providing a sense of control and protection.

Figure 2A shows a *not prospect and not refuge* situation, because it

blocks a full view of the place (*not prospect*) and there is not any protective element (*not refuge*).

Figure 2B shows a *prospect but not refuge* situation, where a full view of the place can be enjoyed but there is not any protective element.

Figure 2C shows, on the other hand, a *prospect-refuge* situation, where the view and the protection are both guaranteed; the person stands near some trees (*refuge*) and he enjoys a full view of the open space (*prospect*).

The figures above show that the human perception of a place is a fundamental element in designing public open spaces. It is necessary
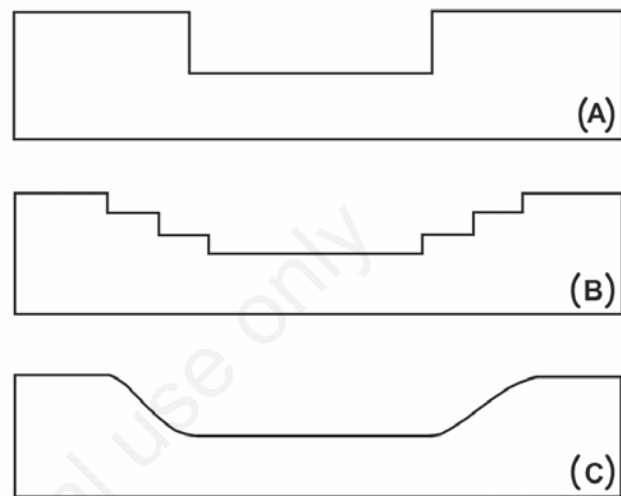

Figure 1. A) Vertical edges; B) margins with terraces or wide steps; C) margins with natural slope.
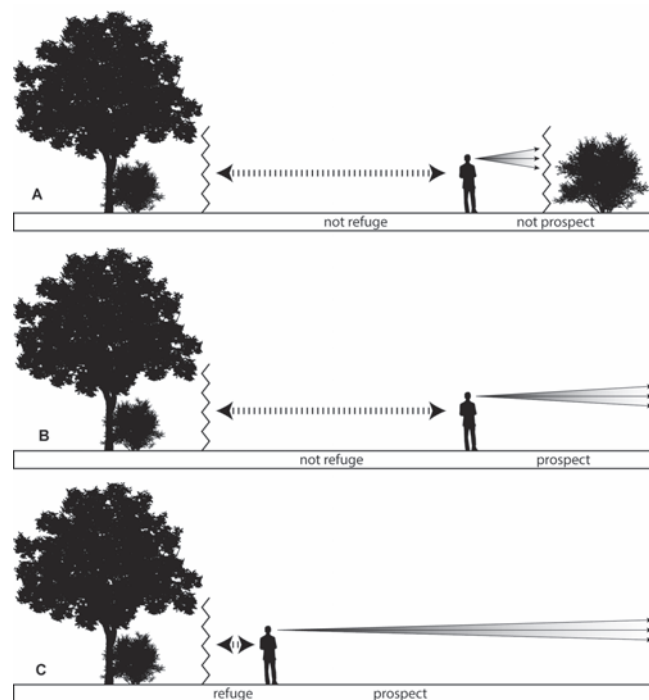

Figure 2. A) Not prospect and not refuge; B) prospect but not refuge; C) prospect and refuge.

to design gardens where the perspective has both an ornamental and a functional value, green spaces at different scales allowing relationships among people, safe places ensuring protection and visual quality.

Design cases

There are some cases of design on the topic of sub-level green spaces, with different solutions and functions assigned to the green area. Below are some examples.

The Thames Barrier Park is a London park located along the Thames near the docklands; designed by Alain Provost in 1995 on the location of a former chemical plant, it is located about 3 m below the urbanised level. It is a large garden with strips of vegetation whose colours vary depending on the season; margins are covered with climbing species in order to create a *green wall*; the internal paths, open only to pedestrians, are made of permeable materials; footbridges allow to cross the park from above (Fazio, 2002).

The Bishan Park is a large river park in Singapore, located between two densely populated districts. The project, started in the 1980s, is an example of integration between functions and different objectives: making the area available as an urban park and creating a habitat in an urban context by increasing the biodiversity of the area. The main interventions were: denaturalisation of the river; greening of banks and edges; inclusion of compatible functions; construction of bridges and walkways for crossing the former river bed (Rinaldi, 2013).

The Promenade Plantée is a green space in Paris (XII arrondissement) used as a city walk and urban park. It was built on the former tracks of an old railway line according to a project drawn up in 1988 by landscape architects Jacques Vergely and Philippe Mathieu. Along its way the Promenade Plantée passes through an area below the street level, which has been turned into an urban park with lawns and shrubs on the embankments. There are footbridges for connection (Furlani Pedoja, 2000).

The Jardi del Turia is a green area in the Valencia historic city centre. It stands on the ancient bed of the river Turia, which was diverted to avoid the continual floods. The design of the park by architect and urbanist Ricardo Bofill takes inspiration from the neoclassical garden with regular shapes, use of water, hedges, pedestrian and cycle paths. There are also playgrounds, a skate park, children's play areas, fountains and pools, exhibition areas and, finally, the *Ciutat de les Arts i les Ciències* by architect Santiago Calatrava (Lanzoni, 2006).

Materials and methods

The study was applied to an area in the municipality of Abbiategrasso (Lombardy region, Italy) located under the urbanised level and currently used as an urban park.

The park (about 3.7 ha) occupies the area of the ancient defensive moat of the historical village (including the Visconti Castle - 13th century), the so-called *Fossa Viscontea*, and is divided into two areas separated by a city street: *Parco della Costituzione* (west) and *Parco della Repubblica* (east) (Figure 3).

The main reason that led to the definition of the proposal is the need to implement an organic plan (avoiding partial actions) able to improve
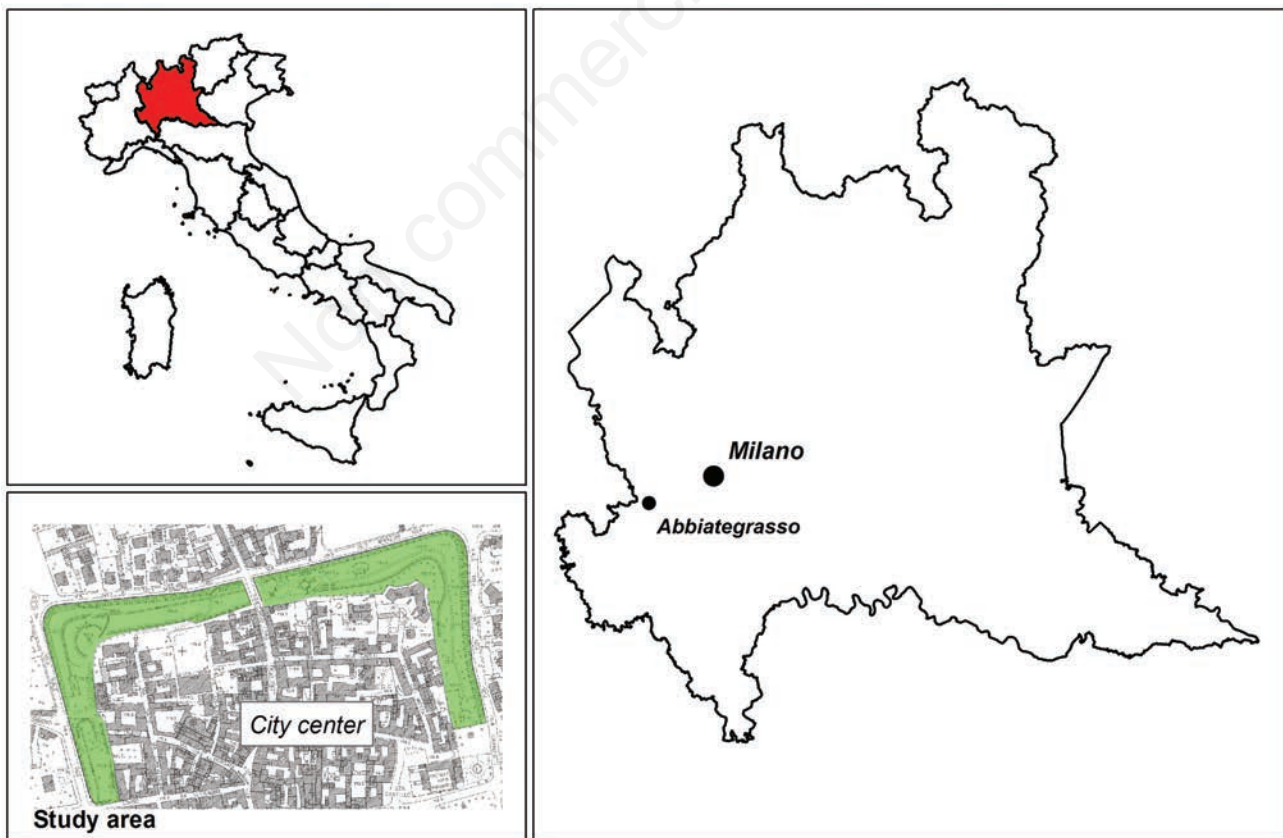

Figure 3. Study area.

the fruition by citizens through the enhancement of the area.

The study was divided into three steps (Beer and Higgings, 2000): i) site analysis; ii) users analysis; iii) concept plan definition.

Site analysis

This step includes an analysis of the characteristics of the study area: territorial context, accesses to the area, morphological characteristics, climate, type of soil, land use and vegetation.

Context analysis has identified elements of historical and architectural interest, public utilities, roads system to reach the park. The main morphological features of the site were analysed through a topographic survey with total station; in particular the differences between the moat and the surrounding area. Some dimensional characteristics of the moat are: i) surface: 3.68 ha; ii) average width: 24 m (max 27; min 21); iii) medium gradient between moat and street level: 2.9 m (max 3.7; min 2.1).

The main points and existing buildings characterising the park, in terms of functions and visual impact on landscape, and accesses were also analysed, by evaluating the functionality and usability by different types of users.

A climatic analysis of the context where the study area is included was performed by using temperature data, rainfall, fog, humidity and winds recorded in the Milan Linate airport station, covering the period 1971-2000; about microclimatic conditions, in absence of official data collected in the site it was carried out a qualitative assessment also based on the discussion in the focus group (see user analysis). Shade analysis was made using software to simulate shadow projections on different days and hours.

A direct survey of plant species in the park was made in order to obtain an inventory of trees and shrubs species present and identify trees with problems. Analysis of vegetation revealed the existence of several species of trees and shrubs (with a prevalence of *Celtis australis L.*) many of which autochthonous (*e.g.*, *Tilia cordata, Corylus avellana, Carpinus betulus*) other appropriate to ensure the consolidation of the escarpments (*e.g.*, *Quercus cerris, Robinia pseudoacacia*) and in a good plant health status.

The plant health status was assessed at this stage via visual analysis (evaluation of the foliage, presence of dead branches, fungi, liquids, lesions on the trunk) in order to identify dangerous situations (to evaluate in depth with instrumental analysis) with eventual substitution to be provided in the design phase.

Users analysis

This step was aimed at understanding how users perceive and live the existing park, and above all how it could be enhanced in the future. This preliminary analysis has played a key role in the design phase because it has identified the users' requirements and it has allowed us to understand how the population interacts with the project themes.

There are various techniques to investigate users' needs (Jansson and Persson, 2010; Thompson *et al.*, 2011; Hofmann *et al.*, 2012); this study was carried out through the creation of a focus group and the preparation of a questionnaire to be submitted to users.

A focus group consists of some people selected on the basis of age, social background, qualification, skill, *etc.*, who are called to discuss and exchange views on a specific theme (Stewart and Shamdasani, 1990; Bloor *et al*., 2002; Zammuner, 2003; Albanesi, 2004; Acocella, 2008). It is a technique used to involve people in policy decisions about land use (Scott, 2011) and more generally about landscape planning and design. In this study was formed only a focus group composed of 12 people (7 men and 5 women) 9 residents in Abbiategrasso, 3 non-residents, all users of the area. The participants were aged between 18 and 40 years. Some members have experience in the fields of green areas/landscape design (architects, students), others do not have a specific competence in the matter

Table 1. Questionnaire.

Questionnaire
1. How many times a week do you go to the park? ……………
2. Which days of the week do you go to the park? □ weekend □ working days □ both
3. In which part of the day do you go to the park? □ morning □ afternoon □ evening
4. Do you go to the park throughout the year? □ yes □ not
5. In which period of the year do you prefer going to the park? □ summer □ spring □ autumn □ winter
6. Why do you go to the park? □ sport □ relax □ take kids to play □ meet people □ transit
7. How long does it take you to go to the park? □ more than 10 minutes □ 5-10 minutes □ less than 5 minutes
8. How do you usually go to the park? □ on foot □ by bike □ by car
9. How long do you usually stay at the park? □ more than 3 hours □ 2-3 hours □ 1-2 hours □ less than 1 hour
10. Do you think that garden furniture and facilities in the park are adequate? □ no □ yes
11. Which aspect of the park do you appreciate? □ safety □ vegetation □ proximity to home □ play facilities and garden furniture □ other…………………
12. Do you perceive the park as an ancient defensive moat? □ no □ yes
13. Which improvements would you make to the park? □ more safety □ improve the quality of vegetation □ better accessibility □ more facilities and garden furniture
14. Which facilities and structures would you add to the park? □ benches □ waste bins □ drinking fountains □ tables □ play equipment for children
15. What other functions and activities would you add to the park? ……………………………………………………………

and carry out various professions; some of them belong to local cultural and volunteer associations, in order to have in the focus group different social categories.

The group was formed by contacting several people frequent users of the park; the authors have subsequently selected the final components.

The focus group discussed the issues related to the design of sub-level spaces, and the specific case of the study area. In particular, the following issues were discussed: connection with the city (edges, accessibility and paths), activities to be provided in the site, vegetation and microclimate.

Regarding the connection with the city, the focus group made very interesting remarks, which were unpredictable for us: first the area was seen as part of the urban fabric, and not as an element of break or discontinuity; then, the presence of a height difference was considered as a positive element; finally, accessibility for the focus group was a fundamental requirement. About the activities planned in the area, the focus groups identified: play activities for children, sports, recreational activities for seniors, relaxation, cultural initiatives. The necessary equipment should be compatible in shape, size and material with the characteristics of the place.

The vegetation already present was considered as optimal in terms of quantity and quality, even though some actions were required on the trees in poor plant health, in addition to the use of suitable species in certain places (*e.g.*, on the slopes). As regards microclimate, the focus was placed on the high humidity in summer and the presence of very hot areas for lack of shade. Therefore, it was advisable not to use water as a decorative element in the park and to avoid the creation of ponds and fountains (also to prevent the proliferation of mosquitoes). Another method to identify users' preferences is based on questionnaires (Whyte, 2001; Wright Wendel *et al.*, 2012). Through this tool, we tried to understand what kind of problems people felt in the area and what were the possible actions.

These questionnaires were delivered to 37 people, frequent users of the area (people that use the park more than 2-3 days a week) of different ages and gender, and consisted of 15 questions about frequency of use, hours of the day, time to reach the park, vehicle used, positive and negative elements, equipment to be added, problems and solutions (Table 1). Questionnaires were delivered and explained at the site and subsequently picked up. According to a series of observations in four days (two working days and weekend) it was estimated the attendance in the park of about 150-200 persons/day (working days) and 450-500 persons/day (weekend), concentrated mainly in the east zone. It is considered that the sample interviewed can be considered consistent with the objectives of the study and representative of frequent users. In particular the sample was composed of 6 people between 8 and 14 years; 13 in the range 15-29; 10 in the range 30-65; 8 over 65.

The answers concerning problems and possible solutions are shown in Tables 2 and 3. In particular children (up to 14 years) pay special attention to the play areas; young (15-29 years) are interested in the spaces for practicing sport, as well as in the quality of places; adults (30-65 years) pay great attention to the condition of the site, maintenance and difficulty of access; seniors (over 65 years) pay great attention to maintenance and degradation as adults do, but they also require appropriate activities and functions. Finally, the movement of users in the park was analysed through observations aimed at understanding the flows of people, the directions of movement, the accesses used and the number of people entering them, the most used paths, and the most frequented places. In particular, landmarks attracting people and less frequented areas were identified to enhance thorough design choices. Also this information was detected during the series of direct observations in the same four days at the entrances and inside the park.

Concept plan

This phase of the study aims at summarising what emerged from the previous analyses (site analysis and users analysis), identifying peculiar characteristics concerning the morphology of the site, the perceptions of the place by the population and the use habits.

The site analysis showed strengths - namely elements already present that can help to increase the use of the park - and critical aspects, that are elements which currently cause problems in the park or are not fully enjoyed and abandoned. The users analysis highlighted the activities and facilities that can be realised in the park, also in the future, as required by the population.

Table 4 shows in summary: main activities to be provided, requests for their location (also taking into account the place morphology), interconnected activities and possible conflicts, potential areas where the activities can be located.

The next step was to set up the concept plan (Toccolini, 2015), that is the schematic diagram of the design choices and localisation of the different activities (Figure 4).

Results

For each functional area defined in the concept plan, design solutions are provided allowing on the one hand a complete space perception (prospect-refuge theory) and on the other hand an effective use of the

Table 2. Problems reported by interviewees.

Problems	Age			
	6-14	15-29	30-65	>65
Poor play equipment for children	X			
Not appropriate flooring	X	X		
Unused playgrounds		X		
Low maintenance		X	X	
Limited activities		X	X	X
Lack of distinctive signs and landmarks		X	X	
Damaged paths			X	X
Evening closure			X	X
Absence of illumination			X	X
Difficult access for some users			X	X
Lack of garden furniture				X

Table 3. Solutions proposed by interviewees.

Solutions proposed	Age			
	6-14	15-29	30-65	>65
Play equipment for children	X			
New playgrounds	X	X	X	
Pavement for existing playgrounds	X			
Maintenance	X	X	X	X
Continuous between the two zones		X	X	
New garden furniture				X
Evening opening and illumination		X	X	X
New activities		X	X	X
Access ramps or elevators			X	X
New paths, maintenance of existing			X	X
Distinctive signs and landmarks		X		
Edible gardens			X	X
Structures and activities for seniors				X

place, ensuring the connection to the external spaces and the creation of proper functions, facilities, vegetation.

The master plan is shown in Figure 5. In detail, the main actions proposed are the following.

Rest areas

Target: create areas for relaxation and resting allowing both refuge and prospect on the site.

How: construction of two rest areas with semi-circular shape and stone paving; insertion of garden furniture and vegetation for ensuring shading; remodelling of the escarpment using wide steps with flowers (Figure 6).

Cultural space

Target: create an open space for cultural events and exhibitions, aiming at enhancing the existing tower building (*Torretta*) in state of severe degradation.

How: refurbishment of the three floors of the tower and conversion into an info-service park point and literary cafe; flooring of outdoor spaces; addition of pots with flowers and shrubs.

Playgrounds

Target: create an area for sport activities.

How: construction of two fenced playgrounds (basketball court, acrylic-resin paved, and football pitch, artificial-grass paved) (Figures 7 and 8); possible realisation of a refreshment area (bar).

Recreational area for seniors

Target: create an area dedicated specifically to elderly people, allowing socialisation and recreational activities.

How: construction of two playgrounds (*bowls*) and a covered area with benches and tables where meetings and other activities can be organised (Figures 9 and 10); orchard.

Play area for children

Target: create a playground for children, with facilities enabling socialisation, properly paved, controllable and safe.

How: construction of a fenced area, with anti-shock rubber paving and addition of a modular wooden play structure and garden furniture.

Terraces

Target: visually connect the city to the park.

How: construction of six terraces at the street level, placed on the escarpment, with stone paving (size 2x5 m).

Footbridges

Target: connect parts of the city physically separated from the park, improve access to the old town and ensure visual connection between the city and the park.

How: construction of two footbridges (also accessible to bicycles) (Figure 8).

Main entrances

Target: ensure accessibility to all different kinds of users.

How: Realisation of two entrance areas in Piazza Cavour and Piazza Castello with slight slope, stone paved and addition of trees and benches; elimination of metal stairs and steps from the current entrances.

Table 4. Planned activities and potential suitable areas.

| Activities	Location requests	Connected activities	Contrasts	Potential areas
Activities for children (fun, playing)	- Shaded area - Visible area - Distant from access points	- Sport - Recreational activities for seniors - Walk, relax	- Cultural activities - Access	Central area near the slope in *Parco della Repubblica*, to ensure protection and control (1 in Figure 4)
Sport	- Shaded area - Visible area - Flat ground	- Activities for children - Walk, relax - Access	- Recreational activities for seniors - Cultural activities	Central area near the slope and access point from *Parco della Costituzione*, to ensure shading and protection (2 in Figure 4)
Walk-relax	- Shaded area - Area sheltered from the rain	- Activities for children - Sport - Recreational activities for seniors - Cultural activities	- Access	Main path (pedestrian and cycle), secondary path (pedestrian) on the top of the escarpment, meadows and wooded areas (3a/3b in Figure 4)
Recreational activities for seniors	- Shaded area - Area sheltered from the rain - Visible area	- Activities for children - Walk, relax - Cultural activities - Access	- Sport	Area near the slope and access points from *Parco della Repubblica*, to ensure shading and protection; proximity to area for children (4 in Figure 4)
Cultural activities	- Shaded area - Area sheltered from the rain - Visible area	- Recreational activities for seniors - Walk, relax - Access	- Activities for children - Sport	Central area *Torretta* in *Parco della Costituzione*, near an access point (5 in Figure 4)
Entrances	- At street level - Visible area - Proximity to external frequented places	- Sport - Recreational activities for seniors - Cultural activities	- Activities for children - Walk, relax	Main access point at the opposite ends of the park (p.za Castello, p.za Cavour), secondary access point close to external frequented places (6a/6b in Figure 4)
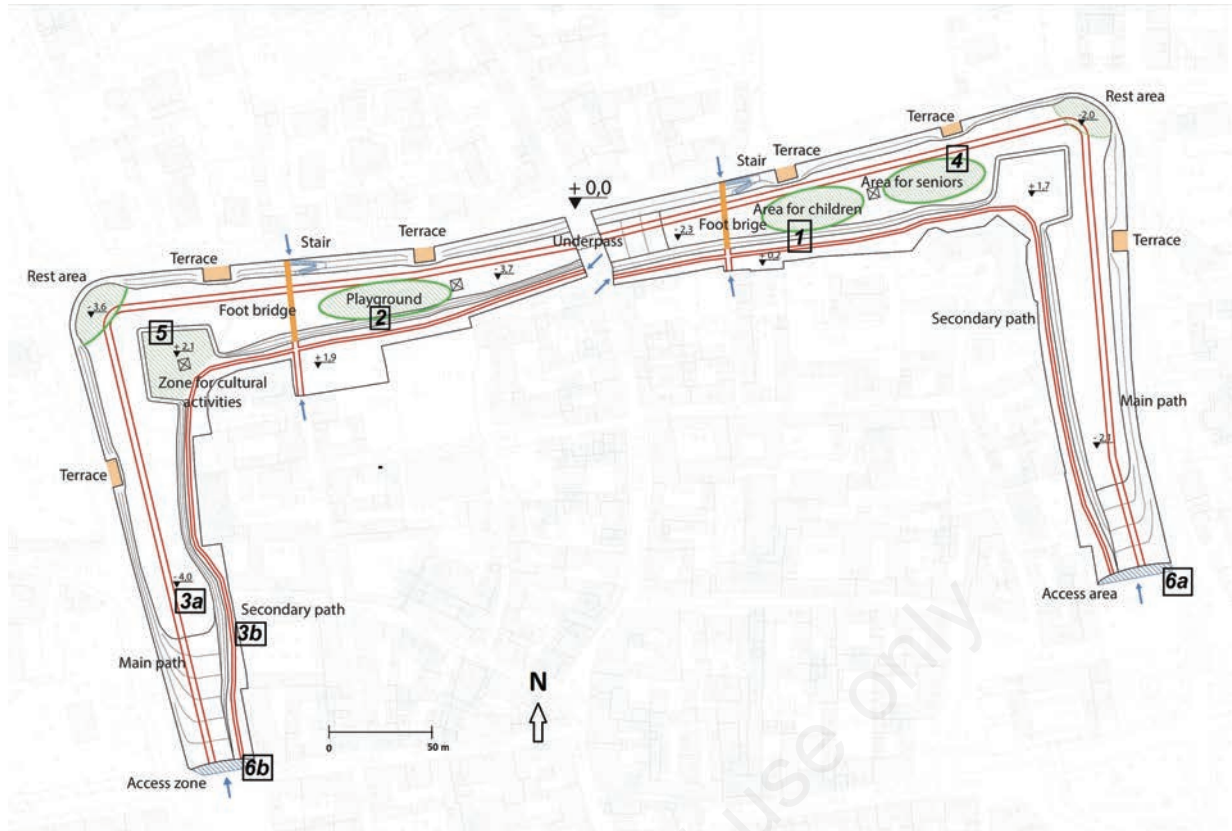
Figure 4. Concept plan.

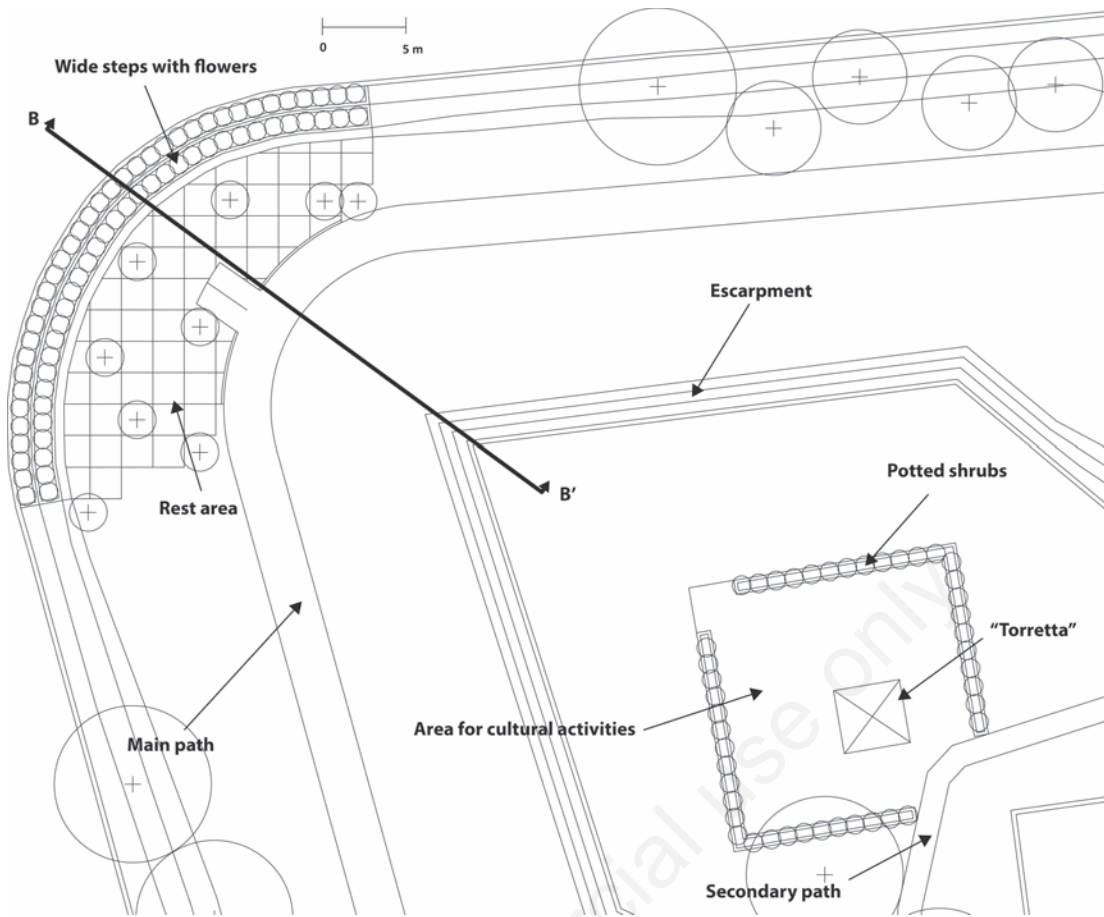**Figure 5. Master plan.**

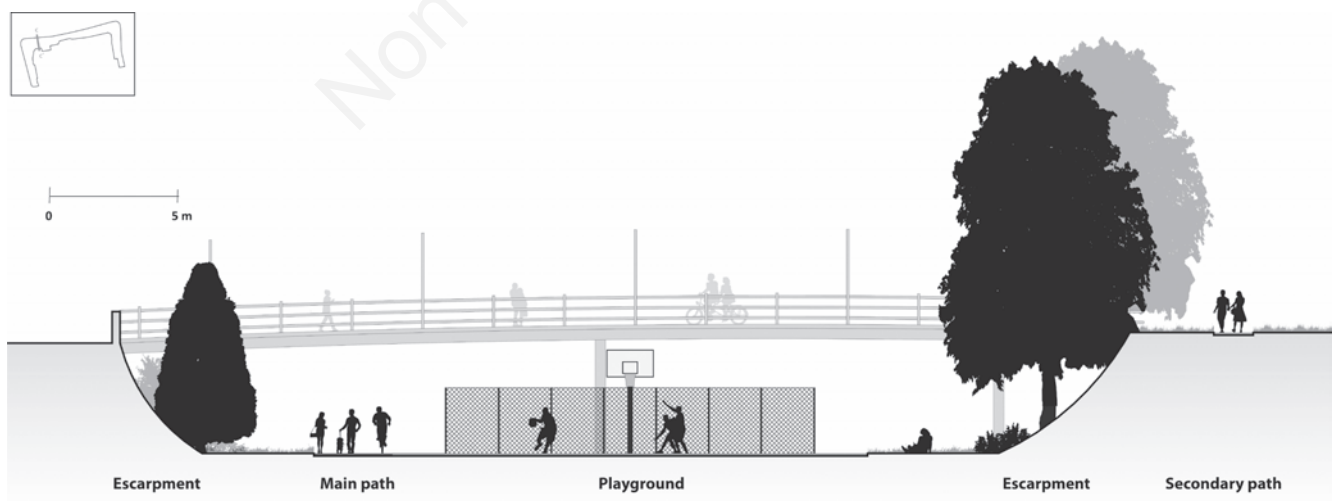**Figure 6. Rest area (plan view).**

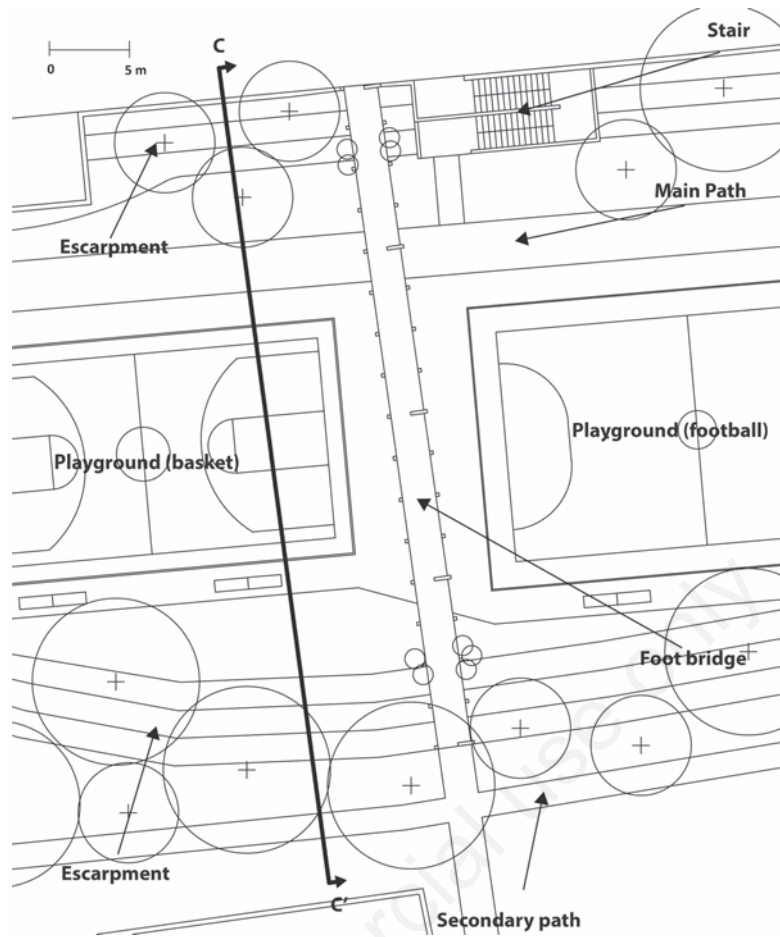**Figure 7. Playgrounds area (section view).**

Figure 8. Playgrounds area (plan view).

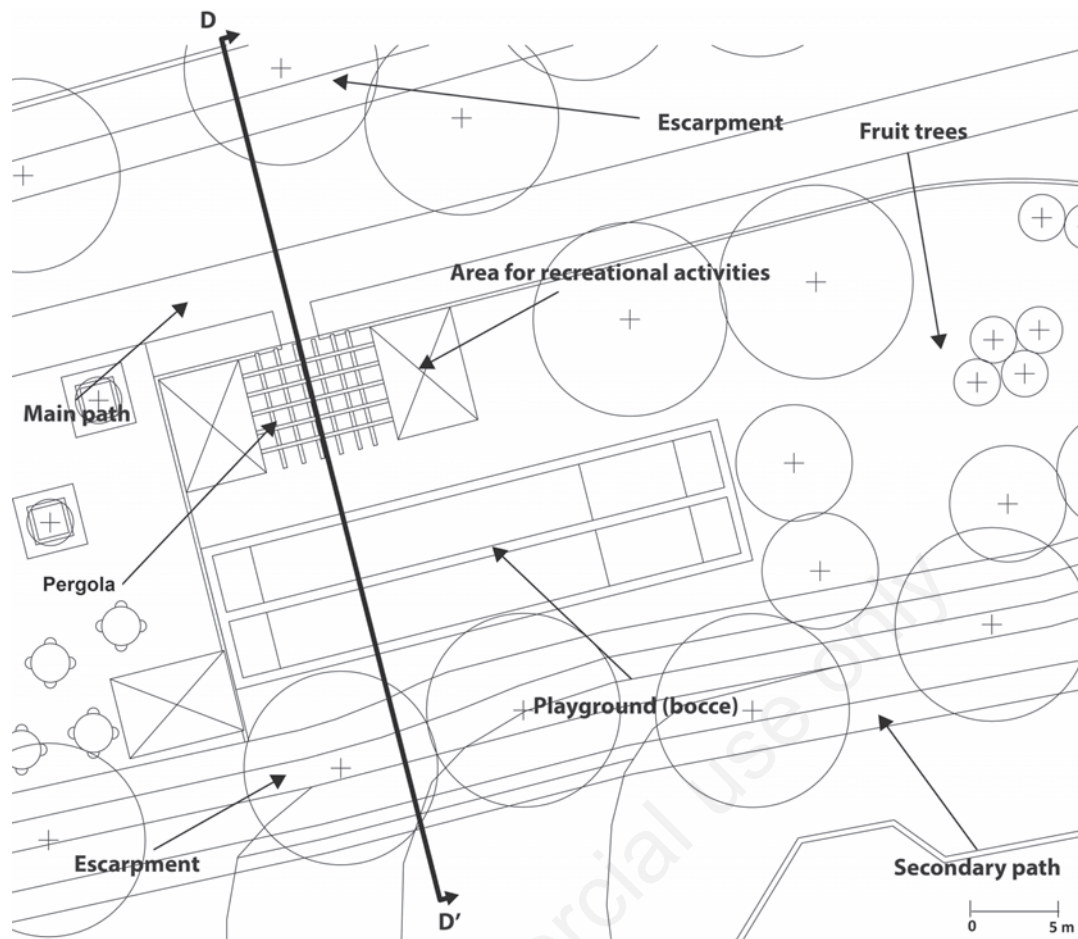Figure 9. Recreational area (section view).

Figure 10. Recreational area (plan view).

Paths

Target: ensure routes for pedestrians and cyclists in the park, and improve existing paths.

How: construction of a main pedestrian and cycle path located in the moat, 3 m-wide and coloured asphalt paving; realisation of a secondary pedestrian path placed on top of the escarpment, 1.5 m-wide and stabilised earth paving; evaluation of the technical feasibility of the construction of an underpass connecting the two parts of the study area.

Conclusions

The study has identified some issues, which require particular attention during design process. These themes include: connection with the urban context related to the difference in height, accessibility, historical restoration, possible functions and activities, suitable vegetation. In particular can be formulated some guidelines, with general validity, for the design of sublevel green spaces: i) create visual connection between the city and the area using footbridges and terraces in order to ensure the top view; ii) valorise escarpments and vegetation as visual background elements in order to give adequate depth to the space; iii) allow accessibility to all types of users through access ramps; iv) realise well-positioned rest areas, so as to create prospect-refuge situations, with the possibility to control the place and to be protected by the escarpment and vegetation at the same time; v) use appropriate vegetation to ensure the consolidation of escarpments; vi) avoid using water as design and decorative element, especially in areas particularly closed, wet and poorly sunny; vii) create simple paths in order to ensure a viable, easy and safe crossing to all users; viii) provide different functions and activities according to various ages and types of users, for the full enjoyment of the place.

In conclusion, morphological elements (escarpments, slopes, margins), vegetation, buildings, furniture, structures and facilities (playgrounds, sport courts) should all be integrated into the project not only as components of the place, but also as functional elements to be combined in order to ensure well-being and enjoyment to users. Providing various views (from above and below, inside and outside), creating different relational spaces, ensuring prospect-refuge situations are all purposes that can be achieved through careful design choices.

Regarding the specific case study the design choices are based on the need to consider the place not only as a historical site to be preserved, but also as an urban park, with different functions for different kinds of citizens. In this context it is therefore necessary to provide, within the design of the urban park, restoration and enhancement of the historical elements. It is considered that the design choices described above can revitalise the area in terms of enjoyment and as a centre for the promotion of cultural and recreational activities.

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