Antonio Leone Carmela Gargiulo
Editors

Environmental and territorial modelling for planning and design

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Smart City, Urban Planning for a Sustainable Future

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Environmental and territorial modelling for planning and design

Antonio Leone Carmela Gargiulo

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- Rosaria Battarra;
- Gerardo Carpentieri;
- Federica Gaglione;
- Rosa Anna La Rocca;
- Rosa Morosini;
- Maria Rosa Tremiterra.

The most heartfelt thanks go to these young and more experienced colleagues for the hard work done in these months. A final word of thanks goes to Professor Roberto Delle Donne, Director of the CAB - Center for Libraries "Roberto Pettorino" of the University of Naples Federico II, for his active availability and the constant support also shown in this last publication.

Rocco Papa
Editor of the Smart City, Urban Planning for a Sustainable Future" Book Series
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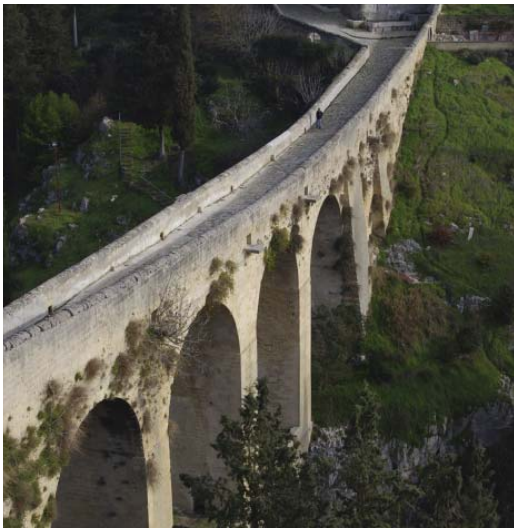

WATER TECHNOLOGIES AND RURAL LANDSCAPES IN THE APULIA REGION

MULTI-SECTORAL AND MULTI-FUNCTIONAL APPROACHES TO ANALYSIS AND PLANNING

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ABSTRACT

Rural landscapes in the Apulia region have been strongly influenced by changes in water technologies and practices occurred in the XX century, which led to the construction of the largest aqueduct in Europe and to a complex system of tamed waterscapes across the region. Modernization was conceived of as a means to free local communities from water scarcity and poverty. Nevertheless, scarcity never ended in the region, as it is entangled with a development approach based on the linearization of ecological processes, whose negative impacts on ecological and socio-economic aspects are more and more evident.

Starting from a critique of this development approach, the paper discusses the innovation potentials rooted in multi-sectoral and multi-functional approaches to water and rural development analysis and planning. For this purpose, reference is made to the new territorial-landscape plan of the Apulia region, which has developed strategic projects fostering integrated approaches to natural resources and landscape analysis and planning. Pilot experiments carried out in the Apulia region for the revival of traditional technologies for water supply and for the implementation of a circular approach to resources management are also described, which suggest interesting innovation pathways to increase resilience and multi-functionality of water technologies and rural development.

KEYWORDS

Rural Landscapes; Water Technologies; Landscape Policies and Planning; Multi-functional Approaches

1 INTRODUCTION

Key changes in rural landscapes in the Apulia region are closely linked to changes in water resources management and planning, as these not only influence crop-cultivation potentials and choices, but have deep implications on environmental aspects and on the way local communities conceive of development patterns and visions, as shown in this paper.

In Apulia, a process of radical technological change in the water sector took place in the post-Unification period, leading to the construction of the largest aqueduct in Europe[1] and to a large-scale system of dams and water works for multiple purposes. This made pre-existing traditional technologies and practices for water harvesting almost completely defunct. The construction of the Apulian aqueduct started in 1904 from the visionary ideas of Camillo Rosalba, which bared to divert water from a nearby region and to carry up to 6,500 l/sec of water through a tunnel as long as 55 km beneath the Apennines and yet another one 16 km below the Murgia, taking a course of about 250 km, from Caposele to Villa Castelli, in a pipeline which distributes water under natural load. At that time, that effort seemed "verging on madness, a challenge to nature" (Viterbo, 2010) even to worthy men of science, while later became in the popular imagination that "work of enduring civilization without equal that has opened up before Apulia a phase of progress exceeding all expectations" (Viterbo, 2010).

This initial masterpiece of work was taken further in the second half of the XX century, by tapping a second spring from the river Calore at Cassano Irpino into the main pipeline and by connecting the main trunk to a complex system of multi-purpose dams feeding the new aqueducts of Pertusillo-Sinni, of Fortore, of Ofanto and of Locone. Today, water from these dams contributes as much as 60% of the total amount of water supplied by the Apulian Aqueduct while only 22% is now harvested from springs, the rest being taken from underground aquifers (AATO Puglia, 2009).

The construction of the Apulian aqueduct was then paralleled in the XX century by a complex irrigation network system made by the newly created *Consorzi di Bonifica* (Land Reclamation Consortia), which took further land reclamation activities carried out since the Borbonic period, when Carlo Afan de Rivera pioneered the works in Capitanata. This produced a gigantic effort of domestication of water, which was particularly impressive in the northern part of Apulia, where the Land Reclamation Consortium of Capitanata produced, since 1933 onwards, a radical infrastructural change in the organization and management of surface water, which had deep impacts on landscape as well as on productive, cultural, social and environmental features (Rienzo, 2012).

Finally, the XX century also saw the widespread dissemination of decentralized systems for groundwater extraction, which were largely conceived of as back-up solutions for irrigation by those who, in the short term, were not able to obtain water through large centralized schemes. The idea that an increase in water supply was an irrefutable right, especially for a population that had long suffered from the lack of water, and the underestimation of the impacts that modern water extraction technologies would have on hydrological cycles and groundwater dependent aquatic ecosystems, de facto led to widespread diffusion and very low public control on such practices. With the final result that today, compared to 873 Mm³ per year of estimated

[1] With its 20,752 km network and 323 tanks, the Apulian aqueduct today distributes more than 18,500 l/sec of water to a population of over 4,000,000 people (Scagliarini, 2010).

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consumption for irrigation (INEA, 2009), only little more than 200 Mm³ is provided by the Land Reclamation Consortia, with the rest coming from private wells, which are for the most part illegal[2].

These changes in the water sector had deep consequences not only on natural resources management but also on rural landscapes and on the way people conceived of technological progress and development patterns. In a region traditionally known as thirsty, due to its almost lack of water streams and very low rainfall[3] these changes reinforced the idea that technological progress and modernization were the only way to break free from age-old deprivation, which in the past had condemned people to unhealthy practices and constrained development patterns[4]. The analysis of the conditions, strategies and consequences of the process of radical technological change undertaken in the water sector in the XX century will be the starting point of this paper (section 1), with the aim to show the deep environmental problems and cultural changes they produced. In the second section, the paper will then analyze some examples of traditional rural landscapes of the Apulia region and the way they embody a more resilient and multi-functional approach to water resources management. Finally, the paper will discuss the innovation potentials rooted in multi-sectoral and multi-functional approaches to water and rural landscape analysis and planning proposed by some pilot initiatives across the region and by the strategic vision and projects promoted by the new territorial-landscape plan of the Apulia region.

2 BEYOND TECHNOLOGY: ENVIRONMENTAL, KNOWLEDGE AND CULTURAL DIMENSIONS OF CHANGE

The construction of the Apulian aqueduct has been traditionally conceived of as the "grand solution" (Viterbo, 2010) largely invoked by local communities to ultimately solve water supply problems in the region. Its construction has been widely analyzed from an historical and political perspective as a process of induced modernization by a new alliance between the most productive and upwardly mobile sections of society with a new idea of the state as "political entrepreneur" (Masella, 1995). But this is not the focus of this article, whose interest lies more on the interplay between technological changes, resource management and changes in the tangible and intangible features of the rural landscapes.

The complex multi-sectoral water network, of which the Apulian Aqueduct represents one of the main pillars, has contributed decisively to bringing about dramatic changes in standards of living and patterns of development within a region traditionally considered to be unable to match the pace of the civil and economic development of the country and constrained within backwardness by the absence of any possibility of irrigating the countryside, which led to the forced choice to grow extensive cultivations of grain (Masella, 1995). The

[2] Irrigation in Apulia is supplied at more than 75% from private wells (Distretto Idrografico dell'Appennino Meridionale, 2010). This makes planning and management of this sector an extremely complicated task.

[3] As early as the 1st century BC, Horace spoke of "*Apulia siticulosa*" (thirsting Apulia). The strong scarcity of water resources, which was experienced both by the Lombards of Benevento and by the Byzantines settled in different parts of the region in the 7th century AD, even brought about the suggestion that the name Apulia itself was derived from the Greek ἀπώλεια (apoleia), meaning "destruction" or "ruin" (Sirago, 1993).

[4] Engineer Filonardi, who had travelled all around the Bari area between 1878 and 1879 to analyse water related problems and possible solutions, admitted that the need for water in Apulia had reached the proportions of a "real and great social question". Not only did he note the scarcity of water – so that in times of drought it even became necessary to transport it on special trains from Ofanto at huge cost – but also the terrible quality of water normally used for drinking, so that he admitted it was almost an unbelievable luck in the Bari area to have "a glass of water that does not contain[ed] a myriad of insects, which do not even require a lens or microscope to be seen swimming around" (A. Filonardi, *Relazione al progetto di massima per condurre acque in provincia di Bari*, Roma, 1881. [Report to draft guidelines for conveyance of water in the province of Bari, Rome, 1881], quoted in Viterbo (2010).

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rapid improvement of sanitary conditions and the great increase in agricultural productivity started in the second half of the XX century would surely not have been possible had these operations not made vast amounts of water available (Del Monte et al., 1978; Masella, 1995) and in turn allowed for a partial replacement of traditional extensive crops with irrigated crops while extending irrigation practices to crops traditionally dry farmed (INEA, 2013). At the same time, the possibility to supply abundant water allowed the development of large industrial centers such as the chemical plant in Manfredonia, the petrochemical industrial area of Brindisi and the mixed (steel, petrochemical and concrete/cement) industrial settlement of Taranto[5] (Masella, 1995).
But while these changes in agricultural and industrial patterns were considered to be the means to kick-off growth and to free the region from a backward past, on the other hand they generated new and significant demand for water resources. In the agricultural sector, the estimated water consumption for irrigation is about 873 Mm³ per year (INEA, 2009). These data are even more significant if compared to nearby regions, which have more abundance of water, as today Apulia has even a larger proportion of water-dependent crops on total crops compared to those regions[6]. Some studies are also beginning to question the sustainability of crop and irrigation patterns in the region by analyzing the relations among crops planted, irrigation technologies and the pedoclimatic and hydrological features of the region (INEA, 2009). As for the industrial sector, recent estimates reported a total requirement of 145 Mm³ per year of water for industrial use (AdBP, 2012). On this point it's impressive to see that in the recent past ILVA Taranto alone had freshwater concessions as high as exceeding 100 Mm³ per year, although its actual consumption has then dropped to considerably lower levels in more recent years (Grassini, 2012).
The impressive construction of water supply infrastructures was then paralleled, in the second half of the XX century, by the construction of wastewater infrastructures, including wastewater treatment plants, also thanks to special funding from the *Cassa per il Mezzogiorno* (Southern Development Fund). Water cycle management was split into two sectors (water and wastewater sectors) dealt with in a separate and linear matter to improve efficiency. Impressive water/wastewater works were constructed; however, these could never match the growing demand for connections induced by the rapid socio-economic development the region was witnessing. Lacks in the wastewater sector and pollution of water resources were also some of the reasons for the establishment of long-lasting extraordinary administrations in environmental matters towards the end of the XX century.
Huge management problems also occurred in the water supply sector, in connection with the ageing and the extension of the system. Despite the use of advanced technologies to check leakages, the water works system today loses approximately 55% of the 563 Mm³ of water channeled into the network from various sources (AATO Puglia, 2009). This is coupled with problems of reduction in the capacity of the Sele-Calore springs and in the quantity of water supplied by reservoirs due to periods of low rainfall as well as to massive problems of depletion of ground water quality and quantity, including salinization of coastal aquifers, which required the adoption of drastic actions to reduce groundwater pumping in several areas. As a consequence, the Apulian

[5] The abundance of fresh water sources near Taranto, although at that time not yet available for industrial use, was one of the location factors highlighted in the technical reports that the Chamber of Commerce and the Municipality of Taranto used to support the candidature of this city for the allocation of the ex-ITALSIDER steel industrial plant (Dattomo, 2011).
[6] Apulia, which is part of the Distretto Idrografico dell'Appennino Meridionale (Southern Apennines Hydrographical District) together with Campania, Basilicata and Calabria and part of Molise (97%), Lazio (21%) and Abruzzo (15%), has a total Utilized Agricultural Area (UAA) representing approximately 36% of the total UAA in the District, while as much as 48% of the irrigated area of the entire district falls within its boundaries (INEA, 2013). Moreover, Apulia hosts half of total water-dependent crop production of the whole District (Distretto Idrografico dell'Appennino Meridionale, 2010).

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Aqueduct seems to be continuously (but unsuccessfully) attempting to catch-up with unattended water and wastewater demands[7]. The irrigation sector is not without problems, as water users consortia are unable to provide enough water to farmers, who largely need to relate on alternative (and often illegal) groundwater pumping, with the final result of worsening the already alarming environmental situation of the water sector.
The author of this paper maintains that the crisis in the availability of water resources in the Apulia region, the current unbalance between demand and supply and the constant need for additional resources, as well as the increasingly compromised quality and quantity of water resources, are not just technical problems. Large infrastructural changes occurred in the water sector in the XX century were somehow the result of (and at the same time one of the determinants of) a deep cultural change, which encompassed the understanding of technology itself and the relationship between man and nature[8]. Starting in the XIX century and even more in the course of the XX century, technology has been increasingly conceived of as a means to overcome natural constraints and to undertake development patterns traditionally considered impossible to be pursued because of restraints in local assets and endowments. While technological change was seen as a sign of freedom, it indeed condemned people to more subtle chains, as people became more and more dependent on natural and cognitive exogenous resources and unable to exit the mainstream pattern of development undertaken. The development approach based on the linearization of cycles and on sectoral specialization has furthermore condemned people to an ever-increasing water demand, which is constantly being unmatched, thus to a fate of water scarcity, which is somehow self-strengthened and self-reinforced.
In this sense technology, conceived of as a means to provide men with a never-ending ability to achieve their aims (Severino, 1988), acted as a powerful shielding mechanism in the fundamental relationship between men and nature (Bevilacqua, 1996). It embodied the dream of Prometheus to free men from the constraints of nature by gifting them the fire stolen from Gods in order to pursue and to build their own ideas outside the constraints imposed by a transcendent deity[9]. But man's continuous attempts to alter the structure of nature to suit himself led "man so far from his origins as to make obsolete the legacy of the customs in which he had grown up and in which he had thought when Nature was his limit […]. This transformation not only affected things, but the relationship that humanity has always acknowledged as impotence in its designs with respect to the insurmountability of the limits." (Galimberti, 1999). After decades of promethean attempts to overcome natural limits, we thus find ourselves abruptly awakened from the positivist dream of risk-free unlimited progress and confronted with the huge environmental problems produced by our actions and with the catastrophic scale of the reckless misuse of our technologies, as shown in the imaginary dialogue between Prometheus and the Eagle made by Bevilacqua (2005).

[7] In the preface of the new edition of Viterbo's work on Apulia and its aqueduct, Scagliarini states "Today Apulia no longer suffers from thirst, but it is still looking for the security that its territory, poor in natural sources, cannot provide; it is enough just to think of the alarm caused by the decrease in water levels of reservoirs, which today guarantee more than 60% of drinking water for Apulia" (Scagliarini, 2010).
[8] Engineers who pioneered the construction of the Apulian Aqueduct like Camillo Rosalba had graduated from the oldest School of Engineering in Italy (the *Scuola di Applicazione di Ponti e Strade* of the University of Naples), which used to train students to use technology to challenge nature. Thanks to frequent trips abroad and to the excellent school library, engineers were trained on the most important scientific discoveries and technological innovations of that time, so that first Neapolitan engineers could quickly achieve authentic primacies during since the XIX century, from the construction of the first steamboat (1818) to the iron bridges over the Garigliano and the Calore river based on the catenary principles (1832-35), to the Naples-Portici-Castellammare railway line (1839) (Russo, 2010). For a more detailed historical discussion on these matters see also Grassini, 2012
[9] The ancient myth of Prometheus, who, contrary to the will of Zeus, gifted humans with the use of fire, has since ancient times been the metaphor of the dream of men to pursue their own ideas and master nature without being fettered by the constraints imposed by a transcendent deity (Aeschylus, 1995).

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How to take up the challenge to develop a sustainable pattern of natural resources management? This is not only a technical matter. It requires a deep cultural and knowledge change as it needs thinking in a different way to recover a more holistic and multi-sectoral approach to water management and planning.

3 LEARNING FROM THE PAST: MULTI-FUNCTIONAL DIMENSIONS OF WATERSCAPES IN APULIA

Water resources are key features of the landscape in its tangible and intangible aspects. They are part of the natural endowments of a territory; at the same time they are part of the culture of the place and have deep influences on traditional technologies built for their use and socio-economic practices adopted in each territorial context. This is shown in several traditional landscapes of Apulia.

In the Alta Murgia, water is quite abundant in rainfall but there are no surface streams due to the outcropping karstic features of the soil. This steppic plateau has thus traditionally hosted extensive crop-cultivations and livestock. Large farmhouses and rural cisterns to harvest water are typical of this landscape. Rural cistern to harvest water for livestock, the so called *cisternoni rurali*, are quite widespread. They are semi-underground storage tanks, with walls typically coated with tufa, which collected water through sub-soil micro-filtration and natural condensation due to temperature differences (Laureano, 2001). Underground tanks for domestic use are also quite diffuse on the Alta Murgia within the premises of large farmhouses (*Masserie*), which constitute the most typical rural architecture of the area with their large cultivated lands for cereal-crops and livestock. There are also the so-called *neviere*, i.e. small buildings with a square or rectangular base, dug to a depth of 5-6 metres in the ground, roofed with a barrel vault and with access to one of the two sides at ground level. These structures used to collect and accumulate snow during winter so as to augment water resources during summer through melted snow. These water harvesting technologies were all in one with the rural landscape of Alta Murgia and its traditional extensive crop-cultivations and livestock. The large substitution of traditional cultivations with more intensive water-fed ones and the abandonment of most *masserie* put these landscapes – as well as the above mentioned water technologies – at high risks of destruction.

Rural cisterns can also be found in several other areas of the Apulia region. Interesting is the way they are part and parcel of the unique landscape of the terraced gardens in the peri-urban area of Ostuni, where they used to gather water through small cannels made of terracotta or carved out of the rocks and make it available for the irrigation of the gardens where horticultural crops were traditionally grown since the Medieval times. Small dry stone walls on the slopes served at the same time to retain the humidity and to protect soil from erosion. Since the 1970s, the availability of flat lands in the surrounding, with easier access to mechanization techniques for crop cultivation and plenty of water supply from dug wells or other sources, made terraced gardens be mostly abandoned or even encroached with illegal dump sites, excavations and buildings.

Other interesting traditional waterscapes of Apulia are wetlands, although they are almost at risk of extinction as it happens in several other regions. While the extensive land reclamation and channelling efforts carried out in the XIX and XX century in Apulia demonstrate an exclusive understanding of these areas as unproductive and problematic areas, they actually represent high value ecosystems as they often support high concentrations of animals and serve as nurseries for many of these species, furthermore providing a wide range of ecosystem services to humankind, including water filtration, flood control and recreation, as stated in the Ramsar Convention. Yet, in Apulia wetlands constitute only residual landscapes today. Very few wetlands remain of traditional meanders of water streams in Capitanata, with severe consequences on the richness of habitats and landscape quality of riversides.

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These are just few examples of traditional waterscapes in Apulia, which show a multi-functional and multi-sectoral understating of the relationship between water technologies and landscape. How to reverse the fate of abandonment or extinction to which these landscapes seem to be deemed to? This is indeed not an easy task as we have seen how transformations of landscapes in the XX century were the results of deep cultural changes besides socio-economic and technical transitions. The extremely intense period of modernization, which was experienced by Apulia especially after the second world war, brought with it not only mammoth rural development, rapid urbanization, growth of large industrial poles, massive tourism and overexploitation of natural resources. It also led to a deep process of abandonment of a wealth of local knowledge, experiences and skills, in favor of standardization and homogenization of pre-existing material and immaterial culture (Barbanente, 2011). To recover seemingly lost cultural roots and to make them flourish again and grow in innovative ways is not an easy task as it requires time and multifaceted efforts on different levels, both material and immaterial. The examples shown in the next section try to take up this challenge.

4 MULTI-SECTORAL AND MULTI-FUNCTIONAL APPROACHES TO WATER AND LANDSCAPE ANALYSIS AND PLANNING

In the last decade, several pilot experiments as well as scaling-up and demonstration efforts have been taking place in Apulia with the aim to recover and innovate local knowledge and skills.

The rehabilitation project of the terraced gardens in Ostuni is among the pilot experiments carried out at the local level for this scope. The idea to recover these gardens mushroomed from the local community, which proposed the idea to the municipality since the Nineties. But it was only thanks to a farsighted attention to the revival of traditional landscapes, which informed the regional administration in more recent years, that the municipality of Ostuni could obtain funds to refine the project and implement it under the umbrella of urban regeneration activities[10]. This project, which brought to a physical rehabilitation of dry stone walls, cisterns and terraced gardens – which are now being assigned to local associations for their communal use – is being taken further through a project proposal recently submitted for additional funding[11] to connect the town of Ostuni to the monumental olive trees plain through the terraced gardens while supporting the creation of a lively peri-urban community working on horticulture and more traditional activities.

Few other projects are now ongoing for the rehabilitation of rural cisterns in several areas of the region. Special funds have been devoted to this purpose by the regional government, in the attempt to combine support for traditional rural water harvesting techniques with the aim to preserve landscape quality and traditional productive vocations of rural areas[12].

Still at the local level, interesting to note is the artificial creation of some wetlands, among which the largest and the most famous in the region is in Melendugno. In this area, a phytopurification plant has been recently constructed to receive wastewater from the treatment plant of three nearby towns for a total of 41,000 equivalent inhabitants in the summer season. The choice to build the phytopurification plant shows a multi-

[10] For this purpose, the Municipality of Ostuni obtained funding from the Regional Operational Program 2013-2020 (Axis VII, Measure 7.1).

[11] This project has been submitted to a call for project made by the regional government with funding from the Regional Operational Programme 2014-2020 (Axis VI – Environmental Protection and promotion of natural and cultural resources).

[12] On this point fundings are worthwhile to be mentioned, which are provided by the Regional Rural Development Plan 2014-2020 (Misura 4.4) for the rehabilitation of drystone buildings for the collection of rainwater (specifically mentioning rural cisterns and *neviere*) and for the rehabilitation of drystone walls for biodiversity strengthening and hydraulic risk mitigation.

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functional and multi-sectoral approach to water management. On one side, it gives a solution to the wastewater treatment problems of the area, where the effluent of the existing treatment plant were previously discharged on the soil with frequent malfunctioning of the final draining system, mainly due to seasonal variations in the quantity of treated wastewater. On the other side, it strengthens the biodiversity and the ecosystem quality of the area as it creates a priority habitat according to the Habitat Directive (Mediterranean temporary ponds) in between a Mediterranean scrubland and a wooded-pine area. As such it enriches the biodiversity of the area and acts as a nursery for many animal species, including migratory bird population, furthermore ensuring a variety of additional ecosystem services including bioclimatic thermoregulation, groundwater recharge, and recreation activities for local communities. The resulting landscape is thus artificial but it is not the consequence of the simplification of landscapes produced by the linear/sectoral approach of the past; instead, it is the result of a paradigm shift towards a multi-dimensional and multi-sectoral approach to landscape management.

The territorial-landscape plan of the Apulia region, recently approved in 2015, constitutes the most comprehensive effort made in the region to support and scale-up a multi-dimensional and multi-sectoral approach to landscape management. This plan is the first regional plan approved in Italy, which embodies and gives actual implementation to the new approach to landscape valorisation required by the European Landscape Convention (Council of Europe, 2000) and by the new Italian "Cultural Heritage and Landscape Code" (2004). These declarations and pieces of law require to extend landscape policies to the entire territory, encompassing both urban and rural areas, outstanding as well as everyday or degraded landscapes, thus abandoning the traditional focus on the protection of "natural beauties" to adopt a more holistic understanding of landscape (Albrechts et al., 2017). Landscape is considered to be the result of the interaction between local communities and the environment; as such it has tangible as well as intangible features as it is shaped by and contributes to shape values, perception, knowledge, culture, practices and behaviours through territorialisation processes (Magnaghi, 2000; Olwig, 2007).

In particular, the territorial-landscape plan employs multifaceted tools for landscape valorisation, by combining a traditional regulatory approach, aiming at preserving those parts of the landscape protected by national laws or decrees and those considered to be worthwhile to be preserved by the regional government, with a strategic and policy design orientation. As such, it has been conceived of as a unique opportunity to change local culture and practices of territorial transformation in line with a collective effort to re-imagine the territory and to define new priorities for its strategic development, which are being promoted by the regional government since 2005 (Albrechts et al., 2017). The strategic and policy design orientation of the plan is supported by a wide variety of tools, including five "regional territorial projects"[13], a set of guidelines and a wide variety of "integrated experimental projects", aiming at showing, through demonstration activities and pilot projects, the feasibility of the strategy of the plan and the potential for the actual implementation of its re-imaginative vision (Magnaghi, 2011). These try to grasp stories of innovative experiences, like experimentation niches, to show how new ways to protect and enhance territory-landscape values may be consistent with the normative and strategic vision of the plan. Special agreements between the regional government and local public and private actors were made in order to develop these projects, while the European Structural Funds and the Agricultural Fund for Rural Development have been used to finance their design and implementation.

[13] They are: the regional ecologic network, the city-countryside pact, the infrastructural soft mobility system, the integrated valorisation of coastal landscapes, the territorial systems for making cultural and landscape assets accessible.

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One of these integrated experimental projects, which is particularly relevant to show an innovative multi-functional and multi-sectoral approach to natural resources and landscape analysis and planning, is the feasibility study for the ecological corridor of the Cervaro river in the Capitanata area. This study was carried out to test the implementation potentials of one of the five regional territorial projects of the plan, namely the regional ecological network. In this study the use of phytopurification plants is widely suggested as secondary treatment systems to get at the same time an improvement of the water quality of the river, where treated wastewaters are discharged, and the improvement of the biodiversity and landscape quality of the river ecosystem through the creation of wetlands besides the river banks, where multiple meanders and wetlands used to exist before land reclamation and artificial channelling of water streams.

Phytopurification plants as secondary treatment systems are also suggested in the feasibility study for the creation of the multi-functional valorisation park of "*Torri e casali*" (as part of the implementation of another regional territorial project, i.e. the city-countryside pact) in the northern part of the Metropolitan City of Bari. In this study, they are considered an interesting solution to combine improvement in ecosystem quality, reduction of pollution from wastewater discharge, increase in groundwater recharge through the discharge of their effluents in ephemeral karstic creeks (lame), which are abundant in this area. Several other interesting activities showing multi-functional and multi-sectoral approaches to water and rural development analysis and planning could be taken from the pilot implementation of the city-countryside pact, including funding of some projects for the rehabilitation of rural cisterns in the Alta Murgia area[14].

More comprehensive studies to promote multi-functional and multi-sectoral approaches to water management within the framework of the implementation of the city-countryside pact are then carried out by municipalities during the revision of urban plans in accordance with the new territorial-landscape plan. One such an example can be found in the new urban plan of the city of San Severo, where a wide range of solutions combining a multi-functional approach to water management and planning and rural development are suggested, including re-naturalization of rural areas through non productive crops and development of conservative agriculture in hydrological risk prone areas (Leone, 2017).

5 CONCLUDING REMARKS

This paper has highlighted the need to re-discover the complexity of the landscape in its multi-functionality and multi-dimensional features, and has tried to show how destructive tendencies in rural landscapes and natural resources use (above all water resources) may be reversed only through a more complex cultural and knowledge change leading to a different way to understand these resources. For this purpose, a more holistic and multi-sectoral approach to resource management and planning needs to be fostered. This includes the need to re-think of the relationship between urban and rural areas, between ecosystems and production, between man and nature.

In this perspective, the examples shown in the paper seem to be promising. While they try to raise awareness of the immense value of the Apulian landscapes and to dig out from oblivion material and immaterial roots of local culture, they try to find new ways to harmonize that material and immaterial heritage with new economies and productive systems for a different route of local development. The new territorial-landscape plan tries to carry out this tasks by synergically orienting practices for the use and transformation of the territory, as well

[14] One such project was funded e.g. in the municipality of Terlizzi through the Regional Operational Program 2007-2013.

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as local and regional public policies, towards landscape and resource safeguarding, valorization and enhancement (Barbanente, 2011). In so doing it tries to challenge socio-institutional awareness, priorities and cultural frames of a wide range of actors, namely local communities, public administrations, development agencies, firms and professionals involved in the local production of the territory. This work requires time to produce an impact, thus the years to come will be the time to assess the actual achievements obtained by these efforts.

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