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Historic Watermills Digital Survey and Sustainable Re-Design in Cilento and Vallo di Diano National Park, Italy

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The present work is part of a multidisciplinary research carried out within the Benecon Competence Center Demonstration Project and related to Cilento and Vallo di Diano National Park area, one of the UNESCO World Heritage Sites and included in the Biosphere Reserve network.

This study concerned the Vallone Auso water system, in the territory of Ottati, a municipality located in the north-eastern part of Cilento and Vallo di Diano National Park and has been structured in three phases.

An initial phase of analysis took into account the hydraulic characteristics of the Vallone Auso, with particular reference to the nature of the water torrent, the vegetation, geological and lithological conditions of the site, the hydrological and ecological environment. The second phase of the work concerned the check on the presence of hydraulic conditions suitable for the reactivation of the historic watermills as examples of the hydro-mechanical technology used in the past. The last phase finally allowed an analysis on the quality characteristics of the waters of the Auso Torrent. It has been possible to hypothesize the creation of a “filter system” with river phytodepuration techniques in order to safeguard the water course from induced pollution.

Keywords: Cilento and Vallo di Diano National Park, Digital survey, Environmental design, Geographical Information System, Sustainable Technology.

Introduction

Cilento and Vallo di Diano landscape is an organic unit generated by the complex combination of physical and natural phenomena, firmly tied each other by mutually reciprocal relationships. The research for a dialogue between man and this heterogeneous set of elements, processes and inter-relations has characterized the anthropized and natural heritage that has formed the landscape of these places characterized by great water wealth, dense slopes and lush Mediterranean vegetation.

The Geographical Information System platform of the territory of Cilento and Vallo di Diano National Park synthesizes the integrated work of knowledge of the area and of all its forms of production either cultural or material, including through the actions of the peoples who have inhabited these sites (Balletti and Soppa, 2004).

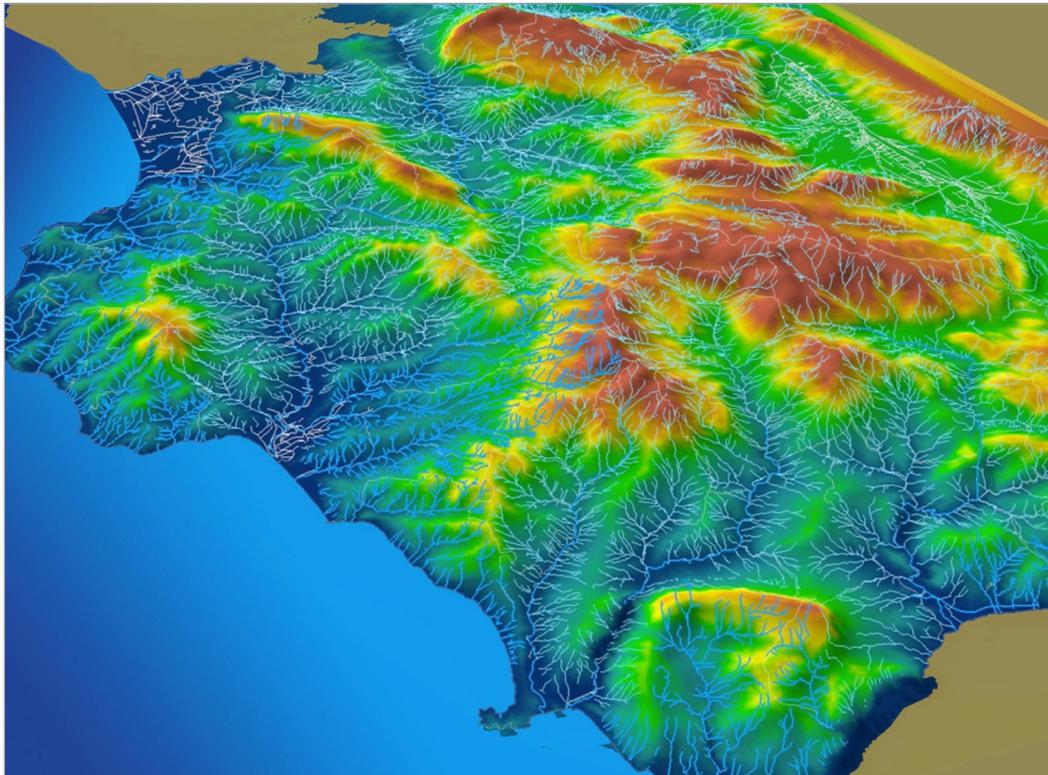
The GIS of Cilento and Vallo di Diano National Park has been developed to create a georeferenced and dynamic database that would gather and integrate the cognitive activities carried out on the area through an innovative equipment. The GIS has been dynamically structured in thematic layers always implementable that at different scale contain the results and the elaborations of survey and



data acquisition. Information, cataloged according to the 'data warehouse' methodology, has been structured to make easy the access by the user and to support decision-making (Laurini, 2001).

The layers, integrating the information with the aforementioned data, are organized, also in reference to the various scales and main time variations. In particular, the census of the territorial resources of the territory concerned the more than two hundred watermills surveyed within the perimeter of the National Park and subsequently surveyed through 3D digital laser sensors, cataloged on the basis of cadastral data and then inserted into the GIS platform on a georeferenced map as a starting point for further documentation actions. The aforementioned analysis has been developed before a subsequent step of the research on technological and environmental issues. On some watermills have been developed a surveys to check the relationship between the water system, soil quality and its uses with to define a reference framework for the use of appropriate environmental technology for water cycle optimization systems.

The Geographic Information System of the National Park of Cilento and Vallo di Diano collects information, cataloged according to the data warehouse methodology, organized and structured for easy access by the user and to support decision making processes through big-data processing. Geometric and metric data acquired, surveyed and processed for land extension and for some buildings have integrated information from different digital sensors. GIS platform allows to catalogue and compare data acquired for historical watermills spread all over the National Park area. It has been very important to collect data through this system because it has been possible to establish an intervention priority about preservation and maintenance works. In particular, the research about historical watermills cannot be detached by the analysis of the territory itself. In order to better understand the position of mills building, GIS platform represents also the relation with hydrographic system of rivers and canals as the link with land morphology (Fig. 1) or modern and historical transportation infrastructures.



Historic watermills census and survey through digital platform and sensors

Fig. 1

Cilento and Vallo di Diano National Park: Digital Terrain Model and territorial water system. Elaboration by Nicola Pisacane

The reference map of the digital platform is the “Carta Tecnica” of the Regione Campania area and its digital orthophoto, both georeferenced. The “layer zero”, containing mostly geometric information, was the support for creating additional levels of knowledge containing vector data with dimensional geometry (dots), mono-dimensional (open polygons), bi-dimensional (closed polygons). Georeferred geometric primitives are associated with additional alphanumeric, graphical, raster, and vector information. The basic mapping has allowed further elaboration that has led to the predisposition of a three-dimensional model of the territory overlapping the geographic data obtained from the sector surveys in order to visualize the spatial phenomena in a simulation mode of real space.

The articulation of digital levels is as follows: Territory, Accessibility, Naturalistic, Anthropoc.

The “Territory” layer contains the mosaic of the aforementioned cartography and the reference to the toponyms that characterize the whole territory.

The “Accessibility” layer is associated with the data of the connection systems, divided by type and importance, inside the Park area and by penetration, through linear geometric entities. The data relating to the access systems via the sea and, by means of precise geometric indications, the presence of railway stations, interchange nodes, ports and airports were also cataloged. This kind of information represents also the difference between historical ways and modern ones, in order to draw the transformation of the territory and of the landscape itself during the time.

The “Naturalistic” layer associates with basic mapping, through precise, linear and spatial geometries, any information about the natural characterization of the territory covered by this research and its subsoil. The National Park of Cilento and Vallo di Diano is characterized by large areas not located by the presence of man and that retain a primordial appearance. It is not unusual in the territory to have Sites of Community Interest (S.I.C.) and Special Protection Zone (Z.P.S.) for the presence of fauna and plant life species of remarkable rarity that characterize the landscape. In further sub-levels were organized data on natural and panoramic points of interest, rivers, lakes, sites of hydrogeological, geological and lithology classification of the subsoil.

The layer that finally allowed, integrating information with the aforementioned data, knowledge of the actions of the populations in the territory is the “Anthropic” layer. Inside later sub-layers, also referring to the different scales, are organized data on the activity of man and people on the territory, also in reference to the main time variations. In particular, the census of the territorial resources of the territory concerned the over two hundred mills surveyed (Fig. 2) within the perimeter of the Park and subsequently detected by laser digital sensors, cataloged on the basis of cadastral data and then inserted into the GIS platform on a georeferenced map. For each watermills the database collects information about the typology of mill, technological and construction data, maintenance status conditions, in addition to pictures, map and other digital documents collected for each single building. In particular, for some of these watermills the study of the building has been deepened through an accurate survey, useful not only for following analysis but also to develop an operative protocol to extend to similar case studies.

The study was carried out to ensure the quality of the Park in a sustainable development through the identification of a network of mills spread across the territory that through their recovery can actively participate in the enhancement of the territory. For the purpose of this research, databases have been developed whose contents have been prepared through multidisciplinary analyzes. The results of the territorial surveys were subsequently acquired in the GIS database and georeferenced and used to study the dynamics related to the development phenomena and as a prediction scenario builder for the identification of optimum allocation resources. The GIS is the tool through which users are transferred to all the information about the territorial realities present in the territory of the National Park of Cilento and Vallo di Diano. Such a approach goes to modify the traditional cartography setting that has always been seen as a preconfigured guide, to the possibility that it is

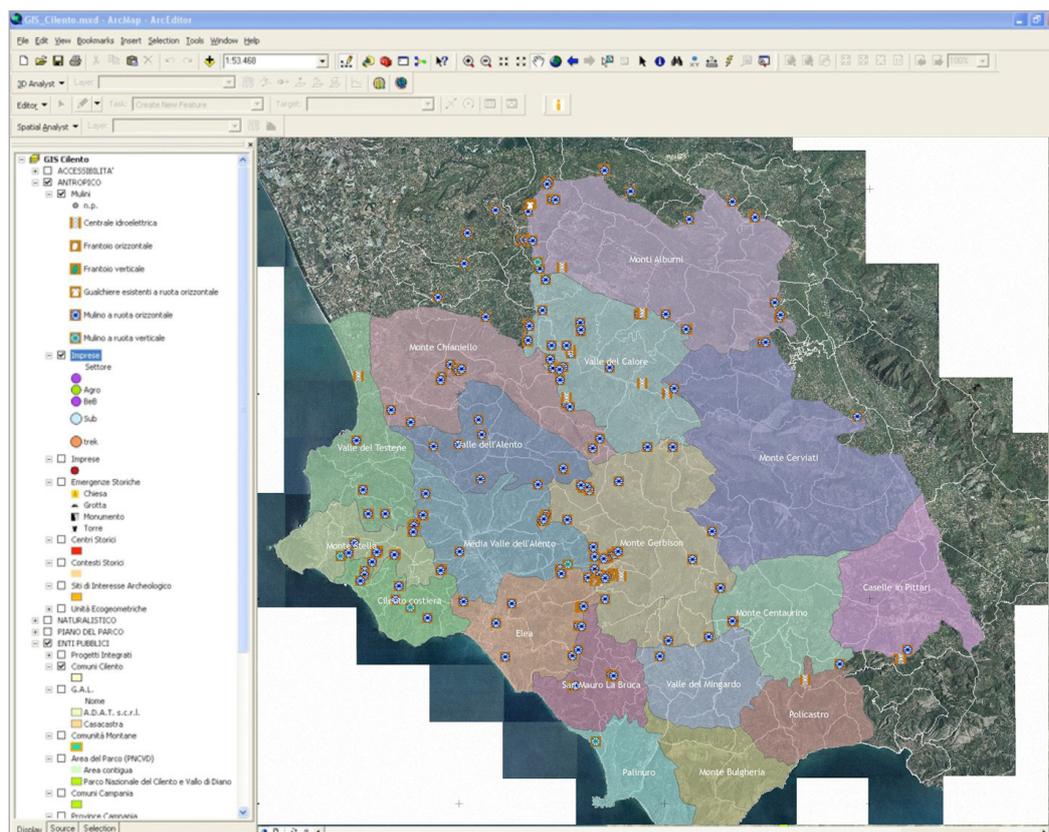


Fig. 2

Cilento and Vallo di Diano National Park: Geographical Information System, watermills census

now the user himself to choose, online, access only to the information that interests him, until he himself creates a its own interactive map starting from a generic map database. This process, of a qualitative, dynamic and interactive nature, is very different from the one used until a few years ago: it is the user who interacting with the territory and interrogating the maps becomes itself, in part, the creator. Thus, the use that can be made of cartography is now changing, that is, you are no longer looking for the map where you are, but by communicating your coordinates to the map, you access a world of multiple dynamic information that automatically grows around the map, user and that the user itself may vary. Such information, which can mediate and give specific answers, allows a comparison of collective experiences, offering a social value to the whole system as well.

The aim of the project was to describe, analyze and control the environmental system called “Vallone Auso” located in the northeastern part of Cilento, in the Campania region, and inserted in the naturalistic context of the homonymous national park. Along the watercourse there are three watermills on horizontal wheel, which have in the past been of considerable economic and social importance. The mills were used for the transformation of agricultural products and at the same time constituted a meeting place between the local population and the foreigners who were going to grind. With a view to the environmental recovery of factories and their grinding plants, as examples of technologies used in the past, the study of the hydraulic conditions of Vallone Auso plays a key role.

The study was structured in three phases. The first descriptive-analytical phase, and presented below, took into account the characteristics of the Vallone Auso with particular reference to the nature of the water flow, vegetation, geological and lithological conditions of the site, hydrological and ecological environment.

Auso is a torrent (Fig. 3), geographically identifiable at the foot of the southern slope of Mount

Ecological and environmental analysis of the Vallone Auso

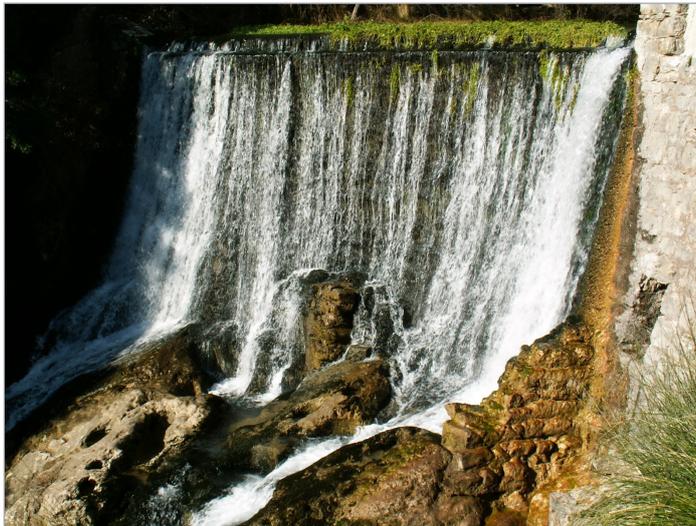
Fig. 3

Auso torrent (photo by R. De Martino)



Fig. 4

Waterfall Auso (photo by R. De Martino)



Alburno, between the municipalities of Ottati and Sant'Angelo a Fasanelle, where it opens, a overhang of about 50 m from which many water bubbles erupt, indicated with the name of Auso source; these waters, through a large slit, feed the river of the same name.

The torrent appears on the surface with a source of outcrop determined by an incision or depression of the topographic surface, which reaches the ground surface.

The water flow temperature during the winter season never falls below 8-9 ° C, even when the outside temperature is below zero: these waters therefore constitute a protective mantle to keep active and lush vegetation.

The torrential stretch of the river is affected by erosive processes very important for the control of river dynamics: in this section, in fact, the erosive capacity is

minimal, and therefore destructive action, understood as a slow but continuous process of erosion and transport of material eroded, is limited to the alveo and the shores in the form of regressive and lateral river erosion.

Regressive river erosion has given rise to the phenomenon of rapids. In fact, along the course of the torrent there was an abrupt rise in the river bed and the waters precipitate forming a waterfall. (Fig. 4).

The lateral erosion of the watercourse led to the expansion of the valley bottom with the possible collapse of the overlying parts (De Martino and Franchino, 2012). Auso torrent has a remarkable ecological interest in the territory that it crosses. The watercourse, with its lateral bands of riparian vegetation, is the main element of the ecological connection, indispensable for linking natural basins in the area. But the quality and dynamics of the watercourse are highly influenced by the conditions of the surrounding area and its level of anthropization. Understand the relationship between the pressures underlying the river under consideration and its "state of health" was essential in order to develop a retraining project aimed at recovering identified criticalities and above all capable of ensure a sufficient level of water quality in the river ecosystem and increase the efficiency of the bands and the diversity of habitats (Ercolini, 2005).

The environmental quality objective is defined by the “Unique Environmental Text” (D.L. 152/2006), *depending on the ability of water bodies to maintain natural self-destruction processes and to support large and well-diversified animal and plant communities.*

Strategies to pursue this aim refer both to the sewerage network of the basin and to the depuration plant present along the river. In fact, the functionality of the plants must go through the improvement of infrastructure conditions, the development of appropriate technologies and the enhancement of management techniques in the industry. The efficiency of the river bands is also an important element: in fact, it depends on the proper functioning of self-purifying processes of watercourses and the reduction of the erosion phenomena of the riverbed.

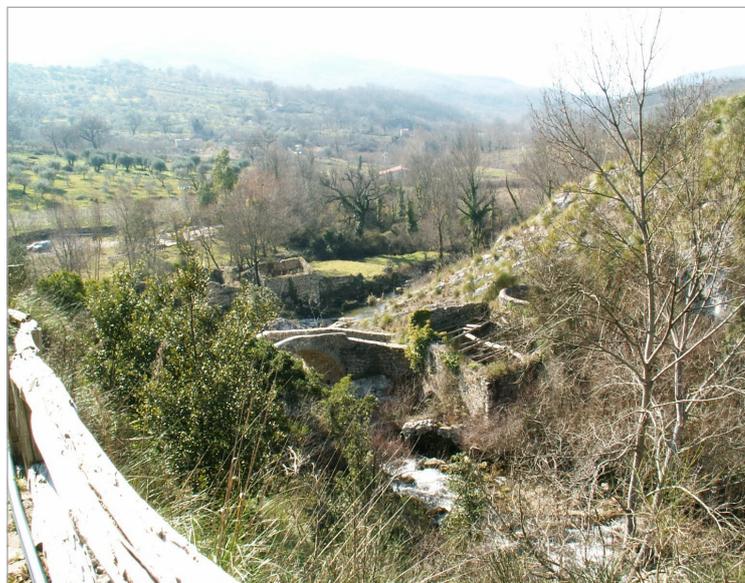
The environment, in its complexity consisting of a set of architectural and functional factors surrounded and interrelated with the constituent elements of it, air, water and soil, must necessarily be configured by the technological interventions that respect the environmental compatibility (Franchino et al., 2011).

The overall objective of the environmental compatibility study specializes in the specific objectives that essentially consist of the ability to detect aspects of the natural and urbanized environment and to limit its transformations in the field of the sustainability. It should be realized that the environment cannot be treated as compartments, but any action that is being undertaken on it, from the realization of works of any type or even of redevelopment may have impacts whose size must be accurately predicted evaluated. In this respect, an accurate analysis phase that can allow for an assessment of the existing environmental configuration and any possible transformations beforehand must necessarily precede any redevelopment intervention.

The analysis phase consists of a careful examination of the existing conditions of the context examined so that the factors that determine any environmental degradation conditions can be evaluated and graded in a functional scale. This phase of analysis must be able to identify the factors to be modified to carry out interventions that will allow the achievement of a new environmental condition that does not cause any compromise on the water, air and soil subsystems. It is also particularly important to identify the various and possible conditions to be achieved, which can be defined as valorisation, that is enable the best use of the natural resources present (landscape, climate, water, etc.) and control the transformations that the proposed intervention determines from the ecological point of view on the surrounding environment.

These are the methodological premise that inspired the present study concerning the environmental quality control of “Vallone Auso” (Fig. 5) and its context that represents an area of particular naturalistic value.

This study also considered the relationship that the Auso river ecosystem establishes with the crossed territory and with the activities that take place



Environmental redevelopment hypotheses of the Vallone Auso

Fig. 5

Vallone Auso
(photo by R. De Martino)

Fig. 6

Historic watermills
(photo by R. De
Martino)



in it. This study also takes into consideration the possibility of reactivating some historic watermills (Fig. 6) as a significant example of the old hydromechanical technology used in the past.

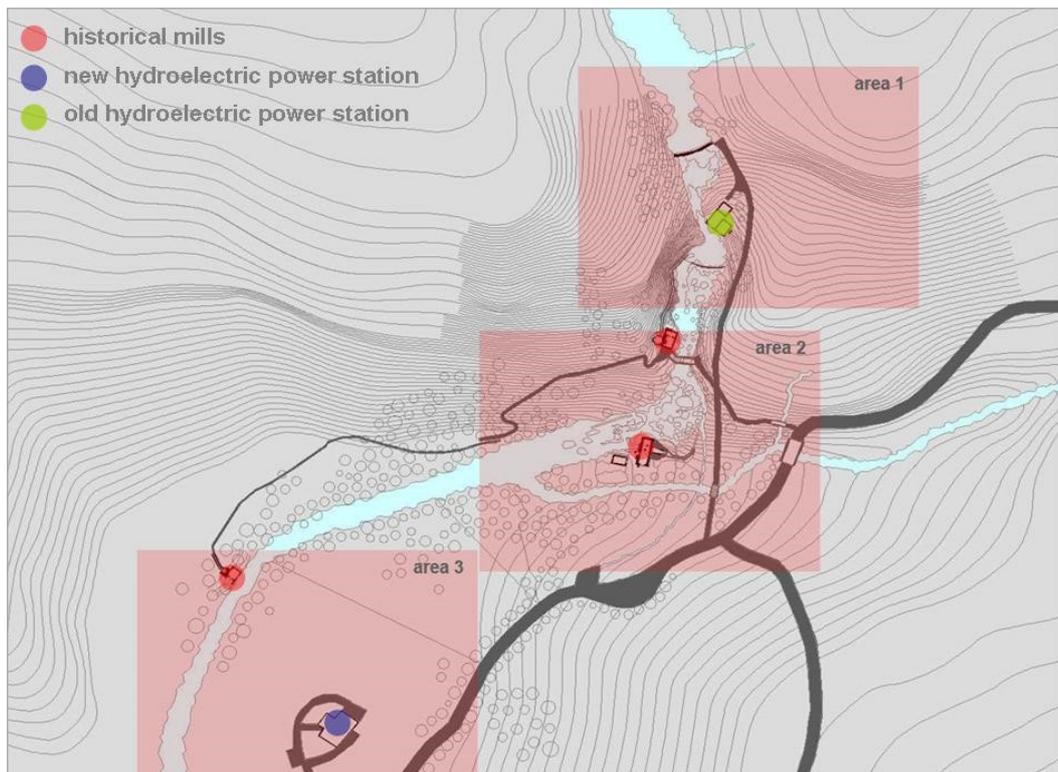
The research included three phases:

- _ analysis of the hydraulic characteristics;
- _ study for the reactivation of the historical watermills;
- _ intervention on river banks for the renaturation of the torrent.

In the fig. 7 are represented the three areas in which the area of the present study has been subdivided and where the remains of the old watermills are located. In the area 1 (Fig. 8) it can be seen that the effluent waters from the purification plant of S. Angelo in Fasanella enter into the Auso torrent. In the area 2 (Fig. 9) is located the pre-existing hydroelectric power station, while in the area 3 (Fig. 10) is located another new hydroelectric plant which has replaced the previous one. The hydroelectric power station was moved to about 350 m further downstream and the displacement allowed for a significant geodesic jump.

Fig. 7

Study areas
(elaborated by R. De
Martino)



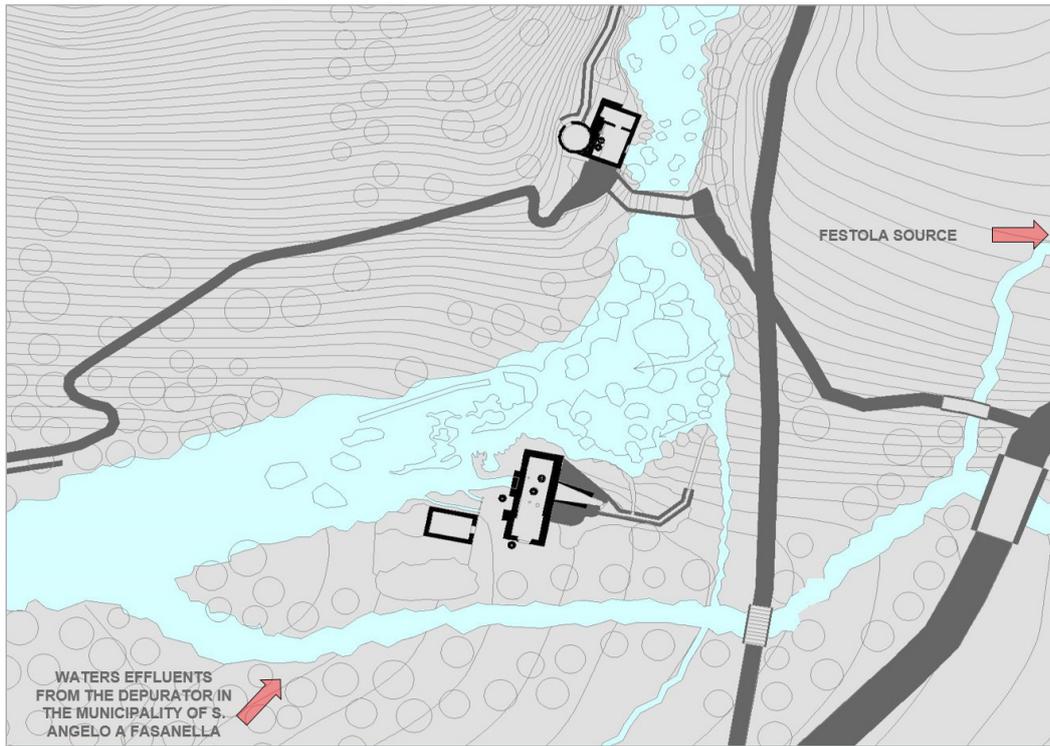


Fig. 8

Area 1 (elaborated by R. De Martino)

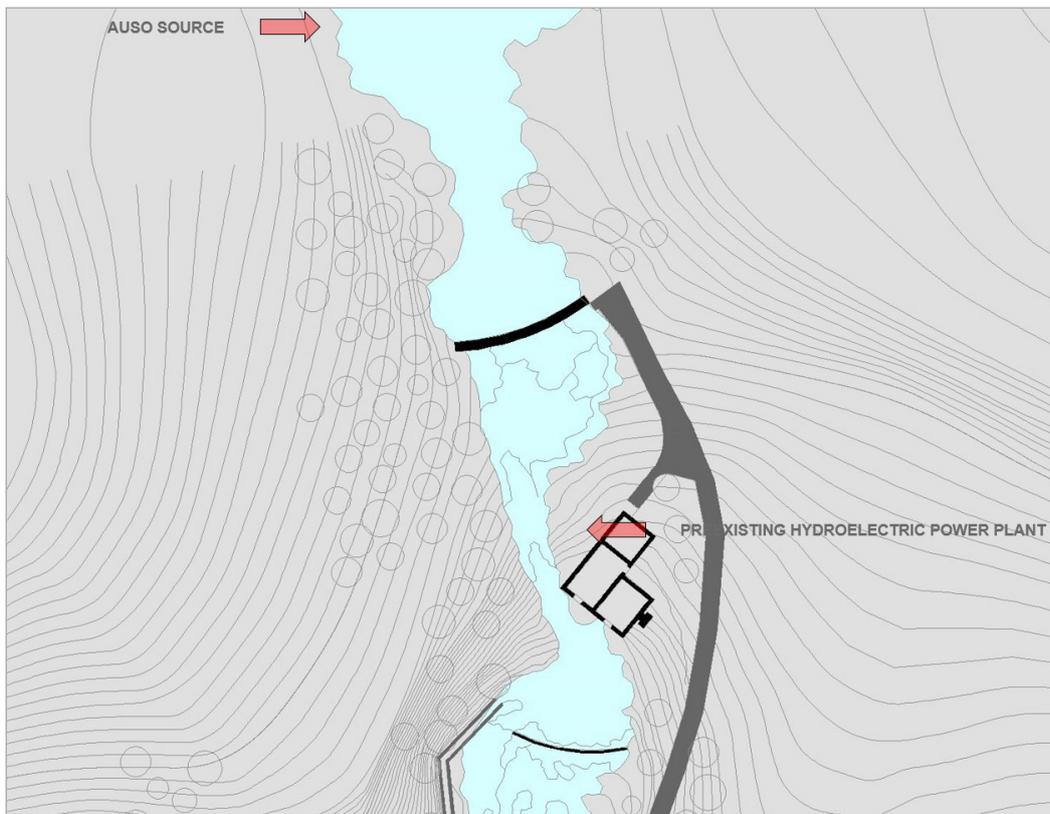
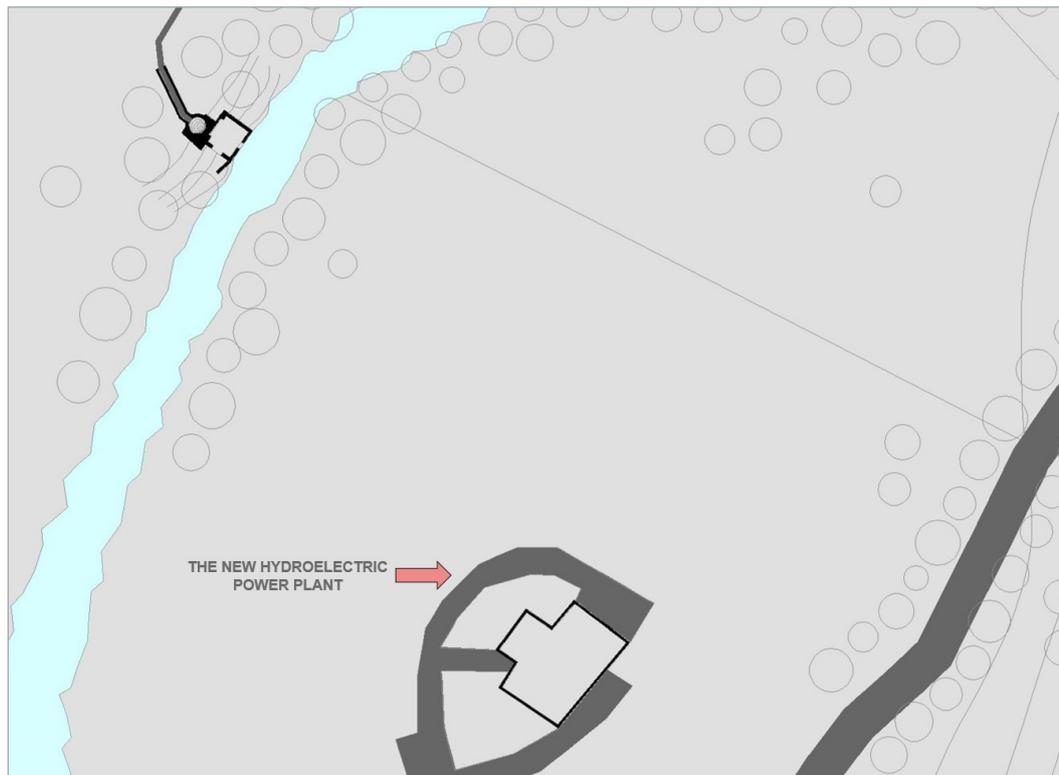


Fig. 9

Area 2 (elaborated by R. De Martino)

Fig. 10

Area 3 (elaborated
by R. De Martino)



The presence of this hydroelectric plant, unfortunately, does not allow the reactivation of the old watermills to be carried out because it absorbs much of the flow of the torrent. In order to reactivate the antique watermills, two solutions have been identified to restore their operation (De Martino and Franchino, 2009). The first solution takes the required flow to restore the watermill upstream at the beginning of the forced conduct of the hydroelectric power plant, resulting in a reduction in the production capacity of the plant. The second solution assumes the restoration of the old hydroelectric power station to its original position, so that the downstream river section is enriched by the flow that is currently channeled for the operation of the new hydroelectric power station and is made available for the reactivation of the three watermills system. In order to safeguard the quality of the waters of the torrent, it has been inserted a filter system at the point where the waters of the purification plant of the S. Angelo in Fasanella enter in the Auso torrent. The utilized technology is a natural purification plant made with lemna-type plants.

Conclusions

The research has highlighted the centrality of the analysis phase as a characteristic element of the environmental redevelopment of anthropic contexts for the overall exploitation of the territory. In particular, the elaboration of the huge amount of data allows to elaborate a development model of the National Park also through the reuse and preservation of historical watermills spread all over the area of the Park itself. The large quantity of water, now as in the past, fostered the construction of such kind of building for take advantage of water power for productive use. Now new functions and different scenarios could be created through the reconversion of such buildings. The study has also analyzed the hydraulic conditions of the water river necessary for the reactivation of the historic watermills and for the optimization of the water-cycle system. Finally, the environmental-ecological aspects have also been verified in order to increase the ecological connectivity and reduce the phenomenon of territorial fragmentation.

The repeatability of the proposed methodology to other territories, which require environmental improvement interventions aimed at restoring both the ecosystemic-ecological quality, as well

as protecting the existing environmental conditions, could be an interesting development of the research, especially in relation to the construction of innovative scenarios based on compatible use mode of anthropized contexts.

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