Seven lessons for planning nature-based solutions in cities

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ABSTRACT

Nature-based solutions are proliferating in European cities over the past years as viable solutions to urban challenges such as climate change, urban degeneration and aging infrastructures. With evidence amounting about nature-based solutions, there is a need to translate knowledge about nature-based solutions to future policy and planning. In this paper, we analysed fifteen cases of nature-based solutions’ experiments across 11 European cities. What makes our case studies stand out is the balanced focus between ecosystem and social benefits in contrast to many published cases on nature-based solutions that have a weighted focus on the climate benefits. From a cross-case comparative analysis we draw seven overarching lessons related to all stages of proof-of-concept and implementation of nature-based solutions in cities: (a) nature-based solutions need to be aesthetically appealing to citizens, (b) nature-based solutions create new green urban commons, (c) experimenting with nature-based solutions requires trust in the local government and in experimentation process itself, (d) co-creation of nature-based solutions requires diversity and learning from social innovation, (e) nature-based solutions require collaborative governance, (f) an inclusive narrative of mission for nature-based solutions can enable integration to many urban agendas and (g) design nature-based solutions so as to learn and replicate them on the long-term. The lessons we draw show that nature-based solutions require multiple disciplines for their design, diversity (of settings) for co-creation and recognition of the place-based transformative potential of nature-based solutions as ‘superior’ to grey infrastructure. We further discern that urban planners need to have an open approach to collaborative governance of nature-based solutions that allows learning with and about new appealing designs, perceptions and images of nature from different urban actors, allows forming of new institutions for operating and maintaining nature-based solutions to ensure inclusivity, livability and resilience.

1. Introduction

Nature-based solutions have become a valid alternative for infrastructure development and infrastructure update in cities that are considering (new) approaches and rethink their time horizon and costs in maintaining them (Fink, 2016). Nature-based solutions are inspired by nature, use nature and/or are supported by nature. Specifically, nature-based solutions have been defined as living solutions underpinned by natural processes and structures that are designed to address various environmental challenges while simultaneously providing multiple benefits to economy, society and ecological systems (European Commission, 2016).

Nature-based solutions are being taken up as solutions to restore ecological flows in cities and as new infrastructure solutions that increase resilience of a city. The recent years, the interest in nature-based solutions by urban planners and policy makers triggered an increasing interest in research of mapping and collecting evidence of their multiple benefits (Brink et al., 2016). The amounting knowledge on nature-based solutions shows that they are locally attuned solutions to societal contexts, and generate multiple benefits (Nesshöver et al., 2017; Raymond et al., 2017). However, there is yet limited research on the ways the knowledge on nature-based solutions can advance urban policy and planning to enable their mainstreaming. This is due to the fact that the majority of the research focuses on single case studies (Kabisch et al., 2015, 2016, 2017), and that case studies focus on providing evidence on the multiple benefits of nature-based solutions rather than their implications for policy, planning and governance (Frantzeskaki et al., 2017; Nesshöver et al., 2017).

Amongst the suggestions for future research, Kabisch et al., 2016 point to the need of multiple case study research as important to draw lessons for urban policy and urban environmental research both in developed and developing countries. In our view, this is not due to the research design of the evidenced cases on nature-based solutions but rather it is a time-scale issue: the majority of the cases are analysed and documented in time-distance to contemporary urban agendas and policy issues and implications for their impact or relevance to them is difficult to conceptualise or even impossible to draw.

To respond to this gap, we conducted a multi-case study

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transdisciplinary research in eleven cities in Europe that set up nature-based solutions experiments with the aim to provide integrated knowledge on lessons learnt from experimenting with nature-based solutions for urban policy, planning and governance. Specifically, we researched and analysed a set of 15 contemporary experiments of nature-based solutions that directly contribute to urban resilience in deprived neighborhoods of the eleven cities. In this way, real-life experimentation with nature-based solutions created a knowledge co-production space for urban planners to learn how to co-create these solutions, which planning tools and programs are relevant to urban communities and a knowledge co-production platform for researchers to on-time translate knowledge about nature-based solutions for urban policy and planning.

2. Materials and methods

The Resilient Europe project was funded by URBACT secretariat of European Union from 2015 to 2018 and included eleven European cities with the common aim to advance their urban planning and governance for fostering urban resilience. In order to do so, the partnership of cities in co-production with experts in the project focused on deprived neighborhoods as areas of eroding resilience to experiment and as challenging places in need of local action plans. Deprived neighborhoods are neighborhoods with derelict infrastructure, facing environmental pollution and a socio-demographic profile of low employment rates and higher urban poverty than the average of the city located in (agreeing with the definition of Vaz et al., 2017).

The cities and their focus neighborhoods are: Sint Antries in Antwerp, Belgium, Lawrence Hill and Easton in Bristol, United Kingdom, Zaleze in Katowice, Poland, Senge Park in Malmo, Sweden, West End in Vejle, Denmark, Pamvotis waterfront district in Ioannina, Greece, City center district in Potenza, Italy, Dolno Ezerovo in Burgas, Bulgaria, Toumba in Thessaloniki, Greece, Ruchill and Possil Park in Glasgow, United Kingdom and Afrikaanderwijk in Rotterdam, The Netherlands. Four cities identified as a priority to explore how nature-based solutions can be valid alternatives for infrastructure re-development as a starting point to foster urban resilience including: Antwerp, Burgas, Potenza and Vejle. All eleven cities considered nature-based solutions as potential alternatives to grey infrastructure for improving the robustness of urban infrastructures.

Over the course of the project, the cities worked in urban living labs in the selected neighborhoods with the aim to formulate local agendas and action plans including experiments to test ideas how to foster urban resilience. An experiment is a daring but specific local action that targets to test an idea/technology and learn from the process and results in response to a greater urban challenge. Experiments show a visible and tangible action that is accessible, invites discussions and can alter thinking and perceptions. For designing and adapting the initial ideas of the experiments they have formulated, the cities selected impactful for their planning practice experiments from past projects and shared them with other cities in March 2017. In total 11 past experiments were elaborated and invigorated. The 4 contemporary nature-based solution experiments were set up between 2016 and 2018 and were also shared and invigorated during the project’s partner meeting in October 2017 in Antwerp and in February 2018 in Rotterdam. The case studies are presented in Table 1. The findings are based on data from multiple sources: (1) documentary information about the urban plans and policies of all cities, also including 11 integrated action plans finalized in 2017; (2) in-person interviews with urban planners and social entrepreneurs (3) participant observations in the experiments (4) focus groups and workshops to discuss lessons learnt from the experimentation process. The data collection and analysis for those experiments is presented in detail in the Supplementary Material.

In this paper, we performed a cross-case comparative analysis of the case studies presented in Table 1 to draw lessons learnt from real-life experimentation with NBS in cities. We use the Raymond et al., 2017 framework for expanded proof-of-concept and demonstration stages of NBS to organize the lessons learnt. The proof-of-concept evaluation framework includes the following seven planning stages: 1) identify problem or opportunity; 2) assess and choose option; 3) design NBS implementation; 4) implement NBS; 5) inform policy makers about results; 6) revise project plans for implementation and upscaling and the transversal stage of 7) monitor and evaluate co-benefits. The lessons learnt from experimenting with and for NBS have been organized and presented across these stages and presented in Section 3. We make these lessons further relevant to urban governance by drawing implications for urban environmental policy and planning in Section 4.

3. Results: Lessons learnt from experimenting with nature-based solutions in cities

The lessons we draw show that nature-based solutions require multiple disciplines for their design, diversity (of settings) for co-creation and recognition of the place-based transformative potential of nature-based solutions as ‘superior’ to grey infrastructure (Keesstra et al., 2018). What makes our case studies stand out is the balanced focus between the ecosystem and the social benefits of these NBS experiments in contrast to many published cases on nature-based solutions that have a weighted focus on the environmental benefits (Brink et al., 2016, p.117; Xiang et al., 2017, p.2). The lessons are summarized in Table 2 and further backed with recent literature on NBS and are elaborated below.

Lesson #1: Nature-based solutions need to be aesthetically appealing for citizens to appreciate and protect them.

For nature-based solutions to be fitting into the urban mosaic, they need to be appealing to citizens, as well as multi-functional. Co-creation and co-design with different actors and especially designers, artists and architects becomes a strategy to generate appealing and socially acceptable nature-based solutions’ designs.

From recent research, we also discern that design characteristics of nature-based solutions play an important role for their acceptance. Specifically, Vanstockem et al., 2018 found how the aesthetics of green roofs (determined by vegetation gaps, weedy species and type of vegetation) play an important role on how they are perceived and thus accepted by citizens. Prestambugo et al., 2016 studied how aesthetics and functional design can work in establishing connections between nature and urban uses in ecoducts further showing the importance of aesthetics in nature-based solutions. Hofmann et al., 2012 found that the naturalness – how natural it looks – is an important variable for accepting and liking urban green areas.

Noticeable is the experiment of the raingardens in Rotterdam, the Netherlands that were designed to look like meanders and were well integrated visually to side walk greenery. This was achieved by engaging citizens, artists and architects in a common process. The courtyard renovation, “Plac na glanc” in Katowice, Poland considered the aesthetics of the pocket parks in the courtyards as part of the architectural design that was co-created with citizens. The aesthetic value of the courtyard was brought to the attention of the architects by the citizens as an important dimension for the recreational use of the place in the future.

Lesson #2: Nature-based solutions create new green urban commons.

Nature-based solutions as being powered by nature and restoring natural flows in cities, create novel ecosystems that require multi-actor collaborations for their design and sustainability. As such, nature-based solutions create new green urban commons. This in turn creates space for new relations between people and nature as well as between people in their communities. Especially in the deprived neighborhoods, the small-scale experiments with nature-based solutions showed that transforming the physical characteristics and appearance of public space is coupled with the perceived benefits people assign to it in the form of sense of place. The narratives in describing the perceived
### Table 1
Nature-based solution experiments contributing to urban resilience by Resilient Europe project cities.

<table>
<thead>
<tr>
<th>Nature-based solution experiment</th>
<th>Characteristics</th>
<th>Recognized co-benefits of the nature-based solution that contribute to urban resilience</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Past experiments</strong></td>
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<tr>
<td>Lambhill Stables, Glasgow, United Kingdom</td>
<td>Initiated in 2007, as a nature-based intervention to restore old minefield next to utilizing the space for environmental education of the community. Currently is run by a social enterprise that maintains the bioremediation part of the location, the constructed wetland is maintained in cooperation with the city and the social enterprise. The park and the community garden supports a social function on training and education. Types of NBS: constructed wetland, urban agriculture, bioremediation ponds.</td>
<td>restoration of ecosystems, social capital through community supporting, environmental education, green jobs.</td>
</tr>
<tr>
<td>Dakakkers Roofgarden, Rotterdam, The Netherlands</td>
<td>Courtyard regeneration and rearrangement has been an initiative to restore sense of place by greening courtyards in Katowice historical buildings by young architects that started in 2013. Architects initiated the greening of these courtyards and residents participated in the planning and realization phase of the project in a series of workshops in which residents openly discussed and communicated their needs and actions in contributing to the regeneration. It is important to note that recycled material were used for the renovation and later in the project, private investors were also involved.</td>
<td>soil restoration, social capital through stewardship of places.</td>
</tr>
<tr>
<td><strong>Revitalization of the River Valley Ślepiotka, Katowice, Poland</strong></td>
<td>The maintenance of the Montreale park in Potenza city was taken up by a self-organized citizen group called 'Hoes armed citizens' who considered the park an important urban space for their recreation and urban life. The replanting of wedges in this park was realized by the citizen group who used plants brought by shop owners. The citizen group stepped in for the maintenance and improvement of the quality of this urban green space when in the aftermath of the austerity crisis the city was unable to maintain this park. Type of NBS: linear park, green waterfront.</td>
<td>recreation, habitat.</td>
</tr>
<tr>
<td>Citizens stewarding the maintenance and restoration of Montreale park, Potenza, Italy</td>
<td>The regeneration of the river banks and river valley Ślepiotka in Katowice city brought together multiple actors from the city including citizens, engineers, planners and consultants to deal with the reestablishment of natural habitats in the river banks and the riverbasin overall, with the aim also to function as a water retention area to mitigate flood risks and the consideration of future users from citizens. The previously abandoned and degraded spaces alongside the river banks were re-imagined with the consultation of citizens. The regeneration effort from the city was a pilot project in the EU project REURIS. Type of NBS: linear park, green waterfront.</td>
<td>recreation, social capital through stewardship of places.</td>
</tr>
<tr>
<td>Regeneration of urban space into green space, Serpentine neighborhood, Potenza, Italy</td>
<td>The regeneration of the urban space in the Serpentone neighbourhood in Potenza, Italy from a ‘cemented’ place to a green urban place started in 2010 after an architectural intervention was completed. The ‘Ship’ that is an underground building, was never used since it was perceived by the local community as an imposed structure to their area. With a series of self-organised workshops of citizens that later also invited urban planners resulted in a common project of a green space on top of the underground ‘Ship’ building so as to create a community recreation and connection place. During the visit of the author in 2016 to the area, the urban green space was used by youth and elderly. Type of NBS: urban park.</td>
<td>recreation, habitat, recreation, heat regulation.</td>
</tr>
<tr>
<td>Delfshaven Cooperative, Rotterdam, The Netherlands</td>
<td>A social enterprise with a place-focus of the Delfhave area in Rotterdam that by collaborating citizen initiatives, entrepreneurs, institutions and municipality works in creating social capital, supported residents in renovation of buildings owned by the housing corporation and establishing a ‘park council’ focusing on the restoration of a local park. Type of NBS: urban park.</td>
<td>restoration of ecosystems, social capital through civic empowerment and actions, social cohesion.</td>
</tr>
<tr>
<td>Dakakkers Roofgarden, Rotterdam, The Netherlands</td>
<td>In a previously vacant building, a citizen initiative advocated to the city of Rotterdam that it will regenerate the building and create new links to sustainable businesses and start-ups by making the first green rooftop garden in the city. The Dakakkers roof garden is a successful nature-based solution created by citizens showing how urban farming in rooftops can provide not only new meanings to places, use urban farming for improving energy efficiency of the building, educate citizens about sustainability and healthy food. Type of NBS: urban agriculture, green roofs.</td>
<td>water retention, food production.</td>
</tr>
<tr>
<td>Boomjes promenade, Rotterdam, The Netherlands</td>
<td>The Boomjes promenade is a successful nature-based solution that concerns the restoration of urban river banks from sealed soil surfaces to green riverfront area. The promenade was realized as part of ‘Give space back to the river’ program of the Netherlands and its urban implementation in Rotterdam city. Type of NBS: linear urban waterfront park.</td>
<td>water retention, flood protection.</td>
</tr>
<tr>
<td>Raingardens, Rotterdam, The Netherlands</td>
<td>The raingardens in the Zomerhofkwartier district in Rotterdam were installed in 2016 as part of the climate adaptation strategy of the Rotterdam city and supported by a Life project on climate adaptation. The raingardens being 100 meters long are featuring a unique design of the tiles by designer Fien Dekker. In Dona district in a vacant space, the Landscape Architecture School of the Aristotle University of Thessaloniki in cooperation with the Municipality of Thessaloniki has developed urban community gardens since 2014. Overall 11 families and residents participated in its creation and operation of the urban agriculture initiative. What is unique in this initiative is that established a ground for collaboration between the University, the municipality and the residents in protecting the vacant space and creating new sense of place through it. Type of NBS: urban agriculture.</td>
<td>restoration of space, food production, sense of place.</td>
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(continued on next page)
benefits were altered from ‘backyard’ or ‘abandoned places’ to ‘welcoming places’ and ‘community spaces’.

From recent research on green urban commons, we further assert the positive impact of nature-based solutions to urban place-making. Colding and Barthel, 2013, define urban green commons as “urban ecosystems of diverse ownership that depend on collective organization and management” (p.157). It is critical how urban green commons are managed not how the land is owned, putting priority that they are co-managed and preserved together with communities. Presence in and experiencing green urban commons fosters acceptance and appreciation of cultural diversity given that ‘people interact during gardening’ and ‘visiting’ allowing for open, unplanned social encounters (Buiks Arjen et al. (2016)).

Another important element of green urban commons is how they instigate transformations in the sense of place and sense of belonging of communities. We found that nature-based solutions positively transform the sense of place of local communities when these communities are actively engaged in co-creating them (Frantzeskaki et al., 2018). Montgomery (2013) (p.37) addresses that green spaces moderate the relationships with people and create new experiences between people and nature. Artmann and Sartison (2018), p. 13) argue that “residents doing urban gardening experience a sense of belonging” and this is further linked to “the demand of residents to reclaim public space and self-governance” and Larson et al., 2016 (p.113) point to the experimental benefits of nature-based solutions. Vierikko et al (2016) address that bio-cultural diversity is another lens to understand how green urban commons are appreciated, co-managed and preserved together with communities. Presence in and experiencing green urban commons fosters acceptance and appreciation of cultural diversity given that ‘people interact during gardening’ and ‘visiting’ allowing for open, unplanned social encounters (Buiks Arjen et al. (2016)).

Especially in the deprived neighborhoods that the nature-based solutions’ experiments took place, communing in the regenerated public spaces was an important leverage for understanding cultural diversity and its benefits for the community. Many cities involved citizens in tree planting programs to re-establish urban parks and urban forests (like Burgas, Vejle, Potenza) and created conditions for active engagement of the community. What these cities work now with is to extend participation to co-creation and co-management of those green urban commons in partnership with the city (Ordonez Barona, 2015).

The Kipos project in Thessaloniki is collectively managed and open to people, accessible to families and residents even in adjacent neighborhoods. What this urban agriculture area shows is that small-scale nature-based interventions (the Kipos urban agriculture is 84 square

### Table 1 (continued)

<table>
<thead>
<tr>
<th>Nature-based solution experiment</th>
<th>Characteristics</th>
<th>Recognized co-benefits of the nature-based solution that contribute to urban resilience</th>
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</thead>
<tbody>
<tr>
<td>Augustinborg, Malmo, Sweden</td>
<td>The Augustinborg district in Malmo is an iconic area for the introduction of sustainable urban water systems for urban drainage in 1980s that showcases how innovative solutions got integrated in urban life by engaging with the citizens, by setting a dialogue with communities about their needs and altering/adapting urban design to them. Type of NBS: bioswells, rain gardens, urban parks, nature-based playgrounds</td>
<td>flood protection, water inundation, sense of place</td>
</tr>
<tr>
<td>On-going experiments initiated in 2016</td>
<td>West End Common, Vejle, Denmark</td>
<td>The focus area/neighborhood in Vejle was the West End in Southern Jutland. The nature-based experiment was set by a group of residents who had participated in the local working group (ULG) on urban resilience and decided to create an urban green common, a green space and a nature-based playground in the West End, called ‘West End Common’. The municipality has contributed with land and soil and the local council facilitated the development of the area. In 2017 the citizen group kicked off the emerging design of the green space, by putting a fence to orient visitors, and started with shaping the landscape for the playground. Type of NBS: urban park and nature-based playground</td>
</tr>
<tr>
<td>The green corridor, Sint Andries, Antwerp, Belgium</td>
<td>A linear park to connect different nature-based solutions for water retention in the district of Sint Andries was envisioned by a co-creation process in the city of Antwerp. The experiment took off in June 2017 with 60 people from the area who participated in identifying and starting up green actions like ‘green spots for playing’, bioswales, and other forms of pocket green spaces.</td>
<td>flood protection, recreation, sense of place, water retention</td>
</tr>
<tr>
<td>Dolno Ezrovo District, Burgas, Bulgaria</td>
<td>In Dolno Ezrovo district in Burgas, citizens together with the city and its deputy mayor of European programmes and ecology, planted trees in the area also by removing discarded cement and opening the closed channel that has been creating flooding problems every winter. The unsealing of soil, the planting of willow trees by the community and the localization of the narrative on the importance and value of nature-based solutions for flood protection were the activities and outputs of this local experiment. This experiment is innovative in its own context since such actions performed in collaboration with citizens are unique in the context of Burgas city. Type of NBS: Pocket park</td>
<td>water retention, flood protection, sense of place</td>
</tr>
<tr>
<td>City Center District, Potenza, Italy</td>
<td>A participatory initiative for the restoration of the urban park in the periphery of the Guevara tower monument in the city center of the Potenza city was initiated in 2017 and is on-going. A repertoire of activities are realized as part of this experiment. Specifically, the Chamber of agronomists and forestry has taken on the commitment to manage the park surrounding the tower, and to recover its habitat quality and accessibility. A petition was launched to propose the demolition of an abandoned building, located just in front of the tower, with the aim to improve the accessibility of the park. To Rotary Club has organised a design contest open to professionals from all over the world to submit possible solutions for the improvement of the quality of the urban space of the area. Type of NBS: urban park</td>
<td>water retention, sense of place, recreation</td>
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Table 2
Lessons learnt from experimenting with and for nature-based solutions organized across the expanded proof-of-concept stages and backed with recent literature on nature-based solutions’ applications.

<table>
<thead>
<tr>
<th>Expanded proof-of-concept and demonstration stages of nature-based solutions (adopted by Raymond et al., 2017)</th>
<th>Lessons Learnt from NBS experiments</th>
<th>Supportive Case Studies of NBS experiments from Resilient Europe cities</th>
<th>Supportive Literature to the lessons learnt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select and assess NBS and related actions</td>
<td><strong>Lesson #1:</strong> Nature-based solutions need to be aesthetically appealing for citizens to appreciate and protect them.</td>
<td>Courtyard regeneration, Katowice, Poland; Zoho raingardens, Rotterdam, The Netherlands; Augustinborg district, Malmö, Sweden.</td>
<td>Hofmann et al., 2012; Van Mechelen et al., 2015; Vanstockem et al., 2018; Ordonez Barona, 2015; Prestamburg et al., 2016; Aalbers and Sehested, 2018; Artman and Sartison, 2018; Colding and Barthel, 2013; Buijs et al., 2016; Carrus et al., 2015; Colding Denis and James 2016; Fink, 2016; Franzenkaki et al., 2018; Kabisch et al., 2015; Larson et al., 2016; Ordonez Barona, 2015; Simic et al., 2017; Tappert et al., 2018</td>
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<td></td>
<td><strong>Lesson #2:</strong> Nature-based solutions create new green urban commons.</td>
<td>West End Common, Vejle, Denmark; Serpentine urban park, Potenza, Italy; Montreale urban park, Potenza, Italy; Dolno Ezernovo, Burgas, Bulgaria; Kipos urban agriculture, Thessaloniki, Greece</td>
<td></td>
</tr>
<tr>
<td>Design NBS implementation processes</td>
<td><strong>Lesson #3:</strong> Nature-based solutions experiments require and feed into trust between the city and its citizens both for the aim of the experiment and for the experimenting process itself.</td>
<td>Courtyard regeneration, Katowice, Poland; Urban park nearby Guevara tower, Potenza, Italy; Sint Andries, Anterp, Belgium; West End Common, Vejle, Denmark.</td>
<td>Bulkeley and Castan Broto, 2013; Buh et al., 2017; Chu, 2016; Clowier et al., 2018; Crowe et al., 2016; McLean et al., 2016; Matschoss and Heiskanen, 2017; Peng and Bai, 2018; Riggs et al., 2010; Brink and Wamsler, 2018; Collier et al., 2013; Huang-Lachmann and Lovett, 2016; Hutter, 2016; Schuttenberg and Guth, 2015; Yamaki, 2016</td>
</tr>
<tr>
<td></td>
<td><strong>Lesson #4:</strong> Different fora for co-creating nature-based solutions are needed that include and learn from urban social innovation.</td>
<td>Courtyard regeneration, Katowice, Poland; Courtyard regeneration, Katowice, Poland; Urban park nearby Guevara tower, Potenza, Italy; Serpentine urban park, Potenza, Italy; Sint Andries, Anterp, Belgium; West End Common, Vejle, Denmark.</td>
<td>Biggset al., 2010; Brink et al., 2018; Fox-Kamper et al., 2018; Russo et al., 2017; Simic et al., 2017; van der Jagt et al., 2017; Ugolini et al., 2018; Wamsler et al., 2014</td>
</tr>
<tr>
<td>Implement NBS</td>
<td><strong>Lesson #5:</strong> Nature-based solutions require a collaborative governance approach. Nature-based solutions are often initiated by local governments and require multiple actors to be designed, implemented and linked to urban life.</td>
<td>Lambhill Stables, Glasgow, UK; West End Common, Vejle, Denmark; Potentini Armati di Zappa, Potenza, Italy; Kipos urban agriculture, Thessaloniki, Greece</td>
<td>Addanki and Vankastaraman, 2017; Aalbers and Sehested, 2018; Artman and Sartison, 2018; Brink et al., 2018; Fox-Kamper et al., 2018; Russo et al., 2017; Simic et al., 2017; van der Jagt et al., 2017; Ugolini et al., 2018; Wamsler et al., 2014</td>
</tr>
<tr>
<td>Communicate co-benefits</td>
<td><strong>Lesson #6:</strong> An inclusive narrative of mission for nature-based solutions can bridge knowledges and agendas across different departments of the city and tackle with departmental disputes.</td>
<td>Andries, Anterp, Belgium; West End Common, Vejle, Denmark; Dolno Ezernovo, Burgas, Bulgaria</td>
<td>Arkema et al., 2017; Collier et al., 2013; Davies et al., 2017; Lovbrand and Linner, 2015, p.55; Martínez-Harms et al., 2018; van der Jagt et al., 2017;</td>
</tr>
<tr>
<td>Transfer and upscale NBS</td>
<td><strong>Lesson #7:</strong> Nature-based solutions need to be designed in such a way and scale that lessons for their effectiveness can be easily harvested and as thus, to be easily replicated into other locations.</td>
<td>Andries, Anterp, Belgium; West End Common, Vejle, Denmark; Potentini Armati di Zappa, Potenza, Italy; Dakakkers rooftop urban agriculture, Rotterdam, The Netherlands; Kipos urban agriculture, Thessaloniki, Greece</td>
<td>Artman and Sartison, 2018; Brown et al., 2015; Van Mechelen et al., 2015; Herzog, 2016; Jim et al., 2018; Poëlling and Mergenthaler (2018)</td>
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meter in size) generate interest, and catalyze new social relations as well as new relations between nature and people. In Potenza, a citizen group self-organised for restoring and maintaining the Monteareal park to ensure the quality of green space and its sustainability. The citizen group ‘Hoes armed citizens’ stepped in the role of maintaining the park in view of a failing responsibility from the city and reclaimed its importance for the urban life, experiencing it as a green urban commons. The city of Burgas created a sense of community in the Dolno Ezrovo district collaboratively removed discarded cement from the closed (inundation) channel and planted willow trees to start the renaturing of their district. The collaboration between citizens of all ages for this, the activation of the community due to the openness and willingness of the city officers to discuss and listen to their needs created the first seeds for a new urban green common in this area, even though it is a pocket green space for now.

Lesson #3: Nature-based solutions experiments require and build trust between the city and its citizens both for the aim of the experiment and for the experimenting process itself.

Trust is an important condition for every participatory process regarding planning, policy and of course, experimentation. Trust building requires starting a relation with citizens based on clarity, transparency and openness to take on board contradicting (often) opinions and beliefs, unclear aspirations as well as frustrations over the wrongs of various preceding processes. In this process, it is important not to only communicate clearly on the aims of the nature-based solution experiment but also to create an environment of trust that the time spent experimenting and the commonly produced outcomes are trustworthy and time-worthy at the same time. Building trust between citizens and city is the first step, and it is a prerequisite for ensuring a trust in the experimentation process they embark in. In such situations where the trust to the aim and to the process of experimentation is a continuous effort, citizens are to be seen as equals in terms of knowledge and ideas’ contributions to experts from the city and from science and consultancy.

From recent literature on experimentation as a process of urban governance, we draw that the objectives of the experimentation and the process of it are equally important to be communicated clearly to participants including also engaging with people not involved in the initiation of the experiment (Matschoss and Heiskanen, 2017; Peng and Bai, 2018). The process of experimentation allows for testing new ideas, trialling concepts (Bulkeley and Castan Broto, 2013) and new institutions that may relate to urban imaginaries and also flexible institutions to how adaptive and relevant they are for urban sustainability. In experimentation, many actors become important to carry out experimentation and the learning that takes place in it, one of them being intermediaries such as researchers to carry out exchange of knowledge and systematization of knowledge as well (Bush et al., 2017). Through the development of new knowledge and new skills, trust can be built in experimentation together with the acceptability of new solutions (Cloutier et al., 2018).

The revitalisation of the River Valley Ślepiopta, in Katowice, Poland showcases a process that citizens together with the city collaborated in rethinking the value and the use of the river valley. A previously abandoned and degraded place, suffered from litter pollution, was brought to planning attention that utilized European funded project to experiment with new ways of participation and engagement with citizens for its future. To build trust to the process of revitalization, the planners of Katowice city engaged the citizens in an open way, shared information of possible solutions to protect biodiversity and restore the habitat in the river banks bringing the citizens with them alongside the process.

The restoration of the urban park in the periphery of the Guevara tower in the city center of Potenza is part of a multi-action experiment that was initiated by the city of Potenza and evolved in a multi-actor activation process. The city of Potenza with engaging multiple actors in dialogues about urban resilience as a way to rethink how to develop the city, how to regenerate areas and districts in collaboration with citizens established trust with the city but also trust in the process of ‘finding new ways together’ as it was framed by the urban planners. The openness and transparency of the process of engagement were critical drivers in establishing the trust in the experimentation itself as an openway to rethink and develop the city for the future. This triggered also other actors such as the Rotary Club to open to experimental ways such as the design competition for experiments on recovering the urban park’s identity and value next to the monuments’ appreciation.

Lesson #4: Different fora for co-creating nature-based solutions are needed that include and learn from urban social innovation.

Given that environmental problems like climate change challenge the capacities of cities to source and manage solutions alone, the shifting focus is on partnering with other capable social actors over time. Many cities have creative and capable urban actors like citizens and businesses to co-create and co-design nature-based solutions not in the shadows of city planning but on the forefront as a city-making practice. A frequent practice of urban planners when wanting to involve citizens in plans and planning decisions is to either involve the same citizens over and over (we name them ‘the usual suspects’) or to exhaust their innovators and face participation fatigue. A way to overcome this and to invite the unusual suspects is to make different fora for co-creation. Especially, when city officers and the city overall change role from regulating and consulting to enabling, participating and facilitating citizen-led projects and dialogues for urban futures, local infrastructure projects such as nature-based solutions become centers for new ways of working together with citizens, changing stakeholders’ perceptions about each other and about the city and transforming relationships through the creation of new ones and of shifting of roles. The new ways of doing, relating and knowing are conceptualized as urban social innovation (Yamaki, 2016, p.213). Social innovation is therefore an important social capital dimension to consider when co-creating nature-based solutions.

From recent literature on how co-creation supports inclusive designs of nature-based solutions, we found that co-creation is a way to cope with the complexity and uncertainty that sustainable solutions like nature-based solutions have in delivering on sustainability and resilience (Hysing, 2015, p.30–31). Eckersley (2006) points to the importance of empowering civil society and fostering “ecological responsibility” through new forms of deliberation and participation in decision-making and planning processes. Collier et al., 2013 (p.24) argue about the need for “the creative and inclusive involvement by wider disciplines and stakeholders, with planners and practitioners as facilitators”. Last but not least, Biggs et al., 2010 suggest that different ways of involving interested stakeholders can benefit how social innovation emerges and links to sustainable solutions.

Antwerp experimented with foresight methods in imagining a green corridor to connect the people with nature and their place in the Sint Andries neighbourhood. A reimagining of a linear park that can establish socio-ecological connections was realized by bringing citizens, designers, planners together in a ‘future walk’ workshop, where pictures, narratives, sketches were put together as a collage to create the future green corridor (Photo 1 and 2). This allowed people with different backgrounds and knowledges to be included, since visual and verbal entries of ideas were allowed. Courtyard renovation project in Katowice city shows that for the co-creation and co-design of nature-based solutions (even of small scale ones) traditional settings like architecture designs can be re-thinked as platforms for engagement and co-creation with citizens. The regeneration of the urban park in the Serpentone district in Potenza demonstrates that through the participatory engagement of citizens in different roles, changing places with nature-based solutions enabled and stimulated a change of sense of place of these places. Local communities altered their views, perceptions and experiences in these places, captured by changes in use and changes in local narratives (Photo 3).
In addition to these, the cities of Glasgow (United Kingdom), Katowice (Poland), Vejle (Denmark) and Burgas (Bulgaria) engaged with the citizens through food festivals, community organized lunches and dinners to deliberate on nature-based solutions, to co-define the needs and challenges in their neighborhoods and to co-decide on the experimental actions to take in their areas. Vejle’s ‘Young people eat together’ experiment targeted the youth as a way to discuss the future of the city and the future robust nature-based solutions for making the city livable and socially cohesive. The dinners organized by the municipality and were attended by 70 first and 113 engaged young citizens who expressed future visions, and took action on continuing on thinking about small-scale actions to improve their neighborhoods. These food-centered engagement practices not only attracted more people in an easy and sociable way but also broke down barriers in terms of role power (e.g. city officers and deputy mayors sat on the same tables, ate and talked in simple ways with citizens, allowing for open and direct dialogues) and in terms of knowledge sharing, by simplifying the narrative of nature-based solutions to respond to ‘what it means for our life’, ‘what it means for our area’. In the city of Katowice, the local community initiative on sustainability education for youth was the central actor in organizing and networking with citizens and the city for the food festival, and played an important role in mediating with the community but also mediating in terms of localizing the meaning of nature-based solutions.

Lesson #5: Nature-based solutions require a collaborative governance approach. They are often initiated by local governments and require multiple actors to be designed, implemented and linked to urban life.

For nature-based solutions to be successfully implemented in cities, thinking only about who can invest in them is not sufficient. The analysis of the nature-based solutions experiments (Table 1) points to the fact that the majority of them are initiated by local governments but their design and operation relies on collaborative efforts of many local actors. Collaboration between municipal staff (urban planners, officers) and other urban actors (citizens, NGOs, social innovation networks and knowledge brokers including scientists) is required to enable the salience of nature-based solutions from design to implementation and operation. As thus, urban planners need to think of collaborative efforts as a continuum, that may first require a leading role of the city to be followed by an enabling role later. When civil society or local business actors take up initiating roles, there is still space and need for collaboration with local governments especially for sharing know-how about operating and maintaining nature-based solutions.

Recent research on nature-based solutions also points to the need for collaborative governance for nature-based solutions. Brink et al., 2018 note that co-creation of knowledge between participants in municipalled projects allows for “(re)integration of knowledge from the trans-disciplinary learning space into both societal and scientific practices” (p.3). This linking to the thinking and practice frames of different stakeholders enables the recognition of the nature-based solution’s benefits and even presence in urban life. In the same vein, Fox-Kamper et al., 2018 in their multi-case study found that community gardens are frequently initiated by municipalities involving citizens and as a progress step, operation and maintenance are passed on, or, acquired by citizen groups. Even community gardens that started as bottom-up initiatives still were supported by local governments in the form of land permits, knowledge and linking to other practitioners (Kamper et al, 2018; Artmann and Sartison (2018), p.13). Collaborative efforts are thus important since they catalyze local and tacit knowledge in the full cycle of planning of nature-based solutions. Ugolini et al, 2018 (p.9) evince that collaboration with scientific institutions contributes to innovation and to ‘transferability of results’. Wamsler et al., 2014 (p.197) point to the importance of leveraging local knowledge for the planning with ecosystem-based approaches to bridge the gap of experience in planning systemic solutions.

The West End Common in Vejle shows how the local government can facilitate a nature-based solution but later it was stewarding in its operation by a local community group. It moves beyond the ‘hand-over’ of a vacant space to stewarding and linking it to urban life by the active engagement of local community. In the West End Common case, the citizen group got motivated by the openness of the local government to...
their ideas on the creation of a common green space and nature-based playground that moved to ‘taking action’ and further connecting it to other members of the local community.

The Lambhill Stables in Glasgow illustrates that for the sustainability of the nature-based solution, it is important to engage with multiple stakeholders and especially to embed it to urban life through community networks and civil society organisations. Another example that illustrates this comes from Potenza, the Potentini Armati di Zappa (Hoes armed citizens in English) that is a civil society initiative that has stewarded the Montreale park, one of the largest green areas of the city, and are self-organised in cleaning and maintaining it.

**Lesson #6:** An inclusive narrative of mission for nature-based solutions can bridge knowledges and agendas across different departments of the city and tackle with departmental disputes. While much focus is on the collaborations between the city and citizens, it is paramount that different departments within the city are involved and informed when a nature-based solution is discussed, shaped and planned. For this, the initiating team of city planners and occasionally citizens needs to be open to ideas from different city departments so as to make the solution a common solution and to create a common inclusive narrative of mission across departments. Early skepticism, criticism even negativity can be turned into constructive points for improving the design and the process of planning and co-creation of a nature-based solution. During the workshop we had with the Resilient Cities partners in 2017, it was concluded that when a solution becomes an iconic project of one department there were many implementation barriers, especially envy from competitive colleagues.

An inclusive narrative of mission can be an integration ‘tool’ in seeking consensus, attract support and salience in policy agendas for nature-based solutions.

For creating an inclusive narrative to inspire colleagues and make them (feel) included, one can use the main objective of the nature-based solution project that (as indicated in all the solutions brought to the workshop) is the climate change pressure. This touches multiple urban agenda points especially since nature-based solutions are multi-functional addressing climate change and social inclusion objectives/targets at the same time. Narratives and (narrative) frames can draw attention to specific topics and in this case, to specific benefits of nature-based solutions and inspire collaborations across departments. At the same time, narratives can also deflect attention away from an issue if not counter-balanced with narratives of ‘reason and focus’ (Frantzeskaki and Kabisch (2016)). As such, narratives can be instruments to foster collaborations across departments for successful communication of co-benefits and planning of nature-based solutions.

Recent research on nature-base solutions, also points to the importance of how knowledge and mission are communicated and shared. (2018) (p.10) point at the importance of ‘getting the discourse right (…) as this can provide a narrative through which individuals and communities can validate and initiate actions, address issues of agency and empowerment’. van der Jagt et al., 2017 (p.270–271) argues for a ‘broadly shared urban food growing motivation’ as captured in an inclusive discourse for urban gardening as being paramount in creating social inclusion and a “scope for socializing”. Davies et al., 2017 (p.104) also suggest that communicating the benefits of urban forests to politicians, citizens and urban managers (next to tree managers) is important for creating support and understanding of the importance of urban green. They also point out that scientific reports on urban trees need to present evidence both on benefits/services and trade-offs/dis-services to provide scientific base for urban management decisions. For this, it is also important to get broader knowledge sharing and weaving into the narrative. Arkema et al., 2017 point that integrating different types of knowledge for designing and evaluating nature-based solutions “may help coastal planners confront disparities in disaster risk reduction and anticipate changes in the nature of demand for coastal protection services” (p.19). This is specifically relevant for the port cities of Rotterdam, Malmo and Thessaloniki.

**Lesson #7:** Nature-based solutions need to be designed in such a way and scale that lessons for their effectiveness can be easily harvested and as thus, to be easily replicated into other locations.

All sizes of nature-based solutions can contribute to more livable and resilient cities. The design and scale of a nature-based solution are critical factors on the viability for the solution to be replicable into other locations in the same city and in other cities. Specifically, concept designs of greening courtyards, green walls and green roofs even in medium scale require a localization when replicated, and the complexity of the concept design may deem some solutions too contextually bound to be replicable.

Recent literature on designing nature-based solutions further supports this lesson. Specifically, van Mechelen et al 2015 point at the biodiversity of green roofs as a design element that influences their multi-functionality and relatively their transferability. Polling and Mergenthaler (2018) point at the city-proximity and the diversification as critical design factors of urban farming for making urban farming socially benefiting. Brown et al., 2015 found that designing urban parks to deal with heat stress requires a careful consideration of both the sunlight penetration through vegetation and the wind speed change from average in the urban environment. Montgomery (2013, p.174–175) argues that cities need to reconsider the ways they use and plan and even regenerate urban spaces. Even for urban spaces like streets that outline generations of urban citizens are “malleable and fluid” hence rethinking how to use them and scale their regeneration and infrastructure update is important for improving quality of life in cities.

A bright example brought to attention include the inclusion of green areas and water drainage infrastructures in the Augustinsburg neighborhood in Malmo that has been celebrated as a global example for integrating new infrastructure (at its time) to green development and has been replicated in other cities. The same holds for the replicated Kipos example of urban agriculture experiment in Thessaloniki, in which the restoration of open vacant space as an urban agriculture patch was introduced inspired by other cities. The simple design and simple dual function helped in its easy replication.

**4. Conclusions**

Nature-based solutions should not be considered as “optional luxury” in cities (Montgomery, 2013, p.120). The investments and efforts in advancing and updating urban infrastructures to deal with climate change pressures and demographic changes require more holistic approaches that take nature into the equation. Nature-based solutions are strong candidate solutions to infrastructure re-development and advancement. From our work with the cities of Resilient Europe, we draw seven lessons from recent nature-based solutions realized in diverse socio-ecological contexts that urban planners can consider across Europe when designing and planning nature-based solutions. We make
Implications for urban policy, planning and governance from lessons learnt from nature-based solution experiments of Resilient Europe project.

<table>
<thead>
<tr>
<th>Expanded proof-of-concept and demonstration stages of nature-based solutions (adopted by Raymond et al., 2017)</th>
<th>Lessons Learnt from NBS experiments</th>
<th>Implications for urban planning and governance (what it means?)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Select and assess NBS and related actions</strong></td>
<td><strong>Lesson #1:</strong> Nature-based solutions need to be aesthetically appealing for citizens to appreciate and protect them.</td>
<td>· Urban planners need to consult multi-disciplinary teams to co-design NBS · Urban planners need to be open to differences in preferences between their designs and citizens’ perceptions (Holmann et al., 2012; Buchel and Frantzeskaki, 2015) · Knowledge brokers can facilitate images of nature in culturally diverse areas to ensure socially inclusive NBS designs (De Vreese et al., 2016)</td>
</tr>
<tr>
<td><strong>Design NBS implementation processes</strong></td>
<td><strong>Lesson #2:</strong> Nature-based solutions create new green urban commons.</td>
<td>· Urban planners need to be open to communicate and to hand-over the leadership of projects to citizens, civil society groups and other urban actors · Urban planners need to celebrate together with communities the new sense of place as shaped by nature-based solutions · Communities or civil society groups need to professionalize in the ways of managing, operating and sustaining their involvement in green urban commons</td>
</tr>
<tr>
<td><strong>Implement NBS</strong></td>
<td><strong>Lesson #3:</strong> Nature-based solutions experiments require and feed into trust between the city and its citizens both for the aim of the experiment and for the experimenting process itself.</td>
<td>· Urban planners can consider experimentation as a way to de-risk new innovative solutions · Urban planners need to remain open to questions, transparent on the vision, and inclusive to new ideas during experimentation with nature-based solutions · Citizen groups or social innovators need to be open to cooperate with local governments when setting up and operating urban experiments of nature-based solutions</td>
</tr>
<tr>
<td><strong>Communicate co-benefits</strong></td>
<td><strong>Lesson #4:</strong> Different fora for co-creating nature-based solutions are needed that include and learn from urban social innovation.</td>
<td>· Urban planners need to think creatively about the co-creation repertoire for nature-based solutions with citizens and other urban actors · Urban planners may need to establish institutional spaces for social innovation initiatives to lead the design and/or facilitation of co-creation fora</td>
</tr>
<tr>
<td><strong>Transfer and upscale NBS</strong></td>
<td><strong>Lesson #5:</strong> Nature-based solutions require a collaborative governance approach. Nature-based solutions are often initiated by local governments and require multiple actors to be designed, implemented and linked to urban life.</td>
<td>· Urban planners need to formulate planning guidelines in consultation with citizens and local NGOs for shaping collaborative governance of nature-based solutions (Russo et al., 2017, p.62) · Citizens or social entrepreneurs need to be open to collaborate with local governments for nature-based solutions</td>
</tr>
<tr>
<td><strong>Communicate co-benefits</strong></td>
<td><strong>Lesson #6:</strong> An inclusive narrative of mission for nature-based solutions can bridge knowledges and agendas across different departments of the city and tackle with departmental disputes.</td>
<td>· Urban planners need to consider communication tools for realizing nature-based solutions · Urban planners can use the multiple benefits of nature-based solutions to link to different urban agendas and create a cross-departmental narrative of integration</td>
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<tr>
<td><strong>Transfer and upscale NBS</strong></td>
<td><strong>Lesson #7:</strong> Nature-based solutions need to be designed in such a way and scale that lessons for their effectiveness can be easily harvested and as thus, to be easily replicated into other locations.</td>
<td>· Urban planners need to formulate easy to apply evaluation and monitoring frameworks for small scale nature-based solutions about their replicability</td>
</tr>
</tbody>
</table>

### Table 3

For urban environmental policy and planning in Table 3.

We recommend that urban planners remain open to learning with other urban actors for co-creating and co-maintaining nature-based solutions while shaping institutional spaces in cities that allow for this co-creation, social innovation and collaboration to continue. A way for such open approach to collaborative governance is experimentation that allows to advance urban planning and urban governance through learning about and with nature-based solutions. In this vein, we have three concluding messages for urban planners and researchers of nature-based solutions:

First, experimenting with nature-based solutions requires willingness to learn and to collaborate across departments and with citizens beyond consultative and regulative approaches. It may seem as a well argued lesson across the urban planning literature that participatory and collaborative governance is paramount when shifting to new solutions and new planning concepts, however nature-based solutions require open, inclusive and co-creation modes of governance for their implementation. Cities may not be equipped for a fully operational co-creation approach hence it is suggested to consider social innovators and other social actors to partner with and to facilitate co-creation processes together.

Second, experimenting with nature-based solutions allows different forms of institutions to be tested and to be flexed into more open to innovation and collaborative governance modes. This has been made more evident in cities with less experience in collaborative governance approaches such as Burgas, and even stressed the cities of Glasgow and Antwerp to think differently about their institutions. Bringing together stakeholders to develop local policies and solutions such as nature-based solutions can be a form of ‘intelligent institutional leadership’ that in turn can foster resilience and inclusive urban development. Experimentation also allowed for new narratives for the cities to be co-created. The narrative of connected city landscapes was co-created in Sint Andries in Antwerp with the green corridor idea as an imaginative-green infrastructure element to kick-start urban resilience in this neighborhood. In line with Brooks et al., (2016, p.1) we conclude that experimenting as a form of governing localities “can be instrumental in shaping the capabilities of a place to withstand and thrive within changing economic and social contexts”.

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Appendix A. Supplementary data

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