GREENWAY NETWORK PROPOSAL AS NATURE-BASED SOLUTION IN LIMASSOL, CYPRUS

A systematic reuse of residual areas inside the cultural heritage city centre

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ABSTRACT (Max. 300 words):

Greenways and green corridors are effective catalysts for social cohesion in communities as they represent places where people can live, work, and play; in addition the green infrastructure can also enhance the most valuable places in cities.

Considering the importance to integrate human needs into natural resources, "greenways and parklands connect with neighborhoods, schools and mixed use centers and provide the unifying element that allows urban and rural values to merge, producing a superior hybrid community form"¹. The aim of this paper is to present a greenways proposal for Limassol by linking the existing green areas, the linear parks along the streams and the "residual areas" inside the city to create a green network system with distinguished footpaths or cycle routes and a significant level of accessibility for people of all abilities and easiness in use. The greenway program in Limassol can bring benefits for nature conservation as well as heritage protection. Moreover it is an opportunity for better mobility, recreation, tourism and new challenging lifestyles as well as sustainable use of natural resources. As it was mentioned at the Ninth Workshop of the Council of Europe², greenways can "inspire citizens, local politicians, authorities and businessmen for joined planning and enhancing quality of life in their community".

As part of the greenway program, "residual areas" are proposed to become natural corridors to the biodiversity, where wildlife or rare species can grow and be protected.

Through the creation of a green network, the integration of urban green spaces can provide a healthier and a sustainable environment to the residents of the city while linking archeological areas and important cultural sites. Furthermore, the lesson that has been learnt from the current pandemic situation is that green spaces and sustainable mobility are crucial elements for the urban design. This paper proposes urban transformation approaches as sustainable pathways towards the management and development of our cities with emphasis to the cultural heritage urban areas. The paper is part of YADES MSCA RISE Project.

KEY WORDS

Greenways; centre of Limassol; Green network; Nature Based Solutions

¹ Arendt, R. (2011).

² Council of Europe (2013).

1. INTRODUCTION: Green Infrastructure, Culturale Heritage and dense urban environment

In recent decades, a scenario of increasingly rapid social, economic and climate changes at a global level has made *resilience* a trending concept on international agendas and in scientific research. This word, borrowed from the fields of biology and materials engineering, has also found application in the domain of urban sciences, starting an important line of research and international policies aimed at defining strategies and tools to guide urban development towards sustainable scenarios. The UN-Habitat Urban Resilience Hub define *urban resilience* as *"the measurable ability of any urban system, with its inhabitants, to maintain continuity through all shocks and stresses, while positively adapting and transforming toward sustainability"*. In particular, the past year has provided tangible evidence of the inadequacy and unpreparedness of most of the cities we live in: the pandemic crisis has also contributed to making even a non-expert public aware of the urgency of a radical transformation and has changed the perception Urban Green Spaces (UGS)⁴.

The Green Infrastructure network plays a key role for the sustainable transformation of cities in response to the needs for local food production, for ensuring green spaces for recreation and outdoor life, for sustainable mobility⁵, and also has to deal with the need for medium and long-term adaptation to a climate and environmental scenario with an increasing number of extreme events. Moreover, *"urban resilience also makes economic sense "*⁶ and from this point of view Nature-Based Solutions are preferable because of the multiple co-benefits they offer, whereas traditional solutions (grey solutions) only provide an answer to a specific problem⁷. Unlike purely artificial solutions and strategies, Nature has an intrinsic complexity that is the only truly effective key to meeting the complex challenges of the contemporary city. Thus, the recent trend to bring Nature back into the city reflects the complexity of the problem and the acceptance of this uncertainty without pretending to simplify it.

Among the many existing Nature-Based Solutions⁸, Greenways and Green Corridors represent a particularly interesting possibility: the considerable potential of these Green Infrastructures is mainly linked to their suitability for different situations as they are effective both in 'shrinking' cities with a

⁵ European Commission (2012).

⁷ Petsinaris, F., Baroni, L., Georgi, B. (2020).

³ UN-HABITAT (2018). The definition given in this document also provide prescription about the futureoriented behaviour of a *resilient city* that "plans and acts to prepare for and respond to hazards – natural and human-made, sudden and slow-onset, expected and unexpected – in order to protect and enhance people's lives, secure development gains, foster an investible environment, and drive positive change."

⁴ Ugolini et al. (2020). This study based on an online survey conducted in six European coutries during the period in which restrictive measures were imposed (March-May 2020) underlines the changes in the use and perceptions of urban green space. Notably 60% of the answers to the open question on the *relationship between urbanisation, people and nature* were associated with the *governance* macro-category (being the other *awareness* and *benefits and services*), showing how the perception of the need for structural interventions of urban planning and adaptation to new needs is increasingly widespread.

⁶ León, E. (2019). The author mentions reports from the World Bank indicating that a one-dollar investment in disaster preparedness may save as much as five dollars in economic losses.

⁸ Somarakis, G., Stagakis, S., & Chrysoulakis, N. (2019). This report provide a list of NBSs, highlighting the main benefits and co-benefits of each one and providing useful references for implementation.

diminishing population where they can occupy abandoned areas and in growing cities to shape and contain urban expansion⁹. The development of a greenways network is effective in reducing land fragmentation, improving urban ventilation, increasing biodiversity in urban areas, and creating a real interconnection between urban and rural environments. In addition to these benefits, which are part of the so-called Ecosystem Services, greenways - and in general Urban Green Infrastructure - are able to generate a complex spectrum of Cultural Ecosystem Services. Indeed, in recent years the relevance of community-based governance models to involve the citizens-users in the decision-making process and maximise the benefits of Green Infrastructure in relation to the specific needs of the local community has been understood: this clearly helps to consolidate social cohesion and foster a sense of collective identity¹⁰.

The key importance of these issues has been widely emphasised by the European institutions through a series of strategic documents from the GI Strategy¹¹ and Climate Change Adaptation Strategy of 2013¹² to the most recent Agenda 2030¹³ and European cities are already experimenting a lot in this field. A crucial turning point was the specific inclusion of Urban Greening for the first time in the EU Biodiversity Strategy for 2030 approved on May 20th 2020¹⁴: this document recognises the value and strategic potential of urban green areas, even when these are not large green areas or extensive parks, and this allows to focus on all those historical or densely built urban contexts – such as the case study of Limassol - where the integration of natural elements seems difficult due to a lack of available space. In this regard, interventions of urban acupuncture such as pocket gardens¹⁵ or parklets¹⁶ have become particularly popular in recent years. This type of intervention sometimes risks being an isolated action with an important social impact, but limited environmental benefits because it is not part of a broader strategy. However, the application of some specific strategies of pocket gardens and parklets, especially the identification of underused spaces to be transformed on a micro-urban scale, can be reinterpreted in a wider strategic perspective and applied to define greenways with recognisable characteristics and more consistent environmental benefits given by the synergic multiplication of many small interventions. This approach is particularly well suited to the Limassol case study because of the density of the built environment, the lack of available space and the difficulty of making structural changes to the street system.

¹⁶ Bertolini, L. (2020). Parklets are small interventions to change the use, accessibility and perception of the public space of the street. The mail goal of the parklets is to re-purpose the parking places by transforming them, even if only temporarily, into semi-public spaces through the introduction of useful structures such as benches and bike racks, but above all natural elements (vegetation).

⁹ Horte, O.S.; Eisenman, T.S. (2020).

¹⁰ Mahmoud, I., Morello, E. (2020).

¹¹ European Commission (2013). Green Infrastructure (GI).

¹² European Commission (2013). The EU Strategy on adaptation to climate change.

¹³ United Nations (2015).

¹⁴ European Commission (2020).

¹⁵ Armato F. (2017). Despite their small size, pocket gardens are a great asset in urban settings, both in terms of biodiversity and as a meeting place and social hub for people. «Pocket Parks can make up for the emptiness, abandonment and no function of many spaces that are located within our cities, triggering processes of urban regeneration through the discovery of a new "life" and a new potentiality to accommodate. This must be rediscovered and brought to light so as to realize and perceive a different urban imaginary.»

2. OBJECTIVES AND METHODOLOGY: tailored NBSs for Cultural Heritage areas

In line with the objectives of the European project YADES¹⁷, the aim of this study is to test a strategy for including green infrastructure in urban contexts in order to enhance the cultural heritage urban sites. The methodology adopted to develop this study consists of the following points: i) selection of the case study; ii) literature review and analysis of the ongoing transformations; iii) spatial analysis; iv) environmental analysis; v) key people engagement; vi) outline of the strategy.

The selected case study is the city of Limassol, in Cyprus. The reasons for this choice are several: firstly, the full adherence to the aims of the study, i.e. a congested urban environment with no greenery, but with a significant cultural heritage exposed to increasing risks; secondly, the inclusion of Lymassol in previous European projects, which constitutes an important knowledge base to start from.

Then a detailed literature review and preliminary information gathering on the case study was carried out, focusing particularly on the many ongoing projects such as the Sustainable Mobility Plan. Thus two different analyses were carried out on the Limassol area: a morphological-territorial analysis to start identifying physically suitable spaces for the implementation of the project strategy and an analysis to identify site-specific environmental and climatic risks that can be tackled through green infrastructure.

In order to fully understand the strategic debate concerning the city of Limassol, the involvement of a number of key figures has been planned: through targeted interviews with members of Limassol municipality, the Lemesos Architects Association of and the main local research institution, different perspectives and priorities on the issue were collected.

On this basis, a strategy for the development of a green network in the historic centre of Limassol has been elaborated. This proposal incorporates some guidelines already expressed by previous or ongoing projects, but adds some specific and tailored elements of the greenways strategy and represents an overall improvement on the proposals made so far because it aims to maximise the environmental and conservation benefits for the historical heritage.

3. COURSE OF ACTIONS

AREA OF STUDY: Limassol historical centre

The topics outlined in the introduction has been explored and concretely addressed in the Limassol case study: the city is situated in the district of Limassol at the south coast of the island and the area of study is focused in the historical city center. The port-city is located in a vital position regarding trading routes and commerce and due to the dry weather of the island, Limassol is as an important touristic hub through its heritage. Indeed, the historical center, is a vastly used area from tourists and locals, as the presence of commercial, public facilities, cultural monuments and heritage sites indicates

¹⁷ The full name of the project is "Improved Resilience and Sustainable Reconstruction of Cultural Heritage Areas to cope with Climate Change and Other Hazards based on Innovative Algorithms and Modelling Tools".

the importance of the area, meanwhile the public spaces are very few and fragmented, while the green spaces are almost non-existent, and the car appears as the predominant element of mobility in the site.

The historical center stretches along the coast, as the city itself, from the Ancient Castle to the municipal gardens and is mostly surrounded by residential housing in the north and east, while in the west the old Turkish-Cypriot settlements are still preserved and the presence of industrial buildings is predominant. The old port is also adjacent to the area used now for small boats, while in the last decade several projects have been developed in order to improve the area around the castle and the seafront. In particular, the plaza surrounding the castle has been revitalised, enhancing the access to the Carob Mill Museum, and the Molos Park was introduced along the seafront. In the old city, commercial activities are dominant, with shops, bars and restaurants being the main attraction points These activities together with a few regenerated housing, public facilities and the presence of TEPAK (Cyprus University of Technology) university ensures the livelihood of the area.

Another quite recent development has been the Limassol marina which provided expensive residences and commercial activities along the seafront. Furthermore, future development is planned nearby the historical city center: where a connection is planned with the new port through several projects along the way and an increased road network (Aktaia Street) in the seafront at the western part of the city, while in the east several high rise projects have been developing along the coast. In addition, a significant proposal comes from the Sustainable Mobility Plan (SUMP)¹⁸ funded by the municipality, which planned the pedestrianization of the most streets in the historical center, the fostering of more sustainable ways of mobility, mainly bicycles, and the improvement of the public transportation network, by enhancing the central bus hub located in the historical center. The result of these recent developments and also those planned for the near future is a dense, crowded urban environment -with particularly high seasonal peaks caused by tourism-, a large supply of private services that are not accessible to all, and a generalised and growing shortage of quality public services and spaces, especially when it comes to environmental and ecosystem services. As a result of the processes described, the quality of the air is increasingly worsening, raising concerns for public health and the conservation of the historical buildings while, sound pollution and humidity add to the issues phasing the historical center.



[fig. 1.1] Limassol Castle represents the main historical site of the city. *Source: https://allaboutlimassol* .com/en/the-medievalcastle

¹⁸ PTV Transport Consult GmbH (2019).



[fig. 1.2] Aerial satellite image of the city of Limassol. Source: https://www.bing.com/maps



[fig. 1.3] The map shows the urbanised areas surrounding the historical city center, points of interest and the agricultural and protected areas around the city. Authors elaboration - data used from the Inspire platform. *Source: author's elaboration, data from Inspire Geoportal Department of Land and Surveys.*

SPATIAL ANALYSIS: dense urbanisation and ongoing transformations

As mentioned before, the city of Limassol is suffering from the lack of green spaces, but also but also significant proposals to address the problem are missing. Seemingly, the only nature-based action was developed as part of the European project EnRoute¹⁹, that attempted to propose a Green Network for the city providing communication between the green spaces morphing around the existing rivers. As a result, the EnRoute programme has concretely led to the design and construction of a segment of linear park along the Garillys and this represents an important starting point for the present discussion. Indeed, the EnRoute proposal, along with the goals set by the environmental department for biodiversity, can act as a driveway and provide a baseline from where to begin the incorporation of natural green spaces, but also nature-based solutions within the most urbanised areas of the city.

Among these areas there is of course the historical city center, which is the main touristic hub, but the locals appreciate and use the historical areas of the city of Limassol as well either for shopping, eating or a night out. The city has been developing in a rapid pace around the center with major transformations happening in the costal front of the city and this process has led to the historic centre losing much of its previous importance. A lot of these developments are mostly privately owned high rise buildings while others include project like the Molos Park and the Limassol Marina. What has been previously the core of the city, seems to not follow the same trend as very small interventions were made in order to improve the area. The proposal of the Sustainable Mobility Plan somehow attempts to redeem that trend, while it proposes a very optimistic approach, in the pedestrianization of the majority of the streets in the area. While the proposal is hopeful, for a city like Limassol, where private vehicles are the selected mode of transport and public transport are not in a high level (thus the SUMP), eventually radical changes are something necessary in order to better utilize the area.



[fig. 2.1] Final proposal for a Green network from the EnRoute Project. *Source: Tzortzi N. -Georgi J. Ioannou A. (2018).*

[fig. 2.2] Implementation area of traffic management measures (Area A zoom)-pedestrianization and one-way system. *Source: SUMP for Limassol.*

¹⁹ Maes, J., Zulian, G., Günther, S., Thijssen, M., Raynal, J. (2019).

Mentioning that, the proposals for the transformations of the streets could be designed in a more analytic way, introducing local greenery and taking advantage of the open underused spaces.

ENVIRONMENTAL ANALYSIS: site-specific risks and climate change scenario

For the analysis of the area, the paper firstly studied the current situations of the city, recognising the urban and natural areas that exist and understanding the land uses of Limassol. Furthermore, an in-depth sudy and data collection hase been done to identify and quantify specific environmental issues of Limassos city, mainly related with incresed temperatures and pollution.

Very important is the increase in the number of warm days in almost all of Cyprus [Fig. 3.1]²⁰; the severity of the increase in temperatures can also be seen by comparing the annual mean temperature distributions between the periods 1986-2015 [Fig. 3.1 and Fig. 3.2]. Over the last couple of decades the greatest part of Cyprus has suffered from high temperatures and the largest part of the population residing in the three major cities, suffered high discomfort and serious socioeconomic problems such as increasin costs of energy for cooling, water consumption and forest fire risk²¹.











[Fig. 3.3] Changes in average annual max. Temp.(Top), min. Temp. (Middle) Between the future (2021 – 2050) and the control period (2021 -2050). *Source: Kythreotou N., Mesimeris T. (2018).*

²⁰ Hadjinicolaou et al., (2011).

²¹ Kythreotou N., Mesimeris T. (2018).

These occurrences along with the pollution of the air [Fig. 4.1 and Fig. 4.2] and the sound pollution [Fig. 5] push for more innovative solutions. The main emission sources of air pollutants in the atmosphere are attributed to human activities, which mainly include transport, industry, residential heating and agriculture. In order to monitor air quality in Cyprus, the DLI Operates a Monitoring Network of 9 stations, 2 in Limassol, fully equipped with automatic and continuous measurement instruments for the following pollutants:

- Nitrogen Monoxide, Nitrogen Dioxide and Nitrogen Oxides (NO, NO 2, NO x),
- Ozone (O 3)
- Sulphur Dioxide (SO 2),
- Carbon Monoxide (CO),
- Particulate Matter (PM 10, PM 2.5),
- Benzene (C 6 H 6) and other Volatile Organic Compounds (VOC's)

From the number of PM 10 exceedances per year for the period 2010-2019 recorded in the Air Quality Monitoring Network with the standard stationary method [Fig. 4.2], it is clear that there are exceedances, both of the annual limit value of 40 μ g/m 3 for the PM 10 set out in the relevant legislation, and of the maximum allowed number of 35 per year.

Based on the results presented in the report, Cyprus needs to take additional measures to reduce annual emissions in order to meet its commitments on the targets set. Among other things, additional measures must be taken in the transport, industrial and agricultural sectors, which contribute significantly to the overall emissions of Cyprus²².



[Fig 4.1] Emission trends for main pollutants and particulates for the period 1990-2018. *Source: Annual technical Report Air quality* 2019.



[Fig. 4.2], Number of exceedances per year of the PM 10 daily limit value in Air Quality MonitoringStations for the period 2010-2019 LIMTRA: LimassolTraffic Station (No of permissible exceedances: 35).Source: Annual technical Report Air quality 2019.



[Fig. 4.3] Concentration interpolated maps of PM 10 (annual mean, μ g/m 3) for 2016. *Source: EEA (2019)*.

²² Annual technical Report Air quality, 2019.

The chosen area of work is selected because of its importance for the city, and the impact that can have in its transformation, from a city with very green spaces to city that provides a green network for its citizens and activities that promote the concepts of caring for the environment and the city.



[Fig. 5] Mapping of the Land use (Left) and Noise Pollution (Right). *Source: authors' elaboration, data from the Inspire platform.*

KEY PEOPLE INTERVIEWS

To accomplish better results, the research opts to conduct interviews with members of the municipality and people who care for the wellbeing of the city, architects and planners alike, but the citizens as well, in order to go through proposals and suggestions that can help improve the project based on the necessities recognised by the people who use the spaces regularly.

The respondent from the technical department of the municipality offered an inside view on how the municipality of Limassol approaches the future developments and offer advice on the capabilities and goals set by the municipality in terms of what is planned, and how it is going to be achieved. Furthermore, the interviewed researcher belonging to the Eratosthenes Research Centre of Cyprus University of Technology (CUT-TEPAK) and the last interwee, member of the Lemesos Architects Association, can offer further considerations and vital ideas for the improvement of the project and subsequently the city.

STRATEGY: Green Network for Limassol historical centre

The solutions proposed to form the strategical approach, initiates by introducing green infrastructure through nature based solutions, and by creating a green network based on the existing cultural heritage sites that will create the platform for the development of the site. The network is based on the recognition of the significant points of interest in the historical city center, from the Ancient castle until the Municipal Gardens(Agkyras Street - Agiou Andreou Street), with this linear area, created by the street, identified as one of the most active throughout the city center, connecting the opposite sites. An additional element is the Anexartisias Street, a historical and active street, which in combination with the previous horizontal axis create a crossroad, which includes the main activities points, from the commercial activities of shopping, bars, cafes and restaurants to the cultural heritage, the castle, museums, and Parks already present, but also the pocket(underused) spaces that will be transformed. Following the suggestions of the SUMP the one-way streets in the activity axis would work normally, during weekdays, but transform to pedestrian ways with temporary activities (markets, exhibitions etc.) for the weekend, this way the functionality of the city center can remain during the weekdays for all the services present, schools of higher or lower education, the municipal buildings and any other utilities that are considered essentials. A small intervention is suggested for these particular types of streets with vegetation introduces on each sidewalk to reduce the impact of the street in the space. The rest of the activities proposed



[Fig. 6] Phases of the strategical approach, (a) Existing and SUMP proposal (b) Introducing the Primary axis (c) Introducing the Secondary axis (d) The complete network including the development areas and POI. *Source: authors' elaboration.*

for the transformed streets will be the introduction of a pedestrianised greenway, that offers multiple typologies of spaces, distributed based on each section of the axis and its surroundings, that includes, permeable paths and greenways with local trees and plants, and water collection systems, for mitigating noise and air pollution, bicycle lanes where necessary, for mobility and open spaces for the local shops to utilize.

As for Anexartisias street (vertical axis to the sea) which initially is occupied by the bus lane, will follow a similar pattern, but as a wider street, the possibility of intervention can be higher, with a mixture of temporary and fixed activities (Installations) and nature based solutions can be used for improving the system. The elements introduced can have a major impact in transforming the city center, with essentially changing the mind-set of how it functions and how the people, used to travel by cars even in these narrow streets, can adapt and enjoy the city no matter of the conditions.



[Fig. 7] Scenarios for converting the primary and secondary axis networks proposed in the strategy. *Source: authors' elaboration*



[Fig. 8] Suggested conversion in a Agiou Andreou Street Section. *Source: authors' elaboration, data from the Guide for the creation of the Cypriot garden.*

4. EXPECTED FUTURE DEVELOPMENTS

A project like the one suggested, will be necessary to be completed in different phases, as the changes will be quite extensive, in the attempt to combine all the projects that exist and are planned for the future. It requires a planning of the phases [Fig. 9], in coordination with the municipality and developers alike, by including the multiple stakeholders that have common interests [Fig. 10], establishing the direction the city will need to follow based on the current European Standards. The 17 Sustainable Development Goals (SDGs) should be the driver in achieving the targets set, for improving the quality of life in the city and create a vision towards sustainable development for all. For a relatively small city like Limassol, the way to accomplish that is by setting stepping stones with each and every intervention.

The proposal to create a green network in a city center that has been nearly eradicated of any green spaces excluding a few existing trees, is a transformation that needs to take in account the capability of the municipality in not only making the developments but also maintaining them. The system should be able to offer minimal future expenses, by the municipality and substantially the citizens. The project should also be able to plan for the future, take in account the changes that will occur based on the planning of the city, which ideally will be taking in account all of its projects, in order to create a homogenous area where each and every space has a purpose, and can communicate without having the feeling of fragments as in individual developments. This can be achieved by the system introduced, where every element either historical, commercial or otherwise, is linked through the green network proposal. This will create great potential for further developments, acting as an expansion network that could, with the help of other projects such as the En-Route, spread in the rest of the city. It will require a lot of further research and experimentation, as to what really can be accomplished in a city like Limassol, a European city that has been under major development but until now without a major focal strategy in mind, for attacking the major issues we are phasing that derive from climate change and the recent Covid-19 pandemic.



[Fig. 9] An example of a systemic approach regarding NBS depicting the utilities and environmental impacts. *Source: Nurmi et al. (2012) cited in Somarakis, G., Stagakis, S., & Chrysoulakis, N. (2019).*



[Fig. 10] Alternative decision-making processes regarding the inclusion of multiple actors. *Source: Somarakis, G., Stagakis, S., & Chrysoulakis, N. (2019).*

5. CONCLUSION

To sum up what has been said so far, it should be stressed once again that the strategy presented is only the first step in a project that will continue to be deepened and will hopefully lead to real stakeholder engagement and concrete results through Limassol's inclusion in the YADES project.

Even this first step, however, is already an interesting result: Limassol presents characteristics that can be easily found in many other urban areas, especially in the Mediterranean area, and many historical centres have the same problems of urbanisation, high risks for cultural heritage and increasing impact of climate change as Limassol. Therefore, the approach presented can be replicated in other similar contexts and the strategy developed for this specific case can be taken as an example, as in the case of the study of sustainable stormwater management proposed by Priari²³. Indeed, the main achievement is the experimental combination of two different approaches: on one side the strategy of *greenways* and *green corridors "as a sustainable planning strategy to contain or shape urban expansion, reduce land fragmentation, and maintain landscape integrity "²⁴, that is usually implemented in the presence of large open spaces, and on the other side strategies of punctual intervention and reconversion of <i>scarce urban resource "²⁵*.

Lastly, from a more general point of view, this project contributes to focus attention on the urgent need to invest research and resources in the development of sustainable solutions and NBSs "to enhance the societal and cultural link with nature and biodiversity, to acknowledge and increase the economic value of ecosystem services and to create incentives for local stakeholders and communities to deliver

²³ Priari, G. (2018).

²⁴ Horte, O.S.; Eisenman, T.S. (2020).

²⁵ Bertolini, L. (2020).

*them*²²⁶, and to adapt these principles also to contexts that are not particularly suitable for climatic and morphological reasons.

6. ACKNOWLEDGEMENTS

The authors acknowledge the belonging of this article to the framework of the European project YADES, that has received funding from the European Union's Horizon 2020 research and innovation programme, under grant agreement N° 872931, work programme H2020 under the Marie Skłodowska-Curie "Research and Innovation Staff Exchange" (RISE), call: H2020-MSCA-RISE-2019, coordinated by the National Technical University Of Athens (NTUA). Moreover, we want to acknowledge the fruitful cooperation between the Geosystems Hellas S.A. [GSH] and Politecnico di Milano for the acquisition and processing of geo-referenced data for spatial analysis.

²⁶ European Commission (2012), The Multifunctionality of Green Infrastructure

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