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ASPECTS DE L'ENVIRONNEMENT URBAIN AU BRÉSIL



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LES DIFFÉRENTES FACETTES DE L'ENVIRONNEMENT URBAIN AU BRÉSIL

LIMINAIRE

Les villes ont depuis toujours occupé une place de premier plan dans le débat relatif aux enjeux environnementaux engagé au niveau international. Depuis la Conférence des Nations Unies sur l'environnement et le développement qui s'est déroulée en 1992 (aussi connue sous le nom du Sommet de la « Terre » de Rio de 1992), les questions environnementales sont au cœur des démarches d'urbanisme et de gestion durables à l'échelle mondiale (Nations Unies, 1992). Le programme Action 21, par exemple, amène les nations à s'engager dans l'élaboration de diverses actions en milieu urbain orientées vers la conservation et/ou la restauration des ressources naturelles. Les principes adoptés à Rio, y compris la mise en œuvre du programme Action 21, ont été approuvés par les délégués dans la foulée du Sommet mondial sur le développement durable (SMDD) tenu à Johannesburg en 2002 (Nations Unies, 2002).

Au fur et à mesure que les villes se complexifient en raison des activités relatives au développement socioéconomique qui se multiplient, elles sont susceptibles d'avoir des effets négatifs sur l'environnement. Face à la croissance historique des villes, conjuguée à la concentration démographique, à la production industrielle et à l'urbanisation intensive, les niveaux de pollution se sont élevés, les ressources naturelles se sont épuisées et la biodiversité s'est effritée. Des recherches internationales ont établi une interdépendance entre les facteurs de risque associés à la vulnérabilité socio-environnementale et les problèmes environnementaux (tels que les inondations, l'érosion du sol, la déforestation, la pollution des eaux, etc.). Si les autorités publiques sont en principe tenues d'agir en vue d'assurer le développement économique et la protection de la qualité de l'environnement, les intérêts liés au développement économique se retrouvent souvent au premier rang des

préoccupations politiques dans la plupart des pays en émergence. Ainsi, les villes brésiliennes subissent les contrecoups des difficultés que connaissent les gouvernements qui tardent à mettre en place des mesures de protection et d'assainissement de l'eau et d'offrir un logement décent et abordable aux couches les plus défavorisées de la population. De telles actions permettraient de freiner la croissance de quartiers de taudis dans les zones vulnérables et ainsi prévenir les désastres environnementaux et les pertes de vies humaines. À l'échelle du pays, 81,25% des quelques 170 millions d'habitants vivent dans les villes et 41% des 5 560 municipalités doivent composer avec des problèmes environnementaux importants, dont certains sont qualifiés de catastrophiques. Cet état de fait hypothèque la qualité de vie des citoyens et peut même, à l'occasion, entraîner des pertes de vies humaines (IBGE, 2005). Il est clair que les questions environnementales doivent être examinées à fond et de manière prioritaire par les instances de gouvernance des villes du Brésil.

Tous les auteurs qui ont collaboré au présent dossier thématique s'intéressent aux questions environnementales, sociales et politiques qui entourent le développement urbain au Brésil. Dans leur article, Rigitano et Barbassa montrent comment la participation et la consultation citoyenne sont devenues des éléments clés dans le développement des plans d'urbanisme. À partir d'une étude de cas qui porte sur la participation sociale dans les processus de l'élaboration des plans d'urbanisme de la ville de Bauru située dans l'État de São Paulo, ces auteurs brossent un tableau de l'évolution historique du cadre juridique régissant la participation des acteurs communautaires dans ce processus. Les auteurs soutiennent que, dans les faits, même si le niveau de participation communautaire est à la hausse, l'attitude que le pouvoir municipal adopte envers la participation des citoyens dans les

processus décisionnels reste mitigée. Les travaux de Costa *et al.* se fondent dans une perspective environnementale plus large qui vise à explorer les projets de restauration de rivières urbaines en périphérie de Rio de Janeiro. Les auteurs se penchent sur l'interdépendance entre la structure environnementale, les modes d'utilisation du sol en milieu urbain et les intérêts que défendent les groupes locaux. Portant sur le projet Iguaçu réalisé dans la région de la Baixada Fluminense, cette étude de cas montre à quel point des projets environnementaux axés sur la prévention de risques (comme des inondations) sont susceptibles de faire émerger de nouveaux aménagements en bordure de plan d'eau qui permettent de tenir compte et de mettre en valeur le potentiel des rivières comme élément central dans la reconfiguration de l'espace urbain. Les auteurs se demandent dans quelle mesure la participation communautaire peut constituer une stratégie efficace dans la restauration environnementale des parcs riverains. Enfin, dans le dernier article, Silva aborde la question de la justice environnementale à Rio de Janeiro à travers une évaluation des inégalités sociales qui caractérisent notamment les espaces d'exclusion dans le bassin des basses terres de Jacarepaguá. L'article se termine en évoquant la faible portée des actions publiques proposées pour réduire l'injustice environnementale, alors que les instances publiques peuvent engager des actions très efficaces qui viennent servir les intérêts privés, notamment ceux du marché immobilier.

L'idée principale qui ressort de l'ensemble des articles est que les mesures prises par les instances publiques face aux préoccupations environnementales dans les villes brésiliennes doivent respecter le principe selon lequel le pouvoir se partage entre toutes les parties prenantes pour trouver des solutions aux problèmes complexes que connaissent les villes en croissance rapide.

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ASPECTS OF THE URBAN ENVIRONMENT IN BRAZIL

INTRODUCTORY NOTE

Cities have always played a key role in the international debate concerning environmental issues. Since the 1992 United Nations Conference on Environment and Development (also known as the 1992 Rio “Earth” Summit), environmental questions have become pivotal to urban sustainable planning and management worldwide (United Nations, 1992). For example, Agenda 21 establishes nations’ commitment to the development of urban projects and programs for the conservation and/or restoration of natural resources. The Rio principles including the implementation of Agenda 21 were strongly reaffirmed at the 2002 World Summit on Sustainable Development (WSSD) held in Johannesburg (United Nations, 2002).

As cities become more complex, due to the development of socioeconomic activities, they tend to cause negative impacts on the environment. The historical growth of cities, with its demographic concentration, industrial production and built-up environments, has caused widespread pollution, natural resource depletion, and loss of biodiversity. International researches have agreed that the risk factors for socio-environmental vulnerability are directly related to environmental problems (e.g. floods, soil erosion, deforestation, water pollution, etc.). Although governments are expected to promote economic development and to protect environmental quality, economic development interests tend to have priority on the agenda of most developing countries. In Brazil, cities suffer from government’s difficulty in implementing sound policies on water and sanitation as well as in providing decent and affordable housing for low income groups, in order to prevent the growth of slums, and avoid environmental disasters and human fatalities in vulnerable areas. Overall, 81.25% of the nearly 170 million people in the country live in urban areas and 41% of the 5,560 municipalities have registered environmental problems and disasters, which substantially lowered citizens’ quality of life

and even caused human fatalities (IBGE, 2005). Assessment of environmental issues is therefore central to Brazilian cities’ governance.

The authors who have contributed to this special topic issue focus on environmental, social and political aspects of urban development in Brazil. In their article, Rigitano and Barbassa show that citizen participation and consultation have become pivotal to the development of urban master plans. In their case study of social participation in the processes involved in master plan development in the City of Bauru, State of São Paulo, they give an account of the historical evolution of the legal framework guiding community participation in these processes. The authors argue that, in reality, even though social participation has increased, municipal authorities’ attitude towards citizen involvement in decision-making processes is not very favourable. Costa et al. take an even greater environmental perspective on the restoration of urban rivers in the metropolitan periphery of Rio de Janeiro. The authors discuss the interrelations between environmental structure, urban occupation and social local interests. They explain in their case study of the Iguaçú Project located in the Baixada Fluminense region how environmental projects aimed at preventing risks (e.g. flooding events) offer opportunities to create new urban waterfronts, while considering rivers as valuable and meaningful features to restructure urban space. The authors examine the many ways in which community participation can be an effective strategy in the environmental restoration of riverside parks. Finally, Silva considers environmental justice in Rio de Janeiro by assessing social inequalities particularly located in spaces of exclusion within the Jacarepaguá Lowland Watershed. The paper concludes that public efforts to reduce environmental injustice are still very limited, whereas they are very effective in collaborating with private interests, especially in the real estate market.

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Collectively, these articles argue that to address environmental issues in Brazilian cities, public authorities must express their true commitment in sharing power with a variety of stakeholders while trying to respond to the complexity of rapidly growing urban development.

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Gabriela DA COSTA SILVA, Guest editor



PARTICIPATION IN BAURU MASTER PLANS, BRAZIL: ANALYSIS OF THE HISTORICAL EVOLUTION OF THE CONSULTATION PROCESS

Maria Helena Carvalho RIGITANO
Ademir Paceli BARBASSA

RESUMÉ

La participation citoyenne est instrumentalisée au Brésil depuis 1988, date à laquelle la constitution fédérale a réglementé la participation dans les programmes d'urbanisme, plus spécifiquement dans le développement des schémas directeurs. Cet article présente une reconstitution historique des schémas directeurs développés à Bauru – Etat de Sao Paulo – Brésil. D'abord, les méthodes de consultation participative de 1968, 1988 et 2005/2006 sont comparées à l'aide d'une grille d'analyse. Ensuite, le degré de participation communautaire aux processus est estimé par l'application d'une typologie fondée sur le niveau de participation des habitants. Enfin, nous proposons de mettre en évidence et de discuter les effets produits par les changements de coalitions d'acteurs au pouvoir, de l'approche de la planification stratégique, du cadre juridique dans lequel s'inscrit la consultation participative, de la reconnaissance de l'importance de la communauté et du savoir-faire acquis au long du processus.

MOTS-CLÉS ■ Participation citoyenne, processus participatif, plans directeurs



ABSTRACT

In Brazil, a policy on citizen participation and consultation in urban intervention programs, in particular in the development of master plans, was first introduced into the Federal Constitution in 1988. This article presents an historical reconstitution of Master Plans in Bauru – State of São Paulo – Brazil. The 1968, 1988 and 2005/2006 consultation methods are analyzed using established criteria. The degree of community participation in the processes is estimated by drawing on a typology based on the level of involvement by residents. The effects of participation caused by changes in political regime, technical planning vision, legal support to consultation, recognition of community importance and knowledge acquired during the process are highlighted and discussed.

KEYWORDS ■ Citizen participation, participative process, master plans

INTRODUCTION

The history of urban intervention programs in Brazil begins in the first decades of the 20th century when the 'improving and embellishment plans' for Rio de Janeiro and the 'avenue plans' for São Paulo were developed. These plans were influenced by the technical ideas of intervention plans such as transport and urban sanitation.

During the 1960's while the intense urbanization process was occurring, the idea that intervention plans could be conceived and used as technical instruments powerful enough to solve the 'urban problems' of the times was accepted by many of Brazil's elite.

This widely-shared belief prompted the Federal Government to establish a Federal Office in 1964 whose mandate was to encourage municipalities to develop Master Plans. In 1967, the State of São Paulo Organic Law of Municipalities (São Paulo, 1967) reinforced this principle by making State financial aid or loans contingent of whether or not municipalities has officially adopted a Master Plan.

Medium-sized counties lacked technical staff to help them develop their Master Plans so they had to rely on outsourcing. In most cases, these specialized professionals, with no prior experience or knowledge of the municipality, produced unrealistic and utopian plans.

Beginning in the 1980's, Latin American societies went through a series of institutional changes and political transitions, ranging from totalitarian to democratic forms of government. During this period the political debate revolved around state democratization and citizen participation.

During the process of consolidation of the Constitution of 1988, a multi-sectoral movement of national scope fought to include in the constitutional text instruments that established the social function of the city and of property in the process of the construction of cities. Once again taking up the cause of Urban Reform, this movement brought up to date and to the conditions of an urbanized Brazil, a platform built since the 1960s. [...] Then, in 1987, an alliance of social actors involved in urban issues – movements for social housing and regularization of land possession, unions, professional associations of engineers and architects, legal assistance groups, urban squatters, NGOs, and academics – joined together to prepare the Popular Urban Reform Amendment – which,

supported by 250,000 signatures, was presented to the Constitutional Congress. As a result of this action, for the first time in history, the Constitution included a specific chapter on urban policy that called for a series of instruments to guarantee, within the jurisdiction of each municipality, the right to the city, the defense of the social function of the city and property, and of democratization of urban management (articles 182 and 183) (Rolnik, s.d., p. 12).

The 1988 Federal Constitution established that "a Master Plan, approved by Municipal Authority, mandatory for towns with more than twenty thousand inhabitants, is a basic political instrument for urban development and expansion" (Brasil, 1988).

Despite the legal implications, no implementation deadline was set, no accountability guidelines were developed and/or penalties defined for disregard of rules and regulations.

Nevertheless, the true milestone in the history of urban planning came in 2001 with the Federal Law 10.257 (Brasil, 2001), known as the Statute of the City¹. It proposed changes to the process for developing Master Plans, which responded to the demand for citizen participation and for the democratic management of cities. This law established a time limit (October 2006) and defined penalties for non-compliance by mayors.

According to Burgos (2007) the inauguration of the Ministry of Cities in 2003 and the establishment of a representative group of professionals engaged in urban reform, heralded an era of broadened participation experiences in urban politics.

The requirements defined in the Statute of the City were complemented by the 2005/2006 national campaign 'Participatory Master Plans: the city belongs to all' promoted by the Federal Government, which in produced "a real explosion of participative processes"².

¹ The Statute of the City aims to regulate the chapter on urban policy found in the 1988 Constitution. "Resulting from an intense negotiation process which lasted more than ten years, within and beyond the National Congress, the Statute confirmed and widened the fundamental legal-political role of municipalities in the formulation of guidelines for urban planning, as well as in conducting the process of urban development and management" (Rolnik, s.d., p. 11).

² According to information issued by the Ministry of Cities in a research conducted in October and November of 2006, 1622 out of

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Motions from the City Council³ provided guidelines and recommendations to municipalities related to participation in the process for developing Master Plans, basic plan content and deadline for approval.

There is an increasing demand today for greater participation of civil society in public policy-making. This issue is being debated in many countries including Brazil.

According to Howard and Gaborit,

Public consultation has become an important task for promotion of urban planning projects. The idea of citizen participation has grown in the United States with the advocacy planning movement during the 1960's. It has expanded during subsequent decades, being reshaped and redefined by politicians, planning professionals, developers, activists, and citizens. (2007, p. 2).

International influences, countrywide democratization and institutional channels for participation provide incentives for the dissemination of consulting and participation processes in Brazil. Burgos (2007) argues that today, the number of existing channels for participation and collaboration is such that debates now focus on issues of quality of participation and of evaluation of previous experiences.

According to New Economics Foundation (NEF),

Participation is a buzz-word that means different things to different people. One way of looking at participation is using a version of the 'ladder of participation' first developed by Sherry Arnstein⁴. This is now 20 years old, but is still relevant. It shows the different ways in which the organization responsible

for an activity – for example a local authority – can involve participants – in this case their citizens (NEF, 1998).

Arnstein (1969) states that “the typology, which is designed to be provocative, is arranged in a ladder pattern with each rung corresponding to the extent of citizens power in determining the plan and/or program” and warns however that the typology does not consider the barriers that may impede the process of ascending each rung. Including these barriers would entail increasing drastically the number of rungs to about 150 in all.

The focus of this paper is not on process related variables. Instead of addressing this complex issue, it aims to provide a historical reconstruction, examine the way in which plans are developed and analyze the level of citizen participation in Bauru's Master Plans of 1968, 1996 and 2006⁵.

These time periods refer to three specific moments when the development of Master Plans in Brazil reached a peak, first under Military Government supervision, then, in the aftermath of the adoption of the Federal Constitution and the Statute of the City. The case of Bauru reflects the development and growth process in Brazil, which was a consequence of changes in how participation was defined politically, socially and conceptually. This paper draws on data from several primary sources including published documents and reports found in the archives at City Hall, legislative records, magazine articles and newspapers from each period under study.

Based on the principles established by Carson and Gelber (2001), the paper presents the results of a comparative analysis carried out on citizen participation in the three mentioned processes. Participation level is estimated according to the eight rungs on the Ladder of Citizen Participation proposed by Arnstein (1969).

I. BAURU MASTER PLAN – 1968

In the 1960's, as urban problems throughout Brazil intensified, Federal and State governments responded by encouraging cities to develop their Master Plans (MP).

the 1682 municipalities who accepted to update their Master Plans had begun the process. (Burgos, 2007, p. 134).

³ The Cities Council is linked to the Ministry of Cities, and comprises representatives from all federal, state, and municipal public agencies and civil society through many segments (community groups, unions, academic bodies and NGOs).

⁴ In the late 1960's, when experiences of citizen participation appear in the USA and Europe, Sherry Arnstein published an article in which she questions the degree of citizen participation in decision-making processes. An eight rung typology called “Ladder of citizen participation” is proposed.. Starting from the bottom rung, Arnstein labels them according to the level of population decision power: (1) Manipulation, (2) Therapy, (3) Informing, (4) Consultation, (5) Placation, (6) Partnership, (7) Delegated Power, (8) Citizen Control.

⁵ Bauru is a town with 370 000 inhabitants in the State of São Paulo, Brazil.

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In 1966, to develop the city's MP, an agreement of collaboration was signed between Bauru City Hall and USP – São Paulo University.

At the request of contracted professionals, the mayor passed a law enacting the creation of a Master Plan Commission and a Consulting Council.

In theory, research would be conducted by technicians from USP's Urban Research and Development Center – CPEU, and the Municipal Commission would be responsible for overseeing and reviewing their work.

Various city and public agency representatives sat on the Municipal Commission appointed for the purpose of selecting participants, advocating and assessing and bringing together the contributions from the community.

These attributions served to bolster claims that active local community involvement in the MP development process was an issue of concern for both technicians and politicians. In spite of that, no records of meetings were found between the representatives of the Commission, community members and technicians over the course of the planning process.

The technicians were already in São Paulo working on the MP, when the Commission took office. Six months later, the technicians reported their conclusions to the city's architects and engineers who responded with "neither debate nor discussion of any kind"⁶. The final report included a diagnosis of the current urban conditions, and general guidelines for zoning which have never been implemented.

The Bauru Master Plan final draft was submitted to the mayor who had reached the end of his term of office. The plan was presented in a public ceremony attended by USP technicians, commission members, local authorities and the newly elected mayor. The mayor publicly expressed "his purposes in fulfilling the established rules during his term" (Autoridades, 1968).

However, the mayor asked his advisors to prepare an Action Plan early on during his term. Many of the elements of the Master Plan were not carried over. Concerning the discrepancies between the proposals in the approved Master Plan and interventions that were implemented, the City Hall

Architect⁷ justified this gap by arguing that the Master Plan was "soothing, imported and utopian". He declared that as soon as he assumed his position in the Technical Planning and Projecting Office, he would put an end to the Master Plan viewing it as a kind of "historical curiosity" (Agroquisa, 1988, p. 75-76).

The Master Plan elaborated by the CPEU (Prefeitura Municipal Bauru, 1968) provided an important diagnosis of problems faced by the municipality and drew on local knowledge. However, the diagnosis did not appear to have played a significant role in defining the guidelines and project proposals. Local knowledge apparently was not taken into account by the technicians. Initiatives that came out of the MP did not follow the recommended assessment guidelines.

2. BAURU MASTER PLAN – 1996

A nation-wide movement in support of a new Brazilian Constitution appeared in the late 1980's. In Bauru, a Committee was formed in 1986 to revise the Master Plan of 1968. The president of the Committee invited the population to participate in discussions held in community-based groups, trade unions, service-related clubs and other municipal agencies.

Although no meetings were held during the next two years, a report by the president of the committee was released in which data and maps were compiled without consulting the local population. He also drew up the political agenda for the following year when the new mayor would take office.

There remains a gap between the discourse about the importance of community involvement in the MP development process and the reality in the field where no initiative was taken in this direction.

The new Federal Constitution was adopted in 1988 and the MP was required in all counties with a total population of more than 20 000 inhabitants. In addition, a statute in the Constitution mandated citizen participation in plan-making.

The São Paulo State Constitution, revised in 1989, made it mandatory to adopt a MP in every municipality, including rural areas.

The Bauru Organic Law, enacted the following year in 1990, required a formal public participation

⁶ Engineer José Cardoso Neto gave exclusive interviews to the authors in December 2007 and April 2008, not published.

⁷ The City Hall architect had taken part in the development of the Master Plan while a student of architecture at USP.

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process for MP development, with a completion deadline set at 18 months. The Federal and State Constitution, as well as the Organic Law did not however develop accountability guidelines or define penalties if this requirement was not fulfilled.

Once Bauru's Organic Law was approved, the municipal government created a committee to promote popular participation in the Master Plan, which was made up of class-based groups, civil society and community groups, to assist in disseminating information about the MP discussion meetings to the wider population. The municipal technicians were responsible for collecting data and suggestions from municipal departments and for developing liaison with the community.

The county government promoted a Seminar called "Bauru in Themes" that ran for five days and aimed at encouraging community participation in the discussions on the issues to be addressed in the MP.

A bill was drafted on the basis of the data and suggestions collected at the Seminar and proposed to City Council in 1991. No further action was taken on the bill.

Once again, with a new mayor taking office in 1993 a Commission was created to develop a Municipal MP. The Commission was composed of 25 representatives from government agencies and civil society. While most of them came from class-based groups representing architecture, urban planning, engineering, commerce and industry, no one claimed to be representing popular movements or citizen groups.

The public meetings and the discussions on the Master Plan took place only in 1996, when the Commission was under new management and the Master Plan's Center for Studies was officially established. Over 40 meetings were necessary to tackle the various issues to be addressed in the legal text.

Both public and private agencies and groups came together to assist in dealing with the issues and contribute suggestions and proposals at a series of thematic meetings.

The ideas that came out of the discussions that took place during the municipal conferences on health and social care, as well as the documents and produced at the "Bauru in Themes" Seminar were collected and debated during community meetings hosted by the Regional Administration.

The MP was submitted to City Council for consideration during a public hearing and was approved in 1996 through a municipal bylaw (Prefeitura Municipal Bauru, 1997).

Many of the actions proposed in the MP were implemented, in particular those closely related to environmental issues, thanks to efforts made by NGOs to this dimension of the proposals.

3. BAURU PARTICIPATIVE MASTER PLAN – 2006⁸

In 2001, the Federal Law number 10.257, called "Statute of the City", provided advanced planning instruments to effectively fight against real estate speculation and land regularization (Brasil, 2001). However, Municipal MP has precedence over this Law, which set a deadline of 5 years i.e. 2006. The focus of the debates during the 1st Bauru Conference held in 2003 was on the new MP development process. The process would need to take into account the demands of the new Federal legislation, Statute of the City, and in particular, of citizen participation.

A Work Group under the direction of municipal agents instigated debates by hosting a series of thematic Council sessions on urban expansion and land use, housing, transit system, drainage, urban parks and transport. Community meetings were also organized throughout the seven Regional Administrations of the city and technical meetings with public agencies, class-based groups and universities.

In 2005, the Federal Government conducted a national campaign promoting the development of Participative Master Plans (PMP). The Federal Government provided didactic materials (booklets and videos) about the application of the new urban legislation (guidelines and objectives) and the need of citizens' involvement in the debates over the PMP.

During the 2nd Bauru Conference held in 2005 in accordance with a Federal Government orientation, the Working Group expanded to include university representatives, class-based groups and social movement representatives. This new entity, the Management Group (MG), was officially recognized by a municipal act and was given the responsibility to coordinate the development of the PMP.

⁸ The description of the procedures used in the elaboration process of Bauru Participative Master Plan is based on Prefeitura Municipal Bauru, s.d.

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It was during this conference that an agreement was reached on the division of municipal territories into urban and rural sectors established according to watershed. Debates addressed issues related to the environment and accessibility at the community level. Planning initiatives would be divided into twelve urban and nine rural sectors.

Another issue that was raised and debated was the way in which the population would be represented at the PMP Final Meeting. The PMP bill text would be approved at this meeting and submitted for approval to City Council.

Representation was divided as follows: section 1 was composed by social movements, section 2 by unions, class-based groups and research institutions and section 3 by public agencies.

The role of social movements was considerably large, with the highest percentage (60%) of the total representatives. The unions, class groups and research institutions represented another 20%, as well as the federal technicians, state and municipal public agencies.

In urban areas, community representation was proportional to the number of inhabitants per area, with one delegate for each 3000 inhabitants. In rural areas, each sector chose at least three community representatives: one land owner, one resident and one worker.

The MG participated actively in training workshops organized by the Ministry of Cities and provided guidance in the form of managing the participatory planning process. The goal of the MG was to balance workloads and responsibilities.

The MG was also given the task of coordinating the work, mobilizing local community groups, reaching local leaders; distributing personal invitations throughout the community and organizing outreach events and using newspapers, radio and television to publicize activities.

Before every meeting, publicity campaigns were launched in the local media to promote their work.

The following steps describe the process.

3.1 Awareness

The first step was to offer participants an overview of their district and of watershed dynamics raising awareness and suggesting to them ways that

they might play a role in the Participative Master Plan development process.

Following a brief presentation of the Working Group giving by a technician, participants were asked to join smaller discussion groups to address critical issues facing them and to propose solutions.

Every proposal was recorded and displayed during the subsequent meetings to increase public awareness of what had previously been discussed and to create opportunities for new contributions from the participants.

A total of 77 meetings enabled 3026 people from various backgrounds and different interests representing rural or urban areas, class-based groups, religious communities and service-related clubs to contribute to the planning process.

3.2 Community Evaluation and Technical Evaluation

On several occasions, Community Evaluation began during the Awareness Meetings, followed by on-site visits to the mentioned “hot-spots”, usually accompanied by people from the community. The primary goal of these field excursions was to study the problems that need to be solved, provide photographic evidence and identify boundaries on maps.

The next step, Technical Evaluation, consisted in interpreting surveys conducted on the positive and negative aspects related in particular to the preparation phase of the MP as well as visits to various municipal services and technical agencies, the solutions to meet the most pressing needs and the short and long term proposals to be included in the MP.

Members of the Working Group and the Management Group were invited to join a “tour” of urban and rural areas. The purpose of this field trip was to identify both the problems that needed attention and the positive aspects that could be improved.

In all, 29 meetings brought together 1082 people.

3.3 Proposals Presentation and Delegates Election

During the final step, conclusions were drawn from the analysis and proposals for improvement for

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each area were made on a host of issues including mobility, environment, infrastructure, development, social function of property and housing.

Elections were held before the close of the meetings. In all, 130 delegates from section 1 were elected, proportional to the number of inhabitants in the sector, which is equivalent to 60% of the total.

Delegates from section 2 took part in a plenary session to hold elections. In all 43 delegates or 20% of the total were elected.

Delegates from section 3 were appointed by the mayor who chose them among technicians who participated in the discussions on developing the PMP. Again, 43 delegates or 20% of the total were selected.

The elected and selected delegates participated in training workshops on urban planning legislation, which provided them with information on the instruments of the Statute of the City and helped them grasp the scope of the proposals made in the PMP.

At this stage in the process, 538 people took part in 16 meetings.

3.4 The Final Conference

The main purpose of the Final Conference was to examine and approve the memorandum on the PMP bill. Many people were present at the voting sessions, including municipal technicians and invited interested citizens, but only the delegates were granted the right to vote.

The memorandum was sent to City Council for approval in 2006, but it was only sanctioned into law in 2008, as Law number 5.631/2008 (Prefeitura Municipal Bauru, 2008). Delegates proposed only one modification to the document which concerned the construction coefficient, as a result of stakeholders' pressure.

At the 4th Municipal Conference held in January 2010, delegates insisted that the original proposal be reinstated.

4. ANALYSES OF THE MASTER PLANS DEVELOPMENT PROCESSES AND CITIZEN PARTICIPATION LEVEL

A considerable amount of documents have been made available so far, which focus mainly on developing strategies for working with a host of

groups, as well as citizen consultation methods and techniques. To date, although several countries have shown an interest in these sorts of guidelines such as Act government (2001), NEF (1998), Renn et al. (1993), little systematic consideration is given to assess the effectiveness of participatory processes.

The main problem in the evaluation of participation methods is the absence of any optical benchmark against which they might be compared and measured, which arises in part because of confusion as to what we mean by effectiveness (Rowe and Frewer, 2000, p. 24).

In order to evaluate public participation methods, Rowe and Frewer (2000) established the following criteria: representativeness, independence, early involvement, influence, transparency, resource accessibility, task definition, structural decision-making, and cost-effectiveness.

Carson and Gelber (2001) then proposed a manual of principles and procedures "for achieving better community consultation" based on Rowe and Frewer's criteria. The results of the analysis are summarized in Table 1. The first column shows the principles on which the development processes were founded, while columns 2, 3 and 4 provide an overview of the key points of the 1968, 1996 and 2006 Master Plans.

These principles are used as benchmarks, indicating that there was a real concern to make the process more participative and a keen interest in providing an efficient consultancy system. Both qualitative (who participated, when the participation occurred, which means of communication was used) and quantitative parameters (number of participants, geographic distribution) were used to establish the validity of this interpretation.

Verifying whether the principles were in fact adopted, even though they do not guarantee efficiency, allows us to measure the level of participation. The 'ladder of citizen participation' typology (Arnstein 1969) was used to classify and compare the three consulting processes. According to Rydin and Sommer (2000) the Litmus project also made use of Arnstein's typology.

Table I
Community consultation and participation in Bauru's Master Plan development processes

PRINCIPLES	MASTER PLAN 1968	MASTER PLAN 1996	PARTICIPATIVE MASTER PLAN 2006
<p>Make it timely: Community must have sufficient time to express its ideas and opinions to influence outcomes.</p>	<p>A Municipal Commission was constituted in the beginning of the process, but citizens had no opportunity to participate.</p>	<p>Many commissions were constituted during the entire process and some public events were held (conference, seminar) but most participants came from technical institutions</p>	<p>The community was involved from the beginning of the process thanks to the creation of a Management Group which was responsible for dividing the municipalities into sections and overseeing the election of delegates.</p>
<p>Make it inclusive: the selection must include a representative sample of citizens</p>	<p>The Commission was composed of private and public groups and agencies, but citizens did not participate. The proposal was developed by the team of hired technicians and was presented to an audience of invited local technicians (engineers and architects).</p>	<p>The Commissions were composed by private and public groups, mostly represented by professionals and coordination did not include citizen participation. Some public meetings were held, but with little citizen participation.</p>	<p>Public meetings open to all community members were held in several urban sectors. The process made it possible to organize 122 meetings with a total of 4691 participants.</p>
<p>Make it community-focused: The focus must be on an issue that affects the entire community</p>	<p>The community was not consulted.</p>	<p>The proposals elaborated by the technicians took into account some suggestions submitted during the public meetings.</p>	<p>During the public meetings were prioritized the problems that affected the community as a whole.</p>
<p>Make it interactive and deliberative: the community must have access to information to help broaden understanding of issues raised</p>	<p>The community was not consulted.</p>	<p>Proposals were presented to residents' associations in all 7 Administrative Regions and in public sessions at the City Council during the last stages of the process.</p>	<p>During the process, the participants joined together in small groups to allow everyone to participate in the debates about the specific problems facing the community. Elected delegates representing each segment voted on the final proposal.</p>
<p>Make it effective: define clearly the process of decision-making and the outcome of community participation</p>	<p>Citizens were not involved in the process. The plan was considered as a solution for all problems, but the proposals were later identified by technicians who participated in its development as utopian.</p>	<p>Technical view still played a leading role in decision-making, without population engagement. Citizen participation was not highly valued.</p>	<p>At the first meeting, all submitted proposals were systematically assembled and presented at another meeting as measures to be adopted or as suggestions to be included in the PMP Bill. Responses are first approved by elected delegates. Debates involved political considerations to address conflicting interests. This was the focal of the decision-making process.</p>

<p>Make it matter: value the consulting process by complying with recommendations</p>	<p>Discussions with local population did not occur. The community did not get involved in decisions made by technicians.</p>	<p>Discussions were restricted to technical groups. Changes to some important issues concerning environmental problems were made before approval in the MP, as a request by NGO's to play a role in the process.</p>	<p>Delegates monitored the bill's progression and the vote at City Council, attempting to avoid having to make drastic changes to the bill's original version. These activities as well as the pressure from the delegates during the 4th Conference are indicative of a high level of citizen involvement.</p>
<p>Make it well-facilitated: facilitator/mediator must be flexible and independent</p>	<p>Since the community was not consulted, mediation was not appropriate in this case.</p>	<p>As most meetings addressed more technical issues, providing participants with didactic material was unnecessary.</p>	<p>At the beginning of each meeting details about the current stage of the project were offered. Making the language accessible to a wide audience was a concern, as was the use of images to increase understanding about the issues.</p>
<p>Make it open, fair and subject to evaluation: The process itself must be evaluated</p>	<p>The process was never evaluated because there were no consultations.</p>	<p>The process was not evaluated.</p>	<p>An evaluation was conducted at the end of the process using a Likert scale questionnaire approach. A total of 118 individuals who had participated in the PMP development process (technicians and community) accepted to take part in the survey. The questionnaire addressed various aspects of all stage of the process.</p>
<p>Make it cost effective: resources should be sufficient to coordinate the consultation process</p>	<p>No resources were spent because there were no consultations.</p>	<p>No resources were allocated specifically for conducting consultations. Community satisfaction or possible benefits from the process were not considered.</p>	<p>Resources allocated for consultations were limited, and made some stages difficult to complete such as mobilization, advertisement, and didactic material production. The limited resources allocated to the evaluation process were the most criticized aspect of the PMP, in spite of being well geographically distributed among a significant number of participants.</p>
<p>Make it flexible: choose the appropriate mechanisms according to circumstances and type of users</p>	<p>The only public presentation made consisted of illustrative panels of final proposals. It is believed that this mechanism is insufficient.</p>	<p>At meetings, the proposals were presented on thematic maps and opportunities were given to make suggestions for change. This procedure may not be adequate for all participants.</p>	<p>The method applied was based on the Ministry of City guidelines, with variations on meeting dynamics and prepared materials which varied according to each community. Visual resources such as maps and aerial pictures were used, debates were held and technical visits were offered.</p>
<p>Work in collaboration: Discussions must resolve conflicts and help reach agreements and avoid misunderstandings.</p>	<p>No collaborative work was undertaken.</p>	<p>It is not known if technicians involved in the process adopted this perspective.</p>	<p>All proposals made by community and other groups were discussed at the final Conference in preparation for the vote.</p>

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In 1968, the Master Plan was not publicized to the wider community and did not provide opportunities for consultation. In fact, the community received few details concerning its launch and some information on the main conclusions that were reached by the team responsible for the plan as shown in Table 1, Column 2.

According to Villaça (1999), “super plans” were developed during this period and had a significant impact on the outcome of the process. Driven by the illusion of a technical vision of scientific neutrality, the plans had no basis in reality and did not provide effective instruments for implementing planning policies at the local level.

Community participation was referred to in the discourse as a way to support technical and political decisions, but was omitted completely from planning practice. In this sense, the 1968 Master Plan development process reached the bottom rungs of the ladder of citizen participation proposed by Arnstein, which she labeled as “Manipulation” and “Therapy”, and characterized as “Non-participation”.

These two rungs describe levels of non-participation that have been contrived by some to substitute for genuine participation. Their real objective is not to enable people to participate in planning or conducting programs, but to enable powerholders to “educate” or “cure” the participants (Arnstein, 1969, p. 217).

The 1996 Master Plan development process included wider public participation than in the previous period. However, participation was limited mostly to representative groups (see Column 3).

Consultation was neither interactive nor focused on the community, and did not include communication facilitators. Citizens simply did not get involved in any aspects of the debate. According to Arnstein (1969), this process would reach the 3rd and 4th rungs, “Informing” and “Consultation”, which are characterized as “Symbolic participation” or “Tokenism”.

When they are proffered by power holders as the total extent of participation, citizens may indeed hear and be heard. But under these conditions they lack the power to insure that their views will be heeded by the powerful. When participation is restricted to

these levels, there is no follow through, no “muscle”, hence no assurance of changing the status quo (Arnstein, 1969, p. 217).

In 2006, the participative process undertaken in preparation of the Participative Master Plan was marked by an enormous improvement compared to the two previous periods. The involvement of a large number of people in various urban and rural sectors was unprecedented in Brazil. This was the result of a major effort of the Working Group and Management Group to effectively provide the possibility of greater participation by a diversity of people.

Consultation included most of the principles defined by Arnstein, as is demonstrated in Column 4. It is evident from our analysis that this process reached somewhere between the 5th and 6th rungs of Arnstein’s ladder, the “Placation” and “Partnership” levels of participation. The process enabled all those concerned to get involved. The proposals were incorporated into the legal text and the community could monitor the process from start to finish. Their views had a direct bearing on decision-making.

Placation is simply a higher level tokenism because the ground rules allow have-nots to advise, but retain the powerholders the continued right to decide. Further up the ladder are levels of citizen power with increasing degrees of decision-making clout. Citizens can enter into a Partnership that enables them to negotiate and engage in trade-offs with traditional powerholders (Arnstein, 1969, p. 217).

CONCLUDING REMARKS

Findings from the analysis of the three Bauru Municipal Master Plans development processes show the extent to which changes have occurred in recent decades. The changes observed in this study are a consequence of the expansion of institutionalized forms and channels of public participation. While the 1968 development process was under way, the country was run by a military dictatorship. Community participation was limited to organized groups and opportunities were not provided for popular participation. Master Plan development was considered a technical matter drawing on scientific knowledge. Ordinary citizens were simply left out. The Master Plan was developed by city staff only and involved little outside input. Intentionally or not, according to Arnstein (1969), citizen manipulation occurred.

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By 1996, Brazil has shifted towards greater democratic principles as embodied in the new Constitution. The process that led to the 1996 Master Plan's approval did include a community participation component. However, involvement was restricted to class-based groups and resident associations. Although the scope of discussions taking place during the meetings was broadened, the public at large was not involved. Far from being inclusive, the consultations did not adequately address people's concerns, resulting in symbolic citizen participation.

Finally, the process leading to the approval of the 2005/2006 Master Plan provided many opportunities for people from various social backgrounds and urban and rural sectors to participate. Citizens could express their opinions, agree and disagree, make suggestions and proposals.

Representatives were elected in open sessions and were assigned the task of monitoring the process from start to finish and of ensuring that the proposals discussed and approved were included in the legal text. However, participatory practices were not established within different spheres of public action and across municipal departments.

In fact, such management practices are increasingly being recognized and applied by the government's executive branch, but their legitimacy still depends in part on the willingness of technicians to open decision-making to a wider audience. To ensure effective public involvement, policy mechanisms for promoting participation are not enough.

- Citizens rarely participated in the 1968 and 1996 Master Plans development processes. Effective participation occurred during the 2005/2006 process. Clearly, citizens are keen on participating in the consultation process, appreciate being consulted and expect to be given the opportunity to voice their views and concerns.
- Urban Planner's more specialized interests may explain part of their involvement in the consultation processes. Highly qualified professionals joined the teams but citizen participation was rare during the first two projects.
- Technicians had reservations about citizen participation in decision-making processed, as did politicians who were opposed to 'power sharing' with the community.

- The majority of the Legislature did not approve of the 'division of powers' in matters relating to urban planning. They challenged the notion that participation was an integral part of representative democracy. Participation should not be regarded as the equivalent of a tax that all citizens are obliged to pay, but as a citizen's right to contribute, to interact in society, to take part in the process of decision making and assert ownership of their territory.

Public participation is a slow and constantly-evolving learning process, due to the complexity of the issues raised in discussions on urban planning policies. Success requires continuous training on the part of municipal technicians and civil society representatives who must work together closely and share information and experiences.

Therefore, climbing up the Arnstein ladder requires a lot of effort and persistence by those involved in the process. Municipal technicians' attitude must change as must the behaviour of government officials as a whole. Instruments in support of knowledge sharing – which is the true nature of participation – will provide new opportunities for citizen inclusion in decision-making processes.

Our study has demonstrated that increases in participation in the Bauru Master Plans are not intrinsic to the development process. Rules on participation can be legally binding and public authorities can be required by law to include public consultation in the decision-making processes. Increased public participation gives rise to new challenges for Brazil which vary from city to city depending on the stage of development it has reached.

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ENVIRONMENTAL RESTORATION OF URBAN RIVERS IN THE METROPOLITAN REGION OF RIO DE JANEIRO, BRAZIL

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❖ RÉSUMÉ

Cet article porte sur les discours environnementaux et les pratiques concernant la restauration des eaux urbaines au Brésil en se penchant sur les rapports entre l'environnement et l'occupation urbaine. Une analyse est menée sur les travaux de restauration environnementale des fleuves et cours d'eau entrepris dans le cadre du Projet Iguaçú à la Baixada Fluminense, dans l'état de Rio de Janeiro. Il s'agit dans un premier temps de dresser un portrait de l'expérience de la restauration environnementale et du paysage, puis de cerner les aspects sociaux et environnementaux de la Baixada Fluminense. Une discussion est ensuite menée sur l'action des pouvoirs publics sur cet espace en mettant l'accent sur le développement des parcs riverains. L'article se termine en soulignant que la prise en compte de la spécificité culturelle est essentielle pour améliorer l'efficacité des actions de restauration.

MOTS-CLÉS ■ Urban rivers; environmental restoration; riverside parks; Rio de Janeiro; Baixada Fluminense



❖ ABSTRACT

This paper aims to expand our understanding of environmental discourses and practices in Brazil pertaining to urban water restoration, by focusing on the interrelations between environmental structure and urban occupation. For this purpose, it examines river and stream environmental restoration proposals within the Iguaçú Project located in Baixada Fluminense, in the state of Rio de Janeiro. The discussion begins with a brief description of the environmental restoration and landscape experience, followed by an exploration of the Baixada Fluminense social and environmental contexts. A program launched by the government is analyzed, emphasizing the development of riverside parks. The paper concludes by arguing that environmental restoration must be culturally specific in order to improve its efficacy.

KEYWORDS ■ Rivières urbaines; restauration environnementale; parcs riverains; Rio de Janeiro; Baixada Fluminense

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INTRODUCTION

Experience of the landscape is usually related to its transformation. It has largely been discussed in terms of experience gained through individual or collective values and of new meanings attributed to the landscape reflected through its reinterpretation and change. For many urban dwellers, this kind of experience is strongly associated with water. A large number of cities around the world are built along rivers or streams, which are the very reason of the settlements' existence. However, despite the undeniable significance of water in the origins and development of cities, only recently has attention been given to the analysis of the relations between rivers, cities and their populations, be it in the academic literature or in the professional practice of urban design and landscape architecture.

For many years, particularly from the 18th century onwards, the main approaches solving problems related to urban rivers both in Brazil and in other countries were focused on drainage issues. One had to contain floods and drain water meadows in order to ensure that the land was suitable for urban development. This understanding involved hard engineering of urban rivers by channelization and, often, the total displacement of watercourses, to sub surface drainage systems. This project-based culture, described as "concrete overcoat" by Penning-Rowsell and Burgess (1999), has had a great impact on how we experience the urban landscape, thus reflecting the collective values attributed to rivers.

In various cities throughout the world, this approach has gradually changed. Rivers have been reevaluated and recovered in their environmental integrity and their potential as social spaces has been reclaimed. New values and meanings have been attributed to rivers that are reflected in the way urban restoration projects consider riverine landscapes.

On the basis of this change, we can uncover new perspectives on the relations between the cities and their surrounding landscape. Initially, urban and landscape studies highlighted the rivers' significance in the formation of the landscape structures of the urban fabric. This approach has, more recently, been expanded, and contemporary studies discuss the importance of urban river landscapes from various enriching perspectives, such as those of green corridors, public open spaces, recreation and leisure, environmental services, just to name a few. This has generated a vast number of contemporary project

discourses and practices aimed at urban river restoration (see, for example, Downs and Gregory, 2004).

Urban projects have been privileged instruments of intervention in many countries including Brazil during the last quarter of the 20th century. At first, the scope of the projects was on community participation and local administration initiatives, and it was expanded to a more strategic profile – either in the formulation of the project itself or in the visibility brought to the city and its local authorities (Iplanrio, 1997). Today, incorporated as a practice of urban intervention in the contemporary city, projects have gained a new dimension. We argue that the pressing challenges facing the 21st century Brazilian city are environmental in nature, *latu sensu*, namely restoring both the environmental conditions and a sense of urbanity. As elsewhere, new approaches are developed to address the metropolitan issue, and it might be asked whether metropolises are simply extensions of cities or rather new entities calling into the question the fundamental attributes of urbanity (Ascher, 2008).

Recent literature about urban projects in Brazil reveal that, within the long-term developing plans for the metropolis, spatial strategies are articulated through large and local scales, the latter being where spaces of urbanity can be rescued. A central theme of the strategies is environmental restoration which gives special relevance to river landscape restoration projects.

The main objective of this paper is to expand our understanding of environmental discourses and practices in Brazil concerning urban water restoration, acknowledging the interrelations between environmental structures and urban occupation. To this purpose, the paper focuses on river and stream environmental restoration proposals within the Iguaçu Project, located in the metropolitan area of Rio de Janeiro. The study draws on the concept of landscape as a cultural construction, and it is based on archival research, analysis of public documents and field work. The paper begins with an examination of the urban environmental restoration and landscape experience and strategy. This is followed by an overview of the Baixada Fluminense social and environmental contexts, with a focus on its rivers and streams. The discussion follows with an analysis of a government program, emphasizing landscape design and the development of river banks for waterfront parks. The paper concludes by suggesting that environmental restoration must be culturally specific in order to improve its efficacy.

I. ENVIRONMENTAL RESTORATION AND LANDSCAPE EXPERIENCE

In general, the idea of environmental restoration is related to the idea of process. This understanding has been achieved through groundbreaking work of Ian McHarg (1969), who developed a methodology of landscape analysis and intervention that addressed diverse scales of the environment and was based on the study of the dynamics of natural processes and of their repercussions on the landscape. When the study of landscape experiences is integrated to the study of natural processes, the complexity of the process is heightened, as a vast number of interests, appropriations and contradictions are incorporated to the analysis. As Corner (1999, p. 3) argues, nature is not “culture-free”. In other words, cultural dynamics should be taken into account in environmental restoration processes in order to improve efficacy (see also Gregory, 2006). A number of academic studies conducted in Brazil have already stressed that environmental degradation is at times directly related to cultural issues (Leonel, 1998; Costa, 2006; Martins 2006; Bueno and Martins, 2007).

Following Corner (1999) who suggests that landscape be considered as a verb and not merely as a noun, attention can be drawn to the processual character of landscape and its capacity to enrich local cultures. The landscape can thus serve as an impetus for and play an interactive role in the re-interpretative and transformative processes of space. As such, one can argue that the strategic efficiency of environmental restoration processes is contingent on the recognition of the full range of socio-environmental values associated with urban water as well as of the complicit and interactive relationship dynamics between the landscape and the different cultural groups involved.

This is apparent when we look at the environmental conservation status of Brazilian's urban fluvial landscapes, which are currently protected by environmental legislation at federal, state and municipal levels. For a variety of reasons, this protection, however, has not proven truly effective. One of the most debated issues is the difficulty in which public spheres can be constructed to provide management and environmental protection (Martins, 2006; Britto and Silva, 2006; Costa et al., 2007). Besides, to ensure effective restoration and protection, preserving environmental values is insufficient. Projects should be more responsive to the riparian inhabitants' cultural values. Due to the lack of public use, stream and river banks in large and medium-sized Brazilian cities are being occupied increasingly by informal housing (*favelas*). With the

expansion of illegal settlements, the original environmental values on which the case for legal protection is built are forgotten (Costa, 2006; Bueno and Martins, 2007).

Various studies on the occupation of stream and river banks in Brazilian urban areas have highlighted that regardless of whether they are under legal protection, they remain vulnerable as the number of poor seeking to build their home on this land is increasing (Costa, 2006; Bueno and Martins, 2007). As a result, although their value is recognized in theory, the water banks are nothing more than residual landscapes in practice, i.e. forgotten areas in the formal process of weaving the urban fabric lacking adequate urban and landscape integration as well as public visibility and access and exposed, consequently, to diverse forms of blight and degradation. On the other hand, studies also demonstrate that, when local people's values and their landscape experiences are taken into account, environmental restoration initiatives can be effective. This is the case, for instance, of the Programa Guardiões dos Rios (River Guardians Program), launched by the Municipality of Rio de Janeiro in 2001. The Program was established to ensure local community involvement in the decontamination and preservation of nearby rivers and streams, and has succeeded in avoiding regular flooding and, in the process, generating income for families in need (Costa et al., 2007).

Watershed-based river restoration projects recognize that the watershed framework serves as a strategic spatial approach for improved intervention and territorial ordination. The concept of a watershed as a planning and administration unit was introduced in Brazil not until as late as the 1990s (Cunha and Coelho, 2003). A combined study of the watershed provides for a better conceptual understanding of the range of environmental and cultural dynamics interacting with each other than a study limited to the course of an isolated river. This approach necessarily entails inter-scaling techniques to conduct an analysis of both the effects of the projects on the landscape and municipal, state and federal project management practices.

Based on an analysis of the watershed, the proposal for the revitalization of the sub-basin of the Bananal Stream, located in the outskirts of the municipality of São Paulo, involves landscape intervention projects along its banks (Pellegrino et al., 2006). A restoration plan was implemented for the sub-basin within the larger watershed context of the Cabuçu de Baixo River. It involves professionals from many fields including landscape architecture, hydrology, biology, and ecology.

Its main objectives were to address the risk of flooding, water resources contamination, and soil degradation. The rapid and haphazard development of *favelas* along river banks is one of the major problems facing the sub-basin area. In addition to displacing approximately 750 inhabitants and moving them to apartment buildings in risk-free zones, yet within the watershed, the proposal for the Bananal Stream included a network of parks and green areas connected to surface water drainage and ecological treatment systems. Initiated in 2003, it is currently in its implementation phase and relies on the participation of the local population and government bodies. Delays in the process are mainly due to difficulties of communication among agents, in particular decision-makers providing financial resources.

The project for the Paranaíba River, located in the state of Goiás, in central Brazil, presents another problem (Gorski, 2007). This revitalization project, although limited to the river's banks up to the city limits of Itumbiara, also considered the watershed in its entirety. This basin is affected by many factors including the presence of hydroelectric power plants, water pollution from agricultural activities, domestic and industrial effluents, deforestation and the high rate of soil impermeability. Initiated in 2005 at the request of the municipality of Itumbiara, this restoration project was undertaken with local people and emphasizes their connection to the Paranaíba River. It aims to reinforce and facilitate public uses related to fishing, nautical activities and other types of recreation activities, as well as the traditional religious processions held on its waters. As this river flows through more than one municipality, the implementation phase of the project relies on successful negotiations between local government authorities and is thus a slow and difficult process.

These projects and other experiences under way show how diverse the interface areas between rivers and cities are being used throughout urban Brazil. There are a number of ways of defining what constitutes a feasible urban river environmental restoration project varies according to the team of professionals, government and popular interests and the amount of available funds. Some common denominators, however, can be identified: an approach articulating the scales of the drainage basin with the local scales for specific projects; the regeneration of the rivers' banks from the standpoint of creating access and public use areas, thus pointing to the need for a combination of social and environmental values; the recognition of the difficulty of reconciling interests and conflicts during the implantation phase.

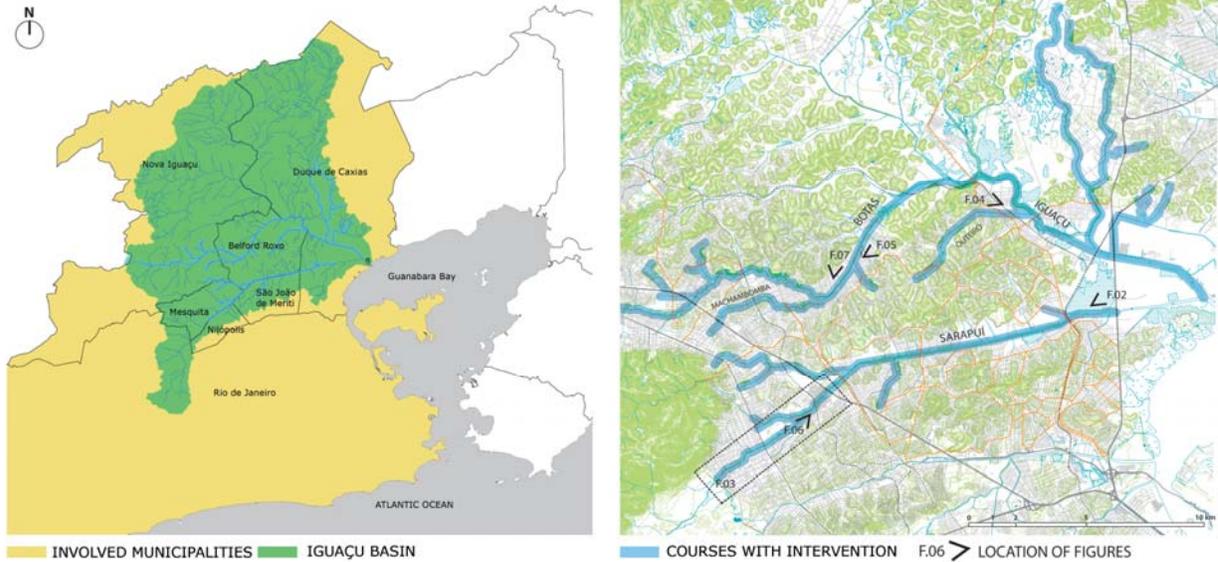
Several of these issues, which are addressed in detail in the following section, are central to the Iguazu Project. We examine this project within the context in which it is located, the Baixada Fluminense.

2. THE ENVIRONMENTAL AND SOCIAL CONTEXT OF THE BAIXADA FLUMINENSE

Baixada Fluminense (Fluminense Lowland) is a dynamic region undergoing landscape and socio-cultural transformations. It has experienced historical cycles of intensive development, abandonment, expansion and retraction, which have contributed to its emergence as one of the most significant areas of the metropolitan region of Rio de Janeiro. At the same time, however, the Baixada is known for its environmental conflicts, its deficiencies in basic public services and for its high level of social deprivation. During the rapid process of urbanization of the second half of the 20th century, conflicts have occurred between the demands made by developers and the need to protect Baixada's fragile ecosystem. Given the urgency of the water-related problems, actions such as fighting floods and draining and canalizing rivers were carried-out at great cost. Tremendous efforts have been made over time to "sanitize" the area and gain control over frequent floods (Sedur, 1990).

Only recently have public policies, especially at the discourse level, incorporated a more complex understanding of this watershed system and of the river within the metropolitan landscape. Various initiatives being taken, as will be discussed further, have drawn on the concept of "environmental restoration", which involves not only solving relatively simple problems related to drainage and floods but also enhancing the ecological health of water resources, restoring the riparian woodlands and, above all, contributing towards a more harmonious relation with the urban surroundings and its inhabitants.

The Baixada Fluminense, an *entre-deux*, is delimited by the Mountain Range of the Sea to the north and the Carioca Mountain Range to the south. To the east, its boundaries are defined by the Baía da Guanabara and the Municipality of Magé, and to the west, by the Guandú River. The Baixada Fluminense is a built-up area composed of several municipalities located in the northern metropolitan region of Rio de Janeiro. These includes the municipalities of Nova Iguaçu, Japerí, Queimados, Belford Roxo, Mesquita, Nilópolis, São João de Meriti and Duque de Caxias. With a total area of 1262 km², and a population of three million inhabitants, the Baixada is home to nearly 30% of the total population of the metropolitan area and generates some 24.6% of its gross domestic product.



Source: Costa, Vescina, Pinheiro Machado

Fig. 1 – Municipalities of the Iguaçú Basin, Guanabara Bay, Rio de Janeiro State. Water courses with intervention receiving support from the Project and location of figures

Water dominates the landscape morphology of the Baixada Fluminense. It is basically a flat, lowland area broken up by small hills and crossed by a vast system of rivers. The Baixada lies within two major drainage basins, the Macro-basin of the Baía da Guanabara and the Macro-basin of the Baía de Sepetiba, and it is in the former watershed where urban population concentrations are greater. In the Macro-basin of the Baía da Guanabara, the largest basins are the Iguaçú, Botas and Sarapuí Rivers. These eastern-flowing rivers originate from the mountain ranges surrounding this macro landscape (Iguaçú in Tingua, Botas in Gericino and Sarapuí in the mountain range of Bangu), running through areas of different urban density before finally discharging into the Baía (Sedur, 1990; Mendes, 1950).

The landscape has been shaped over time by water flow from the rivers or the ocean. The region's soils found in the small plains flanked by mountains were formed, by sand and clay sediments, which were transported from the sea or carried by streams and surface water courses from the mountains and hills. The latter vary in height; the highest being those close to the base of the mountain range and the lowest and roundest being those found in the interior of the range. This type of landform, commonly known as *meia-laranja* (half-orange), is easily exploited by

extractive industries (quarries). Besides modifying the landscape, the combined action of extracting soil from the hills and mountains for the reclamation of flooded areas – one of the historical characteristics of the development pattern of the city of Rio de Janeiro up to the mid-20th century – heightens flood-related problems (Mendes, 1950).

During the summer months, when rainfall is heavier, torrential flows from the top of the mountain ranges gradually wane as they reach the Baixada, running in between the hillsides and flooding the lower areas, before finally reaching the Baía da Guanabara. When tides are high, the lowlands near the Baía are flooded, and the sea water invades the aquifers, in some areas up to six kilometers inland, thus forming marshes and mangroves.

Rivers continue to play a key role in the Baixada Fluminense productive cycles. As noted by Mendes (1950), the significance and role of these rivers have changed over time as the vast territory underwent several cycles of development. The first settlements were located on the shores of the rivers, which served as a major navigation route for materials and goods to and from the inland regions and the port of Rio de Janeiro. The waterways gradually declined and were replaced by rail and road transport. The port

settlements that appeared along the rivers were progressively relocated inland near the train stations. They formed the nodal points through which urban development expanded towards the rural areas and formed the centralities that are still visible today. The 20th century brought on the great roadway infrastructures and a new structural axis, which eventually created a permanent link between the Rio de Janeiro and São Paulo metropolitan areas, passing through the Baixada Fluminense and producing major transformations in the organization and development of the territory.

Sugarcane plantations were the first human activity to modify the landscape. Rural occupation patterns were well adapted to the physiographic conditions of the Baixada Fluminense: settlements were located midway up the hillsides while the plantations were established in the fertile river valleys subject to possible floods. Chapels were erected on hill tops to physically separate them from the dwellings. Nonetheless, by the end of the 19th century, the small and not so productive valleys rapidly subsided, which – alongside the abolition of slavery – led to the abandonment of the land. Following this period, the deterioration of rural activity, together with the discontinued maintenance of the rivers and canals that served the purpose of transportation, gave way to the restoration of the marshlands and to the outbreak of malaria (Sedur, 1990; Mendes, 1950).

In the beginning of the 20th century, another cycle caused further changes to the landscape: the orange cycle. From 1926, with the expansion of the European market, the rapid growth of this crop gave way to a new geometrical landscape of small lots characterized by extensive rows of orange groves and hedges. The sanitary constructions initiated by the federal government from the 1930s onwards, provided an opportunity for the extension of the plantations from the hillsides to the lowlands (Mendes, 1950).

By the late 1940s, the end of the orange “boom” in the Baixada Fluminense had no effect on the government’s plan to transform the city of Rio de Janeiro outskirts into one of the major horticultural and agricultural production areas, which would possibly supply legumes, vegetables and poultry products to the carioca population. As such, the Sanitation Commission of the Baixada (Comissão de Saneamento da Baixada) was created, through which important waterworks projects were undertaken. The construction of dams, the canalization and rectification of its rivers indisputably changed its landscape.

Little incentives for the rural occupation of the “sanitized” areas, combined with the waiving of the orange plantations, opened the way for urban expansion. Starting in the 1950s, the electrification of railways and the construction of a freeway linking Rio de Janeiro to São Paulo contributed to the spatial extension and sprawl of the capital to the Baixada Fluminense. Mendes (1950, p. 30) was one of the first to observe the formation of an urban continuum along the railroad tracks:

the former nodes of rows of houses surrounding the stations and stops in a range of 50 km from the center of the metropolis have practically come together to form as if a single city, stretching itself out as the tentacles or as the open vanes of a fan. The open areas in between the suburban nucleuses, along the railways, are already scarce and will soon all be entirely populated.

The real estate speculation that occurred in the Baixada Fluminense during the second half of the 20th century led to indiscriminate occupation, irregular development without urban infrastructure and aggravated environmental conflicts. Rivers silted up due to their abandonment by authorities and the direct discharge of untreated sewage from the precarious dwellings in addition to the waste generated by industries. In many cases, settlements were built haphazardly on the rivers’ margins. Furthermore, the total absence of waste collection services, the deforesting of the slopes and the geophagy of the hills made conditions even worse (Sedur, 1990; Mendes, 1950).

Despite the considerable amount of effort that was invested so far, their lack of coordination and efficiency has not helped to reverse the process of degradation. A series of initiatives were launched in the mid 1980s but were restricted mainly to the provision of basic sanitation and flood control (Serla, 1996). Such interventions include the provision of water supply, the construction of sewage treatment systems and stations, clean-up and sediment control in rivers and canals and the pavement of roads and related developments. Additional actions include institutional support, waste collection, and environmental education.

A series of actions were carried out under the Rio Reconstruction Project (Reconstrução Rio), which was initiated in the aftermath of major floods that struck the region in 1988. Although these efforts were directed at the macro-drainage systems, including the construction of the Gericinó dam, and helped mitigate

the effects of floods, they failed to solve the totality of conflicts. Owing to their narrow scope and the total lack of maintenance, most of the infrastructure was obsolete or inefficient once the projects were completed.

More recently, in 1994, the Baixada Alive (Baixada Viva) Program – renamed soon afterwards, New Baixada (Nova Baixada) – set out to integrate a diverse set of actions by taking into account the various boroughs that make up the city region. Unlike previous programs, these actions seek to integrate social and urban infrastructure sectors for the “sustainable development of the environment, satisfactory urban development of boroughs and the restoration of citizenship” (Serla, 1996, p18). The so-called integration was hardly achieved, and the low quality of built structures also led to the program’s demise.

The reasons that can explain why the accumulated investments of over a billion dollars have not managed to substantially improve the situation in the Baixada are complex. Porto (2003), in his analysis of the evolution of public policies over the last thirty years in the Baixada Fluminense, discusses how the process of patrimonialization and the influence of clientelism, quite distinctive in the Brazilian political context, have moved the region closer to the brink of disaster. Porto argues that the water and sanitation policies that prevailed in the Baixada played no part in the building of citizenship and in exercising this right.

3. THE IGUAÇU PROJECT

In 1994, a technical commission was given the mandate of elaborating the “Integrated Master Plan of Floods in the Iguaçu-Sarapuí River Watershed” (Plano Diretor Integrado de Inundações da Bacia do Rio Iguaçu-Sarapuí), which established a framework for the management of regional water resources intended to facilitate local and state governments with coordinating public policy decision making processes. The document – later known as the Iguaçu Project (Projeto Iguaçu) – recommended a series of structural interventions to complement the initiatives put forward as part of the program Rio Reconstruction (Reconstrução Rio). Non-structural interventions for land use regulation were also included in the master plan. Coordinated by the Laboratory of Hydraulic Engineering of the Federal University of Rio de Janeiro (UFRJ), and with funding from the International Bank for Reconstruction and Development (IBRD), United Nations Development Programme (UNDP) and Caixa Econômica Federal which is a Brazilian bank, the

master plan drew on the expertise of a wide range of professionals, local and state government representatives and neighborhood associations (Serla, 1996).

The Iguaçu Project aims at “improving housing and urban infrastructural conditions in the flood affected areas of the Baixada Fluminense, as well as recovering the banks of the watercourses and their springs” (Serla, 1996, p.4). It results from the necessity of better controlling recurrent floods which are potentially hazardous for the entire population of the drainage basins. To achieve this goal, the following actions are planned: relocation of approximately 2000 families, living on the rivers’ banks in unsanitary dwellings and in hazardous areas, to nearby residential complexes; dredging and decontaminating the waters; construction of canal right-of-ways and riverside parks. The project includes community participation in all its stages, as well as generating income and jobs particularly during the implementation phase (Serla, 1996).

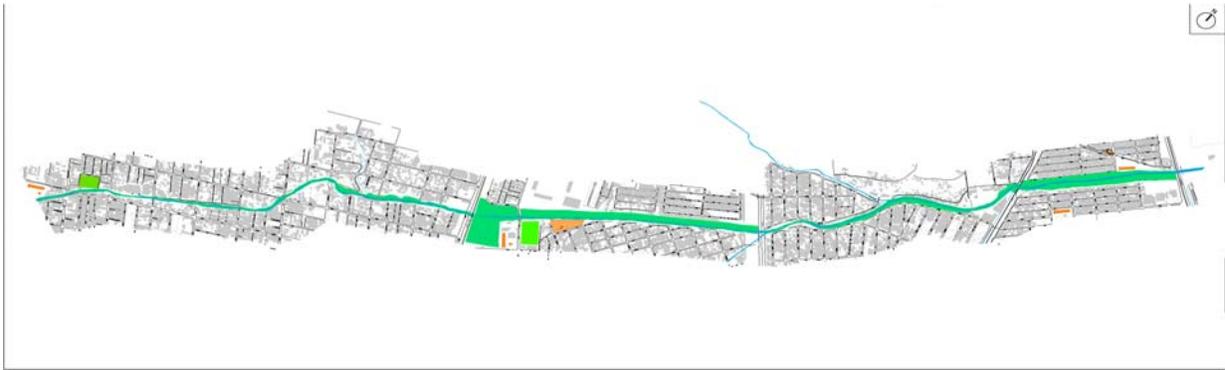
Actions undertaken so far have been limited due to the insufficiency of available funds. More than ten years following its launch, the Iguaçu Project was implemented with the financial support of a federal program named PAC – Program for the Acceleration of Growth (Programa de Aceleração do Crescimento). This program, which allocates funds to logistics projects in various Brazilian cities to help develop their urban and social infrastructure, invested 195 million Reais – about 97 million US dollars – in the project, which has been re-named Flood Control and Environmental Restoration of the Iguaçu, Botas and Sarapuí Rivers’ Basin (Controle de Inundações e Recuperação Ambiental da Bacia dos Rios Iguaçu, Botas e Sarapuí).

Approximately 50 km of rivers and streams running across seven municipalities are the focus of the project, which has developed a range of interventions: hydraulic macro-drainage, including the decontamination and dredging of rivers; repair of sluices; removal of barriers to navigation i.e. narrow bridges; urban and environmental remediation initiatives, including the reforestation of river banks the development of linear parkways; removal of illegally built structures on the banks and relocation of the affected families, and the construction of new secondary roads. Social actions include the registration of families and information campaigns, organization of neighborhood follow-up committees, environmental education, the raising of awareness and citizen participation (Ecologus, 2007).



Source INEA (State Institute for the Environment) archives

Photo 1 – Informal developments along river courses. Aerial view of Sarapuí River, Duque de Caxias



Source: BLAC, 2008

Fig.2 – Opportunities of intervention. Remaining open spaces along the rivers. Sarapuí River



Source: BLAC, 2008

Fig. 3 – Opportunities of intervention. Catch basins, proposed park for Polder of Outeiro River

Public green space within Baixada Fluminense is insufficient to meet population needs. Developing a string of open spaces along the rivers would remedy this situation and offer a new possibility for restructuring the entire territory. Green corridors along the river edges linking vacant lots and other open spaces could form a greenways network and play a variety of recreation and leisure roles while providing ecological connectivity. Connectivity could contribute to the protection and enhancement of urban biodiversity. Nevertheless, green corridors should be considered as an environmental protection measure targeting a wider range of cultural and social goals.

The proposal to develop riverside parks as part of the Iguaçú Project is part of a multi-level strategy intended to address issues related to environmental restoration, the expansion of rivers' social values, and the provision of urban infrastructure by considering environmental, cultural and urban resources.

Initiatives take into account existing realities and deal with the diversity and complexity of situations along the rivers. Opportunities for the development of green corridors are based on existing features and others brought about by the interventions: vacant and abandoned lots waiting for a new designation, informal gardens and green spaces already appropriated by the local population, improvised football fields, reclaimed land after relocation of families, and the like.

Other opportunities arise from hydraulic projects carried out in the retention basins. Owing to impermeable soils and settlements located in hazardous flood-prone areas, hydraulic projects must regulate the flow of flood waters and ensure that large areas remain as open space and are not encroached upon. In these areas, climatic conditions change drastically from very wet during the rainy season to dry the rest of the year. The variation in climate was used as an argument to create floodable parks in these areas. These parks are also designed to perform other functions, including bio-filters for decontaminating surface water. In this sense, parks can be used as large filtering structures while at the same time providing educational and recreational opportunities to the local population.

Following Manning (1997), proposals must seek to combine three features of the experiences of river landscapes: to walk along the river, to have physical access to its waters, and to cross it. In this way, potential relations between river and the local

population can be enhanced, by bringing the river back into the landscape, instead of being inaccessible and remaining hidden from view behind industries, housing and other constructions.

The first rivers to have benefited from urban and landscape projects were the Botas and Sarapuí Rivers, given their structural significance for the territory. The stretch of the Botas River, in between its mouth and the Machambomba River, with an extension of approximately 5 km, flows through the municipalities of Duque de Caxias and Belford Roxo. In the first passage, a predominantly rural area, besides dredging and dragging the river bed, the plans aim at restoring the riparian woodlands along the banks degraded by channel widening. Due to a low level of public – and, consequently, political – visibility, this particular project has not yet begun.

In the Belford Roxo stretch, however, an important section is located within areas of medium and medium-low densities. Past dredging has scared the landscape and left it in a deplorable state. Although the situation was rectified, there was no attempt at reforestation or other restoration of the river banks. On the left bank, a dike and an avenue have been built. Irregular land occupation and an informal network of dirt paths characterize the lower right bank, which is more prone to floods.

Once the dredging is completed, the project calls for the construction of a new roadway on the right embankment, sidewalks and a bike path and the reforestation of key sites to restore riparian vegetation. The water channels in this particular area are in a state of decay and as a result, installations such as sports fields or playgrounds along the river are unsuitable. Wherever possible, however, benches and small leisure areas are authorized in order to establish new links between the population and the river.

The Sarapuí River is composed of two sections. The river maintains its original winding course when flowing through the municipalities of Nilópolis, as well as Mesquita and São João de Meriti where it serves as a boundary. This low and medium-low density urban area is characterized by a mixed land-use pattern along the banks with alternating vacant areas and informal developments. High voltage transmission towers are found on the banks along the river. In certain areas, the power lines form a barrier which could constrain interactions between the river and its immediate surroundings.



Source: BLAC, 2008

Photo 2 – Botas River, Belford Roxo, before intervention. Panoramic view



Source: INEA archives

Photo 3 – Sarapuí River, Mesquita. Panoramic view



Source: BLAC, 2008

Fig. 4 – Botas River. Illustration of the proposed intervention. Avenida Atlántica, Belford Roxo, before and after

Further downstream, however, the situation is different. The river runs through the municipalities of Belford Roxo, São João de Meriti and Duque de Caxias at the point where it reaches a width of 60 to 90 meters. Here, the river's course has been deviated so that the waters no longer flow directly into the Baía de Guanabara but into the Iguaçú River. In addition to the diversion of the river, a dike is partially built along its right bank. This structure is currently occupied by precarious dwellings, thus forming a linear favela on the upper and safe edge of the dike.

The existence of a large open area next to the Sarapuí River serves as a paradigmatic model for the Iguaçú Project. While complex land dispossession processes are under way, current initiatives have focused on a small stretch of this river. In fact, the first of the six proposed riverside parks will be built here. The overall impact of the intervention is negligible but seeks rather to consider how local populations have occupied the area and draw on the existing buildings and other types of informal land uses. The strip of land between the river and a social housing project is a forested area informally used by the residents for leisure and recreation activities. The project integrates existing and new vegetation including both ornamental and fruit-bearing trees. Various uses are proposed: areas of rest and contemplation, sports fields and children playgrounds that form "rooms" within the park. The planning process for the riverside park proposal enabled local residents to share not only their experience of landscape but also their expectations. Public participation was key to enhance the river's capacity to function as a social space.

4. FINAL REMARKS

Interventions in the hydrological system open up a range of opportunities to explore the issues surrounding relationships between rivers, the urban fabric and local residents. This is particularly significant in metropolitan peripheral areas such as Baixada Fluminense. The potential of rivers and streams can be tapped to break the homogeneity of the surrounding urban landscape. Compared to the high density and tightly-built central urban areas where rivers have been canalized and hidden under the streets, the less populated but rapidly-growing peripheries, deprived of financial means and resources, are still endowed with free flowing rivers.

These projects aimed at improving flood control offer a unique opportunity to transform the urban fabric. The investments are justified on social and

environmental grounds. The interventions will significantly transform and bring much needed improvements in terms of infrastructure to an area which had been overlooked by public authorities for a long time.

As discussed above, urban rivers are understood today as environmental structures able to reclaim areas through which they flow. They offer opportunities to create new urban waterfronts, provide new amenities and services and introduce new land uses. Recent academic literature argues that rivers are valuable and meaningful features of urban space. Urban intervention projects emphasize the importance of rivers and their banks in the context of metropolitan level land-use planning practice.

With regards specifically to the Iguaçú Project, urban planning as a discipline plays a minor role in the process as a whole. This is a real concern particularly when projects straddle several municipalities. Isolated decision-making therefore undermines existing metropolitan administrative, political and spatial structures. The Iguaçú Project, although referred to as an interdisciplinary approach, does not differ from other similar former interventions (see Porto, 2003).

Clearly, the proposed riverside parks for the Sarapuí and Botas Rivers will be unable to grapple with the complexity of environmental and social problems specific to their basins. Once completed, the parks have the potential to improve the area, increase public access and enhance the landscape. However, in trying to deal with the complexity of the political challenges facing the Baixada Fluminense, political, socio-cultural, economic and environmental actions and strategies should also be considered.

In view of the above, we argue that environmental restoration of Brazilian cities will require an ability to contend with the complexity, diversity and divergence of a variety of stakeholders and of their views on their experience of the landscape. It implies, therefore, culturally specific interventions which address different needs (such as environmental, economic, and socio-cultural) and integrate various territorial scales (ranging from the globalized scale to the local neighborhood) in distinct time frames. By considering both time and space as heterogeneous, a series of long and short term actions must be undertaken simultaneously on the same landscape.

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ENVIRONMENTAL JUSTICE: A CASE OF SOCIO-ENVIRONMENTAL VULNERABILITY IN RIO DE JANEIRO

Gabriela DA COSTA SILVA

RESUMÉ

La question de la justice environnementale renvoie aux inégalités dans le fardeau environnemental que subissent le plus souvent les minorités et les personnes à faible revenu. Des recherches effectuées au Brésil ont recensé des situations d'injustice socio-environnementale grave dans les zones urbaines. Cette analyse s'intéresse plus particulièrement à la vulnérabilité socio-environnementale afin de déterminer dans quelle mesure les différences socio-environnementales se répartissent dans l'espace intra-urbain et de constituer une base de connaissances pour que la capacité de réaction des communautés aux risques multiples (sociaux, environnementaux, etc.) soit prise en compte dans les décisions en matière d'urbanisme (Mendonça, 2004). Cette étude a pour objet d'évaluer les niveaux de vulnérabilité socio-environnementale dans la région des basses-terres de Jacarepaguá à Rio de Janeiro. Ce faisant, nous abordons les points forts et les limites des pouvoirs publics dont le rôle est de concilier les intérêts privés et publics en matière de justice environnementale.

MOTS-CLÉS ■ justice environnementale, vulnérabilité socio-environnementale, indicateurs socio-environnementaux



ABSTRACT

Environmental justice addresses the unequal environmental burden often borne by minorities and low-income populations. In Brazil, many studies confirm extreme socio-environmental inequities in urban areas. Analysis based on socio-environmental vulnerability allows us to understand the intra-urban spatial distribution of socio-environmental differences and to provide insight for the development of planning policies that enhance the capacity of communities to respond to multiple risks (social, environmental, etc.) (Mendonça, 2004). This study examines the levels of socio-environmental vulnerability in the Jacarepaguá lowlands of Rio de Janeiro, taking into account the existing strengths and limitations of public administrations in their efforts to balance private and public interests in regards to environmental justice.

KEYWORDS ■ Environmental justice, socio-environmental vulnerability, socio-environmental indicators.

I. ADDRESSING ENVIRONMENTAL JUSTICE THROUGH SOCIO-ENVIRONMENTAL VULNERABILITY

The paradigm of environmental justice adopts a holistic approach to formulate public policies. It is based on citizen participation in environmental decisions and communities' empowerment, assuring inter-sector cooperation, inter-agencies coordination, and innovative partnerships' strategies (Bullard, 2004; Heiman, 1996). Increased community participation in government decision-making produces many important benefits, including the reduction of potential environmental risks (Roseland, 2005).

Studies based on socio-environmental vulnerability provide guidelines for public administrators in decision-making processes regarding environmental management and planning (Villa and McLeod, 2002; McHarg, 1969). Socio-environmental vulnerability is the result of marginal and economically deprived groups (social vulnerability) settling in areas of environmental risk or degradation (environmental vulnerability) (Alves, 2006). Studies have shown that an uneven provision of urban infrastructure and services is a reflection of social inequality. Universal access by the population to public amenities and utilities is a key element of distributive justice (Harvey, 1976).

In many Brazilian cities, the spread of areas of privilege, which contributes to the increase of social segregation, is a consequence of socio-political inequalities (Silva, 2007). Jacarepaguá Lowland, a major area of urban expansion in Rio de Janeiro, is an example of the difficulties facing state and municipal governments in promoting urban sustainable development. Real estate interests have shaped the overall pattern of urban development. On the one hand, the evolution of the urban fabric is co-determined by public administrations and real estate companies dedicated to the housing and infrastructure needs of the wealthy. On the other hand, the area's rapid urbanization is increasing stress on infrastructure, compounding the inefficiency of housing for the low-income residents and water and sewerage collection and treatment systems. Effluent discharges from these facilities have caused significant environmental impacts.

This paper examines the levels of socio-environmental vulnerability within the lowlands of Jacarepaguá, taking into account the various ways in which public administrations attempt to balance private and public interests with regards to environmental justice. Social and environmental indexes are used to assess the vulnerability of local communities to inadequate urban infrastructure and to determine the socio-environmental vulnerability of the study area (see Figure 1).

2. THE IMPORTANCE OF THE JACAREPAGUÁ LOWLANDS IN THE URBAN DEVELOPMENT OF RIO DE JANEIRO

The development of Rio de Janeiro in both social and economic terms is characterized by the pattern of urban sprawl which in some cases can be considered as a cause of environmental injustice. The production of urban spaces for the elite began in the 1870s, when economically privileged social classes moved to the south in areas benefiting from government sponsored transportation programs (Leitão, 1995). Before 1930, the wealthy moved to the "new" neighborhoods³ located in the south: Copacabana, Ipanema, Leblon and Gávea. Bourgeoisie, or middle-income classes, lived in the "old" neighborhoods of Catete, Laranjeiras, Flamengo and Botafogo in the south, and Andaraí, Vila Isabel, Tijuca, Aldeia Campista and Rio Comprido in the north. The working, low-income populations settled in the industrial fringe of São Cristóvão and its suburbs (see Figure 2). State and municipal government authorities determined the patterns of occupation and urban development by investing in urban infrastructure for the middle and upper classes in peripheral areas in the southern and northern parts of the city while ignoring the fact that suburbs were home to the working class (Abreu, 1997).

³ In this paper, we refer to "neighborhood" as *bairro* in Brazilian cities. A *bairro* represents the smallest planning unit defined by the municipal administrations and is also one of the census tracts used by the Brazilian Institute of Geography and Statistics (IBGE).



Source: IPP (1997)

Fig. 1 – Jacarepaguá Lowland



Source: IPP (1997)

Fig. 2 – Jacarepaguá Lowland in Rio de Janeiro City

From the end of the 19th century to the early 1920s, residential towers were built along the shoreline of Copacabana replacing the single-family dwellings. Urban density increased as the real estate boom in Copacabana continued throughout the 1950s (Leitão, 1995)⁴. Meanwhile, inefficient public transportation systems “encouraged” the working class to move closer to job opportunities in industry and services. The poor lived in slums on vacant land, especially in areas with difficult access, such as slopes, mangroves, or river banks (Abreu, 1997). In fact, the geomorphology of Rio de Janeiro, composed mainly by mountains and lowlands, determined the spatial dynamics of urban sprawl. Between the 1950s and 1970s, in order to improve vehicular flow and accessibility within the city, the state government invested in expressways, tunnels and overpasses (Abreu, 1997). After the 1970s, the built-up areas expanded westward along the shores of Ipanema and Leblon. Indeed, the “cooperation” between government and real estate companies helped concentrate development in the southern parts but increased segregation across the city along income lines. Since these neighborhoods were intended for high-income groups only, government engaged in slum clearance and was responsible for the relocation of displaced households. At that time, upper class households settled in the neighborhoods of São Conrado and Barra da Tijuca, which launched a population movement westward into the Jacarepaguá Lowlands and further expanded the city limits (Leitão, 1995)⁵.

Before the 1970s, Barra da Tijuca with its geomorphologic characteristics and surrounded by the Pedra Branca and Tijuca hills was very difficult to urbanize and remained mostly uninhabited. Until then, the local government preserved the region as a rural and agricultural residential area under a specific legislation that defined it as Residential Zone 3 (ZR-3, Zona Residencial), according to the Agache Plan⁶. In

1950, the state authorities prepared a road network plan and a building facade plan to regulate urban morphology⁷. In 1956, the Mayor of Rio de Janeiro commissioned the architect and urban planner Lucio Costa to prepare a master plan for the Jacarepaguá Lowlands. Lucio Costa was also mandated to serve as head of a team of consultants (GT-BJ, Grupo de Trabalho da Baixada de Jacarepaguá)⁸. Its role was to define the plan intervention boundaries, building construction regulations, road construction models, private property limits, and the viability of new building construction projects.

The purpose of the plan was to urbanize Barra da Tijuca and the rest of the Jacarepaguá Lowlands by developing a new business center situated in the old historical part of the city of Barra da Tijuca, and by building the new commercial center of Santa Cruz⁹. The area emerged as a metropolitan hub that restructured urban space by joining and diffusing city centers, connecting the city from east to west (see Figure 3). The master plan would serve as well as a legal instrument to discourage predatory real estate activities and indiscriminate land occupation. Also known as the “Pilot Plan”, it defined the area as Special Zone 5 (ZE-5, Zona Especial) (Cardoso, 1989)¹⁰. We emphasize that by 1963, the Doxiadis Plan¹¹ had already established that urban development be concentrated in the northern region of the Jacarepaguá Lowlands and link up with the new road network crossing north-south (Silva, 2004).

⁴ The 2000 Brazilian Census estimated population density in Copacabana to be six times higher than in Rio de Janeiro, respectively 333.6 inhab./sq km and 58.6 inhab./sq km (IPP, 2001c).

⁵ Jacarepaguá Lowlands are divided into three administrative zones: Barra da Tijuca, Jacarepaguá and Cidade de Deus.

⁶ Decree n° 6.000/1937 created the Residential Zone 3. The Agache Plan (1931), the first urban planning scheme after the infrastructure plans of Mayor Pereira Passos (1902-1905), proposed to build a link from the center of the city to Sepetiba and Santa Cruz passing through the Jacarepaguá Lowlands (Costa, 1969).

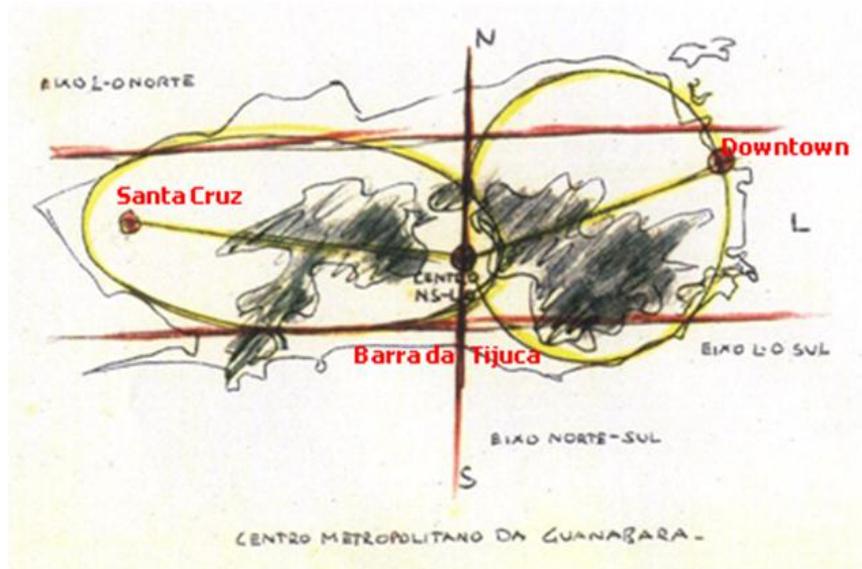
⁷ P.A. n° 5596 established a building facade plan (*Plano de Alinhamento*), according to the road system plan conceived by the Road System Department (DER, Departamento de Estradas e Rodagem).

⁸ In 1974, the group was transformed into the Superintendence of Development of Barra da Tijuca (SUDEBAR, Superintendência de Desenvolvimento da Barra de Tijuca). Between 1974 and 1979, SUDEBAR was in charge of urban development in Barra da Tijuca.

⁹ The new center of Santa Cruz was included in the Doxiadis Plan of 1963 (Abreu, 1988).

¹⁰ In accordance with the specific urban regulation for Special Zone 5 (ZE-5, Zona Especial), the Region of Barra da Tijuca was divided into 46 sub-zones, from A-1 to A-46 (Silva, 2004).

¹¹ In 1963, Governor Carlos Lacerda approved the Doxiadis Plan to urbanize the State of Guanabara, which was a former Brazilian state that existed between 1960 and 1975. The City of Rio de Janeiro is located in this territory (Abreu, 1988).



Source: Modified from Costa (1969)

Fig. 3 – Urban plan for Jacarepaguá Lowland

However, over the course of the last three decades the area went from being a residential-rural place of tranquility to a bustling residential-commercial place also known as “the Miami of Brazil”. The rural landscape was altered as real estate agencies promoted and sold homes and apartments to middle and upper income classes. Government investments in urban infrastructure and the sprouting of slums also brought major changes to the morphology. From 1991 to 2000, the average growth index of the slum population in Barra da Tijuca peaked at 2.23, the highest in Jacarepaguá Lowlands where the overall population doubled (see Table 1). To this day, Barra da Tijuca continues to experience a sustained increase in demographic growth, one of the fastest growing regions of Rio de Janeiro. The number of inhabitants in Barra da Tijuca (XXIV RA, Administrative Region) grew from 2,580 in 1960 to 174,135 in 2000 (see Table 2). Its rate of growth was 21.91 times faster than Jacarepaguá (XVI RA), a neighboring administrative region which has also seen an increase in population due to Barra da Tijuca sprawl.¹²

¹² The City of Rio de Janeiro is divided into five major planning areas called *Áreas de Planejamento* (AP), which in turn are divided into 33 administrative regions called *Regiões Administrativas* (RA). Jacarepaguá Lowlands are part of the municipal planning area 4 (AP-4), which is divided into three administrative regions: Barra da Tijuca (XXIV RA), Jacarepaguá (XVI RA), and Cidade de Deus (XXXIV RA). Each region is then divided into neighborhoods.

Urban sprawl in the Jacarepaguá Lowlands (see Figure 4), especially in Barra da Tijuca, corresponds to the third phase of Rio de Janeiro’s urban development (Cardoso, 1989). The first phase began when suburban sprawled towards the Santa Cruz Lowland area. The second phase occurred in the south, along the shores of Copacabana to Leblon, where occupation was limited to a strip of land between the sea and Mount Tijuca. During the third phase, the state government invested in road infrastructure to increase access to areas to the west and beyond to the Jacarepaguá Lowlands (Pinheiro and Pinheiro, 2001; see Figure 5 and Figure 6). The Jacarepaguá Lowlands represent 25% of the entire land base of Rio de Janeiro (293.42 km² out of a total of 1,182.296 km²) while the wealthier areas to the south make up only 4%, or 43.88 km² (Silva, 2009).

Real estate agents and brokers have contributed to significantly improve this area’s socioeconomic status by shifting their focus to the middle and upper class housing markets. Thus, the area’s urbanization process helped further the interest of real estate promoters and consumers (see Figure 7). With a middle to high status, the Human Development Index (IDH) of Barra da Tijuca ranks fifth across Rio de Janeiro (see Table 3; IPP, 2001b).¹³

¹³ The Municipal Human Development Index (IDH is a composite of the sum of the means of three indexes: Longevity Index (IDH-L), Education Index (IDH-E), and Income Index (IDH-R) (IPP, 2001b).

Table 1
Slum Population Growth in Área de Planejamento 4 (AP-4)

City and Administrative Regions (RA)	Homes		Growth	Population		Growth
	1991	2000	Index	1991	2000	Index
Rio de Janeiro	226,141	308,581	1.36	882,483	1,092,476	1.23
Jacarepaguá Lowlands	18,790	41,289	2.19	72,182	144,394	2.00
XVI RA. Jacarepaguá	14,847	31,952	2.15	56,817	111,448	1.96
XXIV RA. Barra da Tijuca	3,547	8,820	2.48	13,915	31,107	2.23
XXXIV RA. Cidade de Deus	396	517	1.30	1,450	1,839	1.26

Source: IPP (2001a)

Table 2
Demographic Growth of Barra da Tijuca Population*

City and Administrative Regions (RA)	1960	1970	1980	1991	2000	Growth Index
Rio de Janeiro	3,307,163	4,251,618	5,090,700	5,480,778	5,851,914	1.77
XVI RA. Jacarepaguá	164,092	235,238	315,623	428,073	506,760	3.09
XXIV RA. Barra da Tijuca	2,580	5,779	40,726	98,229	174,135	6.74

Source: Modified from IPP (2001c)

* It does not include slum population.



Source: IPP (1997)

Fig. 4 – Jacarepaguá Lowland according to geomorphologic and hydrological marks



Source: SMAC (2000)

Fig. 5 – Barra da Tijuca and Lagoon Tijuca, 1955



Source: SMAC (2000)

Fig. 6 – Barra da Tijuca and Lagoon Tijuca, 1999



Source: Silva (2009)

Fig. 7 – Residential condominium in Barra da Tijuca neighborhood

Table 3
Municipal Human Development Index (IDH) in Jacarepaguá Lowlands Watershed, from 1991 to 2000

Administrative Regions	Longevity		Education		Income		Municipal Human	
	Index		Index		Index		Development	
	(IDH-L)	(IDH-L)	(IDH-E)	(IDH-E)	(IDH-R)	(IDH-R)	Index (IDH)	Index (IDH)
	1991	2000	1991	2000	1991	2000	1991	2000
XXIV RA. Barra da Tijuca	0.741	0.795	0.891	0.961	0.978	1.000	0.870	0.918
XVI RA. Jacarepaguá	0.731	0.780	0.892	0.933	0.770	0.819	0.798	0.844

Source: Modified from IPP (2001b).

Several reasons can account for this unprecedented scale and rate of urbanization. First, real estate agencies had based their marketing campaigns on natural features such as beaches, lagoons, and mountains to attract potential buyers. They “sold” the area to privileged families searching for security and leisure (Leitão, 1995). Second, one third of the area belonged to only four property owners who had hardly subdivided their land into lots. This form of land tenure contributed to the intensification of urban development. Third, in the 1970s and 1980s the federal government “helped” fund real estate agencies with housing lines of credits from the Housing Financial System (SFH, Sistema Financeiro de Habitação). In Barra da Tijuca, 25 to 30 floor apartment towers were constructed alongside axial roads and around small centers, which extended the built-up areas and increased population density (Cardoso, 1996; Pinheiro and Pinheiro, 2001). Between 1980 and 2000, population density in Barra da Tijuca (XXIV RA) increased by a factor of 4.25, in contrast to 1.15 in the city and 1.49 in Jacarepaguá (XIV RA) (IPP, 2001c). Finally, public investments in infrastructure mainly in the construction of the road network in accordance with the Pilot Plan increased the likelihood that real estate agencies achieve high profit margins and become a leading player in the growth and development of the urban fabric (Leitão, 1995).

The Pilot Plan has undergone several changes since its implementation. The most striking modification is the increase in land use density or intensity provisions. This was a direct result of pressure from the real estate lobby to persuade the municipal government to modify the building code (Ribeiro, 1990; Leitão, 1995). Most of the proposed changes to the original plan were approved in the late 1970s. For example, changes included raising the maximum building height regulations, and rezoning

single-family to multi-family housing etc¹⁴. Moreover, Decree n° 324 which made the Pilot Plan legally binding was modified into Decree n° 3046/1981 following appeals by the real estate lobby¹⁵. Once this law was passed, building height regulations and lot subdivision requirements were altered to benefit private capital interests, allowing the construction of residential apartment hotel units all along the Barra da Tijuca seashore (Silva, 2004). The influence of private interests in public affairs has continued to this day, as new urban regulations were introduced in the plan (Schmidt, 2000). For example, the Municipal Law n° 2128/1994 established new planning guidelines: building heights, the urban growth boundary and building types and functions. Also, the Complementary Municipal Law n° 41/1999 approved the construction of residential apartment hotel units that had been prohibited in 1985 (Silva, 2004).

Under the new set of laws, the main beneficiaries were real estate companies. From 1998 to 2005, 58% of the total area zoned for development in the city (19,713,912 m²) was in the Jacarepaguá Lowlands (11,388,466 m²) (SMU, 2005b). In 2005, 46% of building start-ups in the city were located in the Jacarepaguá Lowlands (SMU, 2005a). Most of the private and public investments for the Pan-American Games 2007 held in Rio de Janeiro were concentrated in the Jacarepaguá Lowlands. The massive infrastructure projects are the most likely reason why rapid urban expansion took place. In addition, during 2005, investments were made primarily in residential areas, which represented 65% of the total investment for the city as a whole and 93% of the total investment in the Jacarepaguá Lowlands (SMU, 2005a).

¹⁴ In 1984, the Parliamentary Commission of Inquiry (CPI, Comissão Parlamentar de Inquérito) of the City Council (Câmara dos Vereadores) received many accusations during the mayoral terms of Marcos Tamoio (1975-1979) (Silva, 2004).

¹⁵ Decree n° 3046/81 regulated Zona Especial 5 (ZE-5, Especial Zone 5) and its neighborhoods.

It is important to emphasize that the Pilot Plan set aside a vast area for low-income and social housing. The so called “Parallel Plan” aimed to give an opportunity for poor families to live in Itanhangá, Barra da Tijuca, Jacarepaguá and Recreio dos Bandeirantes. The fact that the municipality never went ahead with this plan is evidence that the sole intention was to attract middle and upper classes to the area, giving rights to real estate property owners only and promoting forms of social segregation in the city (Silva, 2004). Therefore, growth of slum population tends to be higher in Barra da Tijuca and in Jacarepaguá than in the general population. In 2000, Barra da Tijuca (XXIV RA) had 36 slums, more than half as many as the 76 slums found in Jacarepaguá (XVI RA). In relation to population size, slums in Barra da Tijuca region are small: 56.5% are home to less than 500 people, and the average population per slum is 441 inhabitants. The situation in Jacarepaguá differs sharply with a slum population mean of 1,038 people (IPP, 2000). In comparison, between 1991 and 2000, the most populated slums in the Rio das Pedras neighborhood had increased by a factor of 2.23, reflecting not only the demographic expansion of Jacarepaguá (1.96 times more populated) but also of Barra da Tijuca (2.23 times) (IPP, 2000) (see Figure 8). These increases are most likely related to economic development and job opportunities for the low-income and low-skilled classes, hired in the services sector or as domestic workers (Kasahara, 2002)¹⁶.

3. URBAN INFRASTRUCTURE LEADING TO ENVIRONMENTAL (IN) JUSTICE

Environmental inequalities exist within cities. It is also true for Brazilian municipalities. Urban areas tend to produce a social scenario in ways that lead to environmental injustice because they are likely to benefit the elite at the expense of marginalized individuals and groups. In general, urban development reflects wider distorted and destructive social and economic dynamics which may create unequal and unjust conditions for resource use. The distribution of environmental hazards and the access to natural resources within cities are therefore a result of social and economic dynamics (Silva, 2004; Heynen, 2004).

Negative environmental externalities associated with the extensive development of the Jacarepaguá Lowlands have resulted in the deterioration of quality of life. Despite massive public investments in some infrastructure projects that significantly spurred the

real estate market¹⁷, the increase in socio-environmental vulnerability and therefore environmental injustice is somehow linked to the low efficiency of urban infrastructure.

Several reasons can explain this trend. First, the absence of an affordable housing policy aimed at minorities and low-income families who are more likely to live in substandard dwellings. Indeed, slums formed in the area because the state and municipal governments in order to defend the interests of local real estate agencies did not endorse the guidelines of the Pilot Plan to implement the Parallel Plan. Therefore, poor families started building their houses either close to water bodies – rivers, canals and streams – or on hillsides. Since favelas lack sanitary disposal and rainwater drainage systems, raw sewage is discharged in rivers, streams, or lagoons (see Figure 9). They are also more vulnerable to landslides.

The second reason is based on the fact that in these poor communities, household waste is not collected by the municipal administration but instead is discharged or carried by rainfall into watercourses, burned on vacant public land, or discarded on vacant private property. The irregular occupation of land by slum housing or condominiums, which are generally constructed haphazardly on river embankments, violates several state and municipal laws on environmental protection (see Figure 10). For example, in 2000 around 50,000 residents lived in nine slums located on the edges of the Tijuca and Camorim Lagoons, the most polluted lagoons in the Jacarepaguá Lowland watershed (Silva, 2004). In addition, since February 2009 the municipal government is demolishing irregularly-built houses located along Canal Marapendi, with the intention of reinstating the original plan that was developed for Lucio Costa and reducing environmental risk (see Figure 11).

The third and most significant reason relates to the absence of water distribution and wastewater collection infrastructure. An integrated sanitation system was never put into service in the area. The solution imposed by the state government to real estate companies was to construct small private sewage treatment plants for each residential

¹⁶ According to Kasahara (2002), 40% of Rio das Pedras residents work as gardeners, sale representatives and servants.

¹⁷ Among public investments, we highlight the construction of a modern road network mainly between 1966 and 1982, which improved access to the region and increased investment in large scale residential condominium projects. For example: the road pavement in Alvorada Avenue (Ayrton Senna Avenue), the implementation of Rio-Santos Road (Américas Avenue) and Lagoa-Barra Highway, and the opening of the Dois Irmãos Tunnel (Leitão, 1995). In addition, from 1980 to 1983, the state government financed some urban services, such as water, electricity and gas (Leitão, 1995; Gonçalves, 1999).



Source: Silva (2009)

Fig. 8 – Vertical growth of poor houses at Slum Rio das Pedras



Source: Silva (2009)

Fig. 9 – Poor family house on the edges of Canal Sernambetiba



Source: Silva (2009)

Fig. 10 – Medium-income family house on the edges of Canal Marapendi



Source: Silva (2009)

Fig. 11 – Demolishment of house on the edges of Canal Marapendi

condominium complex. Up until 2001, the public authority had never invested in sewerage services, a fact that led to more than 20 years of socio-environmental conflicts and caused water resources degradation in the Jacarepaguá Lowland watershed. Citizens demanded that sewerage facilities be constructed in Barra da Tijuca (XXIV RA), because it was the only area in the Jacarepaguá Lowlands still without an integrated sanitation system. Toward this end, a social movement emerged in February 1981 with the creation of the Association of Inhabitants and Friends of Barra da Tijuca (AMABARRA). In 1982, discussions began with the state government to provide an efficient sanitation system capable of solving or avoiding environmental problems, including surface water pollution and water table contamination (Evangelista, 1989).

Contrary to other socio-environmental conflicts in Brazilian cities where low-income residents organize themselves and form social movements, in the case of Barra da Tijuca, middle to high income residents advocated for improved facilities. All residential start-ups were obliged by law to build and operate private small sewage treatment plants before a construction license was issued. However, because of their high cost of maintenance and of disposing sewage in the public sanitary landfill in Gramacho City, some residential condominiums discharged the effluents in natura i.e. in water bodies (Bredariol, 1997). After 1985, AMABARRA required that a permanent solution to wastewater and sewage treatment be found. Water pollution was a serious problem in Ipanema once a submarine emissary was installed in 1975. The public administration decided unilaterally to build a

submarine emissary and a sewage plant for primary treatment of wastewater in Barra da Tijuca in 1986. Although the state government planned to start construction two years later, it took until February 2001, after years of social, political and technical conflicts, to finally launch the project.

The struggle for sanitation facilities lasted 20 years when the state administration began the Sanitation Program of Barra da Tijuca, Recreio dos Bandeirantes and Jacarépaguá (PSBJ). The project includes the construction of a sewage treatment plan, subterranean and submarine emissaries, pipelines, pumping stations, sewage pumps, collecting sewers and building connections (see Figure 12, CEDAE, 2008)¹⁸. Despite its scope, the program was never designed to service the entire Jacarepaguá Lowlands territory. For instance, only after 2006 the PSBJ included Recreio dos Bandeirantes. Still today, other neighborhoods such as Camorim, Grumari, Vargem Pequena and Vargem Grande are left out of the program and without facilities (see Figure 13). The program was extended from March 2003 to the end of 2011, because of unfavorable climatic conditions during the construction of the submarine emissary and state governments' delay in paying engineering companies (Silva, 2009)¹⁹.

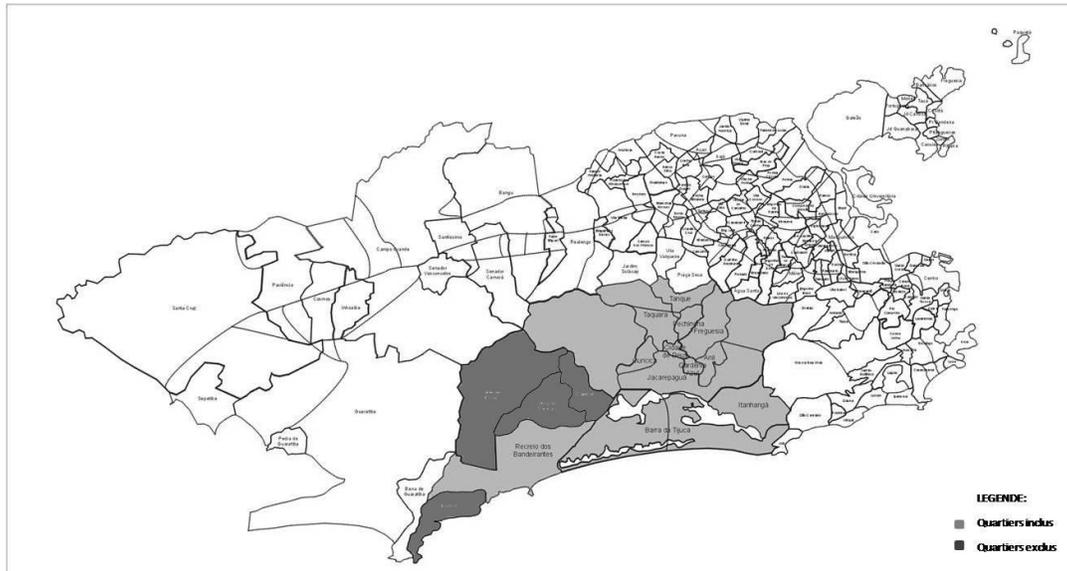
¹⁸ The sewerage collection and transport system in the Jacarepaguá Lowlands consists mainly of a network of underground sewers pipes and pumping stations that carry sewage first to a treatment plant and then to underwater facilities that discharge sewage effluents directly into the sea.

¹⁹ Until 6th June 2009, the state government invested in the PSBJ R\$ 464,809,022.30 and will invest another R\$ 107,762,484.94 (Respectively CAN\$ 267,280,623.28 and CAN\$ 61,967,007.44, according to the Brazilian Central Bank in June 16th, 2009).



Source: CEDAE (2006)

Fig. 12 – Construction of submarine emissary



Source: CEDAE (2006)

Fig. 13 – Neighborhoods Assisted and Not Assisted by the Program of Sewerage in Barra da Tijuca, Recreio dos Bandeirantes and Jacarepaguá (PSBJ), in Jacarepaguá Lowland

On the one hand, as the real property market in Barra da Tijuca has improved conditions for middle and upper income classes, it has driven urban development to unprecedented levels in the area and the entire Jacarepaguá Lowlands. On the other hand, profit-seeking private developers, an inefficient sanitation network and relaxed legislation combine and interact to give rise to several environmental problems. For example, in Lagoons Tijuca and Camorim the Municipal

Cleaning Company (COMLURB) collected, from October 1998 to February 2003, 3,328 tons of aquatic plants and floating garbage, an average of 61.6 tons a month. In some periods of the year, especially in the summer, wind direction and air currents cause tidal changes where the deeper water rises to the surface. When the water turns over, hydrogen sulfide gas is released, which although beneficial to fish and plants gives off a sulfurous bad smell. The resulting

eutrophication process reduces the water surface and depth. In 2000, both lagoons had a mean depth of less than a meter, ranging from a minimum of 30 cm and a maximum of 12.7 meters (CREA-RJ, 2000; see Figure 6). According to Hough (2000), the average natural sedimentation rate is one millimeter per year. In some areas of Lagoon Camorim the 1980 mean depth of two meters (or 200 cm) decreased to 10 cm in 2000 (Portella, 2001), a rate 10 times higher than natural sedimentation. The lagoons in Barra da Tijuca, Lagoons Tijuca, Camorim and Jacarepaguá were classified in 2001 as hypertrophic, highly fertile and supersaturated in phosphorus and nitrogen. Also, the excessive phytoplankton growth contributes to increased water turbidity, unsuitable recreational uses, and a depleted habitat for desirable fish. On the contrary, Lagoons Marapendi and Lagoinha were classified as eutrophic, greener and murkier with higher amounts of nutrients and algae (SEMADS, 2001).

4. SOCIAL-ENVIRONMENTAL VULNERABILITY IN THE JACAREPAGUÁ LOWLANDS

Social-environmental vulnerability refers to damage caused by socioeconomic and environmental hazards. Urbanization in the Jacarepaguá Lowlands has led to inequitable urban development and segregation due to an unequal distribution of resources across advantaged and disadvantaged neighborhoods. Indeed, land use policy has been influenced by exclusionary practices based on real estate interests, have enhanced property values and excluded “undesirable” poor communities.

In order to assess the current situation in the Jacarepaguá Lowlands, we defined a Social-environmental Vulnerability Index (SEVI). This index is designed to provide insights into the processes that can negatively influence the sustainable development of municipalities (Silva, 2006). The purpose of the SEVI is to examine the vulnerability of a territory, especially watersheds, in relation to urban public services (sanitation, water supply and garbage removal) and to local socioeconomic conditions (average family income and level of schooling). We strongly believe that socioeconomic and environmental vulnerability indicators help policy-makers achieve sustainable development goals. The indicator method is an

efficient and standardized way to characterize vulnerability in an overall sense, taking into account socioeconomic and environmental (urban infrastructure) factors. The SEVI is an environmental management tool for decision-making focusing around issues of politics, economics and social and cultural factors at the local scale and concentrating on planned outcomes.

The SEVI builds a connection between indicators of environmental and sanitation public services to the socioeconomic conditions of the local population. It is based on the work of the Brazilian Institute of Geography and Statistics (IBGE). It measures the percentage of the population living in vulnerable conditions. In order to calculate this index, two complementary indices were used: the Socioeconomic Vulnerability Index (SVI) and the Environmental Vulnerability Index (EVI). The SEVI equation is equal to the arithmetic mean between the SVI and the EVI, that is: $SEVI = (SVI + EVI)/2$. Table 4 shows the weight of these and the various complementary indexes. According to Silva (2006), the range of values for the SEVI, SVI and EVI are between 0 and 1. The value 1 corresponds to the highest degree of vulnerability for a spatial unit and the value 0 is the lowest degree of vulnerability. The results of the indicators that compose SVI and EVI are presented in percentile values, varying between 0% and 100% (see Table 5).

Drawing on statistical data from the Brazilian Census 2000 (IBGE, 2000), the degree of social-environmental vulnerability in the Jacarepaguá Lowlands was determined. The Census uses political and administrative boundaries to define neighborhoods (or bairros). Socioeconomic and environmental variables that we considered vulnerable were chosen to calculate the Socio-environmental Vulnerability Index (SEVI). We began our analysis by calculating the Socioeconomic Vulnerability Index (SVI) based on socioeconomic indicators (average family income and level of schooling). We followed-up with the Environmental Vulnerability Index (EVI) which is based on environmental indicators related to urban infrastructure, such as sewage services, water supply and garbage disposal (see Table 6). The methodology used to calculate the indices is described in the following sections.

Table 4
Weights of the indicators that compose the SEVI and the EVI

Vulnerability Indices	Lowest	Highest
Socio-environmental Vulnerability Index (SEVI)	0	1
Socioeconomic Vulnerability Index (SVI)	0	0.5
Indicator of Vulnerability in Average Family Income (IVAFI)	0	0.25
Indicator of Vulnerability in Level of Schooling (IVLS)	0	0.25
Environmental Vulnerability Index (EVI)	0	0.5
Indicator of Vulnerability in Sewage Services (IVSS)	0	0.166
Indicator of Vulnerability in Water Supply (IVWS)	0	0.166
Indicator of Vulnerability in Garbage Disposal (IVGD)	0	0.166

Source: Based on Silva (2006).

Table 5
Degree of vulnerability according to SEVI, SVI and EVI

Degree of Vulnerability	SEVI, SVI and EVI	Indicator Components
Low	0 to 0.1	0% to 10%
Medium	0.1 to 0.2	10% to 20%
High	0.2 to 0.4	20% to 40%
Very High	0.4 to 0.6	40% to 60%
Extreme	0.6 to 1	60% to 100%

Source: Based on Silva (2006).

4.1 Methodology and results of the Socioeconomic Vulnerability Index (SVI)

The first stage of the methodology examines the socioeconomic systems that might increase susceptibility towards environmental features. Socioeconomic vulnerability, thus, refers to the communities' economic, institutional, technical and cultural capacity to avoid or to face changes in the socioeconomic system. Here, the analysis of the socioeconomic vulnerability of the Jacarepaguá Lowlands considers two important parameters: family income and education.

We started with the Indicator of Vulnerability in Average Family Income (IVAFI), which determines the percentage of the local population more vulnerable to impoverishment. To calculate the IVAFI we used only variables classified as vulnerable in Table 6, such as: "> 1 and < 2 MS" (I5), "> 1/2 and < 1 MS" (I6), "< 1/2 MS" (I7), and "No income" (I8). The equation for the

IVAFI is here expressed: $IVAFI = (I5 + I6 + I7 + I8)/100$. Then, we determined the Indicator of Vulnerability in Level of Schooling (IVLS), which refers to the percentage of inhabitants more than 15 years old with an education level deemed vulnerable (Table 6), such as: "4 to 7 years" (E4), "1 to 3 years" (E5), "Illiterate or less than one year" (E6). The equation for the IVLS is here expressed: $IVLS = (E4 + E5 + E6)/100$. Finally, to calculate the Socioeconomic Vulnerability Index (SVI) we relied on the results of the Indicator of Vulnerability in Average Family Income (IVAFI) and the Indicator of Vulnerability in Level of Schooling (IVLS), which is expressed in the following equation: $SVI = (IVAFI + IVLS)/200$.

The results of these indices confirmed what we had initially assumed. The years of schooling an individual has completed are reflected in the type of occupations which carry higher prestige in society and earnings. That is, in general terms, occupation status and income increase with the level of schooling.

Table 6
Socioeconomic and environmental indicators that compose the SEVI.²⁰

Degree of Vulnerability	Socioeconomic Indicators		Environmental Indicators		
	Average Family Income	Level of Schooling	Sewage Services	Water Supply	Garbage Disposal
Non-Vulnerable	> 20 MS (I1)	> 15 years (E1)	Public sewer system (S1)	Connected to water supply system – with plumbing in one room or more (W1)	Directly collected (G1)
	> 10 and < 20 MS (I2)	11 to 14 years (E2)	Septic tank (S2)	Connected to well (in the lot) - with plumbing in one room or more (W2)	
	> 5 and < 10 MS (I3)	8 to 10 years (E3)		With another kind of water supply - with plumbing in one room or more (W3)	
	> 2 and < 5 MS (I4)				
Vulnerable	> 1 and < 2 MS (I5)	4 to 7 years (E4)	Primitive cesspool (S3)	Connected to water supply system - with plumbing in the lot (W4)	Indirectly collected (G2)
	> 1/2 and < 1 MS (I6)	1 to 3 years (E5)	Sewage disposal in ditch (S4)	Connected to well (in the lot) - with plumbing in the lot (W5)	Incinerated (in the lot) (G3)
	< 1/2 MS (I7)	Illiterate or less than one year (E6)	Sewage disposal in river, lake or sea (S5)	Connected to well (in the lot) - without plumbing (W6)	Buried (in the lot) (G4)
	No income (I8)		Another kind of sewage disposal (S6)	Another kind - with plumbing in the lot (W7)	Thrown in vacant lot (G5)
			Neither bathroom nor latrine (S7)	Another kind - without plumbing in the lot (W8)	Thrown into river, lake or sea (G6)
				Another kind of garbage disposal (G7)	

Source: Silva (2009)

²⁰ In Table 6, “I” refers to income, “E” refers to education, “S” refers to sewerage, “W” refers to water, “G” refers to garbage, and “MS” refers to the Brazilian minimum monthly wage, which is R\$ 465 (or CAN\$ 270.96 according to the Brazilian Central Bank as of June 16th, 2009).

First, the results of the Indicator of Vulnerability in Average Family Income (IVAFI) show that the least vulnerable neighbourhoods are Barra da Tijuca followed by Joá, and Camorim and Cidade de Deus, at the other end of the scale, are the most vulnerable. In relation to other areas in the metropolitan region of Rio de Janeiro, the Jacarepaguá Lowlands was an area of high vulnerability in 1991 (IVAFI = 32.18) which reached a medium level of vulnerability in 2000 (IVAFI = 19.96) (Silva 2006). Second, the results of the Indicator of Vulnerability in Level of Schooling (IVLS) of the Jacarepaguá Lowlands show that the least vulnerable neighbourhood is, again, Barra da Tijuca, which implies that the majority of its population is more educated than in other areas. In Barra da Tijuca, 61.55% of inhabitants have more than 15 years of schooling. In contrast, in Grumari, 25.78% of its population is illiterate or with less than one year of education. In comparison to other areas, the IVLS in the Jacarepaguá Lowlands dropped from 42.49% in 1991, a very high level of vulnerability to 34.37% in 2000 (Silva 2006).

Finally, the results of the Socioeconomic Vulnerability Index (SVI) show that the socioeconomic vulnerability of Barra da Tijuca, the neighborhood at the center of the plan of Lucio Costa in the 1970s, is low when compared to Camorim, Vargem Pequena and Grumari (see Table 7; see Figure 14). It is important to mention that the state government denied these three neighborhoods together with Vargem Grande from the Sanitation Program of Barra da Tijuca, Recreio dos Bandeirantes and Jacarepaguá (PSBJ). Moreover, Barra da Tijuca, the lowest vulnerability neighborhood in terms of family income and education benefited from the construction of a submarine emissary and the main sewage treatment plant. However, conditions remained the same in seven neighborhoods (Jacarepaguá, Gardênia Azul, Cidade de Deus, Camorim, Vargem Pequena, Vargem Grande and Grumari) characterized by very high vulnerability for family income and extreme vulnerability for level of schooling. Despite these contrasts, the results of the Socioeconomic Vulnerability Index (SVI) show that the Jacarepaguá Lowlands are one of the least vulnerable areas compared to the data obtained from the 1991 Brazilian Census for the metropolitan region of Rio de Janeiro (Silva, 2006).

4.2 Methodology and results of the Environmental Vulnerability Index (EVI)

The second stage of the methodology addresses urban infrastructure systems. This focus is premised on the view that their absence or low efficiency tends to damage natural resources and to increase communities' susceptibility to environmental hazards. We identified

three components: sewage services, water supply and garbage disposal. These indicators reflect the quality of the public services offered to local communities by the state government (for sewage services and water supply), and by the municipal administration (garbage disposal).

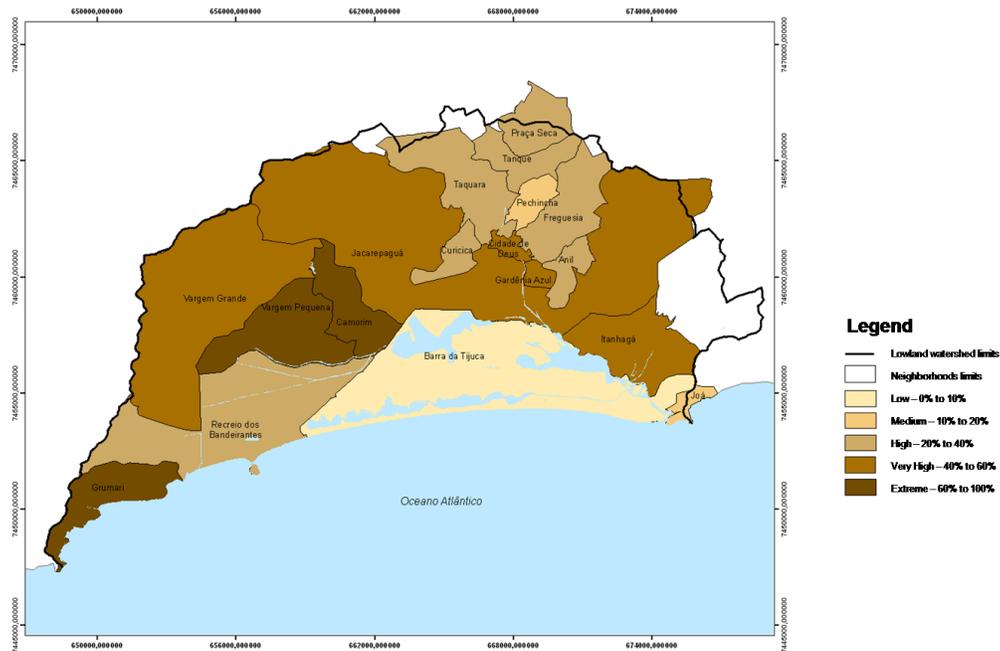
Based on the Indicator of Vulnerability in Sewage Services (IVSS), which determines the percentage of the local population living in vulnerable housing, access to adequate sanitation facilities was initially examined. To calculate the IVSS we used only the variables classified as vulnerable in Table 6, such as: "Primitive cesspool" (S3), "Sewage disposal in ditch" (S4), "Sewage disposal in river, lake or sea" (S5), "Another kind of sewage disposal" (S6), and "Neither bathroom nor latrine" (S7). The equation for the IVSS is here expressed: $IVSS = (S3 + S4 + S5 + S6 + S7)/100$. Then, the Indicator of Vulnerability in Water Supply (IVWS), which refers to the percentage of residents with inadequate water supply, was calculated using the following variables (see Table 6): "Connected to water supply system - with plumbing in the lot" (W4), "Connected to well (in the lot) - with plumbing in the lot" (W5), "Connected to well (in the lot) - without plumbing" (W6), "Another kind - with plumbing in the lot" (W7), and "Another kind - without plumbing in the lot" (W8). The equation for the IVWS is here expressed: $IVWS = (W4 + W5 + W6 + W7 + W8)/100$. For the calculation of the Indicator of Vulnerability in Garbage Disposal (IVGD), which refers to the percentage of residents with inadequate garbage removal and disposal (see Table 6), the variables used were: "Indirectly collected" (G2), "Incinerated (in the lot)" (G3), "Buried (in the lot)" (G4), "Thrown in vacant lot" (G5), "Thrown into river, lake or sea" (G6), "Another kind of garbage disposal" (G7). The equation for the IVGD is here expressed: $IVGD = (G2 + G3 + G4 + G5 + G6 + G7)/100$. Finally, to calculate the Environmental Vulnerability Index (EVI) we relied on the results of the Indicator of Vulnerability in Sewage Services (IVSS), the Indicator of Vulnerability in Water Supply (IVWS), and the Indicator of Vulnerability in Garbage Disposal (IVGD), which is expressed in the following equation: $EVI = (IVSS + IVWS + IVGD)/300$.

The conclusion that can be drawn from these indices confirms the trend found in other Brazilian cities. Public administrations invest in high-income areas and provide infrastructure for their populations. The results of the Indicator of Vulnerability in Sewage Services (IVSS) show that one third of the Jacarepaguá Lowland neighbourhoods are not served with adequate sanitation facilities, for instance: Jacarepaguá, Itanhangá, Camorim, Vargem Pequena, Vargem Grande and

Table 7
Results of the Socioeconomic Vulnerability Index (SVI)

Neighborhoods	Average Family Income (IVAFI)	Level of Schooling (IVLS)	Socioeconomic Vulnerability Index (SVI)
Jacarepaguá	43,83 Very High	63,2 Extreme	0,54 Very High
Anil	19,62 Medium	31,27 High	0,25 High
Gardênia Azul	45,94 Very High	66,73 Extreme	0,56 Very High
Cidade de Deus	53,69 Very High	60,66 Extreme	0,57 Very High
Curicica	29,64 High	48,17 Very High	0,39 High
Freguesia	20,3 High	28,57 High	0,24 High
Pechincha	16,15 Medium	23,14 High	0,20 Medium
Taquara	23,77 High	35,83 High	0,30 High
Tanque	27,88 High	42,22 Very High	0,35 High
Praça Seca	30,68 High	39,58 High	0,35 High
Joá	7,96 Low	13,04 Medium	0,11 Medium
Itanhangá	36,51 High	64,4 Extreme	0,50 Very High
Barra da Tijuca	5,96 Low	7,67 Low	0,07 Low
Camorim	56,29 Very High	66,06 Extreme	0,61 Extreme
Vargem Pequena	56,8 Very High	67,5 Extreme	0,62 Extreme
Vargem Grande	44,36 Very High	65,56 Extreme	0,55 Very High
Recreio dos Bandeirantes	22,23 High	35,56 High	0,29 High
Grumari	43,76 Very High	89,85 Extreme	0,67 Extreme

Source: Silva (2009)



Source: Silva (2009)

Fig. 14 – Results of the Socioeconomic Vulnerability Index (SVI) in Jacarepaguá Lowland

Grumari. This is most notable in Camorim where 85.23% of the population lives in extreme housing conditions. Compared to other areas in the metropolitan region of Rio de Janeiro, the Jacarepaguá Lowlands are rated at a medium vulnerability that decreased from 19.81 in 1991 to 12.62 in 2000 (Silva 2006). On the contrary, the results of the Indicator of Vulnerability in Water Supply (IVWS) show that 78% of its population has access to adequate water services, although 64.85% of the residents of Grumari, the most vulnerable area, must bear the burden of inadequate water supply. Again, compared to other areas in the metropolitan region of Rio de Janeiro, the level of vulnerability found for the Jacarepaguá Lowlands is low, which dropped from 4.12 in 1991 to 0.45 in 2000 (Silva 2006). Indeed, this decrease is a direct consequence of the willingness of the state government to provide universal water service coverage. The results of the Indicator of Vulnerability in Garbage Disposal (IVGD) show that only 39% of the population is provided with satisfactory garbage removal and disposal services. The neighborhoods of Grumari (IVGD = 65.63%) and Itanhangá (IVGD = 51.68%) reach extreme and very high vulnerability levels, respectively. Overall, the level of vulnerability of the Jacarepaguá Lowlands, which increased from 12.22 in 1991 to 15.81 in 2000 (Silva 2006), is considered to be medium.

The results of the Environmental Vulnerability Index (EVI) indicate low environmental vulnerability for Barra da Tijuca while Grumari with an extreme environmental situation stands at the opposite end of the spectrum (see Table 8; see Figure 15). As mentioned before, Camorim, Vargem Pequena, Vargem Grande and Grumari are left out of the state program to provide the Jacarepaguá Lowlands with sanitation facilities, despite their critical environmental vulnerability varying from high to extreme with regards to sewage services. In fact, only the areas settled prior to the implementation of the Pilot Plan are assigned low vulnerability scores.²¹ In addition, the fact that these neighborhoods and some others still cannot count on an adequate public sewerage system is a major contributor to the pollution of water bodies. We can observe sewage discharges flowing without any treatment into rivers and canals, reaching the waters of local lagoons and the sea. Moreover, the vulnerability of some neighborhoods in terms of garbage collection and disposal also increases the risk

of water pollution. Some of the waste is buried and seeps into the water table or is disposed of directly into water bodies.

4.3 Methodology and results of the Socio-environmental Vulnerability Index (SEVI)

The analysis of the socio-environmental vulnerability of the Jacarepaguá Lowlands draws on the results of the Socio-environmental Vulnerability Index (SEVI), which has a value equal to the arithmetic mean between the Socioeconomic Vulnerability Index (SVI) and the Environmental Vulnerability Index (EVI). The SEVI shows that Barra da Tijuca and Joá are neighborhoods with low socio-environmental vulnerability, while Grumari is faced with an extreme socio-environmental situation (see Table 9; see Figure 16). The SVI is a significant predictor of the socio-environmental vulnerability in the Jacarepaguá Lowlands. The Jacarepaguá Lowlands display a high vulnerability level compared to other areas in the metropolitan region of Rio de Janeiro, which decreased from 0.25 in 1991 to 0.18 in 2000 (Silva 2006).

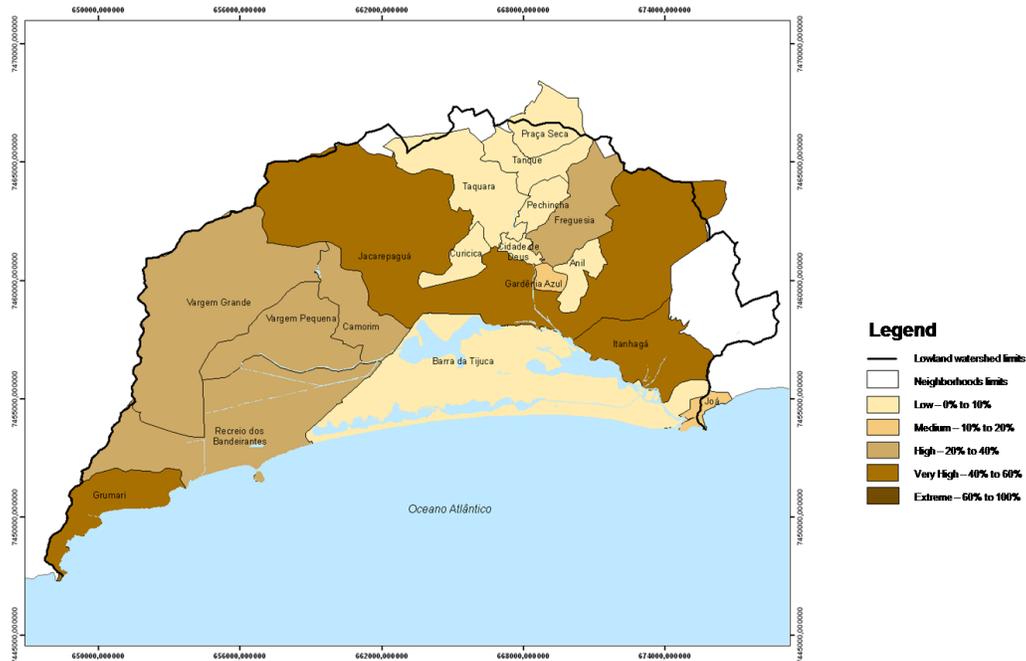
Clearly, urban environmental problems impact rich and poor communities in distinct ways. The purchasing power of the wealthy is significantly greater than the poor, and they can continue consuming natural resources without concern for their cost. On the other hand, when natural resources are rare or polluted the poor will be impacted first and the hardest. Due to their low socioeconomic mobility and status and sense of political powerlessness, most vulnerable populations do not have access to quality housing in neighborhoods with adequate urban infrastructure, such as: water supply, garbage collection and disposal, sanitation services, surface water drainage, etc. Living in these conditions, the poor face greater health risks (e.g.: water-related diseases) but also environmental risks (e.g.: flooding, landslide and other natural hazards). Despite social inequalities in health outcomes, pollution will affect eventually all income groups. Providing ineffective and inefficient services, over time, will adversely affect everyone regardless of income and education levels. For example, the lack of sewage and sanitary systems has resulted in polluted water bodies in littoral cities (Jacobs, 1991; Hardoy, 1992). In all Brazilian municipalities including the Jacarepaguá Lowlands, the role of public administration is vital to mitigate negative impacts on the urban environment and population by investing in sanitation and by introducing specific legislation to regulate and restore the environment.

²¹ The neighborhoods included in the urbanization process of the Jacarepaguá Lowland region in the 1970's, based on the urban plan of Lucio Costa, are the following: Joá, Itanhangá, Barra da Tijuca, Camorim, Vargem Pequena, Vargem Grande, Recreio dos Bandeirantes, and Grumari. The other areas were urbanized before that period and serviced by a public sewer system, resulting in low environmental vulnerability for sewage services.

Table 8
Results of the Environmental Vulnerability Index (EVI)

Neighborhoods	Water Supply (IVWS)		Sewage Services (IVSS)		Garbage Disposal (IVGD)		Environmental Vulnerability Index (EVI)	
	Value	Category	Value	Category	Value	Category	Value	Category
Jacarepaguá	4,05	Low	39,23	High	36,45	High	0,27	High
Anil	1,03	Low	9,05	Low	5,87	Low	0,05	Medium
Gardênia Azul	2,84	Low	24,85	High	18,1	Medium	0,15	High
Cidade de Deus	0,8	Low	8,29	Low	22,09	High	0,10	High
Curicica	1,81	Low	7,71	Low	2,12	Low	0,04	High
Freguesia	0,56	Low	4,36	Low	10,67	Medium	0,05	Medium
Pechincha	0,3	Low	1,58	Low	3,6	Low	0,02	Medium
Taquara	1,82	Low	8,59	Low	2,91	Low	0,04	Medium
Tanque	4,12	Low	5,71	Low	9,05	Low	0,06	High
Praça Seca	3,36	Low	4,55	Low	21,85	High	0,10	High
Joá	0,31	Low	10,25	Medium	0	Low	0,04	Low
Itanhangá	1,34	Low	37,48	High	51,68	Very High	0,30	High
Barra da Tijuca	1,65	Low	4,18	Low	6,09	Low	0,04	Low
Camorim	15,04	Medium	85,23	Extreme	14,27	Medium	0,38	Very High
Vargem Pequena	11,37	Medium	32,69	High	20,2	High	0,21	Very High
Vargem Grande	16,57	Medium	51,08	Very High	19,91	Medium	0,29	Very High
Recreio dos Bandeirantes	4,44	Low	16,87	Medium	12,28	Medium	0,11	Medium
Grumari	35,15	High	76,56	High	65,63	Extreme	0,59	Extreme

Source: Silva (2009)



Source: Silva (2009)

Fig. 15 – Results of the Environmental Vulnerability Index (EVI) in Jacarepaguá Lowland

CONCLUSION

The natural environment is the life system that supports human activities. With the aim to address the dichotomy between natural and urban processes, many researchers focus on issues of urban environmental quality. We argue that contemporary development practices, either private or public, are transforming not only urban morphologies but also landscapes that may reveal socio-environmental vulnerability and injustice.

This paper examined the urban settlement process taking place in the Jacarepaguá Lowlands since the 1970s. It was found that the region has attracted massive capital inflows. Both public and private investments are the most important socioeconomic growth drivers, particularly in Barra da Tijuca. Urbanization and urban expansion in many Brazilian cities are guided by the interests of powerful real estate companies. On the one hand, high-income classes have benefited from the investments made by municipal and state governments in the essential infrastructure needed for urbanization. The planning model adopted supports growth and development of the urban fabric to increase land value and therefore maximize profits for real estate investors. On the other hand, the socio-environmental conditions that result from the rapid urbanization has led to the increase of vulnerability and injustice. For example, in the Jacarepaguá Lowlands, unsustainable housing for low-income communities and the lack of sewerage infrastructure to collect and treat effluents foster socio-environmental vulnerability.

Urban infrastructure should be provided to meet the needs of all populations and territories. As urbanization increases and infrastructure networks expand, nearly all dwellings must have individual connections. The principles of equality and effectiveness can be met only through homogeneous coverage standards. However, in many large cities of emerging countries, like Brazil, infrastructure needs have outpaced the expansion of supply (Silva, 2007). In the case of the Jacarepaguá Lowlands, several reasons can be given to explain this gap. First, it is important to observe that when the government invested in the essential infrastructure (e.g.: road system network, water provision, electricity and gas supply), only the urban dimension was taken into consideration. Second, since sanitation facilities dated back to the 1970s, the public administration did not address the need to protect the region's natural resources, which contributing to the water pollution in the Jacarepaguá Lowlands watershed. These factors lead, directly or indirectly, to environmental impacts such as: (i)

inadequate use of natural resources, (ii) transformation of urban land use, (iii) transformation of urban landscape, (iv) transformation of natural systems, etc; and environmental problems such as: (i) water quality deterioration, (ii) gradual degradation of mangroves, (iii) shrinking shorelines, etc. In fact, urban planning policies have been applied piecemeal, and therefore do not take into account the interconnectedness between the urban and natural systems operating within the urbanized area. In the Jacarepaguá Lowlands, the government has limited its interventions to the urban dimension only. Consequently, urban infrastructure used to reduce socio-environmental vulnerability and increase environmental justice has not been exploited to its full potential.

Third, some neighborhoods of the Jacarepaguá Lowlands watershed are left out of the Sanitation Program of Barra da Tijuca, Recreio dos Bandeirantes and Jacarepaguá (PSBJ). In addition to the implications of this exclusionary policy, a watershed-based approach has not been adopted by the state government as a planning framework to integrate socioeconomic and ecological systems²². Finally, the methodology and results of the Socio-environmental Vulnerability Index (SEVI) in the study area was useful in providing an overall understanding of the urban development practices and processes as a root cause of environmental injustice that is plaguing Rio de Janeiro. In an effort to reconcile socioeconomic development and environmental quality in the Jacarepaguá Lowlands, we recommend reforming the existing regional planning model.

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²² A watershed is a topographic area, drained by a water body, commonly a main river, or a system connected to water bodies, usually its tributaries (Lima-e-SILVA, 1999; Polette, 2000; Brun and Lasserre, 2006). In Brazil, the Federal Law 9.433 (1997) is the political and legal impetus for developing land-use planning and management policies and practices on a watershed basis, leading to the establishment of the National Water Resources Plan (PNRH) and the National Water Resources Management System.

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