Digital Ecosystem and Landscape Design. The Stadium City of Cagliari, Sardinia (Italy)

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Abstract. Increasingly articulated and sensitive is the approach to issues of conservation and/or balanced exploitation of resources because of the value of environmental quality at the basis of fundamental rights. This is demonstrated by the successive regulatory instruments: Environmental Impact Assessment (EIA, 1969), Strategic Environmental Assessment (SEA, 2001), Single Environmental Text (2006 containing the rules on environmental protection and waste management) and Agenda 2030 (2015, 17 for Sustainable Development), aimed at avoiding-containing situations of degradation and risk to the quality of life, including future generations. Among the different methodological approaches, we must also consider the Landscape Assessment to be carried out before and, in an evolutionary continuum, after the realization of a work. This in order to identify interference and impacts on the territory (with descriptive-quantitative investigation of the elements characterizing its structure from a naturalistic, anthropic and historical-cultural point of view, and perceptive investigation of the visual impact) its relations, qualities and balances. Certainly, responding to the purposes of a complete and innovative landscape assessment appears to be the use, although not yet fully widespread, such as that of Open Source Tools, available without a commercial license, therefore within the reach of all: designers and evaluators. In this framework, the aim of the work is to evaluate the role of Open-Source Tools in the assessment of the visual, ante and post operam impact of important urban works that require continuous information-collective participation and therefore capable of fostering the creation of shared values.

Keywords: Landscape assessment · Visual impact · Open source tools

1 Introduction

The Digital Ecosystem takes the concept from biology, Natural Ecosystem, with which it identifies a set of living organisms and non-living matter that interact with each other in

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a given environment, constituting a self-sufficient system. Within this environment there are interactions and exchanges of information, all in an ever-changing dynamic balance. The concept of Digital Ecosystem, on the other hand, contains a link of interconnection and interoperability between software of various kinds and hardware. The concept of Digital Ecosystem, applied to the current context of the case study of environmental impact assessment (EIA), in particular referring to the Stadio Sant'Elia of Cagliari, and its demolition and construction of the new structure, It benefits from the research and applications developed, in particular during the 90s of the past century, and related to Spatial Decision Support Systems (Systems-SDSS) in turn, the result of the integration between Decision Support Systems (DSS) and Geographic Information Systems (GIS). These systems, which form the basis of the application of ICT technologies to territorial problems, concern (and mainly concerned) the application of interactive systems based on IT media, designed to assist final decision-makers on semi-spatial problems.

The Environmental Impact Assessment (EIA) is a technical-administrative procedure preparatory to the implementation of a work and identifies and describes the effects on the environment, health and human well-being. In addition, the EIA identifies measures to prevent, eliminate or reduce negative impacts on the environment. The EIA was thus created (in the late 1960s) to find new decision-making methods, since the traditional ones were no longer adequate to an increasingly complex social reality and to an ever-increasing demand for participation by the various Stakeholders and the introduction of environmental factors between the design components [1, 2].

In relation to the Environmental factors, we must emphasize one of the fundamental aspects of the VIA, the context analysis, better defined as the scenic landscape, within which falls the work to be protected/created. The aesthetic aspect of the landscape, unlike the environment and the territory, is the generalized and social perception, determined by assessable scenic-spatial connotations (height, shape, etc.), characteristic and expressive of a landscape [3].

In particular, as reported in the Guidelines of MiBACT [4], the analysis of the scenic landscape, which correlates the observer with the observed reality, is based on the identification of landscape observation points, such as landscape observation points (panoramic points, public viewpoints with filtered access, equipped belvedere), routes with good or high panoramic views, perspective axes and routes (connecting and crossing, interior and exploration, slow to use) of landscape-environmental interest; on the identification of overall and detailed panoramic beauties, such as visual fulcrums (of the built environment, natural, on a local scale, supra-local and isolated), landscape profiles (ridges, skylines), other elements that contribute to the identity of the landscape (urban and natural fronts, trees, rows, hedges) and visual relationships (intervisibility, focal views, focal views on off-paper elements and frontal elements, wide panorama, visual gates); on the identification of areas characterized by critical elements and with visual detractions, such as punctual, linear and areal critical factors and qualified visual detraction situations based on the type of alteration in progress (perceptual degradation, de-connotation, intrusion, obstruction) [5, 6]. The complex assessment of the landscape context is more and more often carried out with the aid of Open-Source software, thus allowing maximum sharing of the results and the related process.

In this synthetic framework, the objective of the work is to select an open-source digital ecosystem to support the EIA for large urban projects. In this synthetic framework, the goal of the work is to select an open-source digital ecosystem to support the EIA for large urban projects, to identify levels of danger, risk on the landscape, so as to guide from the early planning stages and avoid subsequent mitigation actions [7].

The case study is the project of the new Cagliari Stadium developed on an urban brownfield, in collaboration also with the DICAAR (Department of Environmental Civil Engineering and Architecture, University of Cagliari) for landscape, environmental and circular economy themes.

After the first section (Introduction), the rest of the paper is organized as follows, Sect. 2: Methodology and data: the analysis of digital ecosystems is developed that can support the assessment of the visual impact of the new Cagliari stadium; Sect. 3: case study of Cagliari stadium (Sect. 3); Sect. 4: Results and discussions; and Sect. 5: Conclusions.

2 Methodology and Data

After developing the context analysis (geographic, urban and environmental and landscape), the analysis of digital ecosystems is developed that can support the assessment of the visual impact of the new Cagliari stadium. The analysis focused on 'Open-Source Tools', such as Google MyMaps and Google Earth Pro, which made it possible to identify and evaluate possible critical issues and visual interference on the landscape. In particular: Google Earth Pro is a geospatial software application that offers the ability to analyze and acquire geographic data (as does Google Earth but with additional functions). Google Earth Pro allows you to print high resolution images (the resolution is lower with Google Earth), to automatically geolocate images of the GIS geographic information system (Google Earth requires manual geolocation), to overlay images (Google Earth can only import image files), create animated movies, map points simultaneously, and access demographic and traffic data layers. Google MyMaps is a geospatial software that offers updated and complete information of urban activities and functions and since mobile searches are correlated to the position, it is a real traffic driver. Through the use of Google MyMaps, it is possible to identify the most significant observation points of the city from which the work and (ante operam and post operam), Table 1.

Table 1. Main observation points and routes.

Case study: New Stadium of Cagliari	Points and routes of observation
Points in Proximity	Ranges from: 30–50–70–100–200 m distant big buildings
Points and routes panoramic	Variable spatial distribution

3 Case Study and Data

The Cagliari stadium constitutes the case study, which represents a real symbol for the city, but today it constitutes a Brownfield that requires urgent interventions in the context of an urban regeneration aimed at enhancing the landscape. The city Cagliari, capital of the metropolitan city (population = 421.488 - Istat 2021) with its landscape and naturalistic beauties, dynamic for its international dimension (ICT, economic and industrial hub, sport,..) with the stadium included in an urban project intends to redevelop and integrate parts of cities, some of which have been on the fringes of urban life for too long [8–11].

The work includes a Stadium Building (with multiple sports activities and those connected to them such as museums, bars, commercial activities) and a Hotel Building (with some views of the rooms directly on the playing field). A stadium responding to the needs of landscape-architectural and urban-functional balance, thanks to its circular shape, characterized by an open structure free of barriers, which gives it a symbolic value of social cohesion, generating the idea of a shared collective landscape, also thanks to the presence of a large Mediterranean garden [12–14]. A stadium that will be found to support an improvement of the same city, also passing through the recovery of the suburbs, thanks to a fair distribution of volumes in space, the creation of a system of quality public spaces, the introduction of services in the neighborhoods that today lack them (in a polycentric perspective), the limitation of the environmental impact in the places of commerce, reducing the voids of parking areas, and thanks to the improvement of vehicular accessibility (public and private) and soft mobility, with the creation of a new road network that connects the different functional areas [15–17] (Fig. 1).



Fig. 1. Viewing points of visual analysis from Google Earth. (Color figure online)

Through the use of Google Earth Pro, the visual analyzes relating to the points previously reported were carried out, first considering the old Stadium (Fig. 2 and Fig. 4) and then the new one (Fig. 3 and Fig. 5), so as to then being able to highlight the differences and compare the data collected.

It can be seen from the following photos that what is visible from the identified point is graphically colored in green, while the absence of green indicates the total absence of visibility of the old and new Stadium.

Displayed equations are centered and set on a separate line.

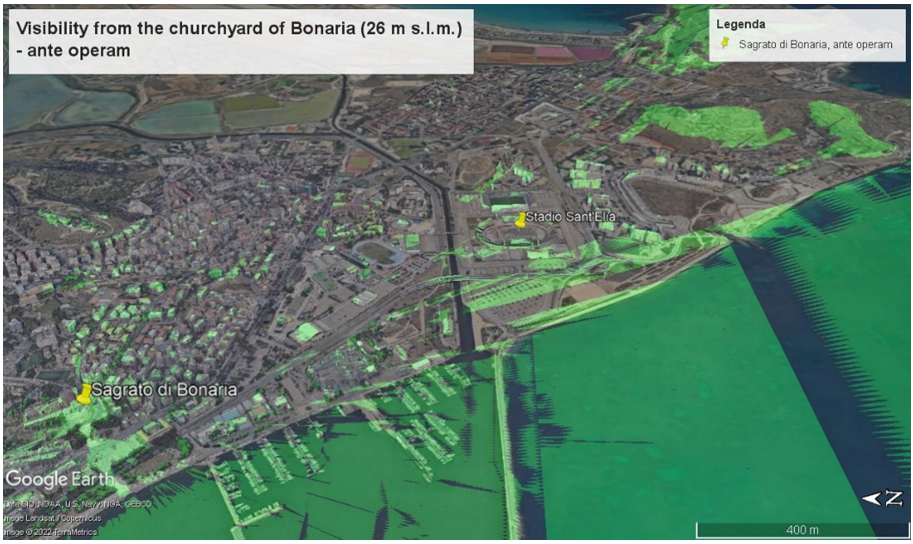

Fig. 2. Visibility analysis from the panoramic point of the Basilica of Bonaria, ante operam. (Color figure online)

The visual analysis carried out with the Open Source Tools revealed significant differences between the old and the new structure. In particular, the ante operam analysis confirms the condition of Brownfield of Stadio Sant'Elia from all the points identified, while from the post operam one can see how the Stadium fits into the landscape without creating discontinuity and fragmentation.



Fig. 3. Visibility analysis from the panoramic point of the Basilica of Bonaria, post operam. (Color figure online)



Fig. 4. Visibility analysis from the panoramic point of the Poetto Tower, ante operam. (Color figure online)



Fig. 5. Visibility analysis from the panoramic point of the Poetto Tower, post operam. (Color figure online)

4 Results and Discussions

The paper is part of a broader research on the demolition and construction of the new Cagliari stadium and has shown above all the usability of open geographic information tools, in particular those based on online platforms.

First of all, through the visual analysis on Google Earth, it was possible to identify the starting points from which to carry out the visibility analysis, and, more generally, the environment within which to integrate various aspects of a territorial nature, relating to the object of study analyzed. In particular, the tool served as a preliminary analysis for the correct localization of the observation points, combining the experience of the research group with the potential offered by the tool (e.g. geolocation, also three-dimensional, calculation of distances as the crow flies and on the road, visibility analysis, etc.).In particular, the work environment of Google Earth Pro made it possible to familiarize with the territory at a scenario level, also observing, thanks also to the presence of the 3-dimensional simulations of the buildings, as well as the profile of the land, the relationships existing between the structure in question (Stadium of Cagliari) in the two moments, ante operam and post operam.

The work also included the insertion of an object identifying the new stadium within the Google Earth platform, in such a way as to more correctly simulate the shape and visual dimensions of the structure, thus facilitating the ante and post operam. The visibility analysis, in particular, proved to be useful and interesting, thanks to the possibility of a correct georeferencing of the observation points, also taking into account the altimetric component, and therefore managing to simulate the point of view even at a height of 'man', fixing the observation point at 2 m above ground level and, therefore, highlighting the areas that are actually visible.

5 Conclusions

This research has dealt with the visual impact of the old and new Sant'Elia Stadium (Cagliari); in relation to this aspect, we limited ourselves to that deriving from the use of "Open-Source Tools", such as Google MyMaps and Google Earth Pro, which made it possible to identify and evaluate possible critical issues and visual interference on the landscape. From the analysis carried out with these tools, it emerged that, at present, from the points considered (panoramic, proximity and along the promenade), no significant visual interference is identified in the post-construction project, unlike the existing structure. The use of such software therefore made it possible to understand whether the new construction project could fit harmoniously into the context, without creating interference, discontinuity, and fragmentation of the landscape. The work carried out also made it possible to test on a practical case the usability of geographic tools, freely available, applied to the evaluation processes (Environmental Impact Assessment and Strategic Environmental Assessment), showing their potential and communicative effectiveness, even to a non-public necessarily expert.

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