GIS-based visual analysis for planning and designing historic urban landscapes

GIS-based Visual Analysis for Planning and Designing Historic Urban Landscapes

The case of Turin

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***Abstract*—Visibility and scenic landscape analysis is an important field of study with direct implications in urban and regional landscape planning and management. More specifically, GIS-based landscape visibility analysis can be a tool to protect, manage, and plan also historic urban landscapes, focusing on scenic and visual values. Using visibility maps it is possible to predict the visual impact of transformations, locate interventions on the basis of visual sensitivity, and protect landscape of natural beauty, cultural heritage and significant landmarks visible from selected viewpoints.**

Among the studies carried out in some cities in the world, in Italy there is a pilot project for the integration of GIS-based visibility analysis in planning decisions for the Piedmont cultural heritage. GIS-based landscape visibility analysis has been developed on different areas located in the Piedmont Region within the framework of the landscape planning activity developed by the MiBAC (Ministero dei beni e delle attività culturali e del turismo) and the Piedmont Region - with the scientific advice of the Politecnico di Torino. A specific study has been carried out in the city of Turin. Set in an international perspective, this paper will focus on describing these applications and on highlighting some problematic issues and possible uses of such techniques in the planning domain.

Keywords— Scenic landscape analysis; Historical Urban Landscape; Urban Planning; tall buildings; visual impact assessment.

I. INTRODUCTION

Nowadays the evolution of cartographic and GIS tools has made techniques that used to require programming very accessible and widespread. Methods for analysing visual landscapes are thus increasing, spurred also by procedures for environmental and landscape impact assessment[1].

In the urban context, landscape visual analyses can play a significant role in the debate on tall buildings, involving experts and lay people. Tall buildings evoke conflicting emotions and provoke controversies. On one hand there is rejection, based on criticism concerning the design and the location of the building and whether it adds quality to the city skyline. On the other, tall buildings are often received with enthusiasm and a lack of criticism [1]. High rise building developments face specific issues in the European city, which is generally characterized by a stratified historic city centre and quite dense urbanization, with only some significant emerging landmarks. Establishing policies and tools to manage these developments requires taking into account functional and aesthetic issues, and how to balance the conflicting questions that tall building developments bring to the contemporary city project.

To balance the issues that tall buildings bring into the city project is complex because the arguments range from context, scale, and appropriateness to competitiveness between cities on the global market, financial returns on both the global and local scale, and with iconic values and identity [2].

Without paying too much attention to these issues, in general terms planning deals with urban transformations and tall building developments by establishing different heights areas[2]. However, things are changing. Among the different tools and methods that have been developed to tackle the issue of the integration of landscape into urban planning and design [3], visual impact assessments are becoming important tools to plan and manage landscape transformations also in urban areas. In some cities in northern Europe the need to manage urban transformations, control the visual impact of new towers and building developments, and show the implicit results of choices has prompted both the development of digital models of cities (by adding building heights in database mapping) and the definition of specific assessment protocols – see, for example, London, Paris, Rotterdam [4, 5].

The paragraphs that follow describe part of an on going study on the use of visibility analyses and their possible applications on urban planning and design. The analysis are applied to the urban landscape of Turin.

[1] In northern Europe, in particular, the rapid growth of renewable energy plants has contributed to intensify the efforts to test and systematize environmental and landscape impact assessments for the phases of analysis, evaluation, representation and population consulting.

[2] For example, the city of New York had established its Scenic District Zoning in 1912.

II. INTEGRATION OF TALL BUILDINGS INTO HISTORIC URBAN LANDSCAPES. THE CASE OF TURIN

Turin's tallest building - though not for much longer[3] - is the Mole Antonelliana, which is also its internationally recognized symbol. Inaugurated in 1889, the building is a challenging 167-meter-high masonry dome that takes its name from Alessandro Antonelli, the architect who designed it. The second tallest building in the city is the Torre Littoria[4]. Built between 1933 and 1934 in the fascist period, the tower - 109 meters high - was designed by the architects Melis and Bernocco and it is situated in the historic city centre in Piazza Castello.

Other landmarks also characterize Turin's skyline[5], but it was only in 2008[6] that the skyscraper designed by Renzo Piano for one of the largest banking groups in Italy - Intesa San Paolo - provoked a heated public debate. Involving both experts and citizens, the arguments for or against the tower have ranged from financial concerns and environmental sustainability issues to aesthetic considerations focused on worries about the strong visible change to the consolidated urban skyline. Indeed the current skyline is characterized by a profile of homogeneous heights and few emerging elements among which there is the first and "only one" of the Mole Antonelliana. As Bagnasco (a sociologist) pointed out, Renzo Piano's skyscraper height has challenged the Mole which is "culturally authorized to be high" [7]. About Piano's skyscraper, De Rossi (Assistant Director of the Urban Center Metropolitano of Turin) wrote: "Hardly anyone has tried to imagine and describe the project - and its possible critical points - in the physical city that is developing" [8], namely that of the *Spina Centrale* [literally, "central Spine"], the new axial centrality proposed by the Regulatory Plan in force. But in reality who tried "to imagine and describe the project" have been committees, associations and thinkers that have expressed their reservations with well-supported arguments and images[7]. Even though some images produced were incorrect from the point of view of the perspective construction, they have had the merit of stimulating public debates able to go beyond the acceptance of the "loss" of the primacy of the symbol of Turin.

Fig. 1. Turin seen from the Monte dei Cappucini viewpoint.

Fig. 2. Turin's city centre from the Grand Madre di Dio church.

Fig. 3. The Mole Antonelliana and the Intesa San Paolo's skyscraper.

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[3] To this day, different buildings that exceed the height of the Mole have been approved but it is unclear which of these will be built. For more insight about Turin's tall building development see [6].

[4] The Torre Littoria is also called "the finger" by Turin's inhabitants on account of its distinctive silhouette.

[5] In order of height: the Santa Zita church bell tower - 1866; the three Michelin Nord Towers in Spina 3 - 2006; CTO Hospital - 1961; RAI tower - 1968; Residence La Torre in Spina 3; Di Vittorio Tower - 1980; the Olympic Arc - 2006; the Palazzo della Provincia - 1962; Lancia tower - 1957; the Duomo bell tower - 1469; BBPR tower - 1961; the Olympic brazier - 2006; Spina 4 Towers; the Principi di Piemonte Hotel - 1935; Mirafiori Tower - 1970; XX Settembre Tower - 1947.

[6] The inclusion of tall buildings in the city plan began with the town planning regulations (PRG) currently in force, which were approved in 1995. The plan provided for the building of new towers along one of the three defined centralities (the *Spina* axis). The towers were designed and the only two currently at the building stage (the Intesa San Paolo skyscraper and the Piedmont Region Tower) were thanks to variations and in derogation from the plan. Unfortunately, they will result as isolated architectural events not included in an overall urban and landscape design.

[7] Some images and written document by the NOGRAT Committee can be found at www.nongrattiamoilcielo.it.

To date, Renzo Piano's skyscraper (166. 66 meters high) and the tower designed by Fuksas for the Piedmont Region (205 meters high) are under construction. Is still not clear whether the other tall buildings approved by the municipality will be built, due to the current economic crisis.

III. A CONTRIBUTION TO TURIN'S HIGH-RISE DEBATE: A GIS-BASED VISIBILITY ANALYSIS

In order to show how the planning and design of new tall buildings can be supported by visual analysis a GIS-based analysis has been developed by the Politecnico di Torino[8]. Using a Digital Surfaces Model (DSM), constructed by combining the elevations of natural terrain features, buildings and the vegetation of Turin's hills, two different visibility analyses have been developed for three different points of interest. The first map highlights all the places from which the Mole Antonelliana, the symbol of the city, is visible (fig. 4). The second map shows the same but for the Torre Littoria, which was the first "tall building" of the city that was likewise placed in its historic centre (fig. 5). The third map proposes a further variation in the use of this type of analysis, showing all the places that are visible from one of the significant and recognized viewpoints of Turin: the Monte dei Cappuccini (fig. 6). Moreover, a map of Turin's visual sensitivity has been developed that shows the range of visibility of the city from some selected and significant viewpoints (fig. 7).

All the selected points are visible to each other and the visual analyses developed propose applications for managing and planning Turin's urban landscape taking into account:

- the visual sensitivity of the areas of the city;
- the visual impact of new buildings as regards the city's topographical and morphological features;
- specific points from which the visual impact can be assessed;
- visual relations between significant visible landmarks.

Moreover, the maps show some of the morphological features of the city:

- homogeneous urbanization composed of slightly lower high buildings: a feature that allows for great visibility of the tallest ones whose height would not list them as "tall buildings" in many other parts of the world;
- an urban structure with deep urban axes which allow for good visibility of the significant landmarks of the city - if they do not already frame them directly.

A 360° cone of vision and a set of visual depths up to 10 km have been set for each analysis, together with specific parameters as described below for each resulting map. Each parameter has been defined to address the viewshed analysis, such as the observer's position, viewing direction, and different distances, that allow the identification and recognition of different elements of the landscape (details, colour, texture, silhouettes, masses, etc.). Different kinds of visual impacts may be expected as a result, and sets of regulations and restrictions can be suggested (see par. VI, [9]).

A. The visibility of a symbolic and identity landmark, the Mole Antonelliana (Fig. 4)

The map shows the areas from which the significant elements of the Mole Antonelliana's silhouette are visible. The selected points are: the base of the dome (45 meters high); the base of the *Tempietto* (85 meters high), which is also a controlled access viewpoint that can be reached by an elevator inside the building; the spire of the building (167 meters high) with its characteristic star whose history is a part of the historical memory of the city.

B. The visual influence of a tower, the Torre Littoria (Fig. 5)

The map shows all the areas from which the tower is visible. The tower can be considered the first "tall building" of the city and Turin's inhabitants still have conflicting feelings about it. Obviously, the same kind of analysis could be carried on others existing or planned towers (such as Renzo Piano's).

C. The panorama seen from a significant viewpoint, the Monte dei Cappuccini (Fig. 6)

The view from the terrace of the convent of *Santa Maria al Monte* is one of the most popular locations for appreciating Turin's panorama thanks to its privileged location and the wide range of vision. In fact, representations of Turin from this viewpoint date back to the 16th century. Moreover the *Monte* and the convent are themselves city landmarks.

The chart shows all the areas that are visible from this viewpoint. The different colours refer to the visibility at a distance of 500, 1200, 2500, 5000, and 10000 meters.

D. Turin's visual sensitivity (Fig. 7)

The map has been developed thanks to the overlapping of the visibility from four viewpoints: Basilica di Superga, Monte dei Cappuccini, Parco Europa, and the Mole Antonelliana. The result is a map that shows which areas are more visible from the selected points of interest and thus the level of visibility of any transformations that can occur in these areas. The gradient from yellow to brown shows the areas from low to high visibility.

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[8] Research group: Claudia Cassatella and Giulia Carlone, supervisors; Paola Guerreschi and Tatiana Bazzi, GIS elaborations. The images have been developed by the *Laboratorio di Analisi e Rappresentazioni Urbane e Territoriali* of DIST (Politecnico di Torino) on the Municipal topographic GeoDatabase (*Città di Torino -Sistema Informativo Territoriale,* www.comune.torino.it/geoportale). Under the patronage of MiBAC (Direzione regionale per i beni culturali e paesaggistici del Piemonte), Regione Piemonte (Direzione Programmazione strategica, politiche territoriali ed edilizia), City of Turin (Direzione Sistema Informativo della Città di Torino), and the Biennale Creare Paesaggi, the outcomes were presented during the III Festival "Architettura in Città", Turin, 28th May 1st June 2013, promoted by OAT (Ordine degli Architetti Pianificatori Paesaggisti e Conservatori della Provincia di Torino) and FOAT (Fondazione dell'Ordine Ordine degli Architetti Pianificatori Paesaggisti e Conservatori della Provincia di Torino).

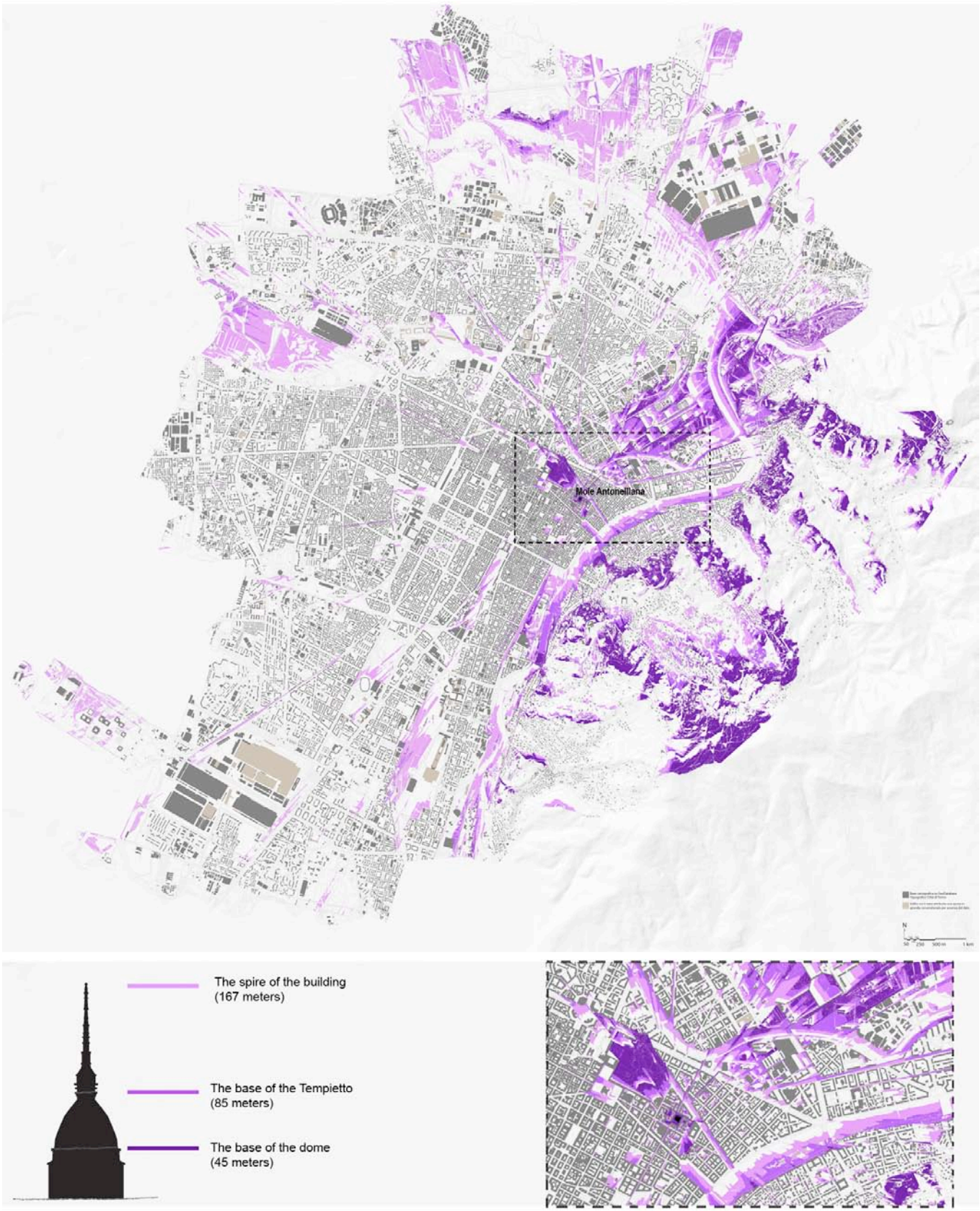

Fig. 4. The visibility of the Mole Antonelliana: the symbol of the city.

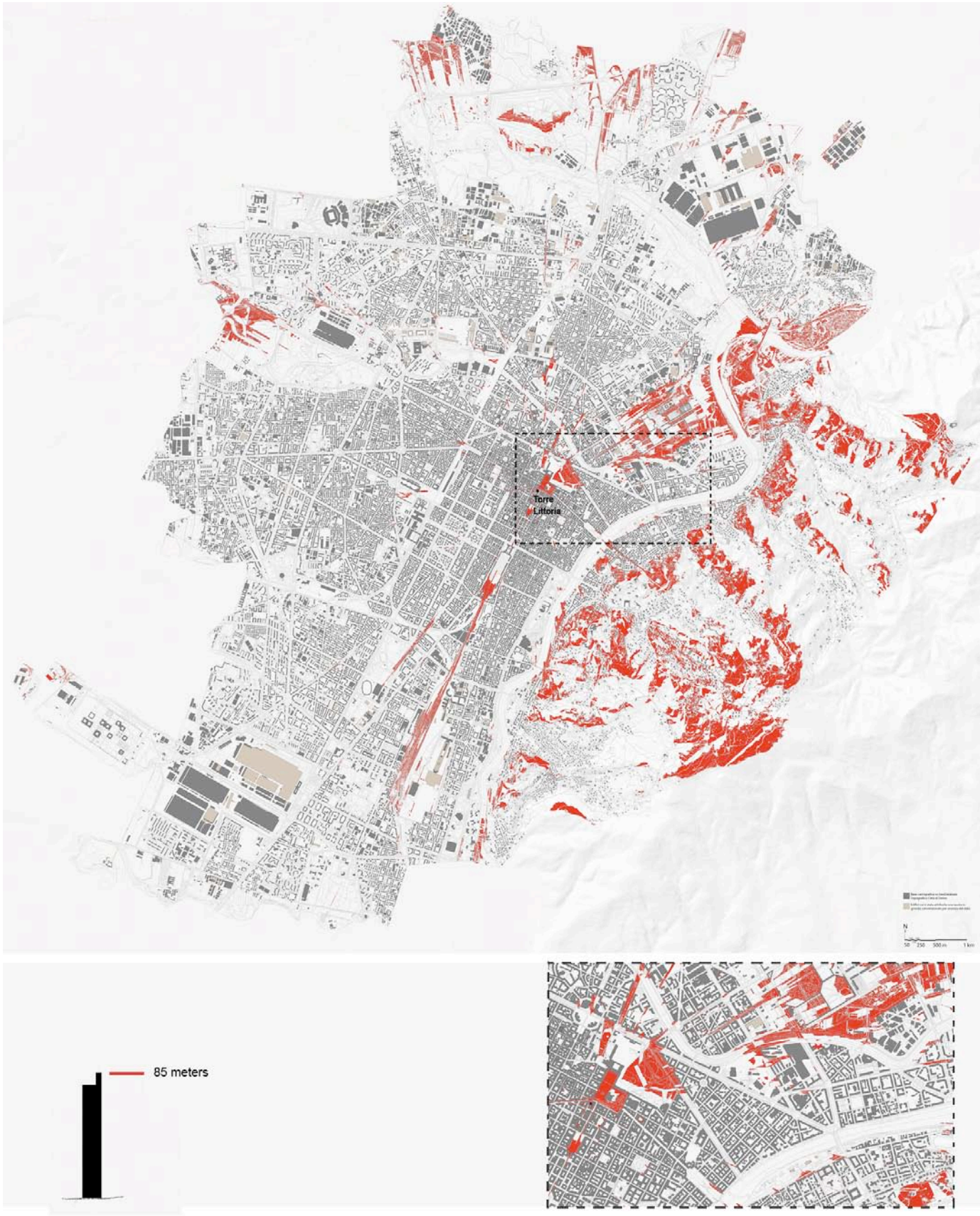

Fig. 5. The visual influence of the Torre Littoria.

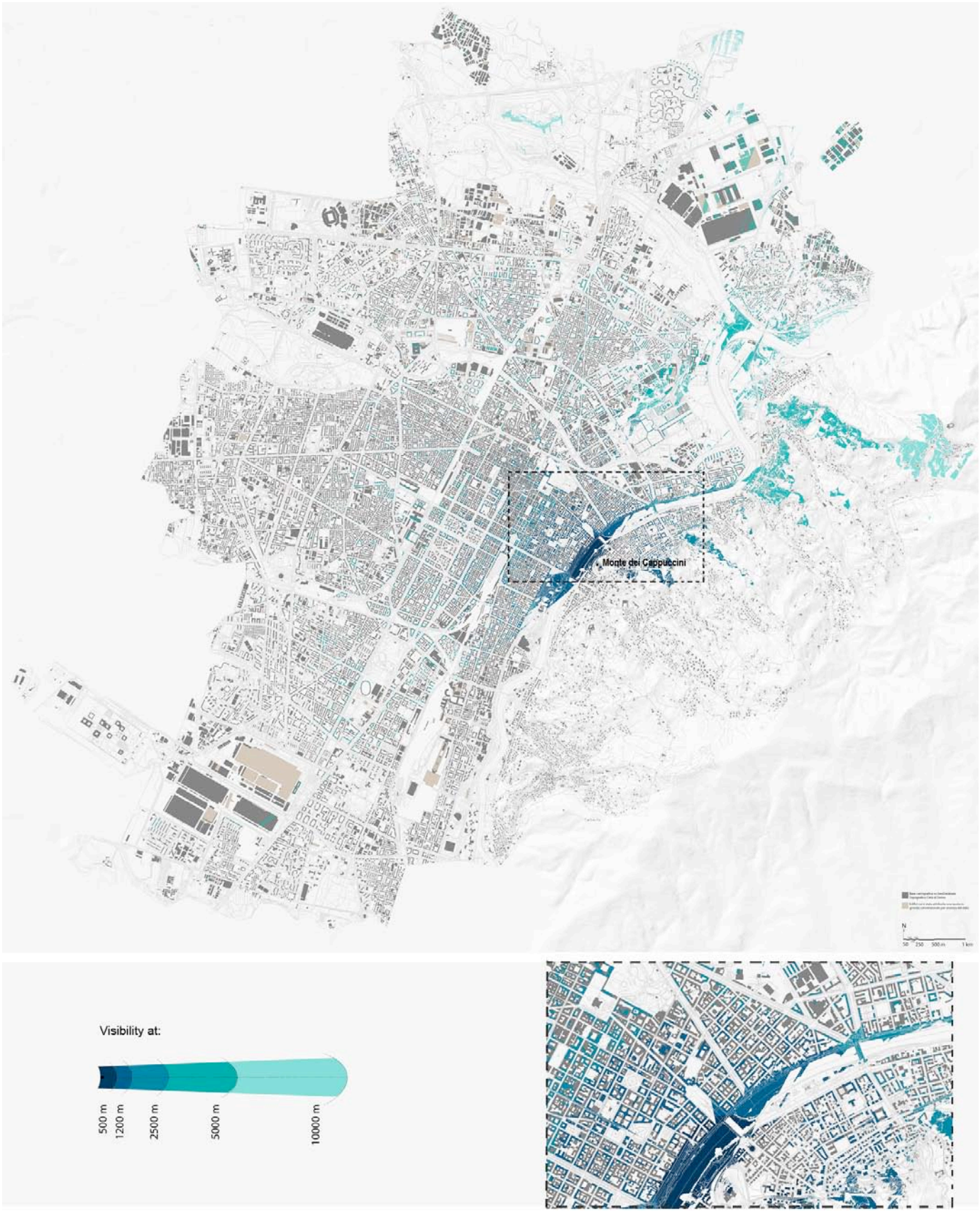

Fig. 6. Areas visible from the Monte dei Cappuccini viewpoint.

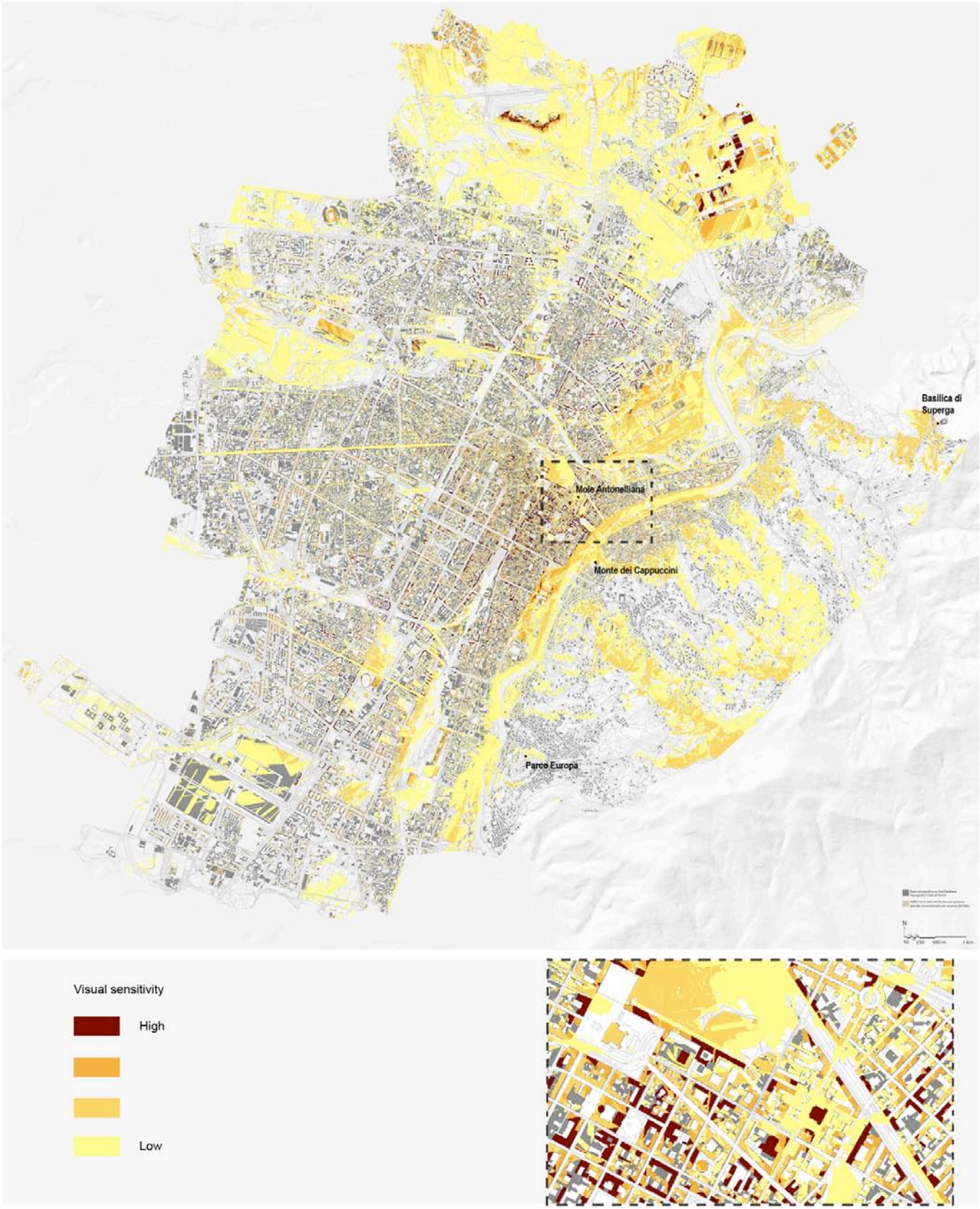

Fig. 7. Turin's visual sensitivity from the selected viewpoints.

IV. APPLICATIONS AND FUTURE PERSPECTIVES

Predicting where the urban transformations might have a visual impact, and where the impact would affect a wider number of scenes (e.g. highly-sensitive areas), protecting areas of natural beauty and significant landmarks visible from panoramic viewpoints, are goals that require the precise identification of the intangible relations between observation points and the objects/areas observable. GIS-based visibility analysis offers the possibility to do so. Thanks to elaborations based on a Digital Surface Model (DSM) and the setting of a specific cone and range of vision it is possible to determine the areas visible from a point or, vice versa, all the areas in which a point is visible. Thanks to visibility analysis it is thus possible to estimate the impact of a proposed project and to locate interventions in accordance with the area's visual sensitivity. Visibility and visual sensitivity maps, integrated within traditional urban cartographies, can be objective supports for planning and not just tools for checking *ex post* the compatibility of interventions.

To date, the scenic aspects of the landscape have become contents within Italian regional landscape plans and they therefore need to be "disciplined" with regulations – if necessary by prescriptive norms - which must be based on – even cartographic - identification of the elements of concern. And the latter is a very complex issue as visual relationships are immaterial.

The issue of how to manage the relationship between the defined borders of a landscape asset (in Italy established by the *Codice dei Beni Culturali e del Paesaggio*) and the visual relationships that can arise from it is particularly thorny. For example, the cone and the range of vision of panoramic areas of beauty can exceed the boundary of a protected area and also the municipality one. This aspect highlights that not all the visual relations may be immediately managed and protected if they extend beyond the protection boundary but, in any case, this way of looking at and analysing the visual landscape promotes both awareness and taking care of scenic values in all the stages of planning, beginning with the local one.

As regards the integration of such tools in planning decisions, a pilot project is underway for the Piedmont heritage within the framework of the landscape planning activity developed by the MiBAC - *Direzione Regionale per i beni culturali e paesaggistici del Piemonte* - and the Piedmont Region - *Direzione Programmazione strategica, politiche territoriali ed edilizia* - with the scientific advice of the DIST - Polytechnic of Turin [9].

Moreover, such analyses and methods can be a support for assessing the landscape compatibility of proposed interventions. At present, in Italy, these are carried out by the *Commissioni locali per il Paesaggio*[9] only thanks to photomontages from viewpoints chosen by the proposer.

Visibility and scenic landscape analysis is therefore an important field of study to support planning and design decisions at both the regional and the local level, because they make it possible to specify laws and restrictions with greater detail and cartographic identifications. Moreover, it should be stressed that it is at the local level that GIS-based analyses have direct implications for landscape planning and design, facilitating its management in:

- choosing the viewpoint from which a proposed intervention can be assessed and from which landscape changes and problematic transformational issues can be monitored;
- the evaluation of both the potential and the limits of a proposed intervention (also by the architect in charge of designing it);
- the identification of an area's visual sensitivity;
- the discovery of less well-known observation points and areas of visual sensitivity.

The availability of Digital Surface Models and/or data on which build them, their accuracy, and the choice of the points are critical elements of this analysis, and they entail GIS skills and theoretical landscape knowledge[10]. Nevertheless, even though the method presented is expert-based we argue that its outcomes could facilitate local community awareness-raising and involvement in the decision-making process, accompanied also by tools such as augmented and virtual reality.

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[9] The *Commissioni locali per il paesaggio* (Local Landscape Commissions) are commissions provided by the *Codice dei Beni Culturali e del Paesaggio* (art. 148 of the D.L. 22/01/2004 n.42). These commissions have advisory status and have to evaluate the landscape compatibility of proposed interventions within protected areas or on protected buildings.

[10] As regards improving GIS skills, the MiBAC has just signed an agreement with the Politecnico di Torino to provide a GIS course for its employees.