A Model of Analysis and Assessment to Support the Valorisation and Management of Green Areas: The Royal Gardens of Turin (Italy)

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Abstract. This contribution aims to develop an integrated model of analysis and assessment for the valorisation and management of green spaces, with particular regard to historic gardens. The model is based on the combination of two main tools: on the one hand, the Geographic Information Systems (GIS), employed for the classification and geolocation of green areas, following the Italian legislation in force on Minimum Environmental Criteria (CAM), and on the other hand, an extended version of the SWOT Analysis, that aims at identifying the strengths, weaknesses, opportunities and threats both at the state of the art and a potential future scenario. The combination of the two tools is applied to a real case study in Northern Italy: the Royal Gardens of the City of Turin (Italy), known for their historical, social, economic and ecosystem-urban values. GIS systems and SWOT analysis can be used in parallel and provide distinct results, or be combined, in the *ex-ante*, *in-itinere* and *ex-post* phases of the assessment process, thus providing valid support to planners and Decision Makers, in the definition of strategic guidelines of valorisation and management of historical green heritage in the medium and long term, as well as professionals and specialized bodies to optimize the care and management of this heritage.

Keywords: Geographic information systems · SWOT analysis · Historic gardens and green management

1 Introduction

Green heritage requires careful valorisation and management especially when it represents the connective tissue between the architectural and urban context. The care and maintenance must regard the individual plants and tree species as well as the whole system. A purely economic intervention is not enough to ensure its valorisation and management. It requires more than ever a sustainability approach careful to the environmental quality, economic development and social equity, for a better quality of life of both present and next generations. Multiscale analysis and assessment approaches on the current and past conditions may support the building of a strategy of medium-long

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term and the citizens satisfaction through a new demand of services. In the context of the Habitats Directive [1], the growing role of Ecosystem Services (ES) in urban areas [2, 3], the achievement of 2030 Sustainability Development Goals (SDGs) and related targets [4], with particular reference to SGDs 11, 13 and 15, the Italian Ministerial Decree no. 63 of 10th March 2020 on the "Minimum Environmental Criteria for the service and management of public parks and the supply of products for the care of the green" [5] has recently been updated by introducing an innovative methodology for a proper classification, organization and management of the elements of green areas. Geographic Information Systems (GIS) provide useful tools to support the employment of the Minimum Environmental Criteria (MEC), through spatial analyses and/or project materials, thus obtaining a Topographic Database (TDB). The knowledge analysis of the green urban areas, thanks to GIS methods, along with the experience of professionals and specialized bodies, favour the creation of database that may effectively support the valorisation and management. To support this analysis, the evaluation methods can further enrich the knowledge of urban green areas and therefore aid the definition of strategic guidelines and actions. Among the various evaluation tools, SWOT Analysis is the most used in various and different fields, to identify strengths, weaknesses, opportunities and threats of a given decision problem. The paper intends to report the functioning of both GIS and SWOT tools and their integration to support the decision-making process in the valorisation and management of green areas. In particular, the paper employs this model in a real case study: the Royal Gardens of the City of Turin (Italy), which belongs to the Crown of Delights of the Savoy's dynasty. The Royal Gardens represent a suitable case study because is at the same time a green space, an urban garden, an historical garden, a prestigious reality, so that it cannot be crystalized like historical monuments. Since its extraordinary value, the constituting elements and the overall system need to be constantly analysed and compared. This model of analysis and assessment is finalized to support planners, Decision Makers in the definition of strategic guidelines and recommendation of medium-long term, as well as professionals and specialized bodies in the employment of specific interventions for the urban green and cultural heritage.

2 Methodology

The proposed model of analysis and assessment aims to valorise and manage green areas, with particular regard to historical gardens. It employs two main tools. On the one hand, it applies GIS methods according to the MEC regulation to build a knowledge analysis on the individual elements of the Royal Gardens and as a whole. On the other hand, the model employs an extended SWOT Analysis to identify strengths, weaknesses, opportunities and threats, by providing a photograph at the state of the art (t_0) and subsequently a potential trend scenario (t_1). The outputs deriving from the integration between the two methods are intended to support the decision-making process in defining strategic guidelines and recommendations for the enhancement and management of green areas, with reference to their historical value. Geographic Information Systems (GIS) are much more than a "tool" that associates alphanumeric data to a cartographic base. Indeed, they can process more complex information concerning the different city dimensions, from socio-economic to historical-cultural features, from naturalistic-environmental to infrastructural ones, through a multisce approach and replicable in different contexts [6]. GIS

methods may contribute in solving complex problems of the decision-making process, especially when combined with evaluation models [7], thus providing a comprehensive knowledge and monitoring. In relation to the valorisation and management of green areas, the relevant literature counts many applications, for example dealing with the arboreal heritage, their history and evolution [8], or the ecological network between the different areas of the city according to an ecosystem perspective [9–11], among others.

Traditional SWOT Analysis was introduced in the 1960s-1970s in marketing sector as a tool for helping the decision-making strategy. It is able to provide information about endogenous factors of the investigation problem (Strengths, Weakness), and exogenous factors characterized by uncertainty (Opportunities, Threats).

SWOT Analysis has been used in many disciplinary fields, in particular this has proved to be particularly useful to solve complex spatial problems [12–15]. SWOT Analysis has recently been interested by modifications to be able to return both a general and specific vision of the problem, for example by integrating the STEEP Analysis [16, 17], or combining other methods and obtaining hybrid models, such as with the Multicriteria Decision Analysis (MCDA)(e.g. A'WOT, SWOT Spatial Multicriteria, or PROMETHEE Method) [18–20].

The GIS and SWOT Analysis tools can be used separately and combined once the respective outputs are obtained. In this application, an attempt was made to assist the two methodologies from the earliest stages of the analysis and assessment process. Thanks to the involvement of real stakeholders and specialists, constant feedbacks have been provided on the knowledge of the case study, during the development of this model. In this sense, the developed model followed a multi-phase process (Fig. 1):

1. *Knowledge analysis:* A multiscale territorial framework is finalized to provide a localization of the case study, in order to know where the Royal Gardens are located with respect to the City of Turin and the rest of the territory, and also to know on its elements. Subsequently, an analysis of the historical evolution of the Royal Gardens was considered essential to know the historical stratifications (XVI–XVIII centuries), as well as the most recent restoration processes, to reach the current state of the art;
2. *Data collection and elaboration:* Several data have been collected and processed in GIS, CAD and Excel environment: for example, spatial data (e.g. shapefiles, or as-built CAD drawings), considering the main statistical and cartographic sources (e.g. Geoportal of Piedmont Region and of City of Turin, high resolution orthoimages, or Treepedia MIT platform), tabular data (e.g. taxonomy and tree species classification, Visual Tree Assignment - VTA) and further materials made available by the Royal Museums of Turin;
3. *GIS application:* Specific tools of the software ArcGIS by Esri favoured the geolocation of the Royal Gardens elements (e.g. flower beds, trees or pots) based on the as-built project. The GIS software made it possible to unify all the information in a Topographic Database (DBT). Each element has been classified following the MECs criteria;
4. *SWOT Analysis application:* An extended version of the SWOT Analysis explores the strengths, weaknesses, opportunities and threats of the Royal Gardens through a qualitative-quantitative approach and at different times. Given the complexity of the

case study, and therefore the amounts of information regarding both different fields and several actors, a conventional SWOT matrix was considered as limited for this application. Therefore, it has been decided to develop a dedicated configuration;

5. *Models integration and final output:* the combination between GIS and SWOT Analysis provides as output a model applicable in the *ex-ante*, *in-itinere* and *ex-post* phases of the evaluation process, thus favouring the identification of strategic guidelines and actions of medium and long-term of valorisation and management of the Royal Gardens.

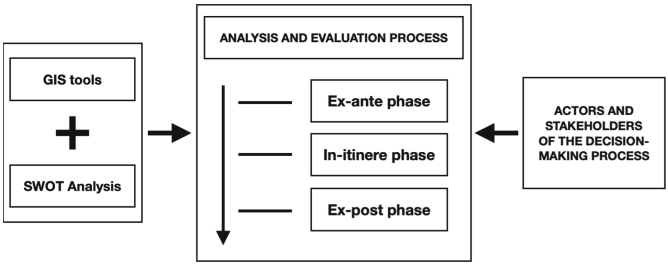

Fig. 1. Model structure [21]

2.1 The Minimum Environmental Criteria (MEC)

The Ministerial Decree no. 63/2020 has recently updated the "Minimum environmental criteria for the public green management service and the supply of green care products", introduced for the first time with art. 18 L.221/2015[1] [5], specifies the methodology for a proper classification and organization of the elements of the green areas. Technical specifications are provided as a natural reference for the application of MECs to public green areas, according to the size of the municipality and following the principles of the INSPIRE European Directive on the management and sharing of geographical and territorial data [22].

3 Application

The integration between GIS and SWOT to analyse and assess historic gardens may provide a reliable support for building strategies of green valorisation and management of medium-long term. The subsequent paragraphs are devoted to the illustration of the case study and the application.

[1] https://www.minambiente.it/pagina/i-criteri-ambientali-minimi (Last access June 2021).

3.1 Case Study: Royal Gardens of Turin

The Royal Gardens represent one of the six main green spots in the core of the City of Turin (Piedmont, Italy). They represent a blend of art, nature and history between the heritage buildings, namely the Royal Palace and the Royal Armory Palace, belonging to the Crown of Delights of the Savoy's dynasty and recognized as UNESCO site for their Outstanding Universal Value (OUV) [23]. The Royal Gardens are publicly accessible so that it is possible to appreciate their heritage value and the relationships with the architectural and urban context. They consist of i) the Duke's Garden, ii) the Boschetto, iii) the Garden of Arts, iv) the Green Bastion (with the "Garittone"), v) the East Garden or Levante's Garden vi) and the Lower Gardens. From a historical point of view, the first plant of the Royal Gardens dates to the mid-XVI century (i.e. Duke's Garden), even if the most significant transformations took place during the XVII century, with the consolidation of its borders and extension, thanks to the contribution of designers of the European panorama of that time, while the city was witnessing a New Renaissance. In the XVIII century, the Royal Gardens were interested by important improvements, so that they were known as the most refined gardens in Europe: from the fountain of the Tritons by S. Martinez (1756) to stone works (e.g. statues and benches), decorative lead vases, hydraulic works and minor interventions. In the XIX century, the Royal Gardens were affected by the construction of the Boschetto and significant changes to the Garden of Arts and the Eastern Garden, whose original shape was restored at the beginning of the XX century. Following the tragic fire of the Shroud Chapel by G. Guarini in 1997, the Royal Gardens were closed to the public for a long time.

The restoration work, which began in 2008 and continued for a decade, led to a partial reopening in 2016 and a complete reopening only in 2018. Some interventions are still ongoing and benefit from some initiatives undertaken by the Royal Museums. The application of the analysis and evaluation model focuses on a part of the Royal Gardens, excluding the Eastern Garden and the Lower Gardens because they are closed for restoration work and property of the City of Turin [23] (see Fig. 2).

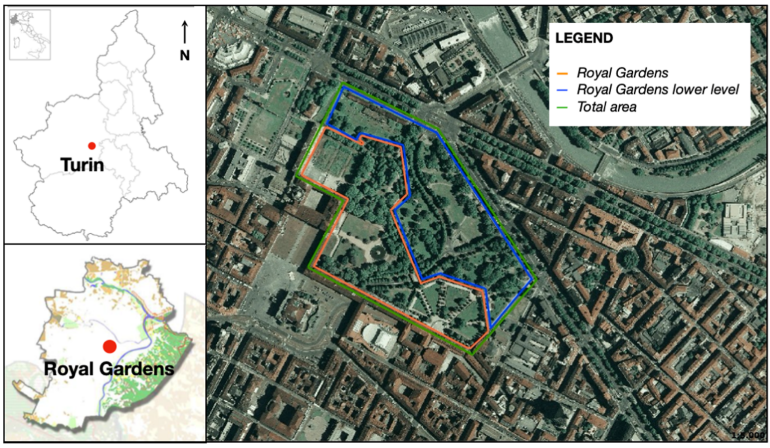

Fig. 2. Territorial localization of the Royal Gardens (Elaboration from Google Earth, 2019)

3.2 GIS Tools for the Creation of a Topographic Database

The GIS tools are retained as suitable for analysing the material provided by the Royal Museums of Turin, in particular the documents that certify their state of execution (or as-built drawings). The operational phase in the GIS environment was therefore anticipated by a process of data wiping and importing through the ArcGis tools (Fig. 3). Subsequently, a Topographical Database (TDB) was developed by classifying and organizing the elements acquired during the data importing. The TDB contains fields adequately filled to make each element as unique with respect to the others (Fig. 4):

1. The first step concerns the distinction of the type of geometry of the elements into points, lines and surfaces;
2. The second step identifies the Main Type of each element (TP), according to four macro-categories, such as i) vegetation, ii) street furniture, iii) use and management, iv) environmental factors (the latter item indicates those elements that impact on green areas and that are independent from them);
3. The third step indicates the Secondary Type of the elements (TS) and allows to differentiate for example in the TS "vegetation", a lawn from a flower bed rather than from a plant;
4. The last step is aimed at the Attribute Assignment (ATT). Considering the same example, assuming a TS code = "plant" as further classification, it allows to distinguish, for example, a tree from a bush.

The result of this operation finds the opportunity of using and processing new information acquired through ArcGIS tools and therefore of carrying out targeted analyses and/or representations where necessary (Fig. 5).

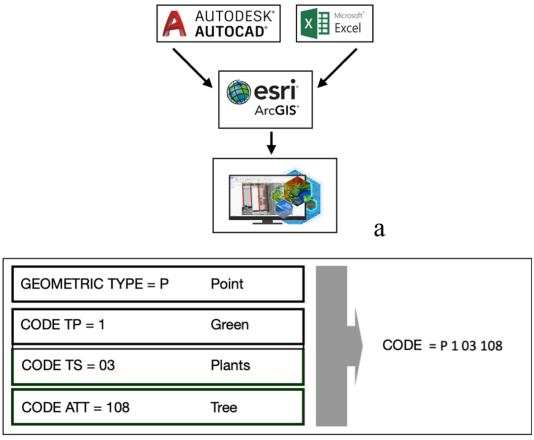

Fig. 3. Tools integration in GIS environment in data importing process

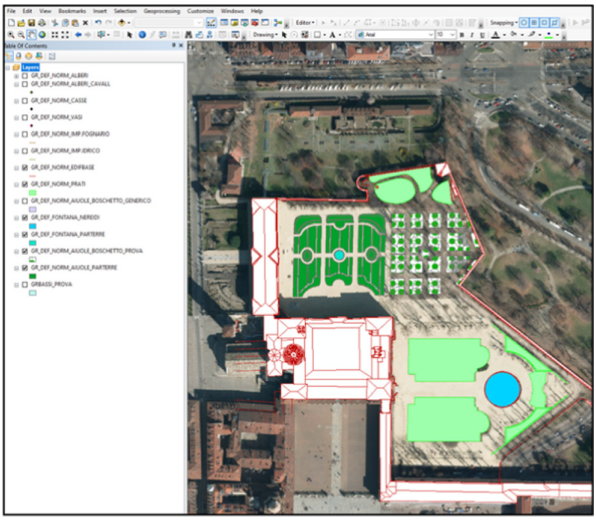

Fig. 4. Outcome in GIS environment, geometries superimposed on georeferenced orthophotos [21]



Fig. 5. Example of VTA classification [21]

3.3 SWOT Analysis to Explore the State of the Art

SWOT Analysis has explored the case study in the years 2019–2020 as the state of the art. In particular, the high uncertainty and negative impacts by Covid-19 of that period, especially in social and economic terms, have also negatively influenced on the Royal Gardens and their role for the city. The conventional SWOT analysis has been extended in a version that aims to integrate the information obtained from the GIS model and with respect to the specificity of the case study. The 4 quadrants of the SWOT have been related to the following elements:

- *Macro-ambits:* they are location and context, society, cultural heritage, traffic, tourism, health and well-being and environmental components;
- *Sub-ambits:* they are tourism origin, psycho-physical benefits, meaning the benefits provided by the greenery present throughout the Royal Gardens of Turin towards the end-users (i.e. residents and tourists).

Each macro-ambits and related sub-ambits related to the Royal Gardens are evaluated through a qualitative-quantitative approach with respect to the 4 components of the SWOT Analysis. The SWOT Analysis was compiled within a survey with real stakeholders, such as the Royal Museums of Turin, the City of Turin, residents and tourists. Scores were assigned according to the degree of incidence of each element, positive or negative, which can vary from 1 to 3 for strengths and opportunities, and from –1 to –3 for weaknesses and threats. The score attribution is also supported by both qualitative scale (i.e. 1 = low; 2 = medium; 3 = high) and semaphoric scale. This is considered useful to facilitate the user in the consultation of the SWOT matrix. An overall view of the results is reported as partial and total summations in support of the main matrix. This configuration was used to explore the state of the art and a potential future scenario (Fig. 6) that is deepened in the next paragraph.

In Fig. 7, for example, a score of 3 was assigned for the "international tourism" sub-ambit of the "tourism" macro-ambit, from the point of view of the Royal Museums and City of Turin, since the statistical data provided by the Royal Museums on the number of visitors differentiated by quantity and period, shows that a considerable part of the entrances to the Palace is represented by foreign tourists. Or for the "significant green spot" sub-ambit of the "health and well-being" macro-ambit, a score of 2 was assigned, from the point of view of the City of Turin since the Royal Gardens represent a green fulcrum in the city centre, even if it is not the only one. Indeed, Turin is recognized as one of the greenest cities in Europe and boasts other important parks (e.g. Valentine's Park, or Pellerina Park). Or again, for the sub-ambit "presence of fine dust deposited on the foliage" of the macro-ambit "health and well-being", a negative score of –3 was assigned, from the point of view of citizens as it appears to be a highly incisive factor regarding the physical health of an individual, especially in a city such as Turin which, according to Arpa Piemonte monitoring, records medium-low levels of air quality in winter season.

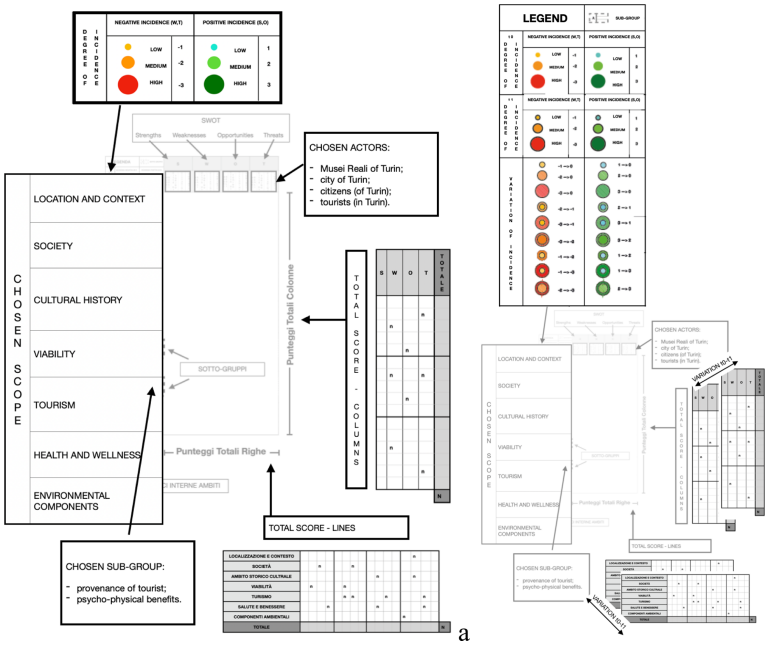

Fig. 6. Structure of the SWOT Analysis t_0 (a) and its extension $t_0 - t_1$ (b) [21]

3.4 SWOT Analysis to Explore a Different Temporal Dimension

The SWOT analysis was applied by considering different times that analyses the same information evolving towards a potential future scenario (t_1).

The SWOT evaluation scale is always of qualitative-quantitative type, even if the chromatic symbology is different: i) degree of incidence at t_0, the full coloured symbols proposed in the previous SWOT matrix remain unchanged because they are considered suitable; ii) degree of incidence at t_1, the symbols keep their shape, size and colour gradient unchanged and are differentiated with a black border to label a new assignment. In fact, solid-coloured symbols label a variation. The maintenance of the style of the chromatic symbology between the two SWOT Analyses is finalized to underline that the same type of evaluation is taken in different times. The two SWOT Analysis have been systematically developed. When both SWOT Analyses are reported in the same matrix, it is necessary to apply a distinctive sign $t_0 - t_1$; iii) variations in incidence, considering that there are two scales of scores, from 1 to 3 and from –1 to –3, 18 variations are expected to cover the entire range of possibilities, and 9 for each scale. Such variations may predict an increase or decrease of the degree of incidence.

In Fig. 8, for example, the "foreign tourism", sub-ambit of the "tourism" macro-ambit, has a dedicated symbol, which is a green background pattern with a blue centre, as it identifies a two-point decrease in the assigned degree of incidence and compared to the state of the art. The Covid-19 pandemic has significantly reduced the influx of foreign tourism which, however, was not absent. When the full coloured symbol is present, this

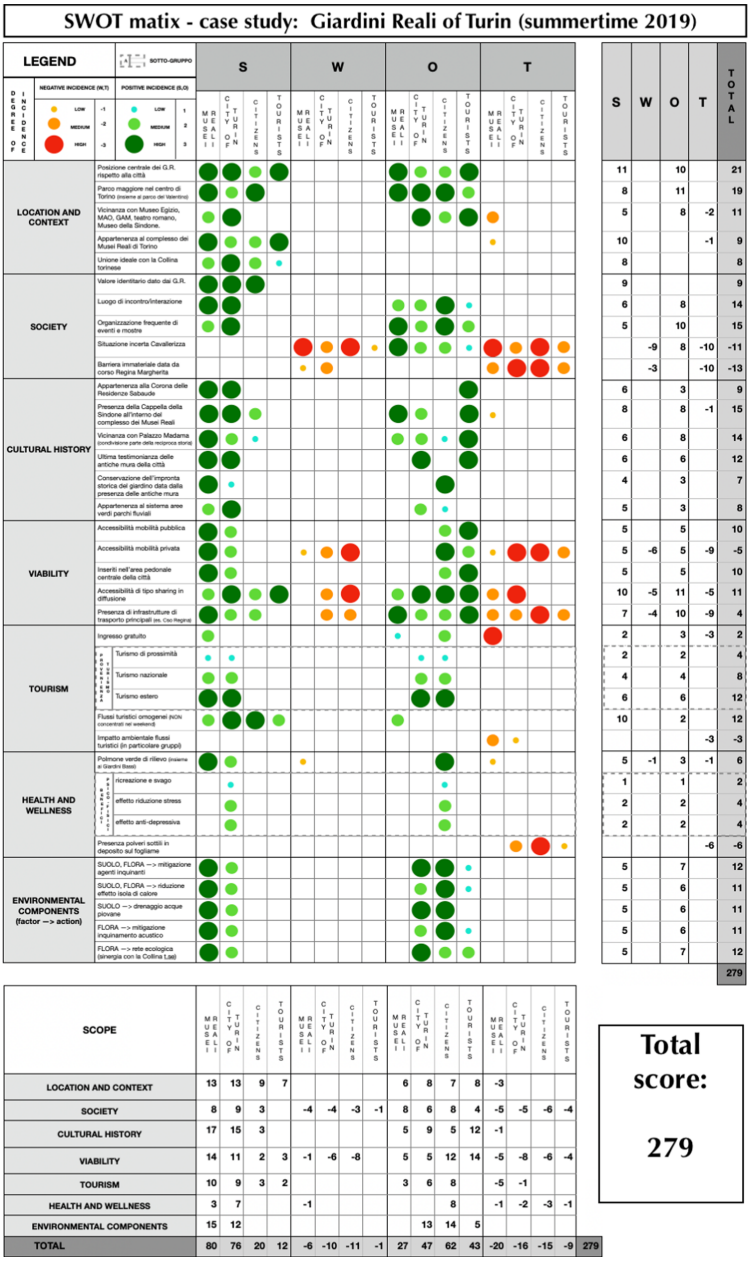

Fig. 7. Elaboration of the SWOT analysis: state of the art (t_0) [21]

means that no variation has been occurred: this value was already present in t_0. By contrast, when the same symbol is surrounded by a black, border it means a new t_1 assignment and the value is null at t_0.

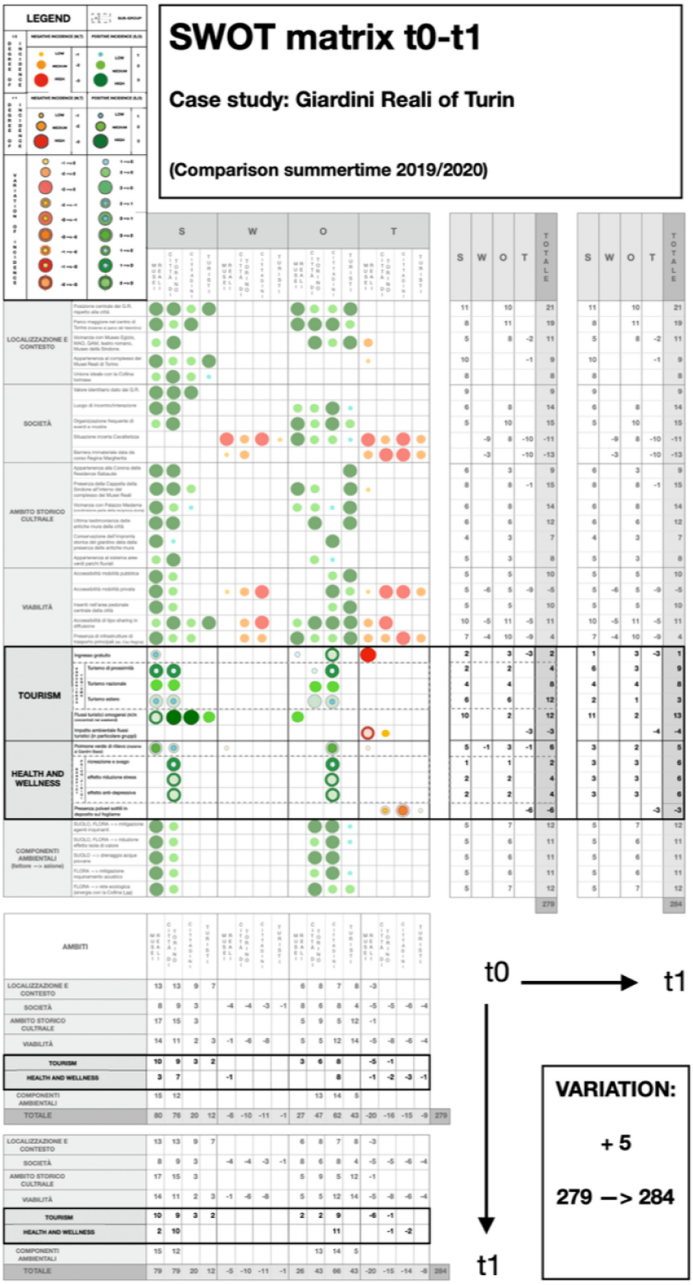

Fig. 8. Elaboration of the SWOT Analysis: $t_0 - t_1$ [21]

4 Discussion of Results

The combination of GIS and SWOT Analysis has provided a comprehensive knowledge analysis and assessment to build a strategy of valorisation and management for the Royal Gardens of Turin. Specifically, in a scope like the valorization and management of green areas, with particular regard to the historical gardens, it is required constant attention and maintenance, therefore management is the key. This application highlighted that, on the one hand, the GIS software with MEC classification, is a powerful tool that may strengthen its role if integrated by SWOT Analysis in envisioning medium to long term strategies. On the other hand, SWOT Analysis requires a comprehensive knowledge of the case study under investigation to support final users in the definition of priority interventions, so that GIS may provide it. In addition, the TDB Database, developed in GIS environment, according to the MEC legislation and the TSE classification, received during the survey highly positive feedback from the Royal Museum staff, in particular with regard to the managerial-organizational potential deriving from this application (Fig. 9). In fact, the research work reveals aligned to the pillars of the current cohesion policies and regional programming, such as the progressive digitalization of public bodies that could be supported by a very promising evaluation model for the management and valorization of the green heritage[2].

The extended configuration of SWOT Analysis has allowed a simultaneous reading between the different macro-ambits and sub-ambits. By focusing on the SWOT matrix $t_0 - t_1$, it has allowed the exploration of the individual elements and the degree of incidence at two different times. With this novel extension it is possible to analyse the new values and at the same time report the variations of the scores in the matrix, without losing information. In this sense, this version can effectively support the prioritization of strategic guidelines and actions for historic gardens, also considering both economic and political features, as well as supporting different procedures of strategic and spatial planning analysis and assessment.

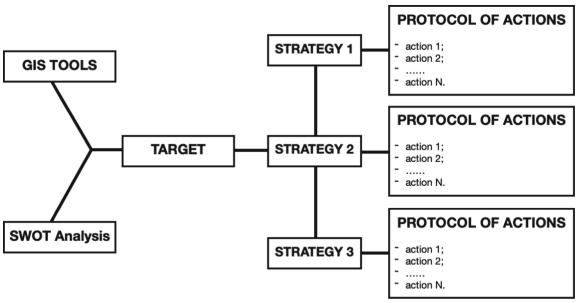

Fig. 9. Output derived by the GIS and SWOT integration [21]

[2] National Plan of Recovery and Resilience (PNRR- Piano Nazionale di Ripresa e Resilienza, Piemonte Cuore d'Europa) https://piemonte2021-2027.eu/pnrr-recovery-plan-italia/ (Last access June 2021).

5 Conclusions

The combination of GIS tools and SWOT Analysis has proved a suitable model in restoring a broader and multiscale vision, thus favouring a twofold support: on the one hand, helping both planners and Decision Makers in facilitating the dialogue between different analysis and assessment tools for an area extraordinary value, and on the other hand supporting public bodies to design strategies and actions for the valorisation and management of green areas in the medium and long term. Looking at the internal consistency of the model, some refinements have been identified regarding the MECs classification. If this is particularly suitable for the maintenance of green areas, compared to the specificity of the case study of the Royal Gardens, it would require further implementation. It should be noticed that a historical garden such as the Royal Gardens, given the value of its elements, many of which belong to a broader group, requires a site-specific classification. The SWOT analysis was applied at time t_0 and t_1 trying to investigate the potential variation $t_0 - t_1$ in the degree of incidence of the investigated elements. From a dynamic analysis and evaluation perspective, the SWOT analysis could be supported by the application of a dynamic approach and identify the different interdependencies between the investigated elements [24] and reproduce it in the *ex-ante*, *in-itinere* and *ex-post* phases of the process. The SWOT analysis could also be integrated as a component of a multi-phase evaluation process to define alternative scenarios of valorisation and management [25]. With regard to the replicability of the model, similar cases study will be investigated, such as other residences of the Crown of Delights, with the aim to work on the site-specific classification and other features to integrate tools with green realities. Looking at the external consistency of the model, we intend in the future to realize a software based on this model to be addressed to specialized users actively involved in the management of green areas and in particular of the green cultural heritage.

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