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Using Nature-Based Solutions to Create more Climate-Resilient, Green and Livable Mediterranean Cities: Experiences from Castellón and Cannes

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1 ABSTRACT

Cities around the world are undergoing significant transformations and are facing substantial challenges in the form of urban densification and extreme weather conditions due to climate change and ongoing urbanisation. Nature-based solutions (NBS) present an approach to address urban challenges through working with nature in order to achieve ecological and resilience objectives, whilstconcurrently creating opportunities for social and economic innovation. UNaLab is a project funded by the European Commission under the Horizon 2020 research and innovation programme, which aims to create a framework for implementation, demonstration and future upscaling of nature-based solutions in three demonstration cities (Tampere, Eindhoven and Genova), as well as for the replication of the solutions in seven replication cities: Basaksehir, Cannes, Castellón de la Plana, Prague, Stavanger, Buenos Aires, Hong Kong.

As part of this project, the cities of Cannes (France) and Castellón(Spain) have been working towards a NBS roadmap using different co-creation formats. In a weeklong on-site process, the current state of the urban systems regarding NBS in the city was examined and suitable intervention areas and project ideas were identified and co-developed together with various city stakeholders to enhance the cities' resilience and climate change adaptation potential. Amongst others, the interventions include the creation of green-themed corridors, the strengthening and revitalization of remaining urban agricultural land, the design and implementation of (circular) water retention systems or the renaturalization of existing rivercourses. Being Mediterranean cities, Cannes and Castellón face similar challenges and opportunities in terms of city greening and urban planning, which will be discussed in this paper. A presentation of the outcomes, impacts and experiences on how NBS are contributing to initiating a positive transformation process and the creation of livable, healthy and feel-good placeswill also be given.

Keywords: adaptation, resilience, mitigation, climate change, nature-based solutions

2 INTRODUCTION

2.1 Nature-based Solutions for increased climate resilience and livability in cities

According to the European Commission, NBS are "actions inspired by, supported by or copied from nature" which "aim to help societies address a variety of environmental, social and economic challenges in sustainable ways" (EC 2015). The concept has the potential to change conventional urban planning and more actively include climate resilience and sustainability topics in the socio-political debate on landscape planning and urban development by promoting a more ecological mindset.Resilience is thereby understood as "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" (Walker et al. 2004), which in the context of climate change adaptation in cities is understood as the ability of urban systems to limit and deal with climate-related risks and disasters. Given this background, NBS are seen as promising opportunity for cities to future-proofing and preparing for the challenges that come with climate change and ongoing urbanization whilst improving the environmental performance of the system. Relevant ecosystem services and functions of NBS thereby include cooling services to mitigate urban heat islands, surface water regulation to reduce flooding and erosion, water and air purification, biodiversity, provisioning services, as well as climate regulation. Reduced disaster risk, improved outdoor comfort and human wellbeing, as well as inclusive green growth and improved social cohesion are some of the often-named resulting benefits (UNaLab 2019; EC 2015). In addition to that, NBS are useful to ensure that urban ecosystems and their biodiversity are correctly managed and protected (Nagabhatla et al. 2018), e.g. through supporting maintenance, enhancement and restoration processes(Wendling et al. 2018). Figure 1summarizessome of the different ecosystem services NBS can provide in urban contexts.

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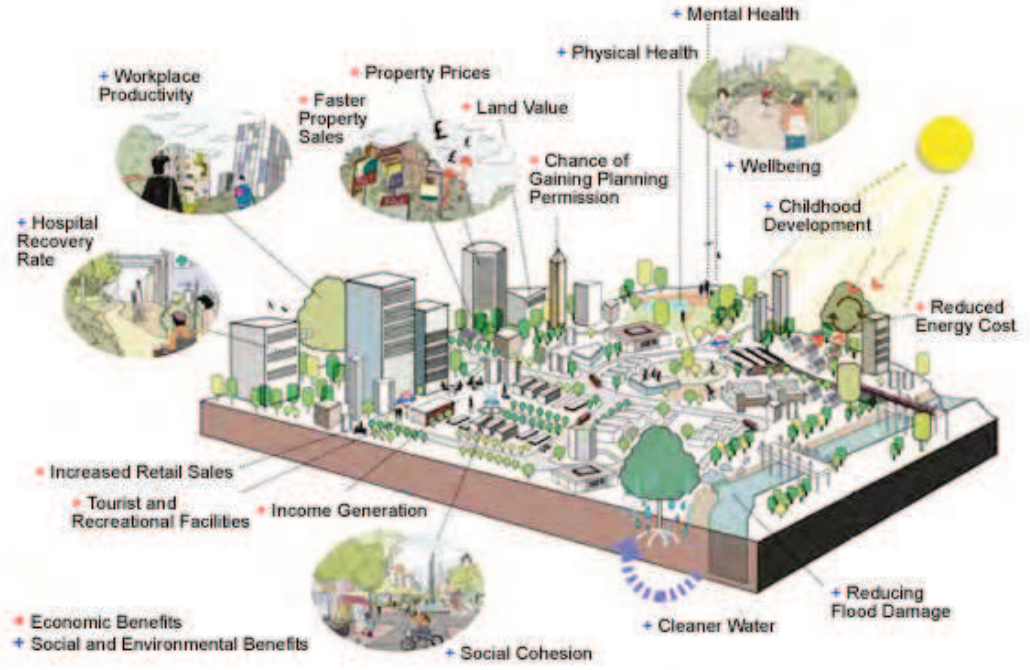

Fig. 1: Ecosystem services and benefits of NBS in cities (Arup 2014)

NBS and green and blue infrastructures are highly interdisciplinary and depend on many stakeholders in- and outside of the municipality due to their multiple benefits and cross-cuttingcharacter. As such, they demand good governance and cross-sectoral coordination for successful implementation(Hawxwell et al. 2019). Actions around environmental protection, greening of buildings, soilimpermeabilization and recovery, river renaturing and daylighting and the likealso depend on global policy support and political commitment. It is thus crucial to understand potential barriers and enablers to successful implementation and identify ways to overcome or fortify these. Within the UNaLab project, an urban systems assessment method was applied and further developed to identify important local impact factors to climate adaptation and green blue infrastructure and whilst involving relevant urban stakeholders in the development of future NBS projects.

2.2 The UNaLab Project

UNaLab is a project within the framework of the EU programme “Horizon 2020” with an international consortium of 28 partners and 10 cities in Europe and beyond.The project aims to demonstrate the effectiveness ofnature-based solutions (NBS), in tackling pressing urban challenges such as urbanisation, climate change and environmental protection in an innovative, efficient and sustainable way(UNaLab). Within the course of the 5 year project, the three frontrunner cities Eindhoven, Genova and Tampere areco-creating, implementing, and monitoring large-scale NBS interventions in an Urban Living Lab approach. The five European follower cities have actively learned from this process to develop their own roadmap towards water and climate resiliency in 2050. After the conclusion of this roadmapping process, the first results from the analysis have become evident, showing, for example, the similar and special characteristics and challenges with regards to NBS and climate change adaptation that arise in Mediterranean cities. In the case of UNaLab, Cannes and Castellón serve as model cities from this region.

Cannes is a Mediterranean city in southern France with about 75.000 inhabitants and a climate that is rather mild in the winter months and hot in the summer months. Due to its location, Cannes is exposed to natural forces such as floods, forest fires, landslides and others(Den Ouden et al. 2019).Castellón de la Plana is a likewise Mediterranean coastal city located in the Valencian Community in Spain. It has a population of 171.728 inhabitants who speak both Valencian and Spanish (Municipality of Castellón de la Plana 2019). With a characteristic soft and humid Mediterranean climate, lacking extreme temperatures but with marked seasonal rainfall and annual precipitations above 400 ml, it is this regards comparable to Cannes.

2.3 Characteristics and challenges of mediterranean cities

The Mediterranean region is located in a transitional area between the arid climate of North Africa and the temperate and rainy climate of Central Europe. This gives it particular characteristics as a result of the interactions between tropical and medium-latitude processes. The Mediterranean region is consequently vulnerable and sensitive to changes in climate, reflected in the non-linear (indeed, above-average) increase of temperature with respect to the world average. Climate models project droughts and a rise in temperatures, with a likely increase in heat waves and dry periods, which will stress the current water scarcity (Zachariadis 2016).AccordingtotheEuropean Environmental Agency(2018), the Mediterranean region is furthermore projected to experience:

- Larger air temperature raise than the world average;
- Decreasing precipitation, river flows, and water availability
- Increment in sea surface temperature and sea water acidification;
- Rise of sea level
- More heat waves intense and for larger periods of time
- Droughts more frequent and intense
- Increased risks of biodiversity loss;
- Adverse effects on forest fires, summer tourism, agricultural production and public health.(European Environmental Agency 2018)

It is projected by the IPCC that this region will suffer one of "the strongest warming of hot extremes" in a scenario of 1,5 °C temperature increment(Hoegh-Guldberg et al. 2018). Finally, reductions in food security are projected in a 2 °C increment scenario due to lower yields in crops (such as maize, rice and wheat), and to a negative impact on livestock(Hoegh-Guldberg et al. 2018). Coastal cities are likely the most affected, since the mean sea level rose 2,6 cm in the period 1992-2008 (Zachariadis 2016).

3 ONSITE ASSESSMENTS AND ROADMAPPING - METHODOLOGICALBACKGROUND AND PROCESS

As part of the UNaLab project, a comprehensive roadmapping process was conducted in all of the five European follower cities to design a development strategy to be followed until 2050 that integrates NBS in their urban planning. The methodology applied for this was co-developed and guided by the Technical University of Eindhoven, the University of Stuttgart and the Fraunhofer IAO and entailed different co-creation methods within the first two years of the project. It consisted of four distinctive steps which followed a general backcasting logic (Holmberg and Robert 2000). In the first two steps, the cities defined their general ambitions and visions with regards to climate resilience in the year 2050. After that, a comprehensive urban systems assessment was conducted in each citiesto define their status quo in climate adaptation and NBS. Finally, the results from these three steps were used as a basis to develop astrtaegic roadmap with specific solutions, projects, and milestones to move from the current state towards the desired future scenario(Den Ouden et al. 2019).

In this paper, specific attention is paid to the urban systems assessment process and its application in the two Mediterranean cities. It is an analitical tool based on the Morgenstadt City Lab methodologydesigned to understand cities in a systemic and holistic way and identify their current state in a particular field (Radecki 2019). Within the UNaLab context, it can be divided into two distinct phases: a) a remote data collection and literature review phase in which current strategies and strategic documents are evaluated and quantitative data collected in forms of indicators (where is the city today with regards to climate resilience?) and actionfields (how is the city already addressing resilience issues?); and b) a one week on-site assessment with expert interviews, site visits and workshops together with various local stakeholders. Seven main themes were chosen to structure and focus the work, all of these related to NBS and climate change adaptation: green and blue infrastructure, municipal strategy and planning, organization and structure, finance and procurement, regulations and incentives, ICT and data governance, and participation and citizen engagement. Furthermore, links to other sectors, such as energy, mobility or waste, were also evaluated (Den Ouden et al. 2019).

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In Castellón and Cannes, the on-site assessments took place between the 15.10. – 18.10.2018 and 05.11. – 09.11.2018 respectively. A team of three researchers visited each city and worked with a local mirror team from the city administration. In total, about 20 semi-structured interviews were conducted in each city with relevant stakeholders from the public, private and civil society sectors to identify local preconditions, barriers and opportunities, as well as to brainstorm current and future project ideas and intervention areas with regards to the aforementioned themes. The results were captured in standarized templates and on maps. At the end of the week, the results were presented, voted on and further elaborated in a larger co-creation workshops, which involved external actors as well. In total, 26 (Castellón) and 40 (Cannes) local stakeholders from diverse backgrounds participatedin theon-site assessment.

4 CASTELLÓN – A BLEND OF LANDSCAPES ON THE PATH TOWARDS SUSTAINABILITY

The local climate of Castellónis largely influenced by the geological interaction between the sea and "Els Ports" (Cordillera CosteroCatalana), which surrounds the Province of Castellón from the Northwest to the East. Its proximity to the shore minimizes the marine influx, making the climate variation mostly determined by North-South masses.Temperatures do not vary significantly throughout the year; the oscillations are mostly influenced by the distance from the shore (further inland, the temperatures are more variable) and altitude (areas close to the coast are warmer than inland, more elevated areas). Precipitation, on the other hand, varies significantly throughout the year.There is also a significant difference in precipitation between mountain and coastal areas, with more rain in the former and less in the latter, apart from large, end-of-summer storms (Municipality of Castellón 2017).

The economy of Castellón de la Plana is focused in services and traditional sectors, such as ceramics, agriculture (especially citrics) and building. However, the great maturity of these activities has generated some economic stagnation. This brings new opportunities to alternative emergent sectors, such as ecotourism, renewable energies, recycling, biotechnology, and more(Municipality of Castellón de la Plana).According to the Strategy for Urban, Sustainable and Integrated development of the urban Area of Castellón de la Plana (EDUSI), the sector <of services comprises most of the contracts with the 80,5% of the total 53.521 (Municipality of Castellón de la Plana).

Agriculture is a traditional sector whichcomprises 9.500 hectares where 86% of total production is of citrus fruits, especially oranges(Municipality of Castellón de la Plana). This sector is also important because it consumes 80 % of the total water uptake in the city(Municipality of Castellón de la Plana). The recent upgrade of the hydric infrastructure has reduced water consumption by 40%.(Municipality of Castellón de la Plana).8.500 ha are under irrigation and 1.000 ha are under rainfed technique. (Municipality of Castellón de la Plana).In addition, agricultural land surrounds the city, forming a "green urban belt", which has two main environmental functions: 1) to mitigate the emissions and pollution from the industry (e.g. ceramics production) and 2) to serve as a landscape, increasing citizens' quality of life(Municipality of Castellón de la Plana).Castellón is part of the Convenant of Mayors, an initiative of the European Commission (Headquarter of Energy) that indicates a commitment of the mayors of European cities to improve the energy efficiency in the urban environment. The Agreement of the Mayors aims to reduce cities' CO2 emissions by 20%.

The geographical location and the particularities of this Municipality described above make it especially vulnerable to the consequences of climate change. Wetlands,for instance, areat a very high risk not only due to their proximity to the coast but also due to the amount of concrete and impermeable surfaces in the urban center. Furthermore, large portions of agricultural land have been abandoned and are not productively used since the soil has been degraded due to the frequent and prolonged use of pesticides (Municipality of Castellón 2017). However, this situation has lead to a natural revegetation by various forest and herbs species (Municipality of Castellón 2017). Additionally, multiple irrigation canals have been closed or sealed and the water resources in general are not being managed in a sustainable way. For instance, less than 10% of the regenerated wastewater is currently being reused, although the existing treatment plant has the capacity to treat all the water collected there(Padilla 2018). Owing to these challenges, strategies are being developed for protecting the environment, increase the city greenery and improve the local ecosystem function such as the development of a green grid with protected zones around the urbanized areas, including wetlands and the coastal zone. However, even if there are multiple plans and documents addressing diverse subjects related to preserving the environment, the concept of nature-based solutions has still been historically absent (Marielisa Padilla 2018).

5 IDENTIFYING AND DESIGNING NBS INTERVENTIONS IN CASTELLÓN

Over the course of the week, 15 intervention zones in Castellón were identified as potential areas for the implementation of NBS. Some of the more relevant ones, including those which have started its successful implementation by January 2020, are presented below:

Creation of a green themed NBS corridor in Castellón:The main idea is to "extend" and re-design the planned implementation of bycicle lanes by using materials such as permable pavements and adding NBS elements such as shading trees and green walls. Further the lanesshould follow a specific 'theme' by connecting specific infrastructures such as sports facilities and museums. It was discussed that the intervention could be partly financed by the budget foreseen for the General Plan, although additional funding would need to be secured. Seven possible thematic corridors were identified: 1) Sports Corridor 2) Agricultural Park Corridor (ermitas) 3) Water Corridor 4) Maritime Corridor 5) Grau´s Civic Corridor 6) Cultural Corridor 6) Ceramic Corridor 7) The Chapel Corridor (ermitas).

Retention and management of rainwater: Building more natural water channels and floating gardens to store rainwater was identified as a key priority due to recurring flood risk. Since the city suffers from the phenomenon "the cold drop" or "la gotafria" in Spanish and also many houses and buildings around the wetlands were built below water level, representing a major risk of flooding for the inhabitants, better management of rainwater is a must when trying to increase the city's adaptability to climate change effects.

Promotion of the use of public and non-motorized transport while using NBS: Although the technologies related to this project are not NBS-specific, the overall concept of improving connectivity, increasing the green areas along roads and introducing non-polluting shared technologies and practices is coherent with NBS approaches in cities. Tree planting for creating shade and cooling the air but also transforming areas into more attractive and green ones was identified as a good way to promote non-motorized transport in Castellón. These initiatives can be also piloted in blocks designated as green islands in the city with pedestrian streets and good cycling infrastructure.

Apart from the above intervention areas, the following were co-created and identified for preparing the city to better face the challenges that come with a change of the climate:

- Reactivation, expansion and strengthening of the system of urban gardens
- Increased reuse of treated waste water for agricultural irrigation, irrigation of parks and street cleaning
- Creation of low emission zones in the urban area of Castellón

6 CANNES, THE INTERSECTION OF TECHNOLOGY, CULTURE AND CREATIVITY

Cannes is located at the Côte d'Azure in the Provence region. With about 75,000 inhabitants, it is a rather small city although the population more than triples during major summer events. Mostly known for the international film festival, the city has become an international hotspot for events, tourism and congresses, some of the largest economic drivers in the region. Further branches include the services, trade and aviation industry. Due to its high popularity and local vulnerability to natural hazards, the city has put huge efforts in risk prevention and management measures. Main risks include flooding caused by excessive rainfall, coastal submersion and flood wave andforest fires, as well as erosion and landslides. Especially, the severe flood event in October 2015 which caused several deaths and huge economic losses, lead to an increased awareness and interest in climate resilience and disaster management (Mairie de Cannes 2018).Cannes has also been very active in the fields of sustainable development and environment, introducing an Agenda 21 in 2008 with a concrete vision and action plan for becoming more sustainable and resilient. It thus uses the opportunity of the UNaLab project to harness the potential of NBS and further complement both, existing risk mitigation and sustainability schemes(Den Ouden et al. 2019; UNaLab).

7 IDENTIFYING AND DESIGNING NBS INTERVENTIONS IN CANNES

In the course of the on-site assessment in Cannes, 22 intervention areas and project ideas were developed, of which six were further elaborated and discussed in the final workshop. A selection of these is presented below:

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Development of a showcase district for NBS and green infrastructure:Currently, there is the plan of rehabilitating a former industrial area to become a mixed use urban district in which a new creative industry could settle and the first high-rise buildings of the city could be located. This was identified as a unique opportunity to pilot new ways of integrating more NBS in the planning process, making it a demonstration site for green infrastructure solutions. This could show the potential of directly incorporating NBS in urban planning and increase the attractiveness and diversity in Cannes by creating a blue-green park that runs through the district. It is hoped that the planned NBS interventionswill improve the local microclimate and contribute to the overall climate and water resilience of the city. Additional funding and political support were identified as the most important enablers for such an undertaking.

Protecting and enhancing closeby agricultural areas: La BasseVallée de la Siagne is the last remaining agricultural area close to the city. Located on a hill, it could serve as a retention area that protects the center from flooding during heavy rainfall events by capturing and absorbing rainwater runoff before it reaches the urbanized areas below. For this to function, adequate irrigation of crops and vegetation has to be ensured during the dry periods, which could be realized through the redirection and use of treated wastewater. Social cohesion, biodiversity, as well as preserving cultural identity and traditional agricultural practices were identified as possible co-benefits.

Redesigning public facilities to become green: Public facilities such as schoolyards, sporting fields, playgrounds, hospitals or parking areas could be redesigned to become small water retention areas in times of heavy rainfall. Greening and depaving these facilities could also result in a higher degree of outdoor comfort and create cooling spots during hot summer days, improving health and environmental awareness of the citizens. New design principles and criteria could enable the uptake of these ideas in upcoming renovations or new building projects.

Further ideas included:

- The piloting of new green roof concepts installed on industrial rooftops that are not traditionally tiled, which could survive the hot and dry summers and help to ensure a more widespread uptake in the future,
- Systematically introducing adapted and attractive green and blue components in renovation and rehabilitation projects in the city center and densely urbanized areas
- Or developing a pedagogical and user-friendly risk management software that could inform about NBS benefits and installations (Den Ouden et al. 2019).

8 RESULTS – NBS FOR INCREASING LIVABILITY AND RESULIENCE IN MEDITERRANEAN CITIES

The co-creative nature and method of the on-site assessments allowed for close stakeholder interactions on the topic of climate change adaptation and NBS in forms that had not being taken place in the two cities until then. As introduced above, the topic itself demanded the participation of representatives of the urban greening, water, energy, mobility, waste, building and many more departments with the local administrations, as well as the inclusion of private and civil society actors. This enabled the identification of synergies and the initiation of unprecedented collaborations and linkages, which enabled new projects and ideas.

Equally important was discoveringthe lack of this intersectoral cooperation (refer to table 1). This was exemplified during interviews when workers of the building department realized that elements such as green roofs, rainwater collection systems or the installation of solar panels were simply not considered in new construction or rehabilitation projects. This is regarded as a topic incumbent rather to the energy or water department. Therefore being able to connect all the different perspectives and having brainstorming sessions for the co-creation of multifaceted projects brought a whole new perspective in the way urban planning could be approached.

Given the climatic characteristics in both cities, a main focus in the on-site discussions was the efficient management and reuse of water. Whereas both cities usually experience a rather dry and hot weather which complicates urban greening (e.g. on rooftops and facades) and requires additional irrigation or the use of drought tolerant plants, large retention capacity is needed during the few days of the year where heavy

rainfalls occur. Locally adapted vegetation patterns, larger retention basins, as well as underground water storages and irrigation systems as supporting measures were thus issues of big interest. It was also stated that more technical know-how and training of technical and administrative staff could help improving successful project planning as well as implementation.

Both of thecity centers are perceived today as rather grey in the sense that most of the streets and public spaces have been paved using concrete; central squares and other important meeting points have been covered by artificial surfaces. This has been done in both cities, ignoring the effects on the water retention capacities of the soil, its permeability, temperature, biodiversity and the losses represented in terms of ecosystem services. This was not foreseen when these infrastructure projects were designed. Today, these Mediterranean cities are facing the consequences of the lack of green spaces, trees and permeable soils, among others. Thus it is seen as important that future refurbishments and building projects require the introduction of more green elements. In this sense it was discussed that the introduction of a locally adapted Technical Handbook on NBS could help build more knowledge around greening Mediterranean cities and reduce the threat of project failures.

	Cannes	**Castellón**
Green & Blue Infrastructure	-Dry valleys as special geological feature lead to high flood risk areas during heavy rainfalls -Focus and knowledge on native, pollinator-friendly and drought resistant species has to be strengthened -Protecting local habitats, especially the marine ecosystems, is very important	- Efforts to recover wetland areas -Low ecological connectivity between green areas -High availability of agricultural land to be restored -Closed irrigation ditches and canals Potential for better water management
Organisation & Structure	-Decision making power is rather centralized -Cross-departmental cooperation works well in existing sustainability or smart city related projects even if not formally institutionalized	-Openness to NBS in planned projects -Insufficient local administrative internal as well as external communication and exchange (with local utilities and service providers) -Limits of local government power
Municipal Strategy & Planning	-Long term vision and related action plan for a sustainable and resilient city and strategy on local flood risk management exist -Tools and criteria are missing to assess and influence building and construction projects	-Sustainability-oriented smart city strategy and priority projects -General structural plan with a strong sustainability perspective exists
Regulations & Incentives	-Building and zoning regulations pay special attention to flood risk and water retention capacity -Better regulation of public water use, soil quality and pollution could support NBS implementation and circular water structures -Centralised policy system makes it difficult for cities to issue incentives	-Lacking norms for NBS in the implementation of infrastructure projects -No incentives such as tax relief for green measures (e.g. roof greening and rainwater storage)
Finance & Procurement	-Additional funding for large scale projects and acquisition of strategically important land needed -National fund for risk mitigation activities exists which is sustained by insurance fees -Holistic cost-benefit analysis and new stakeholder engagement forms should be developed	-NBS projects and concepts can be included in infrastructure projects from the General Plan and EDUSI with allocated budget -The procurement processes allow the inclusion of "green" requirements and take sustainability criteria into account
Participation & Stakeholder Engagement	-Many sustainability and NBS related events exist -Active use of social media and other means of communication that could feature NBS and raise awareness on ecosystem services -Citizen involvement is seen as crucial means to gain political support	-Urban planning supported by a local group from the social and economic sectors. -Cooperation between the municipality and the private sector can be improved
ICT & Data Governance	-Open data strategy in place private companies are often hesitant to share relevant data due to privacy issues -Mapping of flooding zones and priority areas, as well as TIGRE risk management platform could be used to better plan NBS	-Developments with a focus on environmental quality, energy efficiency and waste management -A governance system is to be set up to monitor sustainability strategies
Inclusive Urban regeneration	-Redevelopment projects and provision of family gardens help to even out social disparity -Successful NBS implementation has led to rise in property prices	-Strategic objective of "social integration and poverty reduction" with a line of action to rehabilitate degraded urban areas. -Identification in EDUSI of 11 degraded areas suitable for strategic, green projects
Links to other sectors	-Biowaste composting is being enhanced and systematised in the coming years -Green cycling and walking infrastructure is being enhanced -Solar panels seen as opportunity to protect green roofs from intensive sunshine	-Potential conversion of the traditional transport infrastructure in the city center to green areas -Aim of improving public transport infrastructure and non-motorised mobility, e.g. via green spaces

Table 1: Local impact factors for Nature-based Solutions in the cities of Cannes and Castellón.

Due to their climate characteristics and geographical locations, both cities present ideal conditions for agriculture. However the growth of real estate, harmful agricultural practices, lack of appropriate policies,

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lack of enforcement, lack of financial incentives and challenges related to soil degradation and water shortageshave put some of these agricultural areas under threat or lead to their loss or abandonment. The result is a continuous decrease in green cover.Therefore efforts and thoughts have been put into revitalization and promotion of local agriculture, so that it can continue providing essential cultural, provisioning and regulating services in these cities, including soil recovery, economic competitiveness restoration, local food supply enhancement and water retention capacity (see table 1). In Castellón ideas were formed around reactivating the abandoned urban and peri urban agricultural areas “el Mestrets” whereas in Cannes supporting measures were discussed to protect and further develop the “BasseVallée de la Siagne.”

Viewed from the perspective of NBS and their intrinsic crosscutting character, the co-creation sessions focused in making clear the existing connections between the sectors and more importantly identifying the synergies that could be created. Since its beginning, the UNaLab project has been creating awareness around this topic; the onsite assessments in each of the cities were the optimal platform for the design of projects that help to fight climate change, revert some of the negative effects of urbanization and most importantly apply collaborative approaches.

The table presents further outcomes of the research work carried out regarding local key impact factors for the implementation of NBS in these two cities.

9 CONCLUSIONS AND OUTLOOK

The contrast between a usually hot and dry climate, and very concentrated, intense rainfall during a few days each year is a typical characteristic of and challenge to cities in the Mediterranean region. Forecasts predict these extremes to become even more distinct and cities to become even more vulnerable with ongoing climate change. This highlights the need for better adaptation strategies, especially in the areas of combating urban heat islands, water shortage and flood risks. Recently on the research and demonstration agenda, the concept of NBS presents a promising opportunity to use natural elements and processes to improve water and climate-related resilience, as well as to improve livability and socio-economic development in cities. Under the described climate conditions, similar technical challenges arise. A good management of local water resources, as well as the use of locally adapted plants, is key for successful implementation and final impact of such solutions.

Doubtlessly, NBS can be valuable tools in tackling climate change as they translate into a wide spectrum of interventions for renaturating and protecting ecosystems as well as generally increasing blue and green infrastructure in cities. However, for the standardization of NBS implemention, processes must be institutionalized, for example in requiring an NBS element in every refurbishment or new development project. Changes at the governance level are crucial, and modification of the right policies at different levels can help to guarantee the long term impact of the process that these administrations are enthusiastically participating in within Unalab.

Likewise, efforts around awareness-raising are key to spread the use of NBS. The more people understand the ecosystem services provided by these interventions, the more acceptance and initiatives can be born around this topic. Here, the need for marrying ecology and economy needs to be highlighted. For example, a project for planting trees or increasing green areas can have greater impact when combined with an economic benefit. For instance in the agricultural areas to be restored, increasing shade brings economic benefits in the form of increasing soil fertility, soil water retention ability, plant growth and erosion prevention, among others.

Furthermore, NBS are largely cross-cutting and interdisciplinary concepts which require good coordination and close collaboration between different municipal departments as well as external stakeholders. The on-site assessments in Cannes and Castellón have shown that by directly involving and bringing together relevant actors, local impact factors can be more easily identified, project synergies be discovered and resource efficiency increased. As a result, a colourful variety of projects were co-created, from the renaturation of abandoned agricultural areas to green roofs and urban gardens, thematic green corridors and water retention ponds which will transform the cities into more resilient and livable places for their citizens.

More research and the collection and exchange of different best-practice examples from this region will help to spread knowledge and accelerate the uptake and use of NBS as means to make future cities more resilient and livable. The UNaLab project aims to contribute to these developments by further conducting NBS

impact monitoring and assessing important preconditions and implementation principles. In addition, the project has the goal of developing and testing viable business models, supportive governance actions and co-creation tools, and feeding these into a joint replication framework that can be used by cities and practitioners alike.

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