Forests and Cities: Forests-based solutions in urban areas

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In the face of the ineluctable growth in population and urban sprawl in the countries around the Mediterranean, nature-based solutions within Mediterranean cities offer a real opportunity to enhance their resilience while taking into account the difficult societal, economic and environmental challenges they are bound to face in the years ahead.

The complex of lands bordering the Mediterranean Sea is one of the first areas of the globe where cities developed (Reba *et al.* 2016) and today it is one of the most urbanized regions on the planet. With an urbanization rate of 60%, the current figure of 315 million inhabitants living in cities is expected to increase to 385 million by 2025, comprising more than 61.3% of the total population. The capacity of Mediterranean cities to absorb such growth, is however not growing accordingly. This is due to the peculiarity of urban expansion in the Mediterranean region: urban growth in the Mediterranean is mainly occurring in small-to-medium-sized cities rather than in megacities. Unlike other areas of the world in which megacities are growing – with the exception of the two world-scale megapolises of Cairo and Istanbul (with 16 and 11 million inhabitants, respectively) – more than half of the Mediterranean population lives in 3,900 cities of less than 300,000 inhabitants and a third in urban areas of under 80,000 inhabitants (Figure 1) (Blue Plan Paper, 2001).

Within the Mediterranean region, the coastal areas are experiencing a greater urban increase due to the coastalisation process: people move to the coasts and plan to live there. The exponential growth of population, urban sprawl, grey infrastructures, mass tourism, and economic activities in coastal zones date back to the '60s of the last century in Northern/Western Mediterranean while can be considered a pan-Mediterranean characteristic since the last decade of the 20th century (Benoit & Comeau, 2005). The inland cities in all Mediterranean countries, and particularly the ones having less than 50,000 residents, have substantially shrunk in the last decades, causing one of the most dramatic socio-anthropological phenomena of the region which is still currently ongoing. Furthermore, the population movements generated by

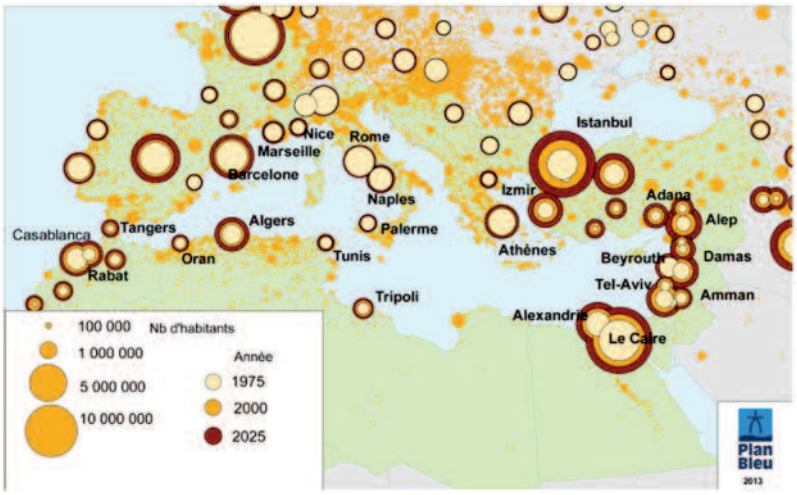

Figure 1: Distribution and estimated growth of the urban population in the Mediterranean region. *Plan Bleu, 2006.*

humanitarian and war crises, the strong demographic growth in the recent past, the migratory flows from inland areas, the changes in residential functions and gentrification processes, the development of tourism as a leading commercial activity, all add up to some of the reasons why the traditional design of compact Mediterranean cities are being modified towards models of urban expansion, creating concern in many areas of the region (Salvati & Morelli, 2014).

There is also a lack of a sustainable urban development model, in which the built-up urban surface area and the number of inhabitants, along with densified and verticalized peri-urban urbanization, are growing rapidly. All these factors have contributed to the fact that many cities in the region are living in a situation of accumulated risk and permanent vulnerability, exacerbated by the effects of climate change by which the projected temperature increases and the decrease in rainfall will exacerbate extreme natural hazards such as storms, floods, wildfires, and droughts.

A major factor that is transforming the dynamics of Mediterranean cities is addressed by the vulnerability of the region to climate change. The Mediterranean region has been identified as one of the climate systems most impacted by increased greenhouse gas concentrations (Giorgi, 2006). In fact, the region is showing a tendency to tropicalization, particularly in sea temperature and marine ecosystems, whose effects are heavily affecting coastal meso-climate where most urban populations are located. Beyond that, it is intimately connected with three regions highly sensitive which are affected by the effects of climate change: the Sahara desert, the Sahel and the critical tropical belt of sub-Saharan African. As a result, Mediterranean cities are the first to face the flow of north-African environmental migrants, also defined as climate refugees by Apap (2019) in the European Parliament. As a result of this trend, more and more sectors of the Mediterranean population will be exposed to environmental degradation over the coming years, resulting in increasing urban poverty, air pollution, social isolation, and threats to the health and quality of life of city dwellers.

A question arises from the above scenario which, in turn, poses new challenges to major cities and administrations: how can we make cities environmentally, economically, and socially more sustainable and resilient?

The implementation of Nature-based Solutions (NBSs) in Mediterranean cities provides a genuine opportunity to boost resilience and to address (when not preventing) some of the societal, environmental and economic challenges expected to worsen over the coming years. The NBS concept is defined by IUCN as "actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (IUCN, 2019). In the Mediterranean region, the implementation of NBSs has proven to be a valuable tool to support the smart growth of cities and increase their resilience to the effects of a changing climate, thus paving the way towards a more sustainable model of urban development. In fact, thanks to NBSs it becomes possible to help address and prevent dysfunctions at different levels: territorial, economic, and environmental. In particular, Forest Based Solutions (FBSs) can provide a number of benefits and ecosystem services to cities, going beyond such contributions to address climate change-related issues and, more widely, to contribute to more sustainable urban development. Urban and peri-urban forests (UPF), and trees outside forests (ToF), which are the backbone of the Green Infrastructure of a city, stand out as fundamental pillars in the reinforcement of urban ecosystems, increase urban resilience to the effects of climate change, and increase the spatial and functional connectivity between cities and their natural surroundings (Salbitano *et al.*, 2016; Salbitano *et al.* 2018) (Table 1). In the

	Role of (Urban and Peri-urban) Forest-Based Solutions	
Type of Hazard/Threat	Active restoration / Benefits	Passive protection / Shields
DESERTIFICATION	Fixing and stabilizing dunes and soil; Water harvesting; Water soil replenishment; Increasing the humidity in the soil atmosphere system; Favoring the condensation of atmospheric water vapour.	Reducing wind erosion; Lowing evaporation water loss; Preserving soil humidity.
FLOODS AND STORMS	Improving the water capacity of the system via increasing permeability of urban and periurban soils; Enhancing the water uptake capacity of root systems.	Extending the time of concentration via canopy interception of rain droplets and slowing their velocity.
INCREASED TEMPERATURES (Heat wave, thermal comfort, urban heat island effect)	Shading; Reducing heat flux and air temperature through evapotranspiration.	Decreasing the energy demand for microclimate control (heating, air conditioning).
LANDSLIDES	Stabilizing the slopes by reducing surface runoff and erosion.	Improving water cycle and reducing the vulnerability to extreme precipitation.
VULNERABILITY TO WILDFIRES	Constituting fire filters and breaks via designing a mosaic of varied canopy cover; Fire-preventive silviculture.	Monitoring and control via sustainable silviculture treatments; Reducing the potential of fire in the urban-rural interface via favoring or introducing low-flammable and native species.
LOSS OF BIODIVERSITY	Improving Beta- and Gamma- diversity at city/city region scales; Hosting exotic species.	Maintaining relict and native species and habitats in urban settings; Supporting programs for preserving/restoring threatened species.
LOSS OF CONNECTIVITY / FRAGMENTATION	Integrating natural- and semi-natural vegetation structures. Interconnecting mosaics of habitats.	Embracing a Green Infrastructure (GI) approach in order to avoid problems associated with the fragmentation of habitats.
PESTS AND DISEASES	Monitoring: urban trees as sentinels to predict and prevent the invasion of new pests.	Limiting the spread and effects of pests and diseases; Testing treatments in controlled environments.
AIR POLLUTION	Removing air pollutants; Blocking removable pollutants in wood and soil; Transforming, storing and sequestering carbon dioxide; Immobilizing particulate matter.	Storing and sequestering carbon; Lowing GHG; Improving air quality (cleaning effect).
PHYSICAL AND MENTAL DISORDERS	Generating spaces for well-being.	Creating settings for informal physical activities for all age groups; Reducing the risk and incidence of non-communicable diseases; Reducing morbidity and mortality; Reducing depression and anxiety; Reducing stress and fatigue.
SOCIAL ISOLATION	Creating identity landscapes and a sense of place; Place-keeping, place-making.	Favoring social cohesion by creating spaces for social interaction; Promote feeling of control; Enhancing the perception of security in popular UPF settings.
FOOD INSECURITY	Supplying essential fruit, vegetables and herbs.	Fostering healthy eating habits; Educating for responsible food consumption.
URBAN POVERTY	Providing fuel and energy, food, fodder, shelter; Supplying water for all uses; Improving water quality for domestic uses.	Creating direct and indirect employment (e.g. tree nurseries, gardening, food production, vendors, performers, etc.); Providing better livelihood and environmental conditions.

Table 1: Role of Urban and Peri-urban Forests in preventing and mitigating environmental events and social hazards in Mediterranean cities. *Adapted from Cariñanos et al., 2018.*

Figure 2: Urban and Periurban Forests has been a distinctive feature of the urban Mediterranean landscape. View of Rome from the FAO's Headquarters Building. *Photo Paloma Cariñanos.*

Mediterranean area, UPF and ToF constitute a distinctive feature of the landscape and are part of the historical heritage of many cities (Figure 2). As such, there is a huge potential for cities to invest in FBS to increase their capacity to adapt to the effects of climate change. And many are already doing so.

Below, we review a number of case studies providing examples of activities and actions implemented within the Region to address key environmental challenges through the implementation of FBSs.

Fighting against the advancement of desertification: Maamora Forests (Morocco)

The Maamora Forest - located on the Atlantic plain in the neighbourhood of Rabat - covers 60,000 ha, largely dominated by cork oak (*Quercus suber*). It is considered the largest oak forest in the world. Thanks to its proximity to the city, the Maamora Forest represents the main recreational space for the large urban population of Rabat, as well as the main source of income for a population of about 300,000 inhabitants (Said *et al.*, 2010). However, human activity is seriously threatening the forest through rapid and uncontrolled urbanisation, deforestation, overgrazing and undue illegal logging for fuelwood production. Such anthropogenic disturbances are associated to, and often amplified by, other environmental perturbations, including severe water stress due to increased frequency of droughts and pests outbreaks (Said *et al.*, 2010). Despite the government's efforts to preserve and conserve the Maamora Forest, human-inducted degradation still represents a major concern for its preservation. According to Said *et al.*, 2010, the socio-economic value of the Maamora forest in the livelihood of both rural and urban local communities becomes clear when looking at the following figures:

– Annual average income: 60 million dirhams,

– Wood industry: 300,000 m^3 (85% of national production), mainly for eucalyptus pulp,

– Cork production: 6,000 tons (47% of national production),

– Legal firewood production: 600,000 m^3/year (87% of the needs of the local community),

– Forage production: UF 24 million/year to 250,000 head of sheep and cattle (75% of the needs of livestock area),

– Non-wood products: mushrooms, lichens (30 tons/year), medicinal plants and tannin (5,000 tonnes / year), honey (1,000 tonnes / year),

– Employment in rural areas: 300,000 workdays per year.

To preserve the socio-economic and environmental value of this forest, a number of measures have been undertaken by the government for the rehabilitation, restoration, and development of the forest. These include strengthening the development of the periurban area and improving the livelihood and the living standards of the local population. Because of the crucial role of forests in protecting the environment and in counteracting desertification, the strategy includes the plantation of more than 20,000 ha of new plantations of cork oaks, including soil preparation, acorn sowing and/or the plantaining of oak seedlings. The involvement of the local population includes actions oriented towards the protection of forests from illegal logging.

Recovery of biodiversity and connectivity in the Manzanares River in Madrid (Spain)

The Manzanares, tributary of the Tajo River, runs for 92 km through the Province of Madrid in Spain. The ecosystems interconnected to the river bed host a significant

number of habitats and the river crosses areas of great environmental value. However, the quality of the river drastically decreases in the 15 km that it flows through the city of Madrid. In fact, the construction of a series of dams in the urban stretch had caused a significant loss of biodiversity and environmental quality along the river banks, exacerbated by the entry and installation of numerous invasive species (both flora and fauna), and the accumulation of trash produced and dumped by the urban community. In 2016, the NGO Ecologists in Action presented a proposal to the City Council of Madrid for the ecological restoration of the river; this included the opening of dams, the creation of banks on both sides as a flood prevention measure, and the recovery of the urban riparian forest by the revegetation of native trees and shrubs (Plan for the renaturation of the Manzanares River as it passes through the city of Madrid, 2017). These actions, which have benefited from active citizen participation, can be considered an ecological success since just a few months after the dams were opened, river banks were covered with natural vegetation (Figure 3). Populations of fish and birds also grew rapidly, and it is also expected that some of the species populating the non-urban stretches of the river, such as the otter, will soon populate other parts of the river. The recovery of the river's biodiversity is also having a positive impact on the local population in social terms: it feels it has now recovered part of the natural environment where they live.

Figure 3:
Renaturation of the Manzanares River as it passes through the city of Madrid.
Photo Telemadrid.

The fight against wildfire in Portugal

The Mediterranean region is one of the most vulnerable in the world in terms of risk of forest fires. Over recent decades, such a risk has been further heightened by the increasing frequency of droughts, even out of the summer season, which have led to an increase in the number, extent, and recurrence of wildfires and, consequently, to a dramatic increase in related human and economic losses. On average, 800,000 ha of forests burn every year. Most of these fires take place at the wildland-urban interface, with a consequent increase in the vulnerability of and direct threat to the cities (Cariñanos *et al.*, 2018). Among the factors identified as most threatening for the occurrence of fires are the fragmentation of territory, the abandonment of agricultural land and cultivation, and urban sprawl consuming natural soils and habitats, which generates proximity to spaces that are not always conveniently covered by forests nor sustainably managed (Gonçalves & Sousa, 2017).

Portugal ranks first in the Mediterranean region for losses caused by fire. Three main factors make this country particularly exposed to the risk of severe and fatal forest fires: the high frequency of intense heat waves in the summer season, the frequent electrical storms, the massive presence of eucalypt forests (whose leaves and bark are highly flammable) at the rural-urban interface. This last factor in particular facilitates the spread of the fires up to the urban areas (which are closer and closer to the peri-urban fringe due to urban expansion, (Figure 4), seriously threatening the lives of the people living in cities. To address this issue, the Portuguese National Plan for Prevention and Protection Against Fires (established by the Portuguese Government in 2005) reviewed

Figure 4:
Eucalyptus forest in Portugal.
Credit: http://noels-garden.blogspot.com/2018/02/portugals-firestorm-disaster-eucalyptus.html

Figure 5: The Urban Food Forests represent a potential for increasing Food security and fight against Urban Poverty in Mediterranean Cities. In the photos, some edible species frequent in UFF of Mediterranean cities. Top, from left to right: date palm tree, pomegranate tree, medlar tree. Below, from left to right: orange and olive trees, grapevine and lemon tree. *Cariñanos et al., 2019.*

the strategies and actions to be carried out to reduce the risk of forest fires and their serious consequences (Oliveira, 2005). Among the measures proposed is the creation of the Agency for the Integrated Management of Rural Fire (AGIF), which supports the development of the collaboration between municipalities in development of consistent forest and fire management plans, including the implementation of sustainable management of abandoned agricultural lands and forests, with particular focus on those nearest to urban areas. The Plan identifies a number of Forest Intervention Zones (ZIF) throughout the country, indicating the areas where primary management actions should be carried out. Among the most urgent measures reported in the Plan, are the progressive replacement of non-native species, the afforestation of the metropolitan communities to reinforce the urban/forest interface, and the integration into the forest management plans of best techniques and practices for forest planning (including the urban and peri-urban forests).

Urban Food Forests to improve food security in urban environments

The major demographic growth experienced by Mediterranean countries in recent decades has led to a continuous increase in food requirements. This situation must be contextualized in the historic specificity of the region, where increasing droughts, wars and famines have historically resulted in the migration of poor people to urban areas, with a consequent increase in poverty and food insecurity in cities. Many Mediterranean cities have historically used urban fruit trees (for example, the orangeries of various French, Italian, and Spanish cities, or the citrus grove of the Secret Garden of Marrakech, Morocco), but few have seen them as an opportunity for alleviating poverty, or as food suppliers and promoters of healthy eating habits (Figure 5). In this context, Urban Food Forests (UFF), defined as the "intentional and strategic use of woody perennial food-producing species in urban edible landscapes to improve the sustainability and resilience of urban communities" (Clark & Nicholas, 2013), represent an opportunity to address the food needs in cities (Castro *et al.*, 2017). In fact, although in the Mediterranean the traditional value of generating fresh and nutritious food in the near-urban areas has been lost over the past decades, some interesting experiences of Urban Food Forest implementation are now being recorded from the Region.

The Picasso Food Forest in the city of Parma (Italy) provides one of the earliest case studies of an urban community food forest in the world. In only 5 years, the forest has been able to promote responsible harvesting, shared care of people, and healthy eating habits. In addition to producing a varied selection of fruits, herbs and edible vegetables, the Picasso Food Forest has reconnected people with nature in the city. The Picasso Food Forest in particular - and UFF in general - provides a model of how cities should be designed to address citizens' needs (Riolo, 2019).

Environmental and social connectivity in Cairo: the benefits of pocket parks

Their rapid urban growth and densification have led many cities to have a deficit of green areas. When the urban texture makes it impossible for the city to invest in the creation of large green spaces, the development of small green spaces (i.e. pocket parks) can be a valuable option: they provide citizens with quality public spaces for them to develop numerous activities. In fact, pocket parks have been shown to have a positive

effect on the urban microclimate, while also benefitting human health and incentivizing socialization and interaction within urban communities (El Aziz, 2017). In this sense, pocket parks can become small drops of nature in dense city areas.

The district of Rod El Farag in Cairo is one of the poorest and most densely populated areas in the city, with a density of more than 75,000 inhabitants per square kilometre. Rod El Farag used to be a residential area inhabited by the middle class of the city of Cairo. However, the migratory influx experienced by the city over the last decades has led to a replacement of the local community, with migrants settling in the area and the middle class moving (as a result) towards the periphery; the consequent abandonment of the area in terms of management resulted in a severe degradation of the district, evident by the significantly low surface of green spaces – just 0.74 m^2/ inhabitant (El Aziz, 2017). To address this issue and the increase in social problems in the district, studies have been conducted to explore the possibility of implementing pocket parks in neglected spaces and deserted streets which could provide the local community with quality spaces for recreation and socialization while at the same time increasing the green spaces in the congested neighbourhood (El Aziz, 2015). Citizen participation has been fundamental in assessing the current problems: citizens express their opinions and preferences and can take part in the maintenance of the space.

Silva Mediterranea Working Group on Urban and Peri-Urban Forestry: the shared vision on urban and peri-urban forests in the region

The urgent need for building a common awareness towards the sustainable development of Mediterranean cities has brought countries to call for developing a regional partnership aimed at addressing urban and peri-urban forestry and issues related to green infrastructures.

The Silva Mediterrenea Working Group on Urban and Peri-urban Forestry was created in 2012 with the mandate of acting as a neutral forum where nations could meet, develop agreements and debate policy aspects of urban and peri-urban forestry. The objective of the WG7 is to facilitate the building in the region of a shared vision of sustainable green infrastructures and particularly urban and peri-urban forest, and make this vision a priority on stakeholders' agenda through:

– the sharing between cities of up-to-date experiences, knowledge, information and key strategic actions towards the optimization of the benefits of UPF;

– the promotion of a cooperative approach between northern, western, southern and eastern Mediterranean countries, oriented to building robust policies and management tools that help urban and regional territorial planners manage urban forests in the region;

– the development of curricula, tools, training modules and technical guidelines for sound planning and sustainable management of forest and non-forest greenspaces in urban and peri-urban areas, aimed to support and guide long-term investments and decisions of local administrators and stakeholders.

The WG meets twice a year to present the outcomes of the ongoing activities, revise the work plan and explore opportunities for collaboration (Figure 6)[1].

Figure 6:
X Meeting of the SilvaMediterranea Working Group held at FAO Headquarters, Rome 2018.
Photo: Paloma Cariñanos.

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1 - See: http://www.fao.org/forestry/silva-mediterranea/88929/en/

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Summary

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In recent decades, situations involving risk to and vulnerability of cities have greatly increased due to unplanned urbanization processes. This situation has caused many sectors of the population to be continuosly exposed to environmental degradation which threatens their health and quality of life. In addition to inadequate living conditions, there is an increasing threat posed by natural events, exacerbated by climate change and human action. The Mediterranean region as a whole, and cities in particular, stand out for their vulnerability to environmental events, as their agedness, compactness and high population density make it difficult to implement measures to minimize impact. To address the upcoming challenges and increase their resilience to a changing environment, cities have to grow in a smart manner and include nature-based solutions in order to maximize the opportunities that the urban environment can offer to a growing population and mitigate the problems caused by urbanization. In this context, urban and peri-urban forests (UPFs) stand out as key elements to reduce these natural and anthropogenic hazards and to boost resilience through nature-based solutions (forest-based solutions) that will allow them to face the challenges of the coming decades. This paper reviews UPFs' mitigating role in some of the main climatic events that will worsen in Mediterranean cities in the coming years: heat waves, droughts and floods, fires, biodiversity loss, among others. At the same time, the important contribution of the UPF as an element of social cohesion and its high patrimonial value will be highlighted.