A MONITORING SYSTEM PROPOSAL FOR URBAN PARKS IN VALLEY BOTTOMS[1]

LARISSA FERNANDA VIEIRA MARTINS[2]
LUIS ANTONIO BITTAR VENTURI[3]
GIOVANNA BELEM WINGTER[4]

Introduction

Urban parks are geographically delimited spaces where arboreal-shrub vegetation is predominant and which have esthetic, ecological, leisure and recreational functions. Such spaces represent the main areas for leisure activities in the open air and the conservation of cities' environmental systems (KLIASS, 1993; SOLECKI; WECH, 1995; SORENSEN et al., 1998; ALVAREZ, 2004; OLIVEIRA, 2007). To perform those functions the parks are endowed with aspects of a material nature (benches, sports courts, picnic areas, toilets, etc.), in addition to their natural elements (vegetation, lakes, contact with animals, weather conditions) and other parameters of an immaterial nature (controls, feelings, emotions, conflicts and collective social images and identities (NUNES JÚNIOR, 2011).

To ensure environmental quality, to minimize problems associated to anthropization and the natural environment and to clearly identify the performance of each of the urban agents that interact in the composition of urban parks, it is necessary to have a base of solid, reliable information obtained through conducting continuous evaluation and monitoring (COSTA, 2011).

It is apparent, therefore, that the absence of monitoring can jeopardize the uses and functions of parks. Monitoring consists of continual systematized accompaniment by park administrators and it should provide information to foster the adoption of corrective measures and operational optimization (VAITSMAN; RODRIGUES; PAES-SOUSA, 2003).

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2. D.Sc. in Physical Geography from the University of Sao Paulo (USP), lecturer at the Nove de Julho University. larissafernanda@usp.br

3. D.Sc. (Physical Geography) from the University of São Paulo (USP). Chair Professor at the Geography Department of the USP. luisgeo@usp.br

4. B.Sc. in Biological Science from the Júlio de Mesquita FilhoPaulista State University (UNESP). giovannawingter@gmail.com

Monitoring processes require indicators as they are the primordial instruments for accompaniment. They, in turn, must be subjected to an integrated analysis to identify the quality of the urban park environments. It is rare, however, to come across studies focused primarily on methodological propositions for integrated analysis.

Research studies addressing the subject of urban parks usually either involve analyses of the vegetation or of the fauna as, for example, those conducted by Souza (2011), Nascimento (2005), Biondi and Muller (2013), or analyses of park users' environmental perceptions and the uses they make of the park, as in Reis (2001), Silva (2003), Teixeira (2007), Coradini (2008), and Alves and Raimundo (2009). However it is worth highlighting the following studies directed at investigating park administration aspects:

Holmes (2008) developed certain ecological risk indicators based on a Pressure-State-Impact-Response model with the aim of fostering good urban park management. The indicators created were: area with sealed soil surface, area with eroded soil, area with contaminated soil and the quality of surface waters. Those indicators were tested in parks in Brazil's Federal District.

Oliveira (2007) proposed a system of park monitoring indicators using a Pressure –State-Response model designed to provide information on the extent to which park objectives are being pursued.

Moura *et al.* (2012) developed an adapted version of the Participative Rural Diagnosis methodology applicable to municipal parks. Their aim was to make it feasible for groups connected with the parks, such as administrators and the population, to reflect on potential problems, share experiences and solutions and to mediate communication among those participating groups.

It can be seen that those analyses of the spaces are of a Cartesian order and generally make use of pre-existing models for their evaluations. In regard to monitoring, Pressure-State-Response is the most commonly used system. Thus there is a need for communication between the analyses of an ecological nature and those of a social nature, and also a need to stimulate the systematization of the indicators and methodologies for monitoring urban parks in order to provide supporting information for the proper conservation, public use and administration of those environments. Against that background, orientated by the research questions 'do urban valley bottom parks fulfill their conservation and public use functions?' and "can the two functions be reconciled?" the main aim of this research is to construct a methodological proposal for a monitoring system that makes it feasible to identify whether the park propitiates conditions for the maintenance of its conservation and public use functions and also to validate the proposed methodology by means of a case study of the Nascentes do Belem Municipal Park in the city of Curitiba, Parana, Brazil.

Devepment of the monitoring system

Structure of the System

The evaluation, analysis and monitoring of the landscape contribute towards improving the quality of the environment and revealing any need for alterations to the

urban spaces (PEREIRA, SILVA E VEIGA, 2011). Accordingly, defining the structure of a monitoring system is of fundamental importance for data gathering and systematization.

The present research used a structure based on a system that Guijt (1999) proposed and Franco (2004) adapted which is based on various stages designed to delimit the scope, simplify the analysis and make replication feasible. Making use of the adaptation made in the research conducted by Franco (2004), the structure was synthesized in five stages:

i) Delimitation of the monitoring objectives

The objectives consist of identifying whether the urban park contains elements that are supportive of the park's conservation and public use functions and, if they exist, to determine whether there is any conciliation of the two distinct functions.

ii) Identification of the phenomena to be studied

In order to identify whether the respective areas perform the functions referred to above, the following aspects were formally identified:

a) natural factors needed to support the maintenance of environmental systems (conservation) such as the presence of vegetation, connection with forest fragments and the structure and characteristics of the water course.

This research views conservation in the same way as Cunha and Coelho (2010) do, considering that the conservationist aspects should be directed at maintaining the functionality and structure of the landscape and that there should be conciliation of the ecological services with the population's exploitation of the park's resources.

b) Equipment needed to make public use feasible.

Note that factors such as behavior, infrastructure maintenance and the park user's expectations are not included.

iii) Defining the indicators

Indicators are designed to characterize the current state of whatever phenomenon is being studied. Altogether 14 indicators were selected, grouped into two categories of analysis: *i)* conservation indicators (7) and *ii)* public use indicators (7). At that stage the criteria for evaluating each indicator were also defined.

Conservation Indicators

– Occupation of the banks of the water course (dominant element)
– Quality of the vegetation (in regard to its structure in the landscape)
– Existence of forest fragments

– Water course (physical layout)
– Urban drainage
– Sewage discharge
– Type of public use

Public Use Indicators

– Solid waste disposal
– Signs
– Toilets
– Visitor Center
– Leisure equipment
– Rest areas
– Sports areas

iv) Data gathering and Systematization

Once the definition and systematization of the indicators had been accomplished, the plan for data gathering in the field was elaborated (Tables 1 and 2). After collection the data were tabulated and systematized in Microsoft Office Excel spreadsheets.

v) Analysis

The analysis took the form of a descriptive report designed to determine whether the park duly performed its conservation and public use functions.

Indicator selection, characterization and assessment

The field indicators were selected to characterize the current state of the environments under study and were grouped into two categories for analysis purposes, namely, conservation indicators and public use indicators. A scoring system was adopted to qualify the existing scenario, based on the reading of articles like those of Harris (1973), Goeden (1983) and Hepcan (2000) who employed a ranking technique and other literature such as Santos (2004) that contributed to the formatting and weighting of the indicators

Magalhaes Junior (2007) considers that when selecting indicators it is important to determine their relative degree of importance, that is, their respective weights, in order to mark those which are of higher priority in regard achieving the established objectives. Attributing weights can be done according to various different statistical criteria and techniques. It is not always possible, however, to avoid incorporating some degree of arbitrariness or subjectivity to the assessment criteria.

To ensure that the indicators are less subjective, the information gathered needs to be transformed into comparable data and that is usually achieved using a binary analysis

system which defines acceptability limits above or below a certain reference value and the response options are either yes or no. Another strategy is to attribute values to positions on a fixed scale applicable to all the categories of gathered data being evaluated; by interpreting the value of the aspect in question, the data can be transformed into numbers when analyzing selected characteristics (SANTOS, 2004).

Thus for each of the analyzed indicators a score was attributed on a scale from 0 to 10 where 0 (zero) corresponds to the least favorable characteristic for the area and 10 (ten), the most favorable one for maintaining its ecological and social functions.

In regard to the maintenance of conservation, the most favorable characteristic was determined to be the presence of natural elements and the least favorable one, an entirely artificialized environment. In the case of the public use aspect, the presence of infrastructure and equipment facilitating public use was designated as the most favorable characteristic and their absence, the least favorable one (Tables 01 and 02).

Degrees of importance were attributed to the indicators under analysis. In other words, within the two categories the attributes were weighted to make sure that the more important indicators should not be obfuscated by less important ones. The weighting criterion was based on the following question: "*which of the elements is most necessary for conservation?*" and "*which element is indispensable for public use?*". In that light it was considered that the gallery forest vegetation provides a habitat for fauna, minimizes surface runoff and the quantity of sediments washed into the thalweg and therefore fosters conservation and that the presence of equipment and installations most commonly used, such as playgrounds, trails, sports courts, fitness installations and others, propitiate the public's constant recreational use of the park. Based on those presuppositions the degrees of importance were attributed as set out in Tables 01 and 02.

Table 01 – Classification, Ranking and Weighting of the Conservation Indicators.

Indicator	Situation	Score	Weight
Type of occupation (dominant element) of the banks of the water course	Gallery forest (continuous)	10	3
	Gallery forest (partially fragmented)	8	
	Grasses + individual trees and/or isolated shrubs	5	
	Buildings	3	
	Exposed soil	2	
	Impermeable	0	

Vegetation quality (in regard to its structure in the landscape)	Continuous along the watercourse + forest fragments	10	2
	Continuous along the water course	8,5	
	Partly continuous along the watercourse + forest fragments	7	
	Forest fragments	5	
	Isolated individual trees	2	
	Non-existent	0	
Existence of forest fragments	Connection with internal and external fragments	10	
	Connection with internal fragments	7,5	
	Connection with external fragments	6	1
	Isolated	4	
	Non-existent	0	
Watercourse (physical layout)	Natural	10	1
	Rectified	8	
	Dammed	5	
	Open channeled	2	
	Closed channeled	0	
Urban Drainage	Non-existent or natural	10	1
	Drainage with energy dissipation at all points	7,5	
	Drainage points with dissipation of energy and others without dissipation	4	
	Drainage without dissipation	0	
Sewage discharge	Non-existent	10	1
	Existent	0	
Type of public use	Discriminated I	10	1
	Discriminated II	6	
	Not discriminated I	3	
	Not discriminated II	0	

Source: Elaborated by the authors.

Table 02 – Classification, Ranking and Weighting of the Public Use Indicators.

Indicator	Situation	Scores	Weight
Solid Waste disposal	Waste bins spaced around 100 meters apart	10	1
	Waste bins spaced around 500 meters apart	6	
	Waste bins spaced around 1000 meters apart	3	
	Non-existent or hard to see or to access	0	
Signs	Distributed throughout the length of the Park	10	1,5
	Present at the entrance + strategic points	6	
	Present at the entrance only	2,5	
	Non-existent	0	
Toilets	Exist	10	1
	Non-existent	0	
Visitor Center	Exist with information about the area	10	1
	Non-existent	0	
Leisure Equipment	Sufficient	10	2
	Insufficient	4	
	Non-existent	0	
Rest Areas	Exist with benches and drinking water fountains	10	1,5
	Exist with benches	5	
	Non-existent	0	
Sports areas	Exist	10	2
	Non-existent	0	

Source: Elaborated by the authors.

After identifying and attributing its importance to each indicator, the final score is given by the following equation:

Equation 1:

$$Sf = \frac{S_a}{S_m} \; x \; P$$

Where:
S_f = Final score
S_a = Attributed score
S_m = Maximum score
P = Score weight

The S_f value corresponds to the final note for each indicator; S_a represents the condition observed in the field; S_m, the maximum score the attribute can receive; and *P* is the degree of importance of the particular attribute in comparison to that of the other indicators being analyzed.

To determine whether the Park does or does not perform its conservation and public use functions it was decided to define a numerical index on a scale from 0 to 10 consisting of the sum of the Final Scores (S_f) – from the first to the nth value for each of the two categories, that is to say, composing a Conservation Index (CI) and a Public Use Index (PUI) obtained from the following equations:

Equation 2:

$$\mathrm{CI} = \sum_{i=1}^{n} Sfc_i$$

Where:
CI= Conservation Index
Sfc_i = Final scores of the Conservation indicators from the first to the *n*th

Equation 3:

$$\mathrm{PUI} = \sum_{i=1}^{n} Sfu_i$$

Where:
IUP= Public Use Index
Sfu_i = Final scores of the Public Use indicators from the first to the *n*th

After obtaining the Indexes for each category, represented by a numerical value between 0 and 10, the classes of degree of function fulfillment were established as shown in Table 03:

Table 03 – Classes of degree of function fulfillment according to the Index values.

Index	Degree of Function Fulfillment
0 ¬ 2	Non-existent
2.1 ¬ 4	Low
4.1 ¬ 6	Moderate
6.1 ¬ 8	Good
8.1 ¬ 10	High

Source: Elaborated by the authors.

The values obtained for the CI and the PUI were then used to compose an interaction matrix (Figure 01) to enable the visualization of both the degree of physical--ecological (conservation) quality and social (Public Use) quality and obtain an index of the conciliation of the two categories of functions. Five categories of conciliation were inferred: high equity, good equity, moderate equity, low equity and non-existent.

Figure 01 – Equity matrix of the two Indexes of the indicators analyzed in the field.

PUI \ CI	8.1 ¬ 10	6.1 ¬ 8	4.1 ¬ 6	2.1 ¬ 4	0 ¬ 2
8.1 ¬ 10	11	12	13	14	15
6.1 ¬ 8	21	22	23	24	25
4.1 ¬ 6	31	32	33	34	35
2.1 ¬ 4	41	42	43	44	45
0 ¬ 2	51	52	53	54	55

CI = Conservation Index
PUI = Public Use Index
High Equity
Good Equity
Moderate Equity
Low Equity
Non-existent

Source Elaborate by the authors.

In this research, equity is understood in the perspective of a systemic approach in which according to Bertalanffy (2020) the Park is considered to be an open system in which occur: exchanges of material with its environment; activities de importation and exportation; and demolition and construction of the materials that compose it (natural elements versus public use). Accordingly, within the Park as a unit, there may be systems in equilibrium albeit the unit itself, as such, cannot be considered a system in equilibrium. Based on that understanding, whenever the functions of conservation and public use have the same weight in the system (the Park) then it can be concluded that there is conciliation, that is, equity of the two functions.

A park that attains the status of 'high equity' is fulfilling its eco-social functions and the existing landscape conception is efficient in conciliating public use with the maintenance of its natural aspects. In turn a 'good equity' status is when the Park fulfills its functions; its current administration is efficient and only requires minor adjustments. If the park is attributed a 'moderate equity' status, it means that the current model requires management. A Park whose status is 'low equity' or non-existent' (equity) means that its current model does not fulfill the functions of conservation and leisure equitably and it requires adjustments to both its landscape conception and its management.

Criteria for Classifying Indicators

Conservation Indicators

a) Occupation of the banks of the watercourse

The most favorable situation for the conservation of this environment is when gallery forest vegetation is present and the most unfavorable when is when the banks have been made completely impermeable. The following classes were therefore determined:

i) Gallery forest vegetation (continuous): presence of gallery forest vegetation along the banks of the entire watercourse;

ii) Gallery forest vegetation (fragmented): presence of slightly fragmented gallery forest vegetation along the banks of the watercourse;

iii) Grass: classification when only grass species planted for ornamental purposes can be seen along the banks of the entire watercourse;

iv) Grass + individual specimens of arboreal species: when the banks of the watercourse present grassy vegetation with scattered individual arboreal or shrub specimens along 60% of the banks of the watercourse inside the Park limits;

v) Furnished: classification attributed when equipment and infrastructure for public use occupy more than 60% of the banks of the watercourse;

vi) Exposed soil: classification attributed when more than 60% of the banks presents no kind of vegetation cover and the exposed soil is susceptible to erosion;

vii) Impermeable: attributed when around 60% or more of the banks of the watercourse within the Park limits have visibly been made impermeable.

b) Quality of the vegetation (in regard to the landscape structure) and Quality of the Vegetation (forest fragments)

Categories were defined considering the best scenario to be represented by the presence of gallery forest vegetation throughout the length of the watercourse and forest fragments in areas adjacent to it, and the worst scenario, one in which there was no form of forest vegetation present. The question of possible connections was verified using satellite images available in the Goggle Earth software (GOOGLE EARTH, 2014). It should be noted that the objective of the system is not to identify connectivity, that is to say, the functionality of those possible fragments, but instead, whether there are any connections with green areas inside or outside the Park. For the evaluation of the indicator 'Quality of the vegetation (in regard to the landscape structure)' the following classes were established

i) Continuous along the length of the watercourse + forest fragments: this classification is made when the occurrence of a continuous formation of gallery forest vegetation along the length of the water course to the perimeter of the Park is identified and there is connections between it and fragments of forest inside or outside the Park;

ii) Continuous along the length of the watercourse: classification made when the occurrence of a continuous formation of gallery forest vegetation along the length of the water course to the perimeter of the Park is identified but there are no connections with internal or external forest fragments;

iii) Partially Continuous along the length of the watercourse + forest fragments: this classification is made when there is sparse vegetation along the banks of the watercourse and connections exist with internal or external forest fragments;

iv) Forest fragments: classification when there are only isolated fragments of forest vegetation present with no connection to other fragments;

v) Non-existent: classification attributed when the Park only has isolated specimens of vegetation.

Classes for the evaluation of the indicator 'Quality of the Vegetation (forest fragments)':

i) Connection with internal and external fragments;
ii) Connection with internal fragments;
iii) Connection with external fragments;
iv) Isolated;
v) Non-existent.

c) Watercourse

This indicator concerns the natural quality of the drainage system; the lesser the human intervention, the lesser the impact on the valley bottom. In the best situation the channel is entirely natural and in the worst, it has been entirely enclosed in. Five classes were defined and the classification attributed through direct field observation according to the prevalent condition of 60% of the length of the watercourse within the Park limits.

i) Natural: classification made when there has been no anthropic intervention in the watercourse;

ii) Rectified: attributed when the course of the watercourse to the Park perimeter has been straightened;

iii) Dammed: when the watercourse has been dammed in the whole of the study area;

iv) Open channeled: when the watercourse has been artificially channeled but not covered over (the sides and the bed of the channel have been made impermeable) within the Park limits.

v) Closed channeled: when the channel has been artificially channeled and covered over (the sides and the bed of the channel have been made impermeable and the channel covered over) within the Park limits.

d) Urban drainage

This indicator is designed to qualify the rainwater drainage network. Drainage systems with no energy dissipaters, such as water stairs, trigger and chain and accelerate erosion processes modifying the channel's structure. Energy dissipaters are a means to control urban drainage erosion (MAGALHÃES, 2001). In this case, the following categories were defined:

i) Non-existent: when there are no concrete tubes of the urban drainage system found in the watercourse within the Park;
ii) Drainage with energy dissipation at all points: classification given when energy dissipaters are installed at all the outlets of the urban drainage system;
iii) Some drainage outlets with energy dissipaters, some without: classification attributed when only part of the drainage system has dissipaters installed;
iv) Drainage without dissipation: classification when there are no energy dissipaters installed at the drainage system outlets

e) Sewage discharge

The objective here was to investigate the existence or non-existence of sewage being discharged into the rainwater drainage system. The quality of the water as whole was not considered under this heading because of the diffuse nature of water pollution. The fact of the water being polluted does not mean that its origin is *in loco* because it may very well be occurring beyond the reach of Park administration.

This indicator was measured on days with no rainfall because effluent discharge is often associated to clandestine connections to the urban drainage network. The parameter merely considered two classes: *i)* Non-existent and *ii)* Existent.

f) Type of Public Use

This indicator was designed to characterize the kind access the public has to the area. The basic premise was that the more restrictions on use there are and the more monitoring there is, the better the conditions for maintaining the Park's physical and ecological features. Public Use was separated into four classes (from FRANCO, 2004, with modifications):

i) Discriminated I: Restricted access to the Park's domain with fixed visiting hours controlled use and/or security surveillance with cameras and/or local security guard;
ii) Discriminated II: Restricted access to the Park's domain with fixed visiting hours but with out security surveillance or control;
iii) Non-discriminated I: Park closed, with pre-established visiting times and public access to all points;
iv) Non-discriminated II: Park open to the public at all times with access to all points.

Public Use Indicators

The public use variables were designed to measure the presence of elements needed to foster public use such as recreation and leisure infrastructure and other kinds of equipment that facilitate the interaction between the public and the spaces of the Park.

a) Solid waste disposal

This indicator characterizes the presence of waste bins for the disposal of the solid waste produced by Park users. The reference value for the spacing between one bin and another in areas accessible to the public was set at 100 meters. That value was based on the premise that the greater the distance apart of waste bins, the more likely it is that Park users will throw their solid waste away on the ground, thereby contributing to *in loco* pollution. The following classes were identified:

i) Waste bins space roughly 100meters apart: appropriate;
ii) Waste bins spaced roughly 500 meters apart: moderately appropriate;
iii) Waste bins spaced roughly 1,000 meters apart: not very appropriate;
iv) Waste bins non-existent or hard to find: inappropriate.

The indicators that follow below were formatted in accordance with what is considered the minimum infrastructure needed for the good use of the spaces of the Park in alignment with the users' expectations as described by Whately *et al.* (2008). It must be underscored that it is not the aim of this monitoring aspect to qualify the state of conservation and maintenance of such infrastructure and furnishings.

b) Signs

The system of signs represents an important communication channel between the Park's administration and its visitors. A poorly developed system of signs is worse than if there were no signs at all because it leads to the disinterest of visitors and a loss of credibility for the administration. The sign system must present clear accurate information and its configuration must be designed to meet the visitors' needs (PIMENTEL, 2007).

In this research the sign system is taken to consist of the presence of signs with information about installations, equipment, furnishings, locations, warnings or other information relevant for Park users' behavior. The following classes were considered:

i) Distributed throughout the Park;
ii) Present at the park entrance and strategic points: presence of signs at the entrance and at points with some kind of attraction or where a warning is needed;
iii) Only present at the entrance;
iv) Non-existent: classification when there is no evidence of signs anywhere in the Park.

d) Toilets

Toilets are infrastructure items that can propitiate comfort for Park users and their presence is indispensable, especially in big Parks. Two classes were determined: *i)* Existent and *ii)*Non-existent.

e) Visitor Center

Santos (2005) states that one of the objectives of a visitor center is to put the visitor in closer touch with nature, making it possible for the Park user to gain an understanding of questions related to preservation and management: each visitor center should have its own objectives established in the light of the area's specific set of problems. The center enables the Park user to acquire information on the area and also about cultural and educational practices and that makes it an indispensable tool for fostering the interaction between Park and Park user. Two classes were established for the question of the center: *i)* Existent and *ii)* Non-existent.

f) Leisure areas

This indicator seeks to identify installed infrastructure and equipment that foster recreational activities such as playgrounds, areas for board games (like chess and checkers), look out points, trails and others. The measurement of this indicator was organized in three classes:

i) Sufficient: when they are well distributed and are present in most places accessible to the public;
ii) Insufficient: when there are few of them and they are not well-distributed in areas the public has access to; and
iii) Non-existent: this classification is made when no equipment or infrastructure for such purposes can be found.

g) Rest areas

These are spaces within the Park dedicated to permitting its users to rest; an aspect that propitiates greater comfort to the public. Three classes were determined for evaluation purposes:

i) Existent, furnished with benches and drinking fountains;
ii) Existent, furnished with benches;
iii) Non-existent.

h) Areas for sports activities

This indicator makes it possible to register the existence of sports equipment and infrastructure such as sports courts, gymnastics equipment, running or walking tracks or similar installations; the aim was to identify whether such equipment existed or not and not to evaluate their quality, quantity or distribution. Classes: *i)* Existent and *ii)*Non-existent.

Methodological validation: a case study – the Nascentes do Belem Municipal Park

General features of the Nascentes do Belem Park

The Nascentes do Belem Municipal Park is located in the northern part of the city and municipality of Curitiba in the Cachoeira neighborhood and in the drainage basin of the Belem river. It is about 11 km from the city center and occupies an area of 11,178m^2. According to the head of the Curitiba's Environment Department (SMMA) (CURITIBA, 2012), the Park was created in 2001 with the aim of conserving the springs and headwaters of the Belem river; a river endemic to Curitiba which flows from north to south and is a tributary of the Iguaçu river (CURITIBA, 2014).

In regard to the availability of visitation to the area, a discrepancy was found between the information provided *in loco* and that displayed by official channels. According to the site of the Curitiba Environment Department the Park is open from Mondays to Fridays from 8 am to 6 pm. However, the sign at the entrance to the Park states that it is open from Mondays to Sundays from 8 am to 5 pm. The main attractions the Park offers the public are: walks through the natural vegetation, a bridge and a lookout point to observe the spring.

Within the Park area there is the Cachoeira Social Assistance Referral Center (*Centro de Referência de Assistência Social Cachoeira* - CRAS) which functions Mondays to Fridays from 8 am to 5 pm in an area which in the original planning of the Park had been intended for an environmental education center.

Data gathering was carried out in the period from August 2012 to January 2014,

Conservation Indicators

Vegetation is present on its borders throughout the extension of the watercourse in the park. The vegetation is thinnest around the area of the spring where it is mostly composed of grasses and some ornamental species. Along the channel, however, vegetation is thick and composed of a herbaceous layer and an arboreal/shrub vegetation layer. Thus the score awarded for the item 'quality of the vegetation (occupation of the banks of the watercourse e was 10. In regard to the aspect of the vegetation in the landscape, continuity was identified between the gallery forest vegetation and forest fragments in the Park's surrounding areas so the score for the aspect of vegetation and forest fragments was also 10.

Considering that the Park's overriding objective is to preserve the springs, there has been no apparent intervention in the watercourse itself, nor are there any outlet tubes discharging from the urban rainwater drainage system. Thus the drainage and the channel were classified as 'natural'. Also, there are no detectable clandestine sewage discharge connections so the score for this indicator was 10.

The Nascentes do Belem Municipal Park has structures that classify it in regard to Public Use as 'Discriminated II'. It has fences, gates and a pre-established timetable for visitation. However, it does not have security surveillance by guards or by cameras which means that Park is susceptible to vandalism and to being entered outside the permitted hours.

According to the proposed Indicators, the items associated to conservation (with the exception of 'type of public use' with a score of 6) all scored 10 points. That would suggest that the elements examined do indeed propitiate the maintenance of the Park's physical and ecological aspects enabling it to fulfill its conservational function.

Public Use Indicators

The waste bins are well-spaced (on average 20 to 30 meters apart) along the whole length of the Park

In regard to signs, there is a plaque fixed to a rock with an inscription commemorating the Park's creation and inauguration and there are two informative plaques: one near the entrance informing the visiting hours and another near the bridge warning about the slippery surface. Thus, for the item 'signs' the score was 6, in consideration of the presence of signs at the entrance and at other strategic points.

According to the official site, the Park has toilets but it was not possible to find any. Thus the item 'toilets' was awarded a score of 0 denoting their absence because even if they are actually present they are certainly not readily accessible for public use.

There is little provision of recreation equipment and none of the constant use type. In terms of equipment there is a paved walkway that goes from the entrance, over the wooden bridge that spans the small lake formed by the spring and on to a set of rustic wooden steps leading up to a lookout point; a trajectory of about 150 meters. Given the absence of constant use equipment that would enable visitors to stay longer in the area, the score attributed was 4, denoting insufficiency in regard to the aspect of leisure. There is no equipment for physical activities or recreational practices therefore the item 'sports areas' scored 0.

There are no spaces exclusively designated for visitors to rest and furnished with benches and drinking water fountains and so, according to the proposed protocol, a score of '0 – absent' was awarded for that item

The best-ranked elements in terms of Public Use were 'waste disposal', followed by 'signs' and then 'leisure areas' with scores of 10, 6 and 4 respectively. Elements that ought to be present to foster public use such as recreation and leisure equipment received a score of 0- Absent.

Analysis of the Nascentes do Belem Park

According to the proposed indicators, the Park's CI was9.6 points which indicates the presence of elements that support conservation processes and ensure that the Park fulfills that function. In the case of the Public Use analysis, the PUI was 2.7 points which means the area only performs its Public Use functions to a minimal degree (TABLE 04).

Table 04 – Synthesis of the conservation and public use indicators and their respective scores and indices for the *Nascentes do Belem* Municipal Park, Curitiba, Parana.

Category	Indicator	Attributed score (S_a)	Score weight (P)	Final score (Sf) $Sf = \frac{S_a}{10}\ x\ P$	Index
Conservation	Occupation of the banks of the watercourse	10	3	3	$IC = \sum_{i=1}^{n} Sfc_i$
	Quality of the vegetation (structure in the landscape)	10	2	2	
	Forest fragments	10	1	1	
	Watercourse	10	1	1	IC= 9.6
	Sewage discharge	10	1	1	
	Urban drainage	10	1	1	
	Type of public use	6	1	0.6	
Public Use	Waste disposal	10	1	1	$IUP = \sum_{i=1}^{n} Sfu_i$
	Signs	6	1,5	0.9	
	Toilets	0	1	0	
	Visitor Center	0	1	0	
	Leisure Equipment	4	2	0.8	IUP= 2.7
	Rest areas	0	1,5	0	
	Sports areas	0	2	0	

Source: Elaborated by the authors.

In regard to the degree of conciliation between public use and conservation, there is a visible discrepancy between the two, given that the conservationist aspect stands out more. The Park is well-endowed with natural elements but, on the other hand, the elements that should meet the leisure needs of the population are relegated to a secondary plane. There are no leisure or recreational furnishings, no rest areas or any other infrastructure related to such uses. Analyzing those attributes using the equity matrix

(FIGURE 01) the Park registers as "little equity", that is to say, there is no conciliation of the conservation and the public use functions.

Based on the scores obtained it is possible to propose the following management measures:

Equipment for community use: any installation of furnishings for public use should be preceded by an investigation into the respective local community's aspirations. That being said, it is necessary to identify the age group of the population in the respective neighborhood, and also investigate whether other Parks in the vicinity already offer recreational and leisure opportunities in order to make a range of different elements available and only then to define the equipment that could constantly serve the population in question. It must be underscored that the Park must not lose sight of its fundamental purpose which is to CONSERVE the springs and headwaters of the Belem River and that accordingly, the equipment that might be installed should not attract mass use but, rather, constant use.

Visitor Center: the Park has infrastructure designed for that purpose, however, currently that space is occupied by the CRAS; it is suggested that it should be re-appropriated for play-learning activities associated to Environmental Education and the illustration of the history of the local area

Final remarks

The monitoring system developed had two aims: to identify whether the Park contains elements that fulfil its functions (conservation and public use) and to find out whether the two functions are conciliated, that is, to see whether or not the public administration devotes more attention to one function than to the other.

This study has shown that the proposed system was efficient in fulfilling its purpose and that in addition to determining the degree of conciliation it also identified priority areas for management attention insofar as the lower the score associated to an indicator the greater the need for an administrative intervention.

However, it must be underscored that the results could be quite different for areas with different formation processes and landscape conceptions so the idea of applying a measurement scheme to the qualitative information enables the facilitation and systematization of the analysis of a set of units such as all the Parks of a given city, for example.

The tool takes in qualitative information and transforms it into quantitative information. It does not, however, asses the quality of the analyzed spaces; it merely identifies the existence or non-existence of certain elements associated to the uses in question. Accordingly, future studies will need to complement this tool using other techniques designed to determine quality, such as: conducting flora surveys to determine the quality of the vegetation; investigating whether the vegetation actually belongs to the phytogeographic unit being studied or whether invasive species predominate; analyzing the quality of the water to identify any possible *in loco* pollution; evaluating the quality and distribution of the shared-use equipment such as trails and walkways, playgrounds, sports courts, benches etc. New studies could possible attribute qualitative classes to the

various uses. Another suggestion is that indicators should be formatted for the analysis of the financial resources allocated to the Park in order to detect whether the attributed Indexes actually have their origin in the area's financial management.

It must be stressed that one technique can complement another given that the tool described is in fact a starting point for determining the existence of the minimum conditions needed to support the abovementioned functions.

Another point to highlight is that in a pilot system that was developed, the identification of species indicative of the successional stage of the vegetation was incorporated to the conservation indicators. However, that variable actually masked the results because one of the species identified is a Climax Forest species (*Araucaria angustifolia* (Bertol. Kuntze)) but it was found in the midst of second successional stage vegetation. That was because it is a species protected from felling by law in the state of Parana, Brazil.

In short, the proposed methodology made it possible to systematize and apply indicators that could complement existing management tools and foster the creation of new ones.

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Original Article

A MONITORING SYSTEM PROPOSAL FOR URBAN PARKS IN VALLEY BOTTOMS

Abstract: **U**rban parks must have physical, ecological and social functions and monitoring is necessary to achieve them. This article proposes a protocol for the monitoring of valley bottom parks. A measurement system was developed using indicators that allow identifying whether the park fulfills its functions and if there is conciliation of them. The indicators were segregated in two categories: *i)* Conservation and *ii)* Public Use. A score was composed for the final grade of each category (Conservation – CI and Public Use – PUI) from 0 to 10, indicating the degree of function achievement. The values CI and PUI values were matched in a matrix of conciliation between the functions. For validation, the method was applied to the Nascentes do Belem Park, in Curitiba, Brazil. The system proved to be efficient in identifying whether the park fulfills its functions and whether conciliation occurs. It also identified priority areas for management intervention.

Keywords: urban park; environmental monitoring; environmental indicators, valley bottom.

Resumo: Os parques urbanos devem apresentar funções física, ecológica e social. Para atingir tais funções faz-se necessário monitoramento. Este artigo tem por objetivo apresentar um protocolo para o monitoramento de parques urbanos. Para isso, desenvolveu-se um sistema métrico por meio de indicadores que permitem identificar se o parque cumpre com as funções e se há conciliação. Os indicadores foram segregados em duas categorias: *i)* conservação e *ii)* uso público. A nota final de cada categoria, compôs um Índice (Conservação - IC e Uso Público - IUP) entre 0 e 10, o qual indica o grau de cumprimento à função. Os valores obtidos para IC e IUP foram cruzados em uma matriz de conciliação entre as funções. Para a validação, aplicou-se a técnica no Parque Nascentes do Belem em Curitiba-Paraná. O sistema mostrou-se eficiente em identificar se o parque cumpre com as funções, se ocorre conciliação, e apontar áreas prioritárias ao manejo.

Palavras-chave: parque urbano; monitoramento ambiental; indicadores ambientais, fundos de vale.

Resumen: Los Parques Urbanos deben presentar funciones ambientales, para lograr estas funciones es necesario monitoreo. Este artículo tiene por objeto proponer un protocolo para el control de los parques urbanos. Desarrollado una métrica de indicadores para identificar si el parque cumple con las funciones y si hay reconciliación; indicadores fueron

separados en dos categorías: *i)* la conservación, y *ii)* de uso público. La calificación final de cada categoría compuesto por índices de Conservación - IC y Uso Público – IUP, entre 0 y 10, que indica el grado de cumplimiento de la función. Los valores obtenidos para la IC y IUP se cruzaron en una matriz de conciliación entre las funciones. Para validar, se aplicó la técnica en lo Parque Nascentes do Belem en Curitiba, Paraná, Brasil. El sistema demostró ser eficiente para lograr los objetivos e inferir áreas prioritarias para el manejo.

Palabras-clave: parque urbano; monitoreos ambientales; indicadores ambientales, fondo de los vales.