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Daniele La Rosa
Riccardo Privitera *Editors*

Innovation in Urban and Regional Planning

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Editors

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Preface

The 11th Edition of the International Conference focuses on how to integrate nature-based solutions in urban and regional planning processes and science. Previously planned for September 2020, due to the COVID-19 pandemic the INPUT 2020 Conference will be hosted in 8–10 September 2021 by the University of Catania (Italy).

The overarching theme of INPUT 2021 edition is "Integrating Nature-Based Solutions in Planning Science and Practice". There is growing evidence that nature-based solutions (NBS) are strategic instruments to restore or improve the functionality of urban ecosystems towards more livable, healthier and resilient cities. Despite their many advantages, NBS are not widely implemented because the evidence of their effectiveness is not yet sufficiently diffused among policy-makers, city-planners and residents and because NBS are often overlooked due to the complexity of their design and lack of normative instruments supporting planning choices. In order to permanently incorporate NBS into planning instruments, more research and international discussion are required to consolidate the fragmented evidence that NBS can significantly improve the overall degree of environmental sustainability of contemporary cities.

INPUT 2020 gathers international scholars in the fields of planning, civil engineering and architecture, ecology and social science, to build and consolidate the knowledge and evidence on NBS and to help an efficient implementation and replication of solutions.

The INPUT 2020 Conference hosts 14 thematic sessions, namely:

- Enhancing the use of nature-based solutions in urban planning
- Modelling to innovate planning solutions for socio-ecological systems
- Input visions: new technologies, data and hybrid models for spatial planning
- Urban metabolism and simulation for decision-making in spatial planning
- Performance-based planning
- Computational planning
- Geodesign for informed collaborative spatial decision-making

- Planning and design of ecosystems services: assessment frameworks, models, mapping and implications
- Green infrastructure for planning healthy urban environments
- The mitigation of peripheralization risk in urban and regional planning
- Strategies and actions for climate change adaptation and mitigation in mediterranean regions
- Analysis and planning of rural landscapes
- Accessibility in urban planning: moving towards innovative approaches
- Maintenance, upgrading and innovation in cultural heritage

This book presents the first collection of 69 contributions submitted to the INPUT 2020 Conference, following the first call for paper launched in Winter 2020. The accepted articles, after a blind-review process, are here organized in 5 topical parts, which group together the 14 thematic sessions of the conference:

- Nature and Ecosystems for Urban Systems
- Models and Technologies for Spatial Planning
- Climate Change and Spatial Planning
- Peripheries, Rural and Cultural Landscapes
- Accessibility in Urban Planning

INPUT 2020 proceedings explores empirical as well as theoretical frameworks for NBS, their attitude to provide ecosystem services, to deal with climate change effects and to support mitigation and adaptation planning strategies. Integration of NBS in planning science and practice is investigated across different contexts and scales, from urban cores to peripheries as well as from rural to cultural landscapes. Above all, this collection presents the state of the art of modelling approaches and innovations employed in urban and spatial planning, with a trans-disciplinary, boundary-less character to face the complexity of contemporary socio-ecological systems and following a practice-oriented approach aimed to problem solving.

INPUT is a group of Italian academic researchers and academics working in different fields related to the exploitation of innovation for urban and regional planning, with particular reference to geo-informatics and socio-ecological aspects of spatial planning. INPUT Conference is held every two years in Italy, with last editions been hosted in Viterbo (2018), Torino (2016), Cagliari (2014) and Potenza (2012).

INPUT 2020 Conference is organized by LAPTA, a research laboratory of Department of Civil Engineering and Architecture of the University of Catania (Italy), working on sustainable urban and landscape planning.

Catania, Italy
December 2020

Daniele La Rosa
Riccardo Privitera

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Urban Occupation Potential by UAV Data: Vale do Sereno—Nova Lima/MG

Pedro Benedito Casagrande, Maria Giovana Parisi, Ana Clara Mourão Moura, Lourdes Manresa Camargos, and Danilo Marques de Magalhães

Abstract Currently new technologies and tools have been used to improve the spatial planning and knowledge of the territory. Thus, from UAV data it is possible to perform the spatial analysis of the study area and to know/understand the potential use for urban occupation. The UAV flyover allows to generate a mosaic of orthophoto which is the basis for generating the analyzes related to the physical environment, and with the use of other geotechnologies it is possible to elaborate indices for urban occupation in the study site. In this case study the chosen area was the Vale do Sereno region, part of the municipality of Nova Lima/MG, which has urban expansion in areas with physical characteristics not suitable for occupation, in general. Thus, the use of geotechnologies as a subsidy for territorial planning and planning is increasingly accessible and indispensable for public management.

Keywords Territorial planning · Geotechnologies · Territorial management

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1 Introduction

The process of accelerated growth of cities, together with the absence of basic infrastructure, lead to the misuse of the physical environment, whose consequences are the impacts on the quality and safety of the population and urban equipment. According to Bathrellos (2007) more than 70% of the world's population lives in urban areas.

The urban settlements have a close relationship due to the impacts generated both positive and negative. Changes in production patterns and population dynamics change the nature of these impacts and, consequently, the socio-environmental conditions of urban agglomerates (Silva and Travassos 2008). Land occupation in areas potentially at risk to mass movements and accelerated erosion present in considerable portions of urban areas of the underdeveloped and developing world is an indication that the environmental issue does not receive due attention in the various types of territorial planning. In this sense, landslides are frequent in urban areas, even in areas considered stable, aggravated due to intense urbanization and the construction of housing over slopes, causing serious consequences.

Mitigating these impacts is fundamental for the efficiency of space and land use, as well as for economic development (Bathrellos 2007). In this sense, there are several ways to measure and improve the ability to understand the territory and it has been proven that with the aid of thematic maps it is possible to direct local planning so that there is no occupation in these places (Casagrande et al. 2017). However, the pressure exerted by real estate speculation induces occupation in areas inadequate from the environmental point of view, leading to the formation of risk areas.

The municipality of Nova Lima, located in the Metropolitan Region of Belo Horizonte, Brazil, has its history related to the development of mining activity in the state of Minas Gerais. Situated in one of the main axes of metropolitan expansion—the southern axis, marked by a concentrated land structure owned by mining companies. However, urban occupation occurred along with the limitations of the physical environment, a process that was aggravated by real estate speculation in areas with high slopes and geomorphological, in addition to the presence of an important area of vegetation cover. These events after the initial period of mining in the municipality, led to urbanization characterized by a differentiated growth (Tonucci Filho 2012), with the vast majority of new projects belonging to the high-luxury real estate market and located in areas of high slope or at the bottom of the valley of sub-basins.

This work aims to analyze the urbanization process that occurs in areas of high slope in the municipality of Nova Lima (Fig. 1), through the analysis of the risks present in the area through visualization with drone modeling, thematic cartography and geomorphology (Magalhães and Moura 2018). Spatial analyses carried out in a Geographic Information System (GIS) environment make it possible to measure the size of recent urbanization, besides indicating growth vectors in order to identify areas that may present high danger and possible geomorphological risks (Santos 2017).

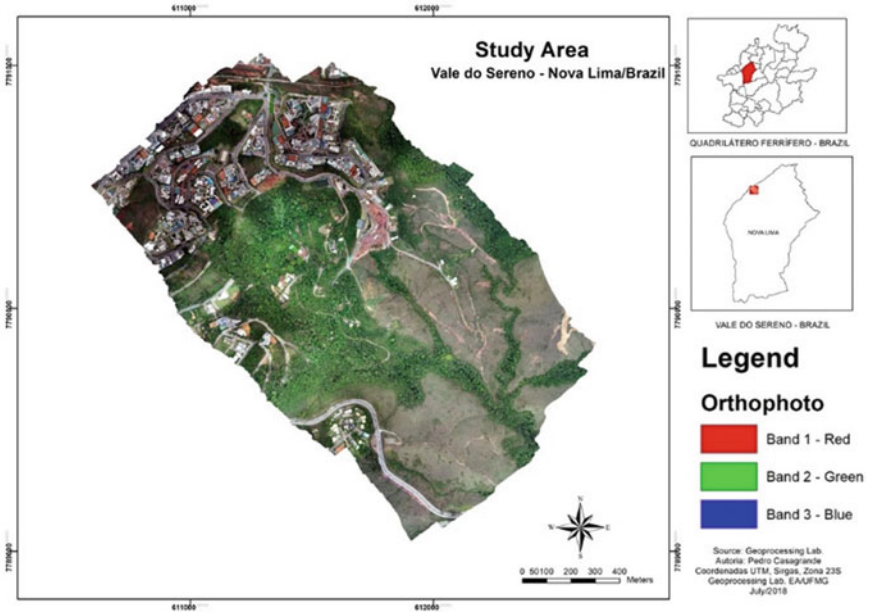

Fig. 1 Image of the study area—by UAV data. *Source* The authors

2 Contextualization of the Study Area

The study area, known as Vale do Sereno, is located in the southern part of the municipality of Nova Lima, whose density of urbanization largely coincides with the area comprised by the vertex formed by mg-030 (Highway) and the municipal boundary with Belo Horizonte.

According to Casagrande (2019) because it is a region with large mineral reserves such as gold and iron, the formation of the municipality of Nova Lima is intrinsically related to mineral extraction activity. According to the authors, this activity caused the economic rapprochement between Belo Horizonte and Nova Lima to be linked to mining and the export sector. It is worth noting that at the beginning of the 20th century, urban and economic occupation in the form of condominiums and allotments had not yet begun, with mining as the main activity in the region (Casagrande 2019). According to Peixoto (2006) the process of occupation of the region began in the 1950s, characterized by a differentiated pattern of occupation directed to the population layers of middle and high income in the form of condominiums. Thus, it is a municipality with a high Human Development Index (HDI) obtained by positive financial return due to mining activities.

Its altimetric composition is characterized by significant topographic variation, resulting from almost 280 m of amplitude, between the lowest point and the highest point of the region. Much of the study area is not yet occupied and corresponds to

the valley funds and their slopes. The most densely occupied portion is close to the highest dimensions of the study area. The slope constitutes an expressive impediment and hindering the occupation of this area, since the sum of the ranges of 30–47% (which by legislation require geotechnical reports for occupation because they are already considered risky), and the ranges above 47%, by local law (Brasil 1979), which are considered non-buildable, occur in much of the region, including in areas already occupied. It is observed that in the Vale do Sereno, an area belonging to the municipality of Nova Lima, there are watercourses, from drainage channels and intermittent streams to perennial watercourses. The presence of vegetation is comprehensive, where expressive vegetation, which can be considered for future evaluation of ecological corridors and which are elements exhaustively cited as landscape components, is very present in the area, mainly at the bottom of the valley and near the main drainage.

It is observed that the Vale do Sereno has several areas of environmental interest, mainly due to the presence of expressive vegetation cover and water streams. The patches of vegetation are mainly located in the center. It should be noted that where these stains are concentrated there are already streets executed. It should be noted that where the perennial watercourse is located, it consists of the place of greatest environmental interest, whose conflict occurs precisely in the bedside areas. It is observed that most of the already occupied portion of the Vale do Sereno is in a hilltop area.

Another problem identified is the occupation process in the areas of slope and hill tops, whose indication is the preservation of vegetation cover, as they are non-uplifting areas according to the legislation.

It is also important to point out that the Vale do Sereno is the target of the high-luxury real estate market, which has as its decoy, the propaganda of a harmonious coexistence between housing and environmental preservation, this situation is in a urban expiation and by now it is in just a part of the area in study. However, according to the legislation and the Master Plan, it consists of an area inadequate for occupation, whose consequence of this process is the compromise of the natural landscape of the area (Moura 2013).

3 Methodology

The obtained database was performed by drone flyover, generating high resolution orthophotos (Magalhães and Moura 2018) by the use of a photogrammetric software (Pix4D). The spatial and spectral resolution of the area is of high quality (Eisenbeiss 2008), which enables the analyses, in a supervised manner.

Through the generated images and supervised classification of them, it was possible to extract the data that allowed the elaboration of the maps of Slope, Drainage (Hack Index) and Vegetation Density (NRVI).

The Occupation Potential (OP) was calculated by combining the variables analyzed in a GIS environment, which allowed its integration with other variables

related to the territorial and environmental planning strategies of the study area (Moura 2005). Initially, the variables that served as input in the model that composes the Potential to Occupation were elaborated.

The slope (Fig. 2) of the relief, in turn, aims to evidence the relief breaks, which was obtained from the processing of images of digital elevation model from the drone data of the study area. The slope data were generated in percentage, being classified into 4 classes, in which they represent from 0 to 5% considered flat and floodable; from 5 to 30% as low slope; from 30 to 47% as high slope and above 47% as inappropriate for urban use and anthropic actions.

The Stream Length-gradient index (Fig. 2) was initially elaborated by Hack (1973), and was applied to the hierarchical hydrographic network according to Strahler's method (1957) for the analysis and spatialization of the action of the fluvial drainage incision in the relief, process that can be triggered by tectonic and structural (endogenous) factors, recurrent in the study area and classified into three classes, which high is where there is greater drainage energy, medium is where the energy of the drainage behaves with less power and low is where this energy is lower. Since the analysis of drainage features is the proposal of this morphometric component.

The Normalized Remaining Vegetation Index—NRVI (Fig. 2) is based on the spectral signature of vegetation behavior, which presents specific responses related to photosynthesis, the process of which absorbs solar radiation in the red band of the spectrum. The index is directly proportional to the amount of vegetation cover of a given spatial unit of analysis (Bonet et al. 2006). The result of calculating this index for the study area generated a range of three classes defined as: high vegetation density, low vegetation density and anthropized areas.

The NRVI can also be associated with other standardized indices to make correlations and verify the environment of the studied site, as well as improve its management (Bonet et al. 2006).

In order to adapt the variables to integrate the analysis of multicriteria by combination, following the methodology of Rocha et al. (2018), each of the variables was noted a numerical value so that when juxtaposed to the variables, the user can judge its meaning in the partial and final results of the process to the point of obtaining the final qualitative judgment for the synthesis of the place of study. Figure 3 shows the process that occurs through stages of peer-to-peer analysis until the result.

The objective is to generate a classification index with the territorial coincidences of the variables in analyses, always following the objective of the researchers, providing information without hierarchy, but rather selective and qualitative (Rocha et al. 2018). According to Groenwald et al. (2009), "Combinatorial Analysis is the part of Mathematics that studies and develops methods to solve problems involving counting or existence, in general, it can be said that it is the part of Mathematics that analyzes structures and discrete relationships". Thus, this method works as a support for the decision to work in an area of study (Rocha et al. 2016).

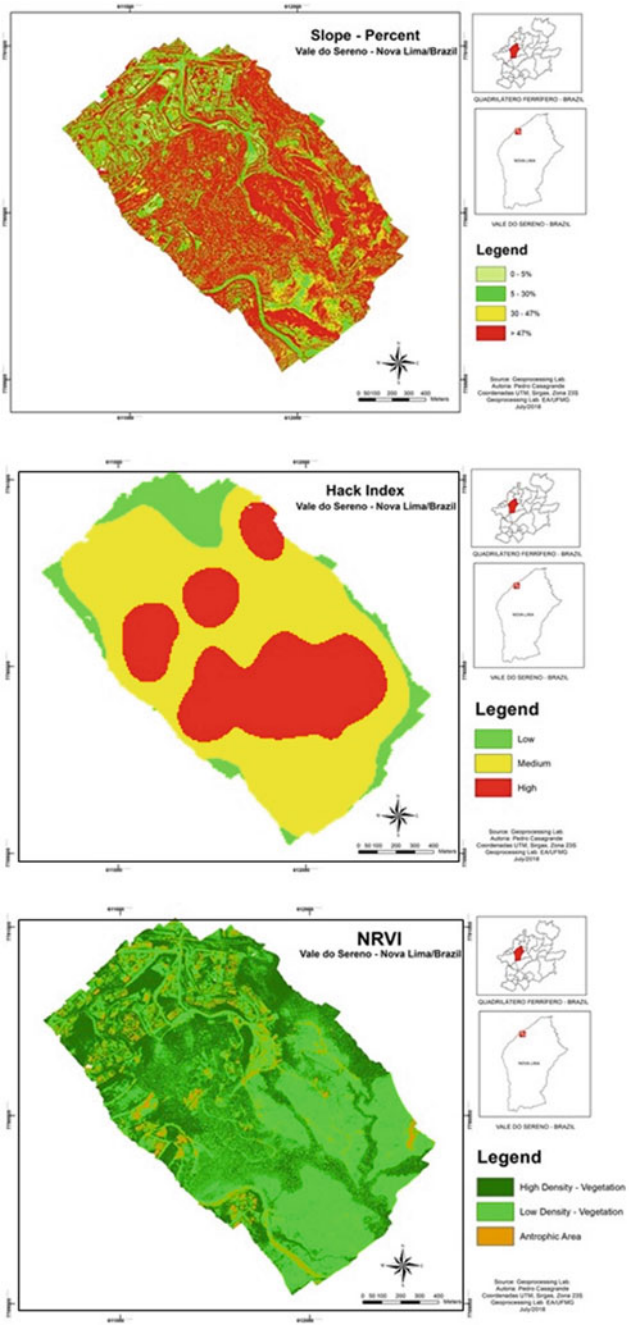

Fig. 2 Slope, hack index and NRVI of the area. *Source* The authors

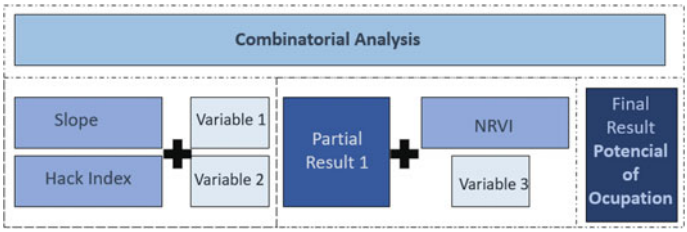

Fig. 3 Logic of the combinatorial analysis. *Source* The authors

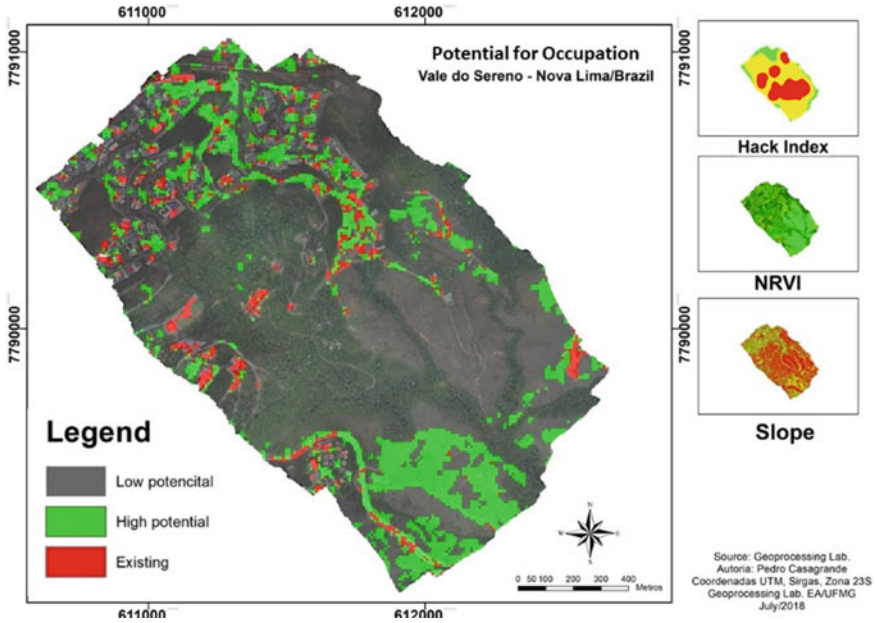

Fig. 4 Potential for occupation. *Source* The authors

With this, the Occupation Potential (OP) obtained is represented by Fig. 4, ranging from low occupancy potential (high risk), low occupancy potential (low risk) and existing occupation:

4 Results

The results obtained by the analysis it was possible to identify two large compartments with considerable potential for occupation. The first located in the southwest territory portion, where there is lower slope of the land, lower density of

vegetation and medium Hack Index, and the second compartment is located in the northern portion, near areas where there is already occurrence of occupations.

Although areas more prone to occupation have been identified, the region has relevant ecological importance, with the presence of water network and high-density vegetation. In this sense, in the areas identified as low potential for occupation, it is suggested the preservation of vegetation and the implementation of measures more restrictive to occupation.

5 Conclusion

The production of spatialized information regarding the potential for occupation is necessary regarding the planning of future occupations, as well as in the management of natural areas.

The OP proved to be an important product for the process of elaboration of the Land Use and Occupation Plan of the Region, composing the systems that represent the environmental characteristics of the region. The OP favored a spatialized understanding of the susceptibility of the inherent local physical environment of the physical and environmental singularities of the area, evidencing the places with the greatest potential for occupation. Although urban occupation in the region is rarefied and with high demographic density, there are risks related to the physical environment, which justifies the production of the cartographic material presented. From this point it may be prohibited of land occupation in areas at risk by the city administration. In addition to the concern with the future of the occupation of the area, the potential for occupation can help in decision-making regarding the intervention in the landscape by man, indicating areas with more favorable for occupation.

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