FRANCOANGELI/Urbanistica

Planning Support Tools: Policy Analysis, Implementation and Evaluation

Proceedings of the Seventh International Conference on Informatics and Urban and Regional Planning INPUT 2012

edited by Michele Campagna,
Andrea De Montis, Federica Isola,
Sabrina Lai, Cheti Pira, Corrado Zoppi

Scientific Committee:

Emanuela Abis, *University of Cagliari, Italy*
Mariolina Besio Dominici, *University of Genoa, Italy*
Dino Borri, *Polytechnic University of Bari, Italy*
Flavio Boscacci, *Polytechnic University of Milan, Italy*
Alison Brown, *Cardiff University, United Kingdom*
Luca Caneparo, *Polytechnic University of Turin, Italy*
Arnaldo Cecchini, *University of Sassari, Italy*
Donatella Cialdea, *University of Molise, Italy*
Grazia Concilio, *Polytechnic University of Milan, Italy*
Luciano De Bonis, *University of Molise, Italy*
Andrea Deiana, *GeoInfoLab, Italy*
Lidia Diappi, *Polytechnic University of Milan, Italy*
Romano Fistola, *University of Sannio, Italy*
Bin Jiang, *University of Gävle, Sweden*
Giuseppe B. Las Casas, *University of Basilicata, Italy*
Robert Laurini, *University of Lyon, France*
Silvana Lombardo, *University of Pisa, Italy*
Giovanni Maciocco, *University of Sassari, Italy*
Fabio Manfredini, *Polytechnic University of Milan, Italy*
Domenico Patassini, *IUAV, Venice, Italy*
Michèle Pezzagno, *University of Brescia, Italy*
Giovanni Rabino, *Polytechnic University of Milan, Italy*
Giuseppe Roccasalva, *Polytechnic University of Turin, Italy*
Bernardino Romano, *University of L'Aquila, Italy*
Francesco Russo, *Mediterranean University Reggio Calabria, Italy*
Ferdinando Semboloni, *University of Firenze, Italy*
Agata Spaziante, *Polytechnic University of Turin, Italy*
Michela Tiboni, *University of Brescia, Italy*
Maurizio Tira, *University of Brescia, Italy*
Daniele Villa, *Polytechnic University of Milan, Italy*
Ignazio Vinci, *University of Palermo, Italy*
Yap Kioe Sheng, *Cardiff University, United Kingdom*

Local Scientific Committee:

Michele Campagna, *University of Cagliari, Italy*
Andrea De Montis, *University of Sassari, Italy*
Federica Isola, *University of Cagliari, Italy*
Sabrina Lai, *University of Cagliari, Italy*
Cheti Pira, *University of Cagliari, Italy*
Corrado Zoppi, *University of Cagliari, Italy*

Planning Support Tools: Policy Analysis, Implementation and Evaluation

Proceedings of the Seventh International Conference on Informatics and Urban and Regional Planning INPUT 2012

edited by Michele Campagna,
Andrea De Montis, Federica Isola,
Sabrina Lai, Cheti Pira, Corrado Zoppi

FRANCOANGELI

This publication is funded by the Italian Ministry for Education, University and Research through the research funds available to the Dipartimento di Ingegneria Civile, Ambientale e Architettura [Department of Civil and Environmental Engineering and Architecture] of the University of Cagliari, Operative unit "*Tecniche per la preparazione e lo sviluppo di processi partecipativi per la pianificazione sostenibile del territorio"* ["Techniques for the definition and implementation of participatory processes for sustainable territorial planning"] – Local scientific coordinator: Corrado Zoppi – within the Research Program of Relevant National Interest titled "*Sostenibilità urbana ed e-governance nella pianificazione fisica*" ["Urban sustainability and e-governance in physical planning"] – National scientific coordinator: Manlio Vendittelli.

This volume is published with funds in the availability of the Dipartimento di Ingegneria Civile, Ambientale e Architettura [Department of Civil and Environmental Engineering and Architecture] of the University of Cagliari for the implementation of the Research Program titled "*Pianificazione e partecipazione delle comunità alla definizione ed attuazione delle politiche del territorio: sperimentazione di metodologie innovative nel contesto della pianificazione paesaggistica*" ["Planning and community participation in defining and implementing spatial policies: experimenting innovative methodologies in the context of landscape planning"] – Scientific coordinator: Corrado Zoppi. Funded through regional law of the Autonomous Region of Sardinia no. 7 of 2007 titled "*Promozione della ricerca scientifica e dell'innovazione tecnologica in Sardegna*" ["Promotion of scientific research and technologic innovation in Sardinia"].

This volume is published with financial support from Fondazione Banco di Sardegna [The Foundation of the Bank of Sardinia].

This volume is published with financial support from Regione Autonoma della Sardegna [Autonomous Region of Sardinia], through regional law no. 2 of 1994, art. 69, and Decision no. 45/21 of 21 December 2010 of the Regional Executive Committee.

All of the essays presented in these proceedings were reviewed through a blind peer refereeing process.

Copy editing supervisor: Sabrina Lai
Copy editors: Daniela Ruggeri and Ignazio Cannas

Book cover: *Cagliari, a view of the Castello Hill* (picture by Sabrina Lai)

Contents

Section one
Accessibility and planning

Section two
Assessment of public programs

Section three
Cultural heritage

Section four
Landscape planning

Section five
Landscape, rural and urban planning

Section six
Planning support systems

Section seven
Remote sensing and other tools to analyze and represent space

State of the art on using Geotechnology to support neighbourhood impact studies

by Gerson José de Mattos Freire[1] and Ana Clara Mourão Moura[1]

Since its creation by the Brazilian City Statute (Brazil, 2001), the Neighbourhood Impact Study (NIS) has been consolidated as an impact analysis instrument, as a result of urban development implementation and operation. Law provides urban policy guidelines and defines NIS as a necessary tool to «obtain the construction, enlargement or operation licenses and permissions, under the responsibility of the local government» for private or public undertakings and activities within urban areas, which may cause «positive and negative effects on the quality of life of the population living in the impacted area and its surroundings, by undertakings and activities». The same law provides that the uses depending on the development of the NIS to obtain licenses and permissions, will be defined by municipal law, further establishing a minimum mandatory content of the NIS, which comprises issues on population density, urban and community equipment, use and occupation, real state valuation, traffic generation and demand for public transportation, ventilation and lighting and urban landscaping and natural and cultural patrimony. Thus, local government provides urban planning possibilities. This paper intends to contribute to discussions on this issue, featuring the NIS as an Environmental Impact Assessment and pondering on the possibilities of impact analysis on the neighbourhood, with the use of tools deriving from the Geotechnologies.

Introduction

Since its promulgation in 1988, Brazilian Federal Constitution has a his-

[1] School of Architecture, Federal University of Minas Gerais (Brazil).

tory of discussing urban planning themes, notions and guidelines, such as property's social role, balanced urban growth and state action tools for insuring social justice (Soares, 2003, p. 287). However, these policies were not regimented, accomplishment which only occurred with the Brazilian Federal Law no. 10257, of July 10, 2001, known as the "City's Statute". This law establishes general directives for urban policies, while handling matters of social interest, especially regarding the use of propriety for collective interests, environmental balance, and the promotion of the full development of a city's social functions. Also, this law offers new instruments for urban organization, as well as regimenting those previously foreseen.

This law also intended to anticipate mechanisms for state interventions, which would regulate urban policy on major cities. The Statute seeks to augment people's participation on processes involving decisions of great collective interest and on the implementation of projects which might comprehend structural transformations on the urban environment or of great extension.

According to Prestes (2003) «The great advancement brought by the City's Statute was to bring society closer to the process of public planning, foreseeing a series of instruments for fomenting development, financing urban policies, democratization of urban administration, as well as land regularization», André *et al.* (2006) define public participation as the involvement of individuals and groups which are positively or negatively affected by public actions, or which are interested in proposing a project, program, plan or policy, still subject to a decision process. This involvement is expressed in two instruments, both common in origin, which are of great importance and are listed on the 4th Article of the City's Statute as instruments of urban policies: the Environmental Impact Study/EIS and the Neighbourhood Impact Study/NIS.

Environmental Impact Assessment

From the second half of the 19th century, environmental degradation and its catastrophic consequences began to be noticed on a global level, originating innumerable studies and methods for decreasing environmental damage. One of the first results presented were the studies undertaken by "The Club of Rome", which diagnosed earth's resources and concluded that the environmental degradation results mainly from the uncontrolled demographic growth and its consequent demands on global resources. They also concluded that unless we reach demographic, economical and ecological

stability, the world's limited natural resources will be extinct, and with them, human populations (Meadows *et al.*, 1972). These studies promoted the association of two ideas: development and preservation of natural resources.

In 1983, the World Commission on Environment and Development, later known as the Brundtland Commission, was established by the General Assembly of the United Nations to study issues related to the environment and economic development. Their works were concluded in 1987, with the presentation of a diagnostic for global environmental problems. The Commission concluded an urgent need for environmental issues to be introduced in the international political agenda as factors conditioning and limiting traditional models for economical growth and natural resources' use. In fact, they were proposing that economical development should be integrated harmonically to environmental issues, thus originating a new form of relating to the environment, denominated sustainable development. It is also defined as meeting present needs without damaging the possibility of future generations to satisfy their own needs (UNWCED, 1987). Thus, the methods traditionally used for project evaluation, based only on economic criteria, were then on deemed inadequate to guide decisions. Viability studies, which were almost always limited to cost and benefit analyses (whilst not considering environmental factors), could have lead to the implementation of projects and activities resulting in unexpected damages to health, to social well being, and to environmental resources (therefore reducing its foreseen benefits). In order to respond to this new reality's demands, the Environmental Impact Assessment (EIA) became a requirement.

The purpose of the EIA is to reach a high environmental quality standard for the impacted and studied areas, compatible with the types of life existing (or to exist) in it. Therefore, the concept of environmental quality, independently of the kind of study to be undertaken, becomes a guiding element for the area's assessment.

In Brazil, the evaluation of a project's environmental impact is undertaken accordingly to the guidelines established by the *Conselho Nacional de Meio Ambiente* (National Council for the Environment) (CONAMA, 1986), body which considers a project's impacts on the environment, its nature, probability, temporality, reach, magnitude and reversibility. The legislation's practical applications gives priority to licensing projects in one-by-one basis. On each licensing stage, the project´s influence areas are submitted to analyses, in varying sampling degrees, compulsorily by multidisciplinary teams, aiming to elaborate a complete diagnostic of the locale. Methods for evaluating a proposal are structured to compare, organize and analyze information on environmental impact, including written and visual

presentation of that information.

Other than a multidisciplinary approach, the methods used on an EIA need to be concerned with subjectivity issues, quantification parameters, as well as qualitative and quantitative investigations. Only bearing these in mind, it is possible to observe the magnitude of these elements' importance and the probability of each impact's occurrence, in order to obtain the kind of data which would approximate the study to a more realistic conclusion.

Basing on an project's EIA, the foreseen impacts which should be of a qualitative evaluation are pointed out. For many cases in which this method is used, this evaluation is implemented using a pre-fixed table, containing attributes and an explanatory text and aiming to analyze and relate the project's impact and the possibility of impact mitigation. Among several existing methodologies, the aspect and environmental impact matrix, initially described by Leopold *et al.* (1971), is note worthy for allowing a cross check between the project's actions and environmental factors susceptible to impact. The identification of these actions and of environmental factors has as a reference the characterization of the project and its surrounding. The study, in general, uses the installation of the region's transforming activity (the project) as a reference. The methodological structure establishes bonds between several environmental events:

- the project's foreseen interventions;
- environmental alterations, which potentially modify the environment;
- environmental phenomena and aspects associated to these modifications, which may or may not impact the environment's quality;
- mitigating measures proposed for each foreseen environmental impact, capable of reducing, neutralizing, or maximizing alterations on the environment.

These methods lead to the recommendation of measures to be implemented on an impact's casual origin, optimizing its administration during the project's implementation and operation. The result of this association sequence is a relational flux of environmental events, configuring the general hypotheses of the project's potential impacts, which can be resumed in the following manner:

- a transforming activity may be constituted of *n* interventions;
- an intervention may originate *x* environmental alterations;
- an environmental alteration may determine the manifestation of *y* environmental aspects, in such a way that these aspects may mean impacts on the environment's and urban infrastructure's quality;
- an environmental impact may or may not be mitigated by compatible measures.

Once the environmental impacts are identified, it is possible to estimate

their duration, and evaluate them according to quantitative attributes (weights), allowing a calculation of their relevance for the project and thus consider the efficiency of a proposed mitigation measure. In order to identify the temporality of the impact, chronograms are used, making possible to associate the intervention's duration and the environmental impact.

The main objective of the environmental analysis is, therefore, to identify the data's spatial properties, in order to detect its patterns, as well as to formulate hypotheses based on the data's spatial location and spatial modeling studies, thus supported both by graphic or visual methods and numeric techniques, usually, statistical analysis.

The study of neighborhood impact

The urban environment in which an project is inserted comprehends material and information fluxes between this project and neighbouring human activities. Each activity presents an impact on the urban environment, interfering on urban dynamic and producing a differentiated transformation. Some projects or activities alter the balance established in a certain region, only by mere speculations of their implementation.

The Brazilian City's Statute, in the 36th article (2001), establishes that municipal laws must define which projects will depend on a conditional study for its approval. Urban legislation attributes the role of guaranteeing the correct soil occupation to zoning; however, zoning alone is not able to mediate all neighbourhood conflicts. The project is thus obligated to formulate a Neighbourhood Impact Study (NIS), contemplating positive and negative effect's analysis on the quality of life of the population resident on the impacted areas and their proximities. The law determines a minimum content for the NIS, discussing issues of population increase, urban and community's equipments, soil use and occupation, real estate valuing, increase and generation of traffic and public transport demand, ventilation and urban lightning, landscape and natural and cultural patrimony. This instrument serves as mediation between the project's private interests and the population's right to quality of urban life.

The main difference between an EIA and a NIS resides on the definition of the project's Direct Influence Area. An EIA considers possible interaction and impacts on the environment. On the other hand, for the NIS, the influence area is defined according to the region in which the project acquires a central position on the urban relations, as described by Dantas (1981). For this reason, the 38th article of the City's Statute states that the elaboration of a NIS report does not exclude the elaboration of an EIA,

which is required by the terms of environmental legislation. In some cases, it may be necessary to extend the scope of environmental studies, according to the impact's nature.

The Neighbourhood Impact Study is a preventive instrument, aiming to avoid unbalanced urban growth and guarantee minimum conditions for the occupation of habitable spaces. It should be noted that the NIS is not only required by private projects, but also by public actions, since the goal of harmonizing the project and the environment should be equally pursued by all social sectors. Therefore, after the implementation of the City's Statute, both the Environmental Impact Study and the Neighbourhood Impact Study are used as instruments of urban policy.

Urban planning is defined by Moura (2003) as the set of actions for analysis and construction of proposals that occur at higher temporal and spatial scale. On the other hand, urban management must incorporate the time dimension, and update itself in relation to changes in urban daily life, on a smaller spatial and temporal scale. The author concludes that the two processes (planning and management) should work in harmony putting order in the urban space, since it is necessary to plan the city and study the consequences of the proposals for the whole city, while the modifications on a smaller scale must be contextualized to what is planned for the area as a whole.

After the development of integrated techniques for impact analysis, urban planning is no longer expected to fulfil solely requirements of soil usage, but to act as a rational tool for natural urban resources usage. Degradation is manifested on the urban setting as impacts on physical, biotic and anthropic environments. This degradation is expressed as violence, as impoverishment of human relations, and as several pollution forms, each with its capacity of affecting urban inhabitants, either through noise, landscape impact, and air, water courses, and soil effluents. When evidencing the similarity between positive and negative effects mentioned on the City's Statute and urban environment impact, Prestes (2003) defines NIS as «a instrument for Environmental Impact Assessment – EIA, on the sector of a policy of urban and environmental administration». By means of it, urban space planning and management present an analogue dimension to control programs and environmental conservation, while seeking for quality of life improvement, protection to historical and natural patrimony, and valuing of cultural resources.

Geotechnology application

In order to relate different thematic components and their way of presenting geographic space, we highlight the need to make an issue of geotechnology use, defined as a conjoint of technologies for collecting, processing, analyzing and making available geographically referenced information (Campos *et al.*, 2009). These geotechnologies include Geoprocessing, Geographic Information Systems (GIS), and Remote Sensing. With these tools, it is possible to produce information promptly and at low costs. This makes possible to all interested party a variety of data combinations for variable interaction analysis, as well as to elaborate preventive models and to offer support to decision making processes (Bonham-Carter, 1996).

The low cost statement is related to optimization in the organization, dissemination and exchange of information, especially in a time when Brazil is experiencing the impact of national law 6666 of November 27, 2008, establishing the sphere of the Federal Executive of the National Infrastructure Spatial Data (INDE). According to this normative data should be public, in fact, publicly available in a wide sense to be used to support planning and decision making. The data must be reliable, has to present their metadata and to have normalization in order to ensure safety in their use. This process has already happened in Europe since the establishment of INSPIRE, and now its time to Brazil to encourage the development of Territorial Multipurpose Cadastre, in order to support the territorial planning.

INPIRE, as pointed out by Craglia and Campagna (2010), represented for Europe the following achievements: data should be collected once and maintained at the level it becomes more efficient; it should be possible to combine data from different sources in the EU and share it between many users (interoperability); the data should be collected at one level of government and shared between all levels; the spatial data needed to be made available under conditions that do not restrict their extensive use; should be easy for everyone to discover available spatial data and its assessment and suitability for each goal and know under what conditions they can be used.

INDE, in Brazil, such as the INSPIRE, aims to maximize the availability of public sector information for use and reuse, emphasizing transparency and good governance, promoting access and conditions of reuse of public sector information, expanding access the use, integration and sharing it. It aims to improve access to information and disseminate their content in electronic format and the Internet; it's critical to promote interoperability: making interoperable GIS, *i.e.* it should be possible to combine data from disparate sources. All this creates the conditions for use of geotechnology

in intervention studies in environmental and urban landscape, between which is the NIS, are performed at low cost in comparison to the procedures of spatial analysis that lacked these features.

Generally, environmental modeling is intended to simulate phenomena and processes with an explicit spatial dimension, such as: flow processes in a watershed, erosion processes, soil contamination, fire dissemination, water dispersed pollutants, and others, which should be studied in relation to space. However, according to Christofoletti (1999), models are simplified versions of reality. Special attention should be paid to the selection of most relevant aspects, trying to make evident the behavior of several environmental variables. After its creation, a model should go through a calibration phase, were an evaluation of all involved parameters is undertaken. Following that step, the model's calibration should be validated, by means of its application to a known situation.

Environmental evaluations result from a direct combination of data, contained in GIS or through the application of statistic concepts such as Pondered Average, and resulting in classification plans. Those represent for each data base pixel, its potential or environmental risk, depending on the issue to be evaluated.

In order to maximize efficiency (and reducing the costs of approximating the analysis to reality), the formulation of a NIS demands a methodological script designed to combine variables. This script should necessarily contain:

- the definition of its main variables, aiming for a reduction of data to obtain a volume reduced representation, and to eliminate redundant or irrelevant attributes, but also producing identical or similar analysis results. Thus it shall improve model performance;
- the study of a project's specific attributes, with the project being either private, of public usage or of urban infrastructure. This analysis must include the difficulties inherent to each social sphere and project type;
- the bibliographic research and revision of previously tested models – including the ones in use – for environmental analyses;
- the structuring of models adequate to each case for spatial analysis;
- the application of a structured model;
- a scenario creation, taking into account all obtained results through several alternatives imposed to the model, as well as the transformation, insertion or variable suppression simulations;
- predictions, as an urban policy and micro-directive instrument for use and occupation.

There are several models available in the relevant literature: from models directed to identifying influence areas (such as Voronoi's) to spatial dis-

tribution models (density, IDW, gravitational, etc.), and from variable combination models to accessibility analyses models. The analysis is integrated to each case's adequate geotechnologies, as well as its efficiency in detecting impacts.

Case study of neighborhood impact

Between aspects related to NIS, it is possible to obtain sub products of EIA, which associated to the use of geoprocessing techniques, may offer relevant information and a gain on the analyses' efficiency. We briefly present here the results of the studies regarding insolation, part of a NIS conducted at the installation of a hospital at Jardim Teresópolis informal settlement, in the municipality of Betim, Brazil.

Area studied

The municipality of Betim is located within the metropolitan region of the Minas Gerais state capital, Belo Horizonte, and had circa 370,000 inhabitants in 2010. The Jardim Teresópolis district is an informal consolidated settlement, populated now for about 40 years, in a widespread manner. Today, the district's inhabitants reach the figure of 45,000.

Urban comfort evaluation at the project's influence area takes into account lightning, insolation and thermal energy dissipation. As large areas are waterproofed, and buildings are closer together (since setbacks are absent), environmental damage is relevant, compromising the city's ventilation and lightning, altering micro-climate, insolation, wind paths, damaging health and comfort conditions inside buildings, and increasing energy consumption.

In the project's influence area, the settlement pattern usually generated two story buildings, without façade's setbacks, and no side setback spaces. The diagnostic undergone also points out the predominant absence of finishing materials (with the exception of exposed masonry). This results in the formation of urban canyons, hindering not only wind circulation and dust dissipation, but also insolation of neighboring buildings.

Insolation modeling

Aiming to simulate the project's impacts on its surroundings regarding insolation, we created a three dimensional modeling of the building and its immediate setting. The modeling for insolation changes was divided into two stages. In the first stage, it has been performed a volumetry modeling of the hospital's building, using as a source, plants and sections of the architectural project. The extrusion occurred from the external masonry projection, considering the highest point in the ceiling. Volumes were created using SketchUp® and ArcGis® softwares, and pilled up, resulting in the building's total volume. On the second stage, we created the modeling of the buildings' surroundings.

Afterwards, a simulation was created depicting the solar traffic reaching the building and its surroundings, for south hemisphere summer (December 21st) and winter (June 21st) solstices. To analyze summer solstice, the analysis focused on hours between 06:00 and 18:00, since during summer it is customary to use Daylight Saving Time. In order to understand solar traffic, we also simulated a third position, corresponding to spring (June 21st) and autumn (March 21st) equinoxes. We then used the tool offered by SketchUp® application for generating shadows for the equinoxes and solstices mentioned, using three hours average intervals. As a result, we created superior orthographic views and perspectives faced views (frontal and right side of the hospital), as shown in the following images.

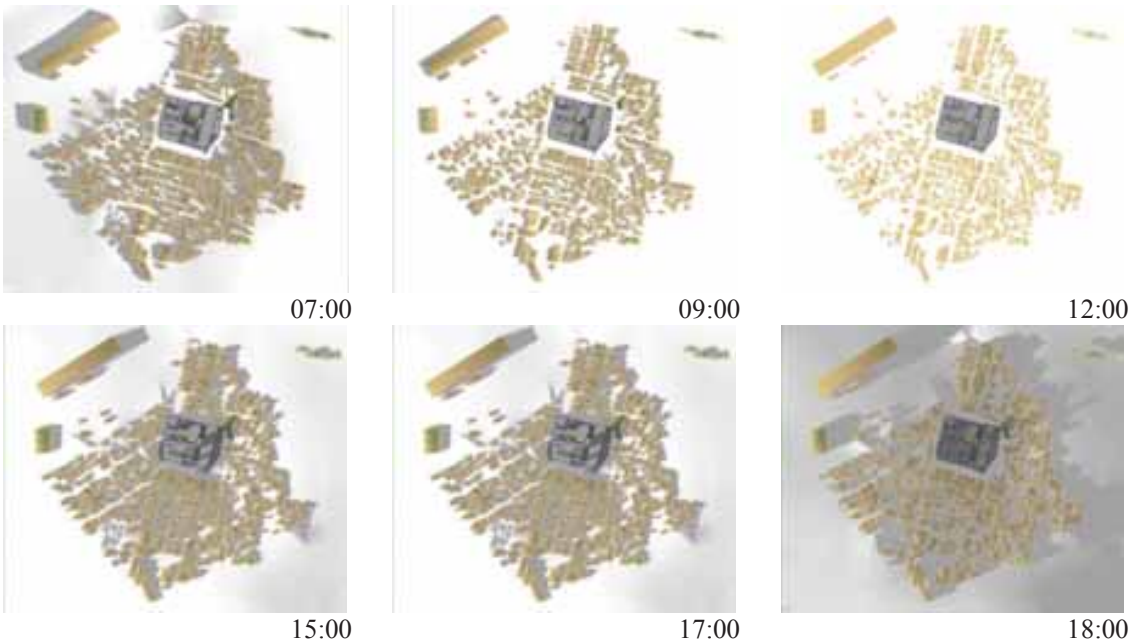

Fig. 1 – 3D Modeling: Summer solstice (21/12).

Results

Volumetric modeling and solar traffic simulation allowed for the identification of shading on public streets and *façades*. The main result of this analysis reveals that the area, especially at the informal settlement, south of where the hospital will be built, do not receive morning sun before 10:00hs or after 15:00hs, meaning an obstructed horizon and resulting poor air circulation.

Conclusion

Neighborhood Impact Studies (NIS) present the characteristics and significance of an environmental study. However, they particularly focus on local impacts on anthropic and urban areas. Through NIS, we point out that the demolition of buildings at the hospital's immediate surroundings will reduce the volume cluster and side setbacks, promoting frontal setbacks following the new structure and wider roads, and, therefore, resulting in lowering the probability of heat islands.

As previously discussed, geotechnologies may contribute in a consistent manner to Environmental Impact Assessment (EIA). This reality is already expressed in the production of reports and Environmental Impact Studies (EIS), which commonly utilizes these technologies and have their results validated, both by foreseen conditions verification in environmental models and by the meeting of legal and normative requirements. However, the application of the same geotechnologies on NIS is not as common in Brazil, and has only recently become a norm in several municipalities and even state capitals. Environmental studies today, in general, have consolidated their processes in such a way that some municipalities now have begun using NIS as an instrument of urban public policies. It is extremely important to establish a series of spatial analysis models applicable to the elaboration of Neighboring Impact Studies, resulting in economizing or optimizing the analysis processes' efficiency. It highlights the role that geotechnologies (such as modeling and spatial analysis) play in augmenting methodological procedures for elaborating NIS.

References

André P., Enserink B., Connor D., Croal P. (2006), "Public participation interna-

tional best practice principles", *Special Publication Series No. 4*, International Association for Impact Assessment, Fargo, ND, United States.

Bonham-Carter G.F. (1996), *Geographic Information Systems for geoscientists: modeling with GIS*, Pergamon, Ottawa, Canada.

Campos P.M., Souza A.L.F., Silva R.A.B., Bilich M.R., Santana H.M.P. (2009), "Uso da geotecnologia para o mapeamento da cultura do café no município de Ribeirão do Pinhal – Paraná", *Anais XIV Simpósio Brasileiro de Sensoriamento Remoto*, April 25-30, INPE, Natal, Brazil, pp. 3629-3634.

Christofoletti A. (1999), *Modelagem de sistemas ambientais*, Edgard Blücher, São Paulo, Brazil.

Craglia M., Campagna M. (2010), "Advanced regional SDI in Europe. Comparative cost-benefit evaluation and impact assessment perspective", *International Journal of Spatial Data Infrastructures Research*, 5: 145-167, available at: http://ijsdir.jrc.ec.europa.eu/index.php/ijsdir/article/view/166/282 (accessed March 5, 2012).

Dantas J.R. (1981), *A nucleação central e a centralidade como estruturas de relações na organização do espaço intra-urbano*, FAU USP, São Paulo, Brazil.

Leopold L.B., Clarke F.E., Hanshaw B.B., Balsley J.R. (1971), "A procedure for evaluating environmental impact", *US Geological Survey Circular 645*, Highway Research Board, Washington DC, United States.

Meadows D.L., Meadows D.H., Randers J., Behrens W.W. (1972), *The limits to growth*, Universe Books, New York, NY, United States.

Moura A.C.M. (2003), *Geoprocessamento na gestão e planejamento urbano*, Ed da Autora, Belo Horizonte, Brazil.

Prestes V.B. (2003), "Plano diretor e estudo de impacto de vizinhança", *V Conferência das Cidades*, Brasília, Brazil.

Soares L.M. (2003), *Estudo de impacto de vizinhança*, in Dallari A.A. and Ferraz S., eds., *Estatuto da cidade (Comentários a Lei 10.257/2001)*, Malheiros Editores, São Paulo, Brazil.

UNWCED (United Nations World Commission on Environment and Development) (1987), *Our Common Future*, available at: http://www.un-documents.net/wced-ocf.htm (accessed March 3, 2012).