A 3D model to safeguard and transform the port of Livorno

Toward a View management framework

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Abstract: Can a modern port expand respecting the historical heritage of the city to which it belongs? Considering the landscape and aesthetics, is it possible to integrate new facilities with existing heritage? This paper explores the problems related to the transformation and development of a modern port in a historical context. The aim is to offer useful tools for the design, planning and evaluation.

The case of Livorno is symptomatic of the problem. For centuries, the port has coevolved with the city. At the beginning of '900, the city has expanded into adjacent available areas to the historic harbor. Now, the size of the ships reaches the 400 meters and storage space for goods is doubled. Therefore, the port necessitates a new expansion towards the sea. This evolution is dangerous but necessary for the preservation of historical heritage and landscape.

Livorno is in Tuscany, and the laws that regulate the territory and landscape are extremely restrictive. To safeguard the internal assets, or adjacent to the port. The city of Livorno and the "Soprintendenza ai beni culturali" (Superintendence of Cultural Heritage) initially proposed to set the maximum height for new port facilities at 20 meters.

Indeed, this constraint makes impossible the installation of structures and functional equipment to ships of 400 meters in length and 50 in height. From this comes the need to find rules and different design and planning tools that take into account the specificities of the port landscape.

These restrictions also collide with the ELC (European Landscape Convention). The ELC defines the landscape the entire territory, including the port and the industrial areas. This does not mean that the rules of the territory applies to the port. But, rather than the port landscape has different rules and features from the remaining farms territory it integrates with this.

You cannot treat the port as the other territories, nor design it without taking into account the context. The Port-landscape monitoring method developed for the city of Livorno has been influenced by the management experiences of the London Plan and Liverpool plan; plans which have been recognised and validated by the UNESCO.

But being the case of Livorno much more stratified at historical levels and having to report to internal specific assets or adjacent to the port have integrated these examples with the Geodesign (NIJHUIS, 2011).

The method implemented uses 3D models and GIS tools like Viewshed analysis and line of sight analysis. These are directly derived from the British and Dutch examples. It has been tested in three fields: design, planning and evaluation.

To design and to plan a port integrated with the landscape and the surrounding area is also an advantage for tourism development.

The large cruise ships require modern facilities and services to enter a port in its own circuits. But at the same time also they are demanding modern architecture of the Cruise terminal and links with the city and historic sites.

Keywords: Landscape, 3d GIS, Livorno, Port

Introduction

The core of the research consists of the methods and tools that allow visual control of transformations in the port area. The concept of visual control is recent and derives from the need to provide for very large structures and spaces for receiving the current ships which are often more than 400 meters long. The structures already in port and those of the city are dimensionally smaller and are likely to be minimized or cancelled by the new structures.

At the same time in the case of the city-port it is important to give a coherent picture of the two areas in order to maintain the space and image relationship between the two. The ports and cities of the past were all in one both functionally and in landscape. The commercial trade of the port was functional to the development of the city. Conversely the inland products and goods were the lifeblood of the ports. This socio-economic symbiosis was reflected in the same shape of the city-port (BRUNI 2011).

In the past, urban and port buildings were comparable in size. Even the spaces between the buildings were similar. The stocks of goods took place within city buildings as well as in docks on the waterfront. From the middle of the '900 with the advent of the Global Shipping Trade, the bond begins to break down. The ports started becoming more industrial and logistical. The "Emporio Port" switch to "Hub Port". With this change the needs of space changed as well (FONTI 2010; GRAS 2013). Ports and cities have very different functional and spatial requirements. The port needs spaces and off-scale structures compared to the city; for manoeuvring the ships, logistics and cargo handling. Also for safety reasons, the common areas and access doors are minimized (GRAS 2013).

The modern port therefore needs new spaces, new structures and new networks connected together. These are often in conflict with the historic city and the densely built territory. In fact, new competitive international ports are located far from the cities so that they can expand freely. These only retain a functional context, not related to history, identity, or space. All this in the Mediterranean area is more difficult. The main causes are the coastal settlement density and the difficulty in developing new infrastructure in densely built areas (GRAS, 2013). The link between the port and the city, which had been the base of success for many places for centuries, become in global competition a restriction to development. Many northern European ports are still able to expand the ports along the river mouths where they stand. This is the case of Rotterdam, Liverpool and Hamburg. This, along with their Atlantic location, allows them to be competitive globally.

In contrast, Mediterranean ports were connected to “hometowns” occupying neighbouring land since the war. Over the past 20 years, attention to the design of city-ports has increased internationally. The design guide "Plan the City with the port" of AIVP (The Worldwide Network of Port Cities) gives some examples along with guidelines. Redesign of the city-port is much more complex than designing a simple port. But by redesigning these complex systems, the benefits in terms of image and socio-economic improvement for the city and its metropolitan area can be increased. Barcelona, Valencia, Marseille have made the waterfront harbor a public

place of striking and distinctive excellence. In these cases, unlike most Italian city-ports, there are no historical buildings inside the port itself. In these cases, however, there are many heritage buildings inside the port as is often the case in the Italian city-port. So in Italy's case, the new projects proposed must take account the existing heritage saw its value and the tourist vocation of the territory.
In cases of historical city-ports which do not have spaces for expansion it is not enough to have a quality design divided into zones. It is necessary to safeguard in a precise manner the historic buildings and parts of cities that blend with the port in transformation. Can this be facilitated by the new methods and new visual and landscape monitoring tools?
With this perspective, the goal of this research is to test and adapt new tools of View Management (Greater London Authority 2012, pp. 17-27) in the context of the Italian city-port, starting from the case of Livorno.
We have used three international research streams adapted to the Italian context:

1. View management. Which defines the framework necessary for planning
2. Visual Landscape (NIJHUIS 2011). Which provides tools for planning
3. Geodesign. Useful for building the 3D model and provide technical GIS analysis

Overview on the role of landscape on the transformation of Italian ports

Italy is one of Europe's most problematic cases when it comes to the mix of historical heritage and operational harbours. This is the primary reason why development of its ports has not occurred with the speed and effectiveness of other European examples. The Italian ports were all born within (or concurrent with) the city. The development of modern sailing has made existing structures and spaces progressively inadequate, even though those same structures for centuries had made the fortune of Italian city-port. The separation between the port and the city has been a slow but steady process especially since the war. The ports and cities in Italy have gradually started to separate in many ways, although they remain adjacent on a spatial and geographical level. The main ones are definitely the governance and planning. The first has a particularly complex structure and includes the Ministry of Infrastructure, the regions and the City. These overly complex governance processes did not allow the Italian ports an opportunity to quickly transform and become competitive, because of the delay in drawing up the Port Plans (PELLEGRINO, 2008). In many cases, previously approved structures were already inadequate for the needs of the dynamic international yachting.
For this reason, designers often resorted to small modifications in the plan that ignored the overall design. Returning to spatial problems, the majority of Italian ports have adequate port facilities using adjacent free spaces out of a systematic and organic planning. In order to make the Italian port more functional and competitive on a global level, the water and land areas should be redrawn. But most Italian ports are "embedded inside the compact tissue" often compressed between the city and the sea. The only option that allows one to build without interrupting port operability is expansion towards the sea. This is the option chosen for Livorno (IMG. 1). Doing so can also liberate the filtering areas between port and city (DI VENOSA 2005). With this new process of transformation, we will also address the use conflicts, born from non-integrated planning during the last fifty years (MASSA 2005).
To remedy current problems, these new port transformations must be radical. Furthermore, lead times of new Italian ports need to be short, to bridge the gap between other European and world ports. The issue is that the limited deadline time and resources do not take into consideration the numerous landscape and aesthetic

features important for any Italian city-port. The Port Authority of Livorno, as with other Italian ports recently, want to prevent this risk. They decided that the preservation of heritage and landscape is also an important objective of the Port Authority Plan.

Attention to quality design in its cultural landscape planning seems to be a nonessential aspect. What drove the port authority to make such a decision?

There are two main reasons. The first is related to attracting investments. Modern ports are not just functional, especially in the vicinity of the city. Many areas liberated from port facilities can attract investment. In order to be competitive, the new port must be a mirror of modernity, dynamism and economy as are, Valencia, Barcelona, Amsterdam, Melbourne, Sidney, etc.

The second reason is related to the business of cruises. In fact, along with commercial trade, big city-ports also attract cruises (GRASS 2013). They can become the doors to the surrounding region. The Port of Livorno would become the port of Tuscany, which has a strong appeal on an international level. Again cruise operators would be enticed to invest. The quality of port landscape has significant economical and strategical value not unlike port functionality and commercial logistics.

The goal is clear and mutual: to redesign the port while safeguarding the heritage and landscape, while simultaneously making it more functional and competitive on a global level. So the problem is not “what to do” but “how to do” it: then by what methods, with what operational tools? The great necessary functional transformations cannot be delayed by landscape features and protection. As often it happens in Italy. It requires clarity, in a territory without a tradition and a methodology in this regard.

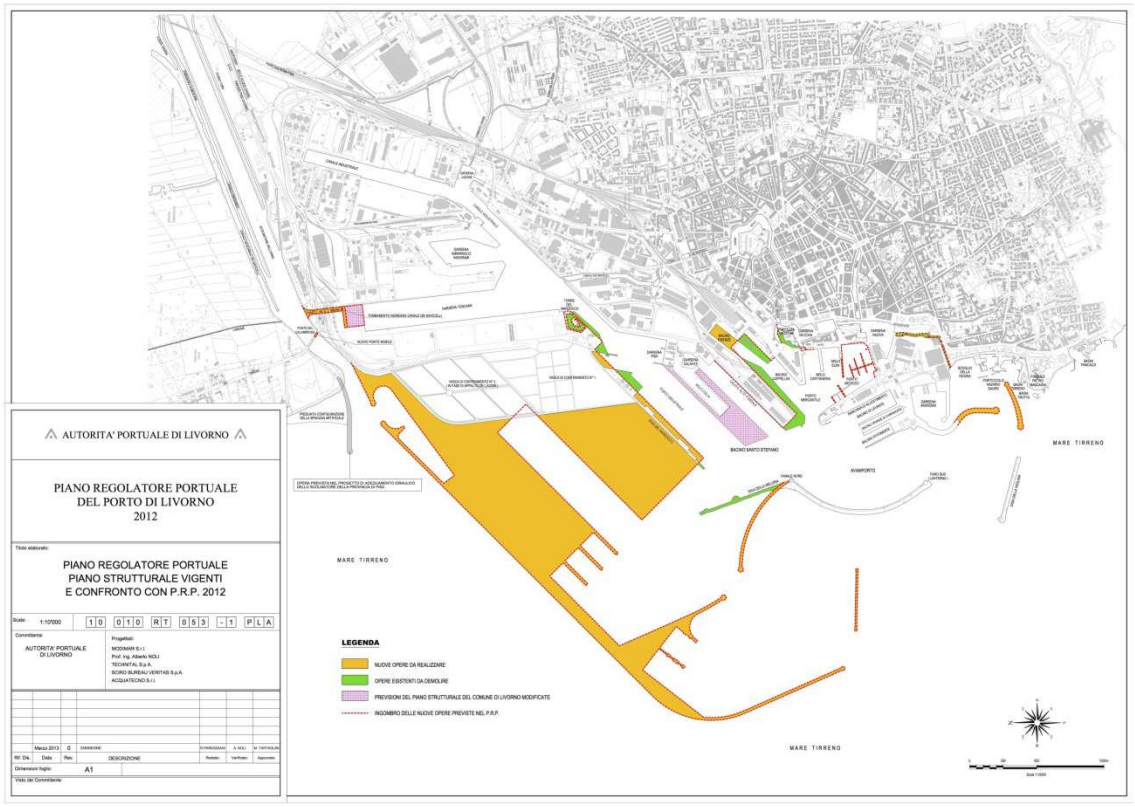


Fig. 1 – The new works provided by the Port Master Plan. Note the size of the new works (orange) compared to the city and that the expansion takes place entirely towards the sea

Problems, methods and tools

This experimental research work made by DidaLab in Regional Design was requested by the Port Authority of Livorno. As previously stated, it is studying a method of innovative tools to control the impact on the landscape of the new facilities planned in the port of Livorno.

In order to achieve this objective, the proposed methodology must address the two major problems of the Italian context:

- The need for a simple and flexible tool that overcomes the rigidity of governance and Italian port planning
- The need for quantitative analysis tools that allow the calculation of visual impact of the changes and enable the assessment within environmental and economic matrices.

The answer to these two problems as apply to Italian experience is incomplete. In Italy, there are experiences of quantitative visual analysis but only on a regional level. In particular we recall the Landscape Plan of the Piedmont Region (CASSATELLA 2014), and the experiments regarding Turin, and intervisibility maps of the Regional Landscape Plan of Tuscany. Unfortunately, in both cases, the scale is larger than that of the Port therefore only useful for the definition of visual basins and definition of panoramic views. This has necessitated widening our research to foreign cases and applications; in particular Anglo-Saxon and Dutch. In these we find cases of application, very useful methodologies and tools to address the problems revealed. The task of this research is to test them and adapt them to the Italian context.

The View Management research helps in response to the first problem (Greater London Authority 2012 p. 5)). Anglo-Saxon projects used both in Liverpool (Liverpool City Council, 2009) and London (Greater London Authority 2012). It is very useful in planning. It consists of a supplementary document that supports the development plan. Being distinct from the main plan configured as a flexible tool that can be implemented during the transformation process. As we noticed, governance and planning of the Italian port authority are very rigid.The View Management methodology allows us to solve this problem. This methodology provides a reference framework for the visual design analyses and for the evaluation of the transformations. For each of the visual categories identified on the map, we are looking for the best representation and IT tool.

The Visual Landscape helps answer the second problem (NIJHUIS 2011). This line of research offers quantitative analysis tools that descend to the architectural detail. If, for the construction of the View Management Framework enough 2D GIS tools are needed, for the analysis of details of Visual Landscape it is necessary to build a GIS 3D model. The integration between these two methods is an added value of this research. An innovative choice that helps to overcome the concept of landscape based on subjective perception trying to objectify least visual perception.

The method here developed can be taken in the following points:

1. It is a supplementary document to the Port Development Plan. It is therefore independent and modifiable by policy makers during the realization of the plan changes
2. It has a reference framework that analyses all the visual of the entire port area. This is summed up with the map of strategic visual.
3. The visual of choice occurs according to four categories: Strategic visual cones towards the sea, Strategic visual windows from the city, safeguard Lines intervisibility and scenic trails

4. For each individual visual category identified in the map is detailed landscape character: visual lines to fully safeguard, the visual on which an approval by the competent authorities and the free visual.
5. The computer analysis in the visual identified in the map of strategic visual are quantitative based on GIS 3D models derived from official maps.
6. The punctual analyses can both support the urban design that provide quantitative data on the visual impact. Therefore, be useful both for the Decision Support System, which for environmental assessments.

The method is multiscale. In fact, it is ranging from urban scale to that architectonic one. At the urban scale, the framework has a strategic function. The particulars of each view are the "tactical" tool that narrowing the scale allows a thorough analysis of the visual impact generated by processing proposal. It allows you to have a framework for the planning and the establishment of land use standards thanks to the paper of the strategic views.

3D GIS analysis is used to assess and support the project and the facilities provided. Using this tool, we can also compare different solutions. The quantitative nature allows its use in environmental impact assessments and the Strategic Environmental Assessment. The method is verified. Thanks to IT tools, each of the analysis steps can be verified and corrected. If an error occurs we can change the parameter or correct the model to have, in real time, the outcome.

The map of strategic visuals and the View Management Framework

This map allows a complete picture of sensible visual transformations. The map needs to communicate more than just technical data. This is to be understood by planners and investors. The most important elements are the location and orientation of the identified visual category. The Designated View areas (Greater London Authority 2012 p. 21) are defined with black rectangles and letters. I.E. public places which represent the various visual categories.

Here are details of the visual categories identified in the map:

- Strategic visual cones towards the sea. The goal is to study and ensure the visibility of the sea and the characteristic elements of the port. These points of view regarding the great utilization areas of the city which enjoy a view of harbor and sea. The visual cones have a large radius and the simulations must be repeated from different observation points in order to evaluate the impact in the whole area.
- Strategic visual windows from the city. The goal is to study and ensure the visual relationships of the port from the city. These viewpoints concerning urban trails that overlook the port from which currently are recognizable characteristic elements of the port landscape. The windows have a particularly close range because the vision is limited laterally by the buildings, in fact, they act as a frame for the port landscape.
- Lines of intervisibility preservation. The objective is to study and ensure the intervisibility by areas, or physical elements, of the landmark. The analysis in this case concerns only one element of which is to ensure visibility. The observation points can be on areas such as on the characteristic elements of these such as the deck of a ferry or a cruise ship in the case of the passenger terminal.

- Scenic trails. The goal is to study and ensure the recognition and identity of the port from the paths. These can be terrestrial, such as walks along the waterfront or coastal road, or maritime, such as shipping lanes for cruise ships or boaters.

The map of strategic visual is accompanied by a document containing the guidelines and specification sheets for each Designated View areas. The map also contains examples, operational guidance and guidelines for the evaluation and support of the transformations in different application areas. In particular, the panoramic photos and specifications sheets of Designated View areas, identified in View Managment Framework, will provide a "snapshot" of the current port.

At the same time, it provides a "vision" of the future port using insertion photos, diagrams, and 3D models. The guidelines indicate in advance the criteria and methods by which the projects will be evaluated as well as the transformation of the port plans. Together with the View Management Framework, the guidelines serve as a "clear and shared base" on which future projects planned by the Port Master Plan rest.

Three significant experimentations

The application experiments have covered only some specific areas. For brevity we report the three most significant examples that relate to as many visual categories identified in the map of strategic visual (Fig. 2). For these experiments we have used the currently available transformation project, in addition to the breakwater works (dams, piers, docks) also the detailed plan approved by the port authority. In the future, these simulations will address any design options that will be submitted to the Port Authority from investors and developers.

The map of the strategic views through the specific sheet and the specific guidelines for each area will provide precise information in order to respect the perception of the balance sheet items and the sea. The tested tools are therefore those of the verified project. They are used to provide a visual impact assessment quantitative and provide spatially accurate directions to any changes as in the case of the passenger terminal.

The strategic visual cones towards the sea.

It is the blue color seen in the map of strategic visual. Thanks to 3D GIS simulation you can measure the impact of the new structures.

The measurement takes place mainly in degrees. It is of course possible to know the distance at which the new structure interferes with the view (Fig. 3). Distances in this example have two ranges and a threshold before and after 2 Km. In fact, after this threshold the vision of linear elements of the sea is no longer stereoscopic and therefore the visual perception is reduced because of elements "confused" with the background; in this case the sea and the sky. The threshold can vary depending on specific studies and analyzes on the view that may be detailed in the specification sheet supplied by View Managment Framework.

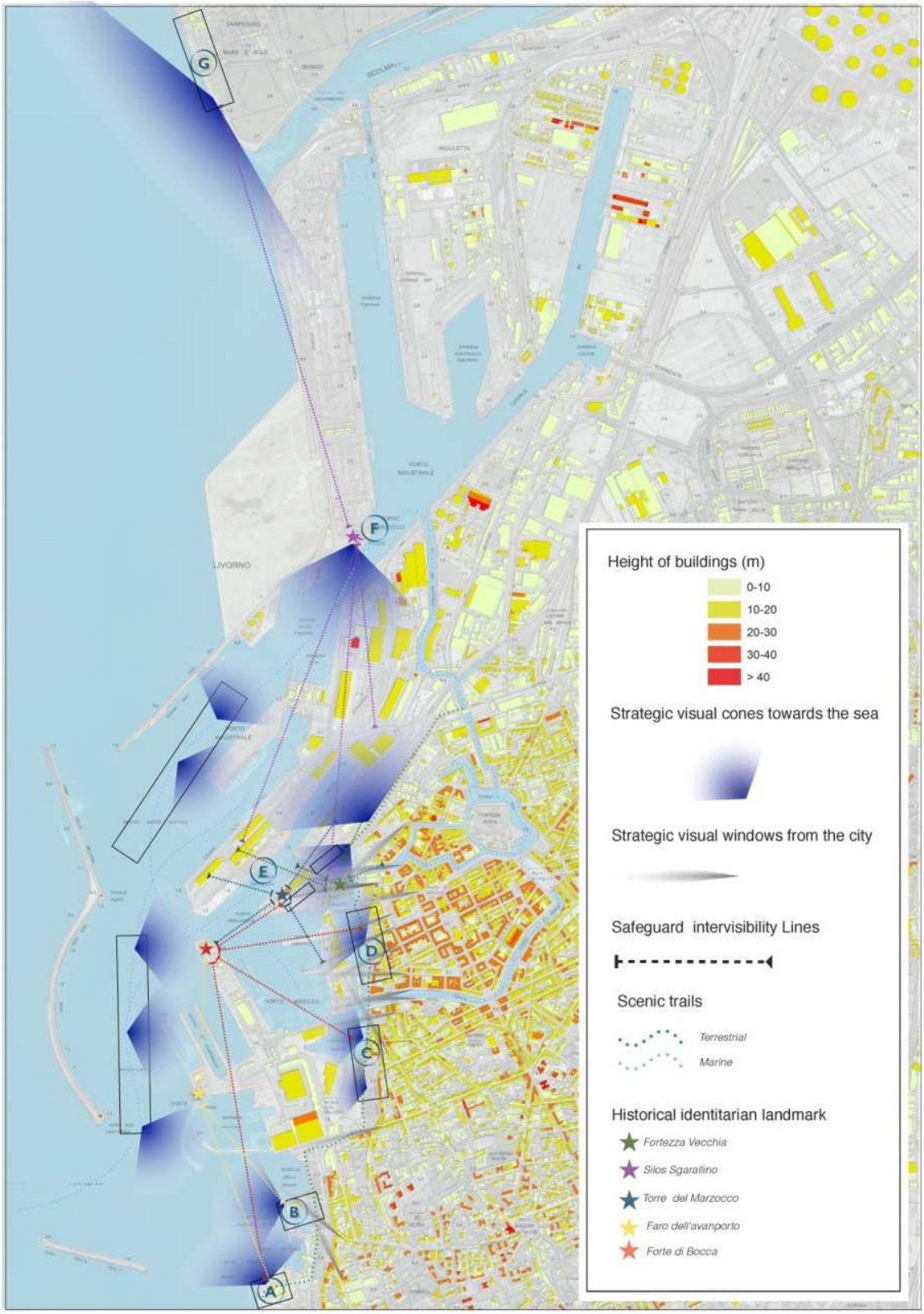
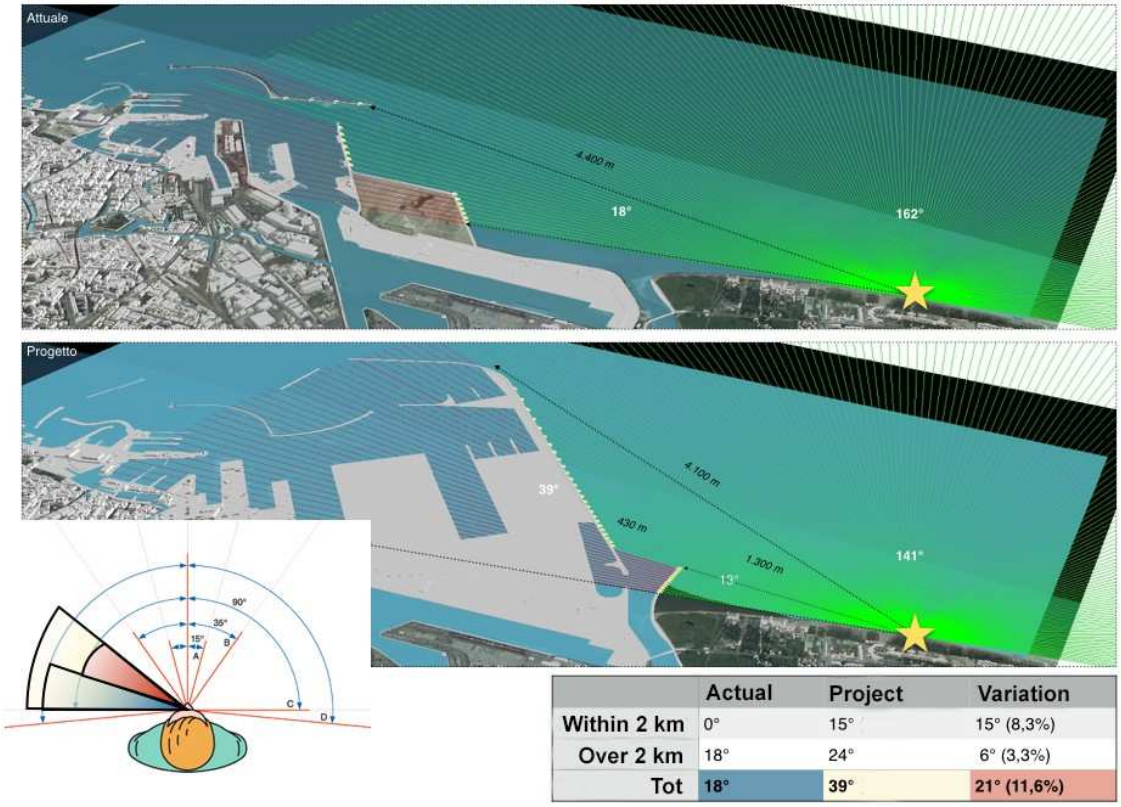


Fig. 2–- in the map of strategic visual



	Actual	Project	Variation
Within 2 km	0°	15°	15° (8,3%)
Over 2 km	18°	24°	6° (3,3%)
Tot	18°	39°	21° (11,6%)

Fig. 3 – The strategic visual cones towards the sea. The impact on the tourist beach of Calambrone.

Safeguard intervisibility lines

This trial relating to safeguarding intervisibility lines refers to the Passenger Terminal. As previously mentioned in this case it was in the presence of a project proposal. It was enough to have the planivolumetric of this to build the transformation model (Fig. 4). One called S1. The intervisibility we wanted to improve was that of the Old Fortress from the passenger terminal. After the first simulation we realized that the designed structures occluded the view. It is therefore recommended an elevated route (S2) be used that has significantly improved visibility. In this case the trial was more Decision Support System than assessment.

Scenic trails

The scenic trail that presents itself is marine trail (Fig. 4). In fact, it is the route that small boats use and to get from the marina to the Torre del Marzocco. The visibility of the Old Fortress of the status quo (S0) and project (S1) was measured. We detected improving the visibility of both the walls of the tower was not considered appropriate to provide guidance to change the S1 project.

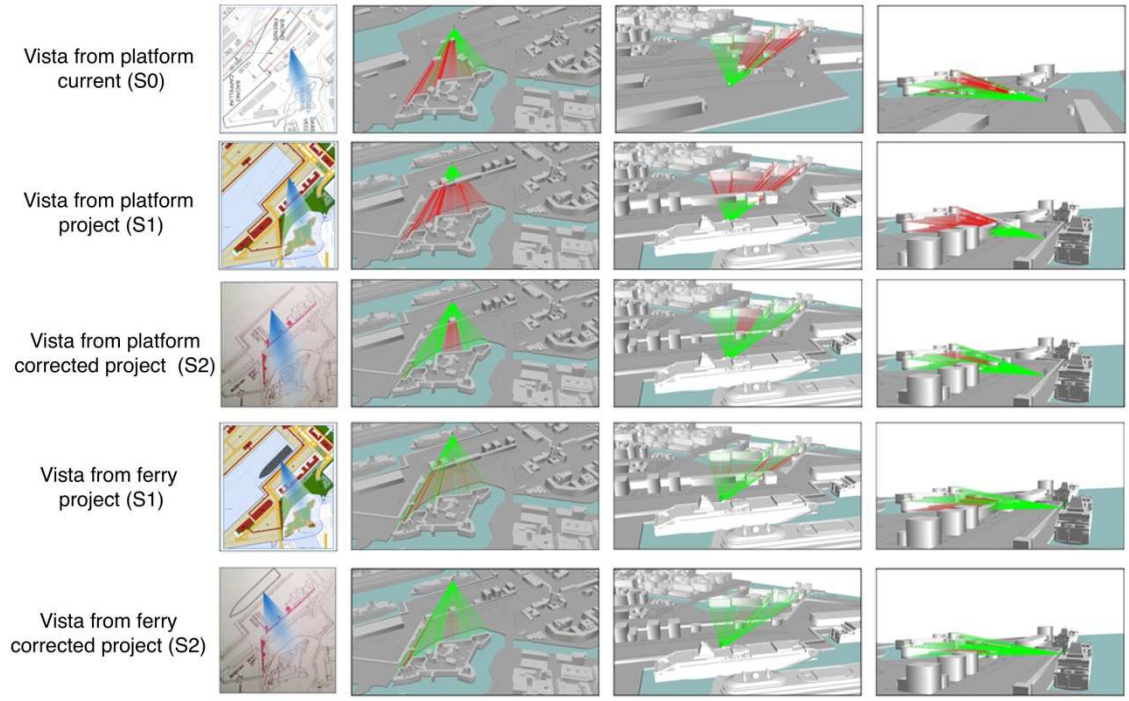


Fig. 4 – Safeguard intervisibility lines. Experimental application View Managment DSS in the project.

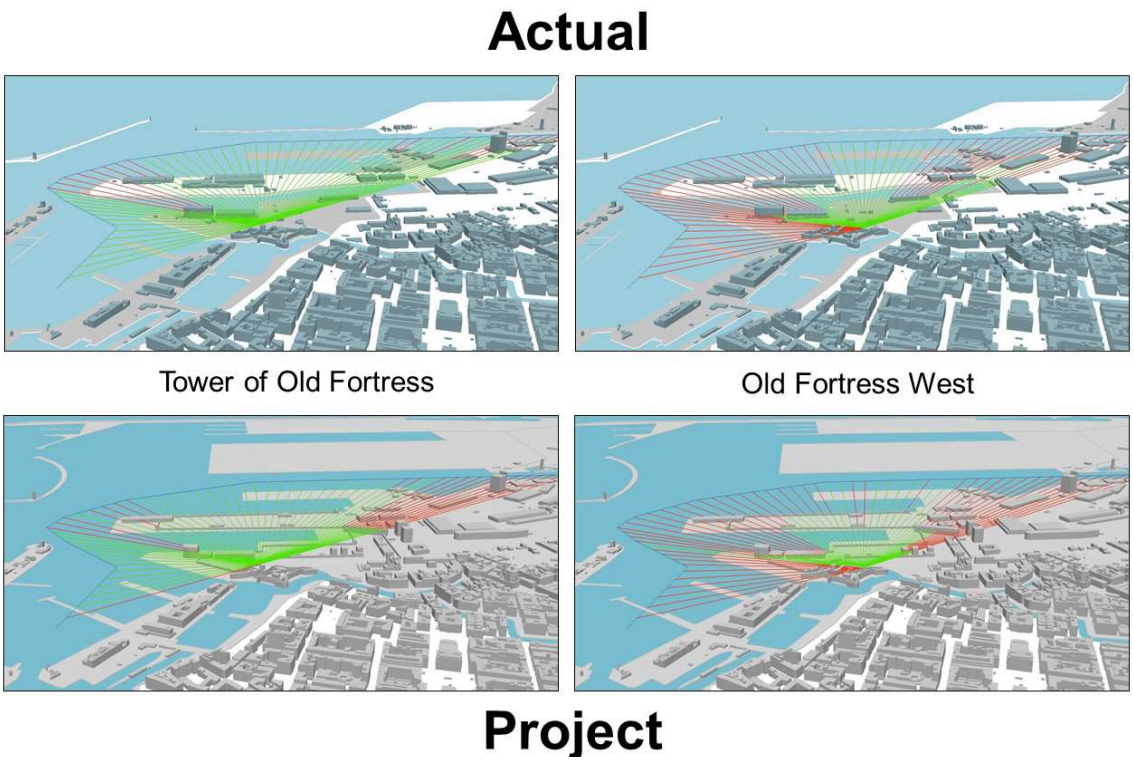


Fig. 4 – Scenic marine trails

Conclusions

The results of the experiments allow us to say that thanks to the 3D GIS model and to the geodesign tools (NIJHUIS 2011) one can perform quantitative analysis of visual impacts. This allows to safeguard the heritage present in great transformations such as Livorno. The first trial concerning the strategic visual cones towards the sea is representative of this aspect. This is very important in Italy, where the qualitative analysis preponderance often leaves designers and entrepreneurs in uncertainty with respect to the realization of large and medium size projects.

The second and third experiments that concerned real projects have shown that the new 3D GIS tools can also help a lot in the correction of the planned projects. The instruments are therefore understood to be useful for the Decision Support System. The development of Visual Management Framework, and its attachment to the traditional planning, can make up for the lack of clarity in terms of landscape of the planned changes. London has used this instrument for the same reason (Greater London Authority 2012 Introduction p. 1). The skyscrapers of its downtown are as necessary to its image as the preservation of Buckingham Palace and Saint Paul. A dutiful observation is that the view Managment Framework is not intended as required for all cities and all territories, but useful for those where there are great transformations planned in the presence of a rich heritage.

This research is continuing with complete coverage of the areas of the Port to get a complete visual control. They are processing the cards with the quantitative information for visual impact analysis. Simultaneously we are developing specifications 3D GIS for each Designated View areas. These will be provided as soon as possible to investors and designers because they have a complete picture on the computer checks that will be made on their projects.Final aspect that is being implemented is to integrate some qualitative analysis within the method. The next step is the ability to synthesize qualitative analysis through indexes and numbers so that they are comparable within the process. For that they are researching indicators and scientific methods of data collection as it does within the Environmental Assessments Sustainable.

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Imprint:

Proceedings of the 20th International Conference on Cultural Heritage and New Technologies 2015 (CHNT 20, 2015)

Vienna 2016

http://www.chnt.at/proceedings-chnt-20/

ISBN 978-3-200-04698-6

Editor/Publisher**:** Museen der Stadt Wien – Stadtarchäologie

Editorial Team: Wolfgang Börner, Susanne Uhlirz