Greening potential of derelict and vacant lands in urban areas

Patricia Mara Sanches [*,1], Paulo Renato Mesquista Pellegrino

Landscape and Environmental - Design Department, Faculty of Architecture and Urbanism, University of São Paulo, Brazil

1. Introduction

The creation and acquisition of new green spaces are significant challenges for large cities, mainly in developing countries. Land value is extremely high in city centers, which are usually densely populated and have large impermeable surfaces. At the same time, in suburbs, the few natural open spaces, forests, and remaining rural areas are being lost due to urban sprawl, where there is a high demand for new settlements (Grimski and Ferber, 2001).

Although these two situations are in different urban contexts, both are facing the same problem: the lack of green spaces. City centers and outskirts have the highest demand for green spaces not only for social purposes (leisure and recreation), but also to minimize environmental impacts and increase ecological connectivity (Sanches, 2011). Due to the challenge of acquiring new green spaces in cities, this research addresses the conversion of derelict and vacant land into green spaces as one of the most advantageous and smart landscape planning strategies to solve the green space shortage.

Nowadays, any medium or large urban area sustain examples of degradation and urban voids due to several reasons in the urban-ization historic process. These lands are defined as any empty, abandoned or underused space that has lost its value in economic, social, and environmental aspects. This means that it is neglected and excluded from investments. These areas are very vulnerable to being used for marginal activities, in particular, crime and violence. They are also vulnerable to illegal settlements being established, in addition, the local community has no connection or sense of ownership to the place. Finally, their biophysical and chemical characteristics are damaged and ecological processes modified, due to the loss of flora and fauna, pollution and contamination, or erosion and silting up (Sanches, 2011).

Considering the scenario of big cities or metropolitan regions in developing countries, where social inequality and exclusion are challenging, the greening derelict and vacant land approach becomes a suitable opportunity to reduce crime and social tensions. In addition, the social role of green spaces is crucial to enhance the quality of life, leisure, recreation and social cohesion both in the central zones and on the outskirts of the city.

Besides the recognizable and valuable environmental services that green spaces provide, such as minimizing flooding, erosion, and silting up, as well as regulating humidity and microclimate, the cities could increase biodiversity, with more green corridors, parks, and protected areas while urban citizens would have more opportunities to be in touch with the natural landscape (Sousa, 2003; Herbst and Herbst, 2006; Moffat and Hutchings, 2007.)

Greening derelict and vacant lands can be seen as an offensive planning strategy when taking remedial or restorative actions (like ecological restoration, bioremediation, and daylighted river)

* Corresponding author at: Rua do Lago, 876 - Cidade Universitária Butantã, São Paulo, SP 05508-900, Brazil.
E-mail addresses: patricia.msanches@uol.com.br (P.M. Sanches), prmpelle@usp.br (P.R.M. Pellegrino).
[1] Present address: Rua Dr. Edgar de Sousa, 1142 ap 61 Vila Matilde, São Paulo, SP 03502-010, Brazil.

to reintroduce abiotic and biotic functions. However, in some cases, it can be seen as an opportunistic strategy, recognizing the potential of the underused landscape to be managed or structured differently to provide specific functions, such as greenways or pedestrian and cycle paths (Ahern, 2007).

To apply the greening vacant and derelict land strategy, this work assumes that new green spaces should be part of an urban green infrastructure, which means providing and improving the infrastructural functions, such as mobility, stormwater system, ecological networking and social issues related to recreation and leisure (Pellegrino, 2006).

Greening derelict and vacant land is not a new landscape planning strategy since the literature shows local practice in numerous cities worldwide, mainly in cities of United States, Canada, United Kingdom and Germany, (IEDC, 2001; Sousa, 2003, 2004, 2006; Wagner, 2002; Siikamäki and Wernstedt, 2008; Doick et al., 2009; Harnik, 2010; Sanches, 2014). Nevertheless, the most common practice is still the reclamation for other land uses rather than green spaces, despite the unquestionable great benefits of greening derelict and vacant lands (Sousa, 2003).

Specific funds that focus on brownfields redevelopment prioritizes the support of profitable projects whose end uses result in direct income to the government, from tax revenues, such as residential, retail and offices. (Siikamäki and Wernstedt, 2008; IEDC, 2001; Sousa, 2003; The Scottish Government, 2015). However, some lands with a high and unique potential to be converted into green space aren't easily identified. Therefore, methods and multicriteria tools to evaluate them are fundamental to support public policies and priority for funding decisions.

Although the methods regarding green space acquisition, assessment and related subjects have an important role in the consolidation of the discussion on the potential of derelict and vacant lands (Thrall et al., 1988; Herzele and Van Wiedemann, 2003; URGE, 2004; ParkScore Index;.[2] Natural England, 2003; Greenspace Scotland, 2008; Los Angeles City, 2007), methods that measure specifically the greening potential are scarce (Peintinger, 1988; Freeman, 1997; Tara and Zimmermann, 1997; Herbst and Herbst, 2006; Newlands Programme, 2003; Staples, 2006).

The criteria of Peintinger's and Tara and Zimmermann's methods focus only on the ecological aspects of sites Herbst and Herbst (2006), while Freeman focuses just on sites that are naturally regenerating.

Herbst and Herbst (2006) is one of the few that works with GIS (Geographic Information System) in the evaluation and presents a wider range of aspects. Herbst' criteria comprise the "Potential for experience nature" which is related to size, surface sealing, diversity of successional stages, diversity structure and water features of derelict and vacant lands; "Usability of site" regarding accessibility and safety; "Potential users of site" which analyze the population density around the derelict land and the proximity to schools and bike paths, and "Importance of site in green space strategy" to assess if the site is located in wildlife deficiency zone or are important to green space network. Although this method evaluates wastelands as urban wildlife areas so that people may experience nature, it doesn't address the social vulnerability issue to prioritize most deprived people to access green spaces, since there are many cities with high social inequality.

Staples (2006) presents criteria related to proximity from derelict or vacant land to residential properties and schools as Herbst and Herbst (2006) does, but he also set parameters to measure transport links, deprivation areas and criteria regarding to

current uses, ownership and potential contamination that could influence on the economic viability, which make his focus much more socioeconomic rather than ecological.

Finally, Newlands Programme (2003), from United Kingdom, seems to have one of the most complete evaluation GIS tool of reclaiming brownfields. It addresses environmental, social and economic aspects, like proximity to employment areas and local house prices. If in one hand, it presents a more complete method, in other hand, it requires a wide range of dataset from different agencies and governmental departments, which make the evaluation process slower and more difficult. It was developed to be run specifically across England's Northwest lands, and the purpose is transforming those sites into community woodlands, therefore, the end use and the scale intervention are very specific.

The main objective of this paper is to propose a more complete, easy and unique methodological tool with the use of GIS to assess the greening potential of derelict and vacant urban land, considering a wide range of sizes and green spaces purposes as end use, from a woodlands to small public gardens. It intends to cover a wide range of criteria that reflect the complexity of the city, particularly in developing countries, and consider environmental, ecological, social and economic aspects related to the existing local urban structure to create more livable and vibrant places.

1.1. Case study

The case study to apply this strategy is part of São Bernardo do Campo, located in the metropolitan region of São Paulo, Brazil, (Figs. 1 and 2), which is also experiencing a process of deindustrialization. The few urban green spaces accessible to the community are increasingly scarce while there are several empty and apparently abandoned areas, which many of them are regenerating by natural succession.

As water systems have a strong correlation with green spaces, watersheds are considered a basic unit of environmental planning. Therefore, the case study of this research comprises of the Tamanduateí watershed within São Bernardo do Campo, as shown in Fig. 1, outlined by the yellow line. This part of the city was chosen due to following reasons:

- It represents the major portion of the urban land (around 74%), and most of the people of São Bernardo do Campo live there;
- The environmental concerns of the municipality are focused mostly on the Billings watershed and reservoir; therefore, there are a lack of policies and projects to improve the environmental quality of the Tamanduateí Watershed;
- The urban area represents only 30% of the territory since 55% are legally protected areas, of which 30% are forests that belong to the Parque Estadual da Serra do Mar. The urban and rural landscapes are completely different, and the landscape changes very abruptly from urban to rural. The urban matrix is very hostile and impermeable and needs to be better connected to its natural landscape;
- Although São Bernardo has extensive areas of forest that protect even the Billings water reservoir (represents 70.8% of the municipal area), they are not accessible for recreation and leisure. There is a shortage of accessible green spaces (parks and gardens) in the urban zone considering the large population. The total public green spaces represent 2.5% of the studied area, equivalent to 2.66 m^2 of parks and squares per inhabitant.
- There is an extensive forest, which is a protected area in the rural zone (south and southeast of São Bernardo do Campo) located approximately 8 Km from the city center and that could assist the ecological restoration of vacant and derelict land that form part of this case study (see Fig. 1);

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[2] ParkScore is a comprehensive rating system to measure how well the 75 most populous U.S. cities are meeting their residents' need for parks. See: http://parkscore.tpl.org/