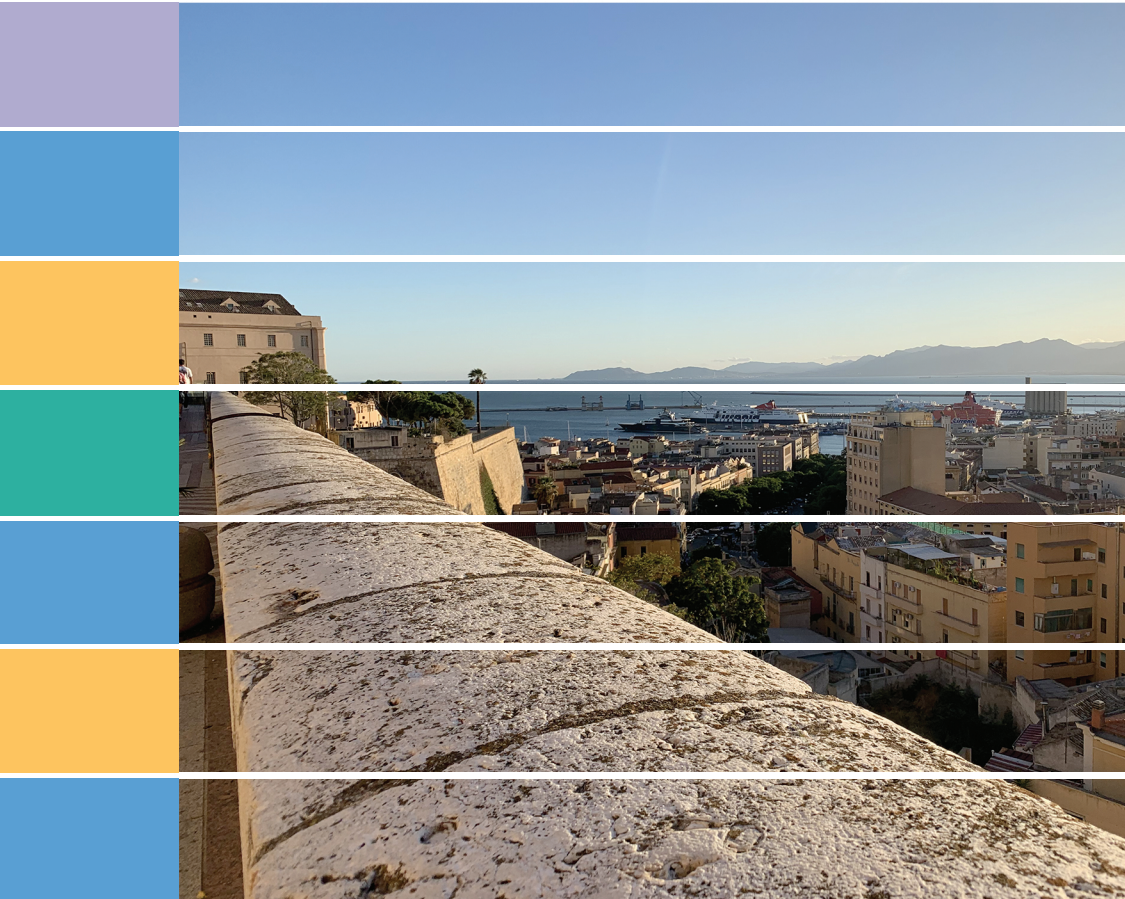


Carmela Gargiulo Corrado Zoppi  
*Editors*

# Planning, Nature and Ecosystem Services



**INPUT** TeMA Lab Dicaa UniNA

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Università degli Studi di Napoli Federico II  
*Scuola Politecnica e delle Scienze di Base*

Smart City, Urban Planning for a Sustainable Future

**5**





Carmela Gargiulo Corrado Zoppi

*Editors*

## **Planning, Nature and Ecosystem Services**

INPUT aCademy 2019

*Conference proceedings*

Federico II Open Access University Press



*Planning, nature and ecosystem services* / editors Carmela Gargiulo, Corrado Zoppi - Napoli: FedOAPress. 2019 - (Smart City, Urban Planning for a Sustainable Future. 5).

Web link:

<http://www.tema.unina.it/index.php/tema/Monographs>

ISBN: 978-88-6887-054-6

DOI: 10.6093/978-88-6887-054-6

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Università degli Studi di Napoli Federico II

Centro di Ateneo per le Biblioteche "Roberto Pettorino"

Piazza Bellini 59-60 - 80138 Napoli, Italy

<http://www.fedoapress.unina.it>

Published in Italy

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Cover and graphic project: TeMALab

This book collects the papers presented at INPUT aCA<sup>d</sup>emy 2019, a special edition of the INPUT Conference hosted by the Department of Civil and Environmental Engineering, and Architecture (DICAAR) of the University of Cagliari.

INPUT aCA<sup>d</sup>emy Conference will focus on contemporary planning issues with particular attention to ecosystem services, green and blue infrastructure and governance and management of Natura 2000 sites and coastal marine areas.

INPUT aCA<sup>d</sup>emy 2019 is organized within the GIREPAM Project (Integrated Management of Ecological Networks through Parks and Marine Areas), co-funded by the European Regional Development Fund (ERDF) in relation to the 2014-2020 Interreg Italy – France (Maritime) Programme.

INPUT aCA<sup>d</sup>emy 2019 is supported by Società Italiana degli Urbanisti (SIU, the Italian Society of Spatial Planners), Istituto Nazionale di Urbanistica (INU, the Italian National Institute of Urban Planning), UrbIng Ricerca Scientifica (the Association of Spatial Planning Scholars of the Italian Schools of Engineering) and Ordine degli Ingegneri di Cagliari (OIC, Professional Association of Engineers of Cagliari).

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This book is the most recent scientific contribution of the "Smart City, Urban Planning for a Sustainable Future" Book Series, dedicated to the collection of research e-books, published by FedOAPress - Federico II Open Access University Press. The volume contains the scientific contributions presented at the INPUT aCAdeMy 2019 Conference. In detail, this publication, including 92 papers grouped in 11 sessions, for a total of 1056 pages, has been edited by some members of the Editorial Staff of "TeMA Journal", here listed in alphabetical order:

- Rosaria Battarra;
- Gerardo Carpentieri;
- Federica Gaglione;
- Carmen Guida;
- Rosa Morosini;
- Floriana Zucaro.

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  
Published by FedOAPress - Federico II Open Access University Press



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## INTRODUCTION

This e-book contains the Proceedings of the INPUT aCAdeMy 2019 Conference held at the University of Cagliari on 24-26 June 2019, titled "Planning, nature and ecosystem services."

Input aCAdeMy follows the tenth INPUT Conference, held in September 2018 at Tuscia University, in Viterbo and, in some way, it breaks the biennial tradition of the INPUT Conferences. The reason for the frequency increase of the INPUT Conferences is that the Department of Civil and Environmental Engineering and Architecture of the University of Cagliari is involved in a project funded by the Programme INTERREG Marittimo–Italia France–Maritime 2014–2020, Axis 2.

In the context of the project, entitled "GIREPAM–Integrated Management of Ecological Networks through Parks and Marine Areas", the Department and the Office for Nature Protection and forest policies of the Regional Autonomous Administration of Sardinia are studying and defining an experimental methodology to integrate conservation measures concerning Natura 2000 Sites into marine protected areas regulations. The methodology is implemented to build the new regulations of two marine protected areas of Sardinia, namely the Island of Asinara and of the Island of Tavolara and Cape Coda Cavallo.

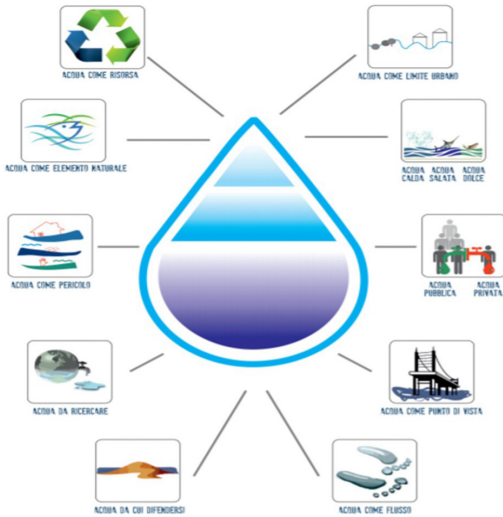
Since GIREPAM allocates a considerable amount of funds to the organization of an international conference on protection of nature and natural resources, ecosystem services and their relationship with spatial planning processes and practices, green infrastructure, and integrated management of protected areas and Natura 2000 Sites, and these funds must be spent by December 2019, the research group at the Department proposed to the INPUT Community, during the 2018 Viterbo Conference, a 2019 INPUT Conference focussing on these themes. The INPUT Community responded enthusiastically and, that being so, the research group has made every effort to make the event come true.

The Conference develops through plenary sessions and parallel tracks. The scope of the plenary sessions is to propose distinguished points of view concerning research and implied planning ideas and policies on important and significant issues which feature the ongoing scientific and technical debate on nature and natural resources.

The questions proposed and discussed in the Conference are three central topics which are characterized by several studies available in contemporary literature, and by vibrant debates as well, both from the theoretical and technical points of view. These questions are presented and discussed in the three plenary sessions which are the starting points of the three days of the Conference. Each plenary session is organized as follows: first, a speaker, a distinguished scholar, proposes the findings of his theoretical and/or applied research work and derived implications for spatial policy; secondly, a discussant, a distinguished

# THERMAL URBAN NATURAL ENVIRONMENT DEVELOPMENT

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*How to cite item in APA format:*

Moraci, F., Fazia, C., & Errigo, M.F. (2019). Thermal urban natural environment development. In C. Gargiulo & C. Zoppi (Eds.), *Planning, nature and ecosystem services* (pp. 714-722). Naples: FedOAPress. ISBN: 978-88-6887-054-6, doi: 10.6093/978-88-6887-054-6

## ABSTRACT

*Thermal wells are a historical, cultural identity space; but often a fragmented and marginal sector of the city; it has characterized by an unplanned development. Sometimes there is a lack of regional and municipal management of this resource; wellness tourism is not developed or is weakly linked to tourist flows involving provincial or regional area in which this resource is present. The management often suffers from a lack of professionalism and planning but also a lack of knowledge and attention. Four cities will be studied as best practices and front runner in this area, the city of Viterbo in Italy, Turnhout in Belgium, Heerlen in The Netherlands and the town of Caldes de Montbui in Spain. In the whole process will be engaged all partners and followers cities to take advantage from the relationship and from involvement in the experimentation of nature based innovations procedure and technologies for cities and environment. Viterbo is front runner for the enhancement of the thermal resource from an health and economic point of view; Caldes de Montbui as regards the use of waste water of the spa process for agricultural purposes. Turnhout and Heerleen for an energy transition with the use of geothermal energy as a lever towards a carbon neutral society. The front runner cities are conceived as "living laboratories" and are coaching cities; the followers city will carry out a local implementation of achievements developed in the front runner cities and will enhance the development of sustainable urban planning.*

## KEYWORDS

*Sustainable design; Integrated water management; Thermal springs*

## 1 INTRODUCTION

The project is based on the use of the environmental resource of thermal waters to create a redevelopment of the whole urban system, favoring the creation of a project that is able to locate the hot springs and the ability of pumping of each of them and thus creating a project of territorial development that, based on the aims already synthesized and on a compatible and sustainable use of environmental, historical and cultural resources, can promote the use of thermal springs of Viterbo, Turnhout, Heerlen and Caldes de Montbui, developing attention to the waste water spa treatment that will be used for the creation of urban gardens and for the upgrading of existing urban gardens, with promotion of biological agriculture, and for an energy transition with the use of geothermal energy as a lever towards a carbon neutral society. The main goal of this project is to pursue leadership in "innovating with nature" through locally implementable actions (in the four front runner cities of Viterbo, Turnhout, Heerlen and Caldes de Montbui) aimed at developing natural urbanization, promoting the reuse and enhancement of elements that are part of their territorial capital. Overall goal is to create healthier and greener living environments in some European cities through the widest possible participation of civil society, implementing of nature-based solutions focused on improving the quality of life in the study contexts. The methodology and organization of the proposed work plan allows to maximize the effectiveness of environmental improvement projects and also the faster replication of the processes and operations, even in contexts in different regions and states. The presence and distinction between front runners and followers is dictated by the desire to increase the effectiveness of actions and to pursue the replicability of the results in different contexts. The development of nature-based activities is promoted in relation to two main environmental systems, two ecological trails, as stated in the call: blue infrastructure and green infrastructure. The blue infrastructure corresponds to the network of the water, water and groundwater surface; springs and thermal waters are at the center of an enhancement process and of urban and regional regeneration also able of acting on occupational improvement, also economic because less not renewable energy will be imported and replaced by locally bought renewable energy. Green infrastructures are the environmental routes that connect together the area's resources; are ecological paths that develop urban links "creating a system of environmental resources"; they are high natural spaces included in the thermal basin and are spaces that link the different spatial areas using bioengineering and so innovative mobility solutions, able to create added value in the project. Moreover the geothermal energy can be an enabler in abating climate change, supporting a transition towards carbon neutral cities. Projects and actions that will affect the spaces of the water and the high natural areas will be implemented in Viterbo, Turnhout, Heerlen and in Caldes de

Montbui; these actions will produce a sustainable development connecting territories, and will get social, environmental and economic consequences and benefits; social because they will contribute to improving the quality of life and will be participatory; environmental, as they will favor the nature-based solutions, attribute to transformation of cities and the full respect of the environment; economic, as they will have very significant implications for employment in related sectors (hospitality industry and agriculture especially).

From a landscape point of view, the actions are important because the different thermal baths that form the thermal basin, are, themselves, landscape units characterized by high naturalness and historicity; urban gardens, which are promoted, are natural actions of control of spatial morphology but also actions that lead to an improvement of the urban naturalness through discovery and exploitation of a sector, the agriculture, that is strategic for environmental sustainability and capable of triggering autopropulsive actions (agricultural cooperatives, 0 km products, slow food) able to increase the employment. Geothermal energy as a heat source can be integrated in the existing environment, without jeopardizing the existing historical buildings and city quarters. As such a solution is provided to reconcile the challenges in climate change with cultural heritage, which cannot be made energy efficient. These nature-based activities will increase urban and regional resilience, especially water resilience, and encourage climate change adaptation.

The challenge facing the proposal, is to improve, on the one hand, climate and water resilience, and, secondly, to pursue an inclusive urban regeneration, promoting employment. Another result to be achieved is the protection and enhancement of biodiversity; biodiversity protection that belongs to the thermal environments and increasing the biodiversity of urban gardens using organic farming experiments. The research aims to demonstrate the feasibility of such interventions, using the project as a space of verification and knowledge. One of the aims is to contribute, through the landscape and architectural project, to improve the preservation and enjoyment of thermal areas, the recovery of water through nature-based architectural interventions; to rationalize and optimize the use of thermal fields and sources, encouraging both "new abstraction, rationalization, restructuring and protection of the existing intake structures of mineral water for spa use ..." that "investigations and hydrogeological studies for the discovery of mineralized aquifers suitable for thermal use and promote studies of the therapeutic qualities of the different waters".

## 2 METHODOLOGY

The project is based on the use of the environmental resource of thermal waters to create a redevelopment of the whole urban system, favoring the creation of a project that is able to locate the hot springs and the ability of pumping of each of them and thus creating a project

of territorial development that, based on the aims already synthesized and on a compatible and sustainable use of environmental, historical and cultural resources, can promote the use of thermal springs of Viterbo, Turnhout, Heerlen and Caldes de Montbui, developing attention to the waste water spa treatment that will be used for the creation of urban gardens and for the upgrading of existing urban gardens, with promotion of biological agriculture, and for an energy transition with the use of geothermal energy as a lever towards a carbon neutral society. Four cities will be studied as best practices and front runner; the city of Viterbo in Italy, Turnhout in Belgium, Heerlen in The Netherlands and Caldes de Montbui in Spain. These cities will be assumed for pilot projects and they will test and implement the project activities according to the priorities listed in the four-master plan for urban development. Viterbo was chosen because, within the territory, for years has been present a heated debate on the spa town (not yet built), because inside there are numerous hot springs, some of which are not used in thermal plants but are lost in the territory, because of the spa district area it is very large (30 sq km) with a pumping capacity of 105 l/s; Furthermore Viterbo Baths are characterized by exceptional historical, we also find traces in famous works such The Divine Comedy by Dante. Caldes de Montbui was selected for the innovative contribution of wastewater reuse projects of thermal process that made it possible to create a strong circular economy and to use resources, diversifying the uses and thus creating the greatest economic and environmental sustainability. Turnhout was chosen because of the good experiences with thermal water at the municipal swimming pool from the 1950's until 2005. Since then, a strong support has grown in the city region to use this geothermal resource as a key enabler in the transition towards a low-carbon society. A very proactive plan to provide sustainable heating in the city region, involving various sources including geothermal energy is being worked out. The masterplan includes a sustainable heat net in the city, with a planned integration of using geothermal heat. In 2016, the first small district heating grid in the city (one of the first in the country) was taken into service with a bio mass boiler as the transitional technology. This system is being expanded as we speak, to supply 600 homes an office building. The goal is to scale the system up, to be able to support a business case for additional wells to be drilled for geothermal sources. At this moment a second area in the city could be integrated in a heat grid, including 2.800 new houses and an existing, but to be expanded, large regional hospital. Historical heritage (eg. The Castle of Turnhout, built in the 12th century, today in use as a court house) that could be connected to a heat grid with renewable geothermal energy, can be converted to a sustainable building, without impacting its Cultural and historical value. Heerlen implemented a strong use/recovery of energy from water; Heerlen has an actual grid of heat and colling provided from minewater at 25 °C. They are very advanced in getting heat and cooling energy out of water; the water is in mine pits all

over the city. Mijnwater BV is the operating company of the Municipality of Heerlen to develop, exploit and innovate the low-exergy DHC-grid based on shallow geothermal energy. In the different areas of study have already been drawn up studies and projects for the exploitation of thermal, energy and agricultural fields; considerations that make the pilot project very interesting and especially implementable given the copious amount of work that has been produced. The five follower cities, which should benefit the project are the city of Maribor in Slovenia, the city of Levico Terme in Trentino Alto Adige, the city of Cahul in Moldova Republic with involvements of Ecological Counseling Center Cahul, the town of Sassari in Sardinia and the island of Pantelleria in Sicily. The last two seats, belonging to two islands and then forming a unified and concluded territory, were chosen because they have many undeveloped thermal resources and could benefit from the pilot actions undertaken in the project, because they could duplicate it. Sardinia has already undertaken a regional project on "System of Sardinia's spas". On the island of Pantelleria there are many events of secondary volcanism. Nowadays, the use of the island's thermal system is presented as "ancillary" activities to the most popular summer tourism. Slovenia's spa facilities are a strong attraction for tourism, which focuses on spas not only as treatment centers, but as places of relaxation and fun; in Levico Terme we have a lot thermal springs and University of Trento and Edmund Mach Foundation are developing topics related to enhancement of quality of life through very strong attention to biological agriculture and energy saving. In the follower cities will carry out a local implementation of some achievements developed in the front runner cities and will be enhanced the development of sustainable urban planning that will replicate and adapt to the local context, the based solutions tested in pilot projects. The Followers will have a privileged contact point with research partners and will have access to all the know-how experienced and to all achieved outputs and actively participate in the definition of the methodology that has to be implemented to allow replication of the results. The other universities of the networks are located on very important thermal basins and have developed an expertise level, distinguished by particular projects relating to the spas, that will be very useful and will be applied within the four pilot projects in Viterbo, Turnhout, Heerlen and in Caldes de Montbui. The methodology allows to maximize the effectiveness of environmental improvement projects and also the faster replication of the processes and operations, even in contexts in different regions and states. The presence and distinction between front runners and followers is dictated by the desire to increase the effectiveness of actions and to pursue the replicability of the results in different contexts. To improve this, we plan to build a e-learning, co-creation and participation platform (DEDiP) that will enable the synchronous exchange of experience and expertise among the various partners and the continuous updating of the actions. The platform will also provide a Geographic Information System,

which will also ensure the updating of maps. The DEDiP platform, with its participation function, informs and involves the local community to express and participate along the whole project activity, in the various phases of implementation; in that way ensuring a collaborative project implementation. For mediating conflicts and to reduce the complexity while increasing the efficiency, we will use participation with all stakeholders or selected stakeholders or actors, depending on the issue and implementation phases. In Viterbo, Turnhout, Heerlen and Caldes de Montbui will be designed a master plan that will provide the promotion of the whole spa; Municipal Basin will be divided into zones that constitute the priorities for action in case of European funding. Masterplan will provide a design that will take place on four elements:

- Enhancement spas basins and architecture creating public baths based on bioengineering actions compatible with the environment but which helps to highlight the spa area;
- Actions on urban mobility. It will include a set-system of the whole spa area. Will be developed actions as creations of green infrastructures and of sustainable mobility to connect the areas with each other and with the city center, in respect of environmental characteristics of the area;
- Agricultural production enhancement: will be developed a design of urban gardens in areas close to the thermal areas; in these urban gardens will be developed the production of fruits and vegetables farm through the use of the thermal waste water that will be conveyed into special tanks phytore mediation to lower the temperature and to purify water; the waters are so used for agricultural purposes. This method, tested by the University of Barcelona to Caldes de Montbui in Spain, has already received two prestigious European awards for agriculture in 2016;
- Exploitation and innovation through the low-exergy DHC-grid based on shallow geothermal energy.

### 3 AMBITION AND EXPECTED IMPACTS

TUNED aims to contribute to the improvement of the attractiveness of thermal areas, to the diversification of the economic base of the involved cities, to the creation of urban circular economy that values the natural aspect and the primary sector, to the improvement of quality of life, innovation and quality of governance. The involved cities, Viterbo, Turnhout, Heerlen and Caldes de Montbui, but also the followers, must be designed and treated as environmental testing laboratories, living landscapes, based on innovative practices and a wide popular participation which results in a mutual cultural enrichment. From an operational point of view, the project wants to be an element of urban and environmental regeneration of the thermal

territories through the implementation of engineering and architectural solutions characterized by the highest environmental sustainability.

STATE OF ART	PROJECT AMBITION	HOW IS ACHIEVED
The thermal resources are used in a poor way; each city often promotes a single or (at least) double use of thermal resources	Creation of urban circular economy	Through a complete use of thermal water (for baths, for care and therapeutic aims, for the creation of urban gardens and for the use in the heating system with energy saving. There is no waste of water and it is created a circular scheme with the use of water from the spring till the end of their life in agriculture with the enhancement of urban gardens and biological products.
Thermal water are often lost and there is no reuse of them (except in Caldes de Montbui).	Regulating the use of waste thermal waters.	Through a constructed wetland process that lowers the temperature and allows their use in irrigation farming.
The thermal springs are not rationalized.	Rationalize the use of hot springs.	With the implementation of a masterplan that describes the total amount of water that could be used by each thermal spring.
There is no urban or policy project that manages the thermal sector.	Develop a design implementation.	Will be implemented a masterplan with pilot projects based on funding and priorities established and agreed with the City Council
The employment in private or public sectors involved with thermal resource is not well defined and developed. There is no engagement between thermal springs and Energy sectors except in Belgium and in the Netherlands. The employment in thermal sector is low in each thermal city.	Develop employment able to check the results in the four main cities.	In both the Spa industry, which in those sectors linked to its supply chain, that in the management of urban gardens and social management co-operatives.
Today is not well defined and development the use of water for heating and for the promotion of sustainable heating using hot springs.	Develop energy use of water (especially for heating).	Enlarging the methodology developed in Heerleen project, replicating it in the pilot projects and encouraging the replication on a larger scale. Develop a very proactive plan to provide sustainable heating involving various sources.

Tab. 1 Explanation of the main achievements

The assumed project, and its territorial implementation, in line with what is stipulated in the field of Smart and Sustainable Cities, is aimed at achieving efficient management of natural resources through a number of actions concerning energy efficiency (which you get with the reuse of thermal waters), mobility (through the development of a system of green infrastructures and means of electric and hybrid mobility), water quality (through constructed wetlands trails and sewage for agricultural purposes), air quality through solutions aiming to favor the development of alternative mobility (also in TPL) to that of rubber, at least in the



front runner cities. The key challenges actions on mobility, on air and water quality, on energy efficiency, will involve deep economic, social and environmental effects, which would affect an improvement in urban and regional quality parameters, in particular concerning the territorial competition and improvement of employment. The Consortium has a strong portfolio concerning the ambition; Ciclica and Caldes de Montbui received two european grants regarding urban gardens; Herleen won the European Geothermal Innovation Award in 2015; Viterbo has developed recently a rationalization of thermal spring sources commissioned by Lazio region and almost all involved academies has a strong relationship with municipalities and sme with the aim to develop thermal resources. All the actions will be evaluated through the Lycfe Cycle Assessment (LCA) that will evaluate the enviromental impact of the supposed actions. So the ambition is to produce a better quality in environment and in social life. Through dissemination of results, which is realized through the implementation of DEDiP platform and the drawing up of the Dissemination Plan, the benefits of the experimentation carried out will help to create a "community of practice" based on efficiency of policies and governance and an interactive decision making process. The tested and implemented actions inside pilot projects (and supported by the project partners, especially by followers, strenghten the achieved benefits and, through comparison of the case studies and the obtained results (analyzed by appropriate quality and performance indicators), will emphasize the role of transformations and nature-based innovations as key role for the enhancement and urban and regional regeneration. It is also planned the implementation of Community policies such as the "EU Water Framework Directive", the "EU Biodiversity Strategy to 2020", the "EU Climate Change Adaptation Strategy", "The Blueprint to safeguard Europe's water" and the "Communication on Green Infrastructures ". The expected results are to bring the cities together, not only at the level of experts and the entire project of a city, but also down to the level of stakeholders and elaboration of specific ideas, to facilitate the cities' experience exchange throughout the entire process in different digital and physical participation and co-design steps and to link the innovations that are taken from other cities from the start with what the citizens experience as needs, challenges and opportunities in the city who wants to adopt those ideas (not just copying, but smart adoption, taking all aspects into account).

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## A NETWORK APPROACH FOR STUDYING MULTILAYER PLANNING OF URBAN GREEN AREAS: A CASE STUDY FROM THE TOWN OF SASSARI (SARDINIA, ITALY)

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*How to cite item in APA format:*

Palumbo, M.E., Manca, S., Palumbo, S. & Farris, E. (2019). A network approach for studying multilayer planning of urban green areas: a case study from the town of Sassari (Sardinia, Italy). In C. Gargiulo & C. Zoppi (Eds.), *Planning, nature and ecosystem services* (pp. 723-733). Naples: FedOAPress. ISBN: 978-88-6887-054-6, doi: 10.6093/978-88-6887-054-6

### ABSTRACT

*Urban development determines some of the largest local biodiversity extinction rates (McKinney, 2009), mainly by means of habitat fragmentation (Kong, 2010). The Theory of Island Biogeography (TIB) of MacArthur and Wilson (1967) applied to biological conservation suggests the need to project widespread ecological network seven in urban environments (Massa, 2002). The adoption of a network approaching the urban green areas (UGAs) planning is fundamental to make cities more permeable to the biological components; however, to do this it is important that the pieces of the planned landscape do not become sink-type areas (negative biological traps). Applying the principles of landscape ecology, in this work flora and structure of UGAs of the town of Sassari (NW Sardinia, Italy) were studied in order to identify the main structural drivers that determine the observed plant biodiversity and create a scientific base on which to root an UGAs planning implemented at the landscape level. Preliminary results suggest that native plant diversity is conditioned more by green patches configuration than spatial arrangement of patches within the urban matrix. The main application of our data is the re-development of each area, that from monovalent becomes polyvalent, thanks to the multilayer overlapping of single layers, each focused as a key issue for city life, as inspired by the network approach.*

### KEYWORDS

*Source-sink dynamics; Urban flora; Urban sustainability*

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