

HORIZON 2020

Coordination and support actions



Development of a multi-stakeholder dialogue platform and Think tank to promote innovation with Nature-based Solutions

WP5 - Identification of barriers and uptake of the necessary decision making mechanisms of the various local authorities and stakeholders

Deliverable 5.3

Policy proposals and decision-making mechanisms for Climate change Adaptation and mitigation using NBS

Authors: Emeline Bailly (CSTB), Dorothee Marchand (CSTB), Liz Faucheur (CSTB), Inès Daoussi (CSTB), Alexis David (ECTP), Francesco Pilla (ECTP, University College of Dublin), Rui Florentino (ECTP, Escola Superior Gallaecia), Denia Kolokotsa (TUC), Nikolaos Nikolaidis (TUC)

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Distribution

Name	Organization
Emeline Bailly	CSTB
Dorothee Marchand	CSTB
Liz Faucheur	CSTB
Ines Daoussi	CSTB
Anne-Claire Streck	ECTP
Alexis David	ECTP
Francesco Pilla,	ECTP, University College Dublin
Rui Florentino	ECTP, Escola Superior Gallaecia
Nikolaos P. Nikolaidis	TUC
Denia Kolokotsa	TUC
Silvia Enzi	CNR ISAC
Adriana Bernardi	CNR ISAC
Juraj Jurik	GIB

Table of Contents

VERSION HISTORY	2
DISTRIBUTION	2
INTRODUCTION	5
PART 1 GENERAL OVERVIEW: BRIEF DESCRIPTION OF NBS USED FOR CCAM AND IDENTIFICATION OF BARRIERS AND UPTAKES FOR THE DEPLOYMENT OF NBS FOR CCAM	6
I) NBS FOR CCAM: TERMS AND CONDITIONS	8
II) THE STAKES RELATED TO URBAN GREENERY AND WATER BODIES FOR URBAN CLIMATE	13
III) ADAPTATION AND MITIGATION THROUGH NBS AND NATURE IN INHABITED AREAS	16
IV) ISSUES OF IMPLEMENTATION OF NBS TO ADAPT AND MITIGATE CLIMATE CHANGE IN INHABITED TERRITORIES.	26
PART 2: QUALITATIVE AND QUANTITATIVE SURVEYS WITH EXPERTS AND STAKEHOLDERS ON NBS	31
I. QUALITATIVE SURVEY WITH EXPERTS AND RESEARCHERS ON NBS TO FACE CLIMATE CHANGE.....	31
II. QUANTITATIVE ANALYSIS: IDENTIFICATION OF BARRIERS AND DRIVERS FOR THE IMPLEMENTATION OF NBS USED FOR CCAM	44
PART 3 PARIS CASE STUDY: BARRIERS AND UPTAKES FOR THE IMPLEMENTATION OF NBS FOR CCAM	60
I. PARIS RESILIENCE CHALLENGE, CSTB.....	61
II. PRESENTATION OF THE OASIS PROJECT AND RELATED STAKES	70
III. SURVEY BASED ON A SOCIAL-PSYCHOLOGICAL APPROACH OF OASIS	76
CONCLUSION: RECOMMENDATIONS	85
CULTURE.....	86

GOVERNANCE AND POLICY.....	87
COMMUNICATION AND KNOWLEDGE	91
REFERENCES.....	93
ANNEXE	98

Introduction

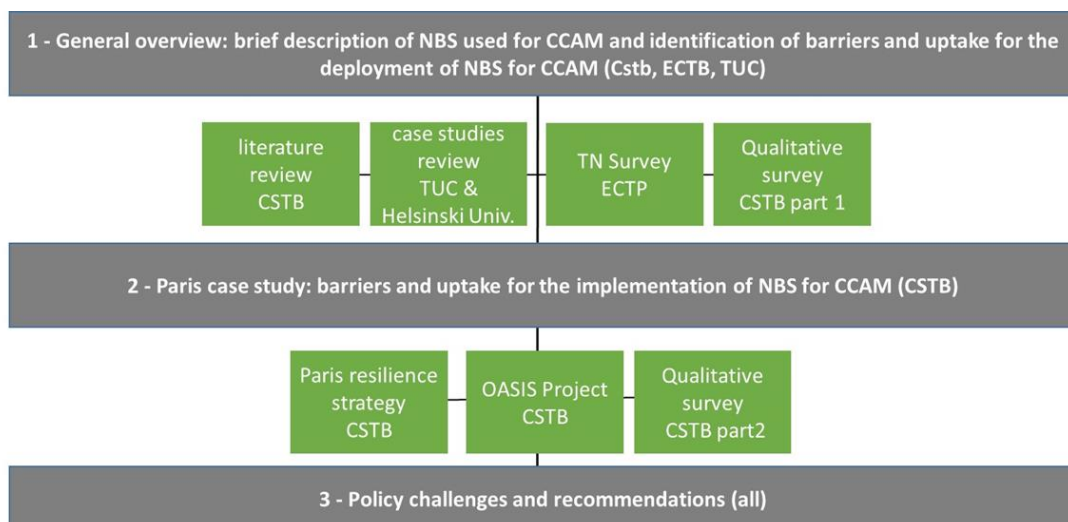
The objective of this deliverable is the identification of barriers and uptake of the decision-making mechanisms of the various local authorities and stakeholders for climate change adaptation and mitigation using NBS.

To remind, two processes (adaptation et mitigation) and three main topics are considered: the management of heat stress, the management of flood risk, and the plantation of sustainable woodland.

New inputs have been added to help deepening the analysis of those barriers and drivers regarding NBS for climate change adaptation and mitigation providing a more qualitative approach.

4 approaches are crossed to be able to draw recommendations:

1. Literature and case studies review (CSTB, TUC)
2. Analysis of the Questionnaire's answers completed by interviews with some specific stakeholders working on Climate Change adaptation and mitigation (European institutions, cities, experts, associations, working groups...) (ECTP)
3. Qualitative survey with researchers, experts, cities who work on hazards and NBS (CSTB)
4. Focus on Paris Example (the Paris Resilient Strategy and the Oasis courtyards school Project) (CSTB)



Part 1 General overview: brief description of NBS used for CCAM and identification of barriers and uptakes for the deployment of NBS for CCAM

Introduction:

We will focus here especially on climate change adaptation and mitigation using NBS. To be able to deal with related barriers, obstacles and issues, a thorough examination was needed and was done as follows: we intend to stress in this part firstly general barriers and potential uptakes related to NBS, with literature review and illustrations of exemplary cases. Then, a more detailed analysis was provided through quantitative and qualitative surveys led by Think Nature members and CSTB, bringing to light several categories of obstacles and uptakes. Such a process is meant to increase the knowledge on NBS used for CCAM to ultimately scale up in a relevant way Nature based solutions.

To remind, the focus in this deliverable is on three topics especially:

- Flood risk management
- Heat stress in urban environments
- Plantation of sustainable woodlands

Almost four billion people currently live in cities and official forecasts predict a very high increase in the next years (INED, France, 2019)¹. Urban population is increasing rapidly because of the childbirth and the important migration of the rural population into the cities caused by expectations for a better life, local conflicts and lack of resources in the country areas. As mentioned by PWC (Rapid Urbanisation, 2014) the increase of the world's urban population is close to 1,5 million of people per week. High density and increased consumption patterns make cities the higher consumer of global resources as they are responsible for almost 75% of the world's assets. In parallel, the urban environment experiences a very significant territorial expansion, known as urban sprawl, combined with a significant change of land use. Losses in green spaces and sealing of the urban land because of the extensive use of opaque surfaces of paving, in combination with a very high increase of the released anthropogenic heat, affects the urban climate, resulting in a serious environmental degradation and have increased significantly the urban ecological footprint, (Oke 1997).

Global climatic change caused by the increased concentration of greenhouse gases in the atmosphere contributes to increase urban temperatures and the frequency and length of extreme climatic phenomena like heat waves. The magnitude of the ambient temperature increase caused by the global climate change is forecasted by the IPCC Committee. For the period 1990-2005, predictions indicated an increase

¹ <https://www.ined.fr>

between 0,15 K to 0,3 K, which already confirmed by measurements, (IPCC, The Intergovernmental Panel on Climate Change, n.d.). At the same time, predictions for the period 1990-2100 indicate that the possible ambient temperature increase will range between 1,8 K to 4 K.

In addition to the global climate change, the thermal balance of cities is highly affected by the increased absorption of solar radiation, the corresponding increase of sensible heat released by urban structures, higher anthropogenic heat, reduced latent heat, higher emission of infrared radiation and other specific sources (Landsberg 1981). Additional heat accumulated and released in the urban environment results in a positive thermal balance and increased urban ambient temperatures compared to the surrounding urban environment. Such a phenomenon is known as 'Urban Heat Island' (UHI) and it is the most documented phenomenon of climate change. The difference between the urban temperature and the corresponding rural or suburban one is referred as the Urban Heat Island Intensity and its magnitude is a function of the physical, structural and morphological characteristics of the cities, the urban layout, local climatic parameters, the synoptic weather conditions and also the total anthropogenic heat generated and released in the city, (Oke T.R, G.T. Johnson, 1991). Studies on the heat island characteristics are available for most of the medium and large cities in the world and the reported urban heat island intensities reach values up to 10 K.

To reduce the risks linked to climate change, two strategies are often underlined: adaptation and mitigation.

- **Mitigation** contributes to stabilize the concentrations of greenhouse gas in the atmosphere to a level that limits dangers for the climatic systems. OECD states that it includes the reduction or limitation of greenhouse gas and the protection of carbon sink.
- **Adaptation** contributes to limit the negative impacts of climate change and to maximize the benefits. Such actions, according to the OECD, are related to: our ways of organizing - The localization of our activities - The technics we employ. (Ademe, 2018).

To achieve adaptation and mitigation, Nature Based Solutions are often quoted as relevant. Nature Based Solutions are solutions inspired and supported by nature, which are cost-effective and simultaneously provide environmental, social and economic benefits and help build resilience. They can be convened to deal with climate change adaptation and mitigation. (European Commission)

They are also referred to as "*actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits*" (IUCN).²

Nature Based Solutions aim to meet several challenges related to climate change and other great challenges of our time such as food and water security, disaster risk etc: they take different forms and have different targets. Implementing trees to cool

² <https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions>

places and foster biodiversity, restructuring riverbanks to avoid floods, putting green roofs and facades on buildings to capture carbon.

Method

We review existing literature to give a general insight. We also study many cases studies to identify the options (and limits) to renature cities and territories:

- NBS used to impact CCAM
- The stake related to urban greenery and water bodies for Urban climate
- The stakes related to adaptation and mitigation
- The stakes for public policies

I) NBS for CCAM: terms and conditions

I.1 Multiple categories of NBS

NBS need to be considered according to the multiple categories they relate to: their impacts and scope go beyond the environmental field as they are also related to social, health, cultural, economic matters. These categories are permeable and have to be considered together, holistically.

Most are benefit but this positive meaning of NBS needs to be more balanced. NBS are likely to bring benefits for society and ecosystems, but it is not systematic, meaning that the implementation of one NBS is not necessarily followed with positive impacts of all sorts. Some negative impacts are also likely to appear, and it is crucial to take such disservices into consideration not to promote a naïve implementation of measures without seeing the potential risks.

Category of impact	Positive (desirable) impacts	Possible negative local impacts	Negative wide-scale impacts
Environmental	Absorption and reduction of air pollution	Release of VOC's; increasing pollution by preventing air flow	Pollution emissions at the production site and during transport of materials
	Support biodiversity, offer space for declining species	Damaging biodiversity via transport of exotic species	Homogenised landscapes with one-size-fits-all NBS
	Carbon sequestration		Carbon release during production, transport and construction
	Mitigation of urban heat island (Taha, 1997)	Heat retention via prevention of air flow	Intensified global warming due to carbon release

	prevent and recover from pluvial flooding	Flood risk not reduced enough due to poor solutions, e.g. sedum roofs	Exacerbating cloud bursts and sea level rise due to carbon release
	Improved landscape connectivity	Connectivity does not work for the organisms it was built for	Wide-scale dispersal of unwanted organisms
	Aesthetic improvement		Uniform aesthetics through uniform NBS
	Noise abatement	Noise from management machinery or unexpected forms of use	Noise from production and transport
		Thinking that NBS are enough, focusing on local solutions rather than the root cause	
	Cleaner water		
Social	Proximity to nature	Unwanted organisms	
	Social cohesion	Exclusion due to failure to recognise different user groups and their needs	
	Well-being (joy, hope, attachment), rich childhood environment	Disease vectors, dangerous animals	
	Place attachment, involvement, stewardship	Lack of history & unknown cultural acceptance	
	Offer public space	Spaces remain unused/mischief	Wasted natural resources and investment
Cultural	Cultural heritage		
	Symbolic value		
Health	Psychological benefits (recovery from stress, mitigation of ADHD)		
	Immune system activation	Release of allergens	
	Increase in activity level		
	Well-being for people with dementia or disabilities		
Economic	New economic activities, income opportunities	High private investment & management cost, with low ROI	

	Public savings due to avoided risks	Cost of governance & management; need for economic incentives	
	Increased value of the space or area with NBS	Inequality, gentrification, space needed for NBS	
	Reduced maintenance costs (e.g. meadow vs. lawn and forest vs. park)		
	Savings due to longer life cycles (e.g. vegetated roofs)		
	Savings in energy use and costs	Increased need for cooling due to unsuitable plants	Fossil fuels used for material production
	Workplace productivity		
	Increased retail sales		
	Faster planning permission		

I.2 NBS and CCM: a need for a holistic approach and multifunctionality

Several approaches exist, making NBS an “umbrella concept”: ecosystem restoration, protection, management approaches, issue-specific (IUCN)



In any kind of approach favored, what is interesting is the multifunctionality of NBS: they are designed to serve not only one goal but several. While meeting a specific challenge such as the risk of flood, one NBS can also be relevant to improve well-being, urban quality etc. NBS bring multiple benefits in the environmental, social, economic field and participate to the sustainable trajectory of territories if implemented correctly.

They need to be thought as a whole, to be considered in all their dimensions. In order for them to be considered and to serve as more than a “narrow and insufficient corridor of ecological modernization”, they need to be taken fully, in their social embeddings notably. Economic, social, environmental and technical elements are to be brought in dialogue and not against each other, in a more holistic view (Haase, 2017).

Thinking about NBS holistically allows us to understand the interdependencies between the various dimensions and fields, and permits a complex thinking to take into account all the fundamental concepts, enter into a dialogic process so as to assess the wanted and unwanted impacts before putting in place any measure. Complex thinking is necessary to deal with uncertainty, mistake and risk (Morin, 2014).

The overarching concept of NBS could use a complex thinking in order to examine the obstacles to any implementation, the potential outcomes, the most optimal ways of implementing any measure.

An example of multibenefit measures in the city of Bilbao

NBS for dealing with extreme temperature and rainfall events, Bilbao

Locality and Climatic conditions & urban space

Bilbao and its metropolitan area has an oceanic climate with mild winters and warm summers. According to the European Environment Agency, Bilbao lies within the Atlantic biogeographical region. The climate of Bilbao and the rest of the north-western part of Spain is different from the rest of the country, characterized by a higher amount of rainfall and precipitation days, fewer sunshine hours and mild temperatures, in summer comparable to northern half of Europe with temperate climate. Extreme climate events in the recent - and not-so recent - past have shown that Bilbao is more vulnerable than most other cities. This realisation prompted scientific research into how the city could plan for sustainable development and prepare itself for further climate-change risks. NBS could play a role in this plan by helping to make Bilbao more resilient towards cold spells, heat waves, and frequent floods.

Actions

NBS1-Zorrotzaurre project: The Zorrotzaurre project is an urban renewal project to promote the sustainable restoration of a currently derelict site in the Zorrotzaurre peninsula, northwest of the city centre. The plan is to create a new quarter that is well-connected to the rest of the city, with affordable housing, environmentally friendly business areas, social and cultural facilities, and spacious green areas for recreation. The Master Plan was designed by the architect Zaha Hadid and includes the conversion of the current Zorrotzaurre peninsula into an island by opening up the Deusto Canal. The plan foresees a total surface of 673 000 m² and includes flood prevention measures, a transport network, and restoration of the area's cultural heritage.

NBS2-Bilbao Greenbelt Expansion: The Bilbao Greenbelt project aims to expand and connect the city's green areas. It has already led to 1 million extra square metres of green areas in Bilbao in the last 10 years. The project aims to create a

network linking the peripheral green belt with urban parks and other green areas inside the city.

Results

Local authorities clearly understand that NBS projects have multiple benefits. This is evident in Bilbao's upcoming Master Plan, which strongly promotes NBS as a means of achieving the city's four main objectives. Bilbao's history of successfully managing severe crises with commitment and creativity has helped it to adopt innovative measures.

I.3 Renaturing inhabited territories

Holistic vision

We stress that a holistic approach to NBS must reconcile the term's diverse definitions. The IUCN presents NBS as a way to regulate predicted climate changes using ecosystem services, while pursuing environmental-justice objectives through access to natural resources for all. The European Commission, meanwhile, stresses the economic benefits of NBSs, which promote "green growth". Hilde Eggermont et al. (2015) propose expanding the concept by incorporating dimensions other than biodiversity conservation, notably human wellbeing and the associated social issues (fighting poverty, protecting societies from environmental risks). Accordingly, issues of adaptation to climate change, of environmental justice, of economic development, of individual and society wellbeing are associated with NBSs.

Promote large scale NBS: a way towards renaturation

NBS need to be seen beyond their punctual manifestations, they must connect and multiscale; indeed, isolated measures can't be enough to face the effects of climate change. With the term renaturing, we aim to deploy NBS with a view towards spatial transformation resulting from the expansion of natural habitats and the restoration of ecological functioning to human environments. Such a dynamic would lead to change the current paradigm nature vs city to envision cities as integral parts of nature, biodiversity and its landscapes. It is about welcoming and accepting nature to live better with it and adapt to its current changes. As climate change is at work, mitigate this process is important by changing our organization and lives habits, but adapt to its effects is also paramount and is an unprecedented occasion to understand and respect living cycles better.

II) The stakes related to urban greenery and water bodies for Urban climate

I.4 Urban greenery

The relationship between urban development and greenery is mostly negative. According to (Kiran, B. C., Mamata, P. and Meena, 2004) “shrubs, grasses, trees and other forms of natural vegetation are usually the first victims of urbanization”. Buildings and vegetation are competing for space in the city. The diminishing of greenery has led to the increase of air temperature, i.e. UHI effect.

Various forms of greenery exist in the city areas, such as nature reserves, parks, rooftop gardens, vertical greeneries, but they are mainly categorized into two major categories: natural and man-made, as shown in Figure 1.

Natural landscapes of the aboriginal flora, fauna or geological features preserved in the built environment are called as natural reserves. However, as cities are developing, the existence of natural reserves is diminishing. Majority of vegetation in the city which is designed, planted and maintained belongs to man-made landscape. City parks usually have larger areas as compared to neighbourhood parks. Building these parks has various purpose including preserving natural landscape, providing recreational facility and beautifying the built environment. Other green areas include the vegetation in-between urban spaces, such as road side planting and vegetation in spaces between buildings.

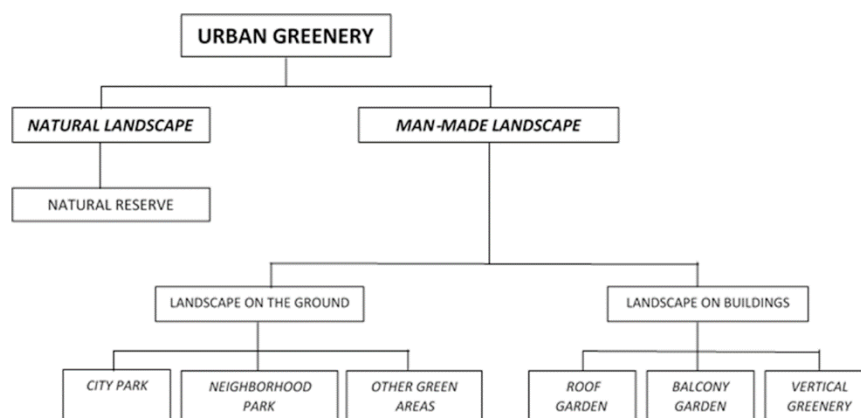


Figure 1. Formations of urban green (Adapted from Wong and Chen, 2009)

In the last decade, landscape in buildings has gained popularity as an effort to increase greenery areas in high-density cities, especially rooftop garden and vertical greenery. Rooftop gardens can be categorized into two types: intensive and extensive, as shown in Figure 2.

Intensive rooftop garden requires relatively thick substrate for various plant types to grow, including grass and trees. It is usually designed to be accessible for people and is used as parks or building amenities. The extensive one features lightweight growing media for grass or turf.

Although introducing plants on the building facades is not a new concept, vertical greenery (Figure 3) becomes a common feature in buildings which are designed to be “green”. More and more researchs are conducted to develop better irrigation system, growing media and construction systems. Vertical greenery can be simply divided into three fundamental types: wall-climbing, hanging-down and the most recent one, module type. The wall-climbing type is a very traditional way of vertical climbing method. The plants can either cover the wall of buildings naturally or grow upwards with the help of supporting system. The hanging-down type is also a popular method of vertical landscaping, of which can form a vertical green belt in multi-storey buildings. The module type is the latest vertical greenery system that requires proper design irrigation system, structure growing media and selection of plants (Chen, Y. and Wong, 2006).



Figure 2. Rooftop garden: intensive system (top) and extensive system (below)

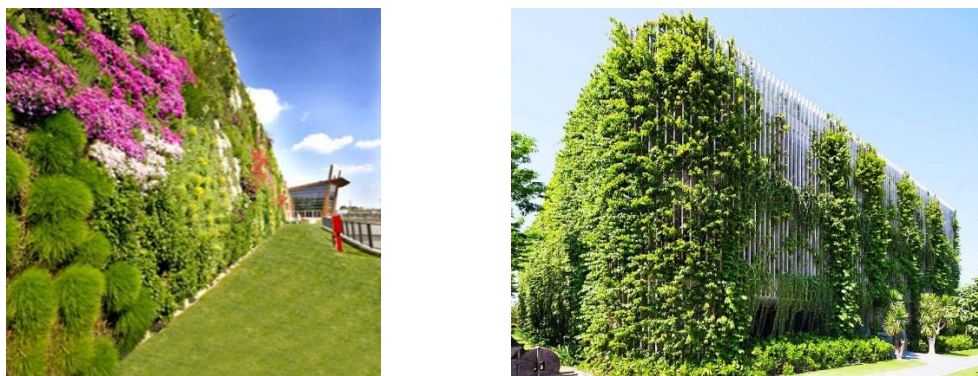


Figure 3. Vertical greenery system

The benefits of greenery have been investigated extensively by many researchers from thermal aspects to social aspects. From thermal aspect, the presence of greenery in urban areas helps to cool the environment through the process of evapotranspiration where large amount of solar radiation can be transformed into latent heat, converting water from liquid to gas which in turn results in a lower leaf temperature, lower ambient air temperature and higher humidity (Chen, Y. and Wong, 2006). It can reduce long-wave radiation exchange between buildings due to the low surface temperatures created by shading of plants (Wong, N. H., Chen, Y., Ong, C. L. and Sia, 2003), as the leaves of deciduous trees can intercept from 75% to 90% of incoming solar radiation on a clear day condition (Heisler, 1986). With

reduction of incoming solar radiation on buildings, there is decrease in cooling loads, but there may be increase in heating loads in winter (Canton, A., Cortegoso, J. L., Fernandez, J. and de Rosa, 2001). Evapo-transpiration contributes to creating lower-temperature spaces in an urban environment, known as “the oasis phenomenon” (M. Santamouris (Ed.) 2001), which characterized by Bowen ratios in the vegetative canopies of 0.5-2 (Taha, 1997). A proper arrangement of plants around buildings improves both psychological effects and unfavourable microclimatic conditions (Robinette, 1972).

I.5 Urban climate and water bodies

The influence of water bodies on urban climate is well known, and it has been studied in depth by different authors. On one hand, the absence of water and evapo-transpiration from vegetation has been identified as one of the reasons for the so-called Urban Heat Island effect (T.R., 1987). On the other hand, the use of water in the urban environment is one of the most effective ways to remove the urban heat in summer conditions (Santamouris M. and Asimakopoulos D., 1996).

At the same time, the water bodies have been studied for their influence on outdoor comfort (B 1976???) (Akbari H., Davis S., Dorsano S. 1992), as well as for its impact on the energy consumption of surrounding buildings (M. Santamouris (Ed.), 2001) (Santamouris et al., 2006).

Nowadays, the approximation to the problem pass through the empirical results by experimental campaigns, the numerical solutions given by detailed software tools, based on CFD simulations, and even the use of satellite images. Thus, the wetlands impact on the surrounding thermal environment has been analysed thanks to the use of satellite images. This technique presents an interesting potential to study large areas, and provides practical data to guide decisions in urban landscape design targeted to mitigate UHI effects (Sun and Chen, 2012).

The importance of the presence of water on the UHI effect, and then, its role as a natural cooling technique depends on the climate. This dependency has been identified as relevant for some applications of water to decrease the air temperature, both indoor and outdoor. One of these techniques is based on the use of shower or misting towers, when using sprays or micronizers, respectively. The cooling potential of such cooling towers can be expressed in terms of applicability maps (Salmerón et al., 2012).

Interesting and useful results for urban designers, builders and architects can be obtained from previous experiences, case studies, or by the use of simplified or detailed models (Bruse and Fleer, 1998) (de la Flor and Domínguez, 2004) (Asawa, Hoyano, and Nakaohkubo, 2008) .

Finally, the interactions between water bodies and other urban cooling techniques, have been considered, especially in combination with the evapo-transpiration of vegetation (Robitu et al., 2006) (QIU et al., 2013) (Gago et al., 2013). A comparison of the cooling potential of different techniques has been also assessed in terms of water use, since this aspect could be crucial in hot and arid climates (Shashua-Bar, Pearlmutter, and Erell, 2009).

III) Adaptation and mitigation through NBS and nature in inhabited areas

Flood risk and heat waves constitute two natural hazards that will become more intense and frequent due to the ongoing climate change and urbanization (Davis and Naumann, 2017).

In cities especially, dealing with those risks has become a major stake and can integrate two relevant strategies: mitigation and adaptation to climate change (see definitions in part 1).

We here intend to stress how it is possible to adapt to those two hazards through NBS, and how to mitigate them through the deployment of green solutions. Measures to adapt and mitigate are bringing multiple benefits which can't all be reviewed in this part (see part 1).

We also aim to show how woodland is especially relevant in both processes of adaptation and mitigation of natural hazards such as floods and heat waves. They could constitute a suitable NBS for those specific matters.

I.6 Adaptation: coping better with heat waves and floods

Adaptation to the effects of climate change means acknowledging a potential risk, accept it and live with it better.

I.6.1 Adapting to flood risk

The high urban densities and the resultant soil sealing is making flood events more intense, and is leading to high economic losses, troubles in organization, and more importantly, possible casualties. Managing water is then a very serious challenge. The traditional solutions chosen, often piped drainage systems, are insufficient in the context of climate change. As cities have for a long time tried to cope with floods through grey solutions, advance research are making the case for what is called sustainable drainage systems (SUDS). As they intend to deal better with potential floods, they are also expected to bring other benefits regarding to climate change stakes (Davis and Naumann, 2017).

SUDS take different forms according to each local context and intend to reduce the negative effects of urban flooding, which potentially make them a strong tool for climate change adaptation.

They can be:

- rainwater harvesting systems (on roofs...)
- green roofs
- permeable pavements
- bioretention systems
- trees
- swales, detention basins, retention ponds and wetlands
- soak ways and infiltration basins
- etc.

Such devices need to be implemented taking into account the local context, meaning the current existing drainage system, the availability of technologies.

The challenges related to the implementation of SUDS remain the uncertainty related to such systems, the effectiveness (which varies according to the context) and the performance. Also, one serious barrier is the potential trade-offs when dealing with floods: for instance, wetlands are relevant in many ways to adapt to climate change when it comes to cooling places down, filter pollution and increasing water storage, but they are also likely to bring disservices such as diseases from insects (Haase, 2017).

Hence, increasing knowledge around NBS is essential to foster a wide implementation.

Managing flood risk: the case of Cloudburst Management Plan, Copenhagen

Locality and Climatic conditions & urban space

Copenhagen is in the oceanic climate zone. Its weather is subject to low-pressure systems from the Atlantic which result in unstable conditions throughout the year. Apart from slightly higher rainfall from July to September, precipitation is moderate. While snowfall occurs mainly from late December to early March, there can also be rain, with average temperatures around the freezing point. On 2 July 2011 large areas of the city of Copenhagen were flooded in a cloudburst. The flooding caused significant problems for the infrastructure in the inner parts of Copenhagen and Frederiksberg (Figure 4). In certain places up to half a meter of water covered the street and several houses and shops had suffered serious damages.



Figure 4. Copenhagen climate conditions (Photo Credit: Ramboll and Ramboll Studio Dreiseitl)

The “Cloudburst Management Plan” addresses 8 central city catchments (Nørrebro, Ladegårds-åen and Vesterbro, Valby & Vanløse), encompassing a total area of 34 km². It includes 300 separate projects that are expected to run over the course of the next 20 years.

The Ladegårds-Åen catchment was selected as a prototypical test area due to its high risk to flooding and sea surges. Comprehensive site analysis led to establishing the Copenhagen Cloudburst Formula and a Cloudburst Toolkit of urban mitigation strategies and components.

Actions

The process was formalized as the Copenhagen Cloudburst Formula, a six-step procedure for integrating the Blue-Green Approach:

- Data and Investigation: The city investigated, identified, and ranked areas according to their overall threat due to Cloudburst risk indicators, their potential to stir investment and

influence property value, and the viability of implementation affecting adjacent developments.

- Modelling and Mapping: Municipalities divided their regions into stormwater catchments, undertaking large-scale hydrological models (including GIS, surface water, sewage, landscape character, risk assessments) to map vulnerable areas. The conclusion - traditional piped solutions alone were not enough. The result - public water utility companies began financing solutions that integrated Cloudburst events.
- Cost of Doing Nothing: An analysis undertaken by the city and consultants calculated that the effect of climate change was so large, that the cost of doing nothing would amount to approximately €55-80 million a year from now to 2110.
- Design and Qualify: Hotspots were identified, transferring strategic planning to human-scale experiences as a model for how other cities can mitigate Cloudbursts and daily rain events. The “Cloudburst Toolkit” was developed as a palette of universally applicable, multi-functional, flexible elements.
- Involvement and Iteration: Cloudbursts would influence each area of Copenhagen; an overall strategy for a public participation program was established to gauge the requirements of the citizens who would be affected.
- Cloudburst Economics: A detailed socio-economic Cost-Benefit Analysis (CBA) tested two masterplan options. The option with the highest percentage of Blue-Green solutions and also the least additional infrastructural pipe improvements created a potential savings 50% greater than Conventional solutions alone. Additional qualitative social benefits, such as health, environmental, and urban spatial quality improvements resulting from the enhancements would potentially push this number even higher.

Demonstrating the relevance of the Cloudburst Toolkit palette of retrofit techniques on the first selected Hot Spot of the 10 km² catchment of Lådegåds-Åen (a priority catchment set in the center of Copenhagen and at a high risk to flooding) investment opportunities in the form of Blue-Green techniques were created on the surface where they are visible, interactive urban components. The solutions are based on real situations, aligned to preexisting underground infrastructure.

Two masterplan variations were developed to assess potential advantages and disadvantages - Option 1_Conventional and Option 2_Blue-Green. Crisscrossed by a number of constructed urban barriers (such as streets, sidewalks, buildings, or train tracks) and with only minimal grade differences that prevent floodwaters from positively draining towards the main Copenhagen harbour outlet point into the sea, the key difference between the two options is the strategy for mitigating Sankt Jørgens Lake.

The Conventional Masterplan Option retained Sankt Jørgens Lake as it exists; there is cultural value in keeping the historical layout yet the lake currently lies above the surrounding street level and floods during rain events, requiring the creation of a new 5m diameter pipe to funnel flood water to the harbour. The technical engineering investment is calculated at twice the size and cost of the pipes required for the Blue-Green Option, and also creates limited new public green space.

In contrast, the Blue-Green Masterplan Option lowered the lake level from +5.8m to +2.8m, creating a new Cloudburst storage volume of 40,000m³ and a revitalized lakeside connection which had previously been only partially accessible. The lake overflows into a 2.5m diameter tunnel to the harbor as a reduced sized pipe. The solution combines the Blue-Green with the Grey (conventional) piped solution to result in a harmony between infrastructure and green space. (Figure 5).

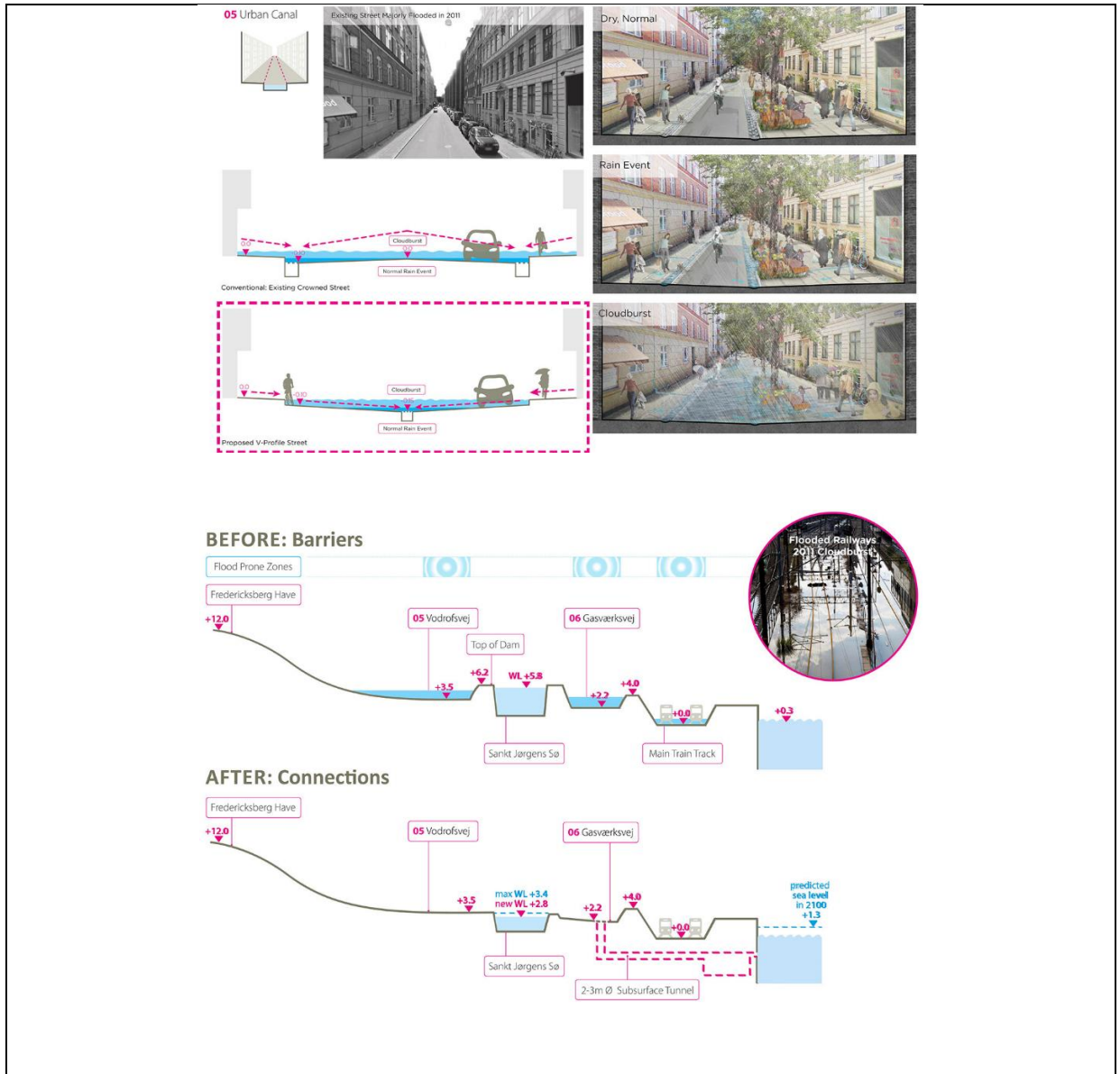




Figure 5. Cloudburst masterplan

Results

The Copenhagen Formula adapts interdisciplinary approaches, moving away from isolated thinking. A common vision aligned engineers, hydraulic experts, GIS and information technologists, architects, planners, biologists, economists, communication specialists, and landscape architects with local citizens, investors and politicians.

Cloudburst solutions are now implemented in local plans where synergy projects are encouraged between municipalities, water utilities, and philanthropists as catalysts for development. Public participation workshops encourage and allow citizens to actively shape their municipality's Cloudburst strategy.

Blue-Green is the future for establishing urban ecological waterscapes while balancing sound investment and economic opportunities with social benefit improvements.

Blue-Green Infrastructure represents the next generation of water infrastructure considerations where nature, city and recreational space are rolled into a holistic package. Cities around the world can look to the Copenhagen Cloudburst Formula as a model for implementing innovative, pragmatic, feasible measures within existing urban fabric.

1.6.2 Adaptation to heat waves

Ongoing urbanization as well as climatic changes result in effects on urban temperatures. As the global climate change is responsible for these large mutations, local circumstances are very likely to exacerbate this phenomenon: the urban heat island effect is then directly related to overpopulated and over polluted areas. The course of urbanization allowed the development of infrastructures and practices unsuitable to this current issue.

For instance, the development of dark surfaces (composed, for instance, of asphalt) contributes to increase the heat island effect because they conserve and accumulate heat. Urbanization also allowed less vegetation and created concentrated human activity (Taha, 1997).

Obviously, cities are currently not ready to face the heat waves to come, worse than this, the current cities' organization contributes to make their effects even harder. For instance, the 2003 European heat waves proved to be harder in urban areas: during the day the temperatures were higher than in rural areas, and the urban heat island effect was at work even at night (mainly because of the characteristics of urban places quoted above); in intense heat conditions, cool nights are especially important to recover from hot days. The threat was then higher in urban areas. (EE Europa)

Reducing the effects of urban heat island can be done in different ways, one popular measure being increasing urban green spaces: vegetation indeed plays a key role in the regulation of surface temperatures (Shishegar, 2014).

Urban green spaces can take different forms:

- urban forests (urban parks, street trees)
- ground vegetation
- green roofs
- they are expected to decrease urban temperatures through three processes:
 - evapo-transpiration
 - increase of direct shading on urban surfaces
 - influence on air movements and heat exchange (Ibid)

Case studies: adaptation to heat waves in different areas:

Bioclimatic Boulevard, Vallecas, Madrid Spain

Locality and Climatic conditions & urban space

In the framework of LIFE 'ECO-Valle Mediterranean Verandahways' project, the Ecosistema Urbano Office Architects has designed and built a bioclimatic boulevard at the New Expansion of Vallecas (Madrid, Spain) (Soutullo et al., 2011). The region is depicted in Figure 6. The region is experiencing the Mediterranean hot and arid climatic conditions.



Figure 6. The bioclimatic boulevard IN Vallecas.

This avenue is composed of temporary installations that will be reused in other open spaces once the boulevard has developed its own wooded zone, providing a comfortable area for pedestrians. In the urban space three different constructions are built along the boulevard under study as depicted in Figure 7. The first one is a set of wind towers and evaporative system, the second one is a vegetable envelope and the third one is a projector screen.

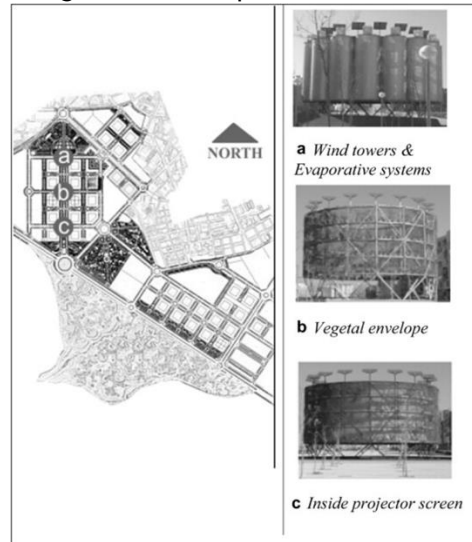


Figure 7. The different constructions are built along the boulevard.

Actions

As mentioned in the previous section each cylinder has a different approach aiming to improve the outdoor comfort and increase the social sustainability in the region. The northern one is composed of wind towers with direct evaporative systems installed on the top. The central 'Air Tree' is surrounded by a vegetal envelope that shades the interior area and reduces the ambient temperature thanks to the evapo-transpirative process. The third one is covered inside by a screen with a double purpose: to shade the interior of the 'Air Tree' and to be used as a television screen. All the structures are surrounded by sixteen units with four photovoltaic panels each; with a power rate of 165W per module. This photovoltaic installation supplies all the energy requirements and makes the 'Air Trees' independent of the electricity grid.

Results

The average temperature decreases due to the evaporative cooling at the pedestrians' height (1 m) is almost 3.5 °C with an average saturated cooling efficiency of about 32%. Moreover, the Heat index and the thermal sensation Givoni index are calculated based on the outdoor conditions measurements (i.e. air temperature, humidity, solar radiation, wind speed and direction) showing that the pedestrian zone closer to the evaporative tower have increased comfort levels for higher fraction of the day comparing to the regions outside the bioclimatic boulevard.

River Don, Sheffield, UK

- Locality and Climatic conditions & urban space

The area under investigation is situated along the River Don in Sheffield, UK (Hathway and Sharples, 2012). The climatic conditions in UK are influenced by the Atlantic Ocean and is generally temperate with cool wet winters and humid summers.

The river Don in Sheffield enters the city of Sheffield after passing from the rural area. The urban heat island of the city is evaluated by (Hathway, A., & Sharples, 2011) (Lee, S. E., &

Sharples, 2008) and its intensity is almost 2K. The space under investigation is the one adjacent to the river in locations which are either parallel or perpendicular to it.

- Actions

The main urban heat island mitigation technology is the water of the river and the cooling of the adjacent areas via evapo-transpiration. As a result, a series of measurements were taken either directly adjacent to the river or running perpendicular to the river bank.

- Results

The results show average cooling of nearly 1K or more for outdoor conditions with air temperature higher than 20 °C. Hourly averages of the two hottest periods indicated that the cooling effect depends on the urban form and the materials' used.

Tsim Sha Tsui and Sheung Wa, Hong-Kong

Locality and Climatic conditions & urban space

Hong Kong is situated in a region with humid sub-tropical climate which is strongly affected by the monsoons. The city experiences hot and humid summers with temperatures higher than 30 °C and relative humidity of around 80%.

Hong Kong is a densely populated urban region with insufficient buildable land resources. This compact urban morphology can cause thermal heat stress, especially during the hot and humid summer months.

Actions

Hong Kong's policy from 2000 onwards was the greening of the urban area to provide improvement of its environment. The 1999 Policy Address stated that the government should put power to make Hong Kong a green model for Asian cities. A number of Master Plans have been elaborated targeting in the increase of greenery in Hong Kong. Therefore, the main mitigation technology examined is the increase of greenery.

Results

The performance is analysed by measuring the outdoor conditions in the various regions and by numerical modelling using Envimet 3.1. (Team, 2010). The analysis showed a temperature decrease varying from 0.2-1.2 K depending on the size of greenery surface area and height of plantation above ground. It is concluded that a cooling effect of about 1 K is possible when tree coverage is larger than 1/3 of the total land area when the building coverage ratio is set to 44%, which is the average value in Hong Kong.

University Putra Malaysia, Malaysia

Locality and Climatic conditions & urban space

Malaysia is a South-East Asian country situated in a tropical region near to the equator. The country lies between 1° and 7° North latitude and extends from longitude of 100° -119° East, with hot and humid climatic conditions and heavy tropical rains. As a tropical country, Malaysia experiences constantly high temperatures and relative humidity, light and variable wind conditions, long hours of sunshine with heavy rainfall and overcast cloud cover through the year. The daily air temperature varies from a low of 24 °C up to 38 °C while the recorded minimum temperature is usually during night. Malaysia has high humidity while the mean monthly relative humidity ranging from 70% to 90% all over the year varying from place to place and from month to month.

The urban space under investigation is the campus of University Putra Malaysia. The analysis is focusing on the outdoor comfort of the pedestrians in shaded spaces under hot and humid conditions. The two study areas are both shaded but with different shading material. The one is shaded by polycarbonate while the second space is shaded by plants and trees.

Actions

The urban heat island mitigation technology under study is shading with plants and vegetation.

Results

The outdoor comfort conditions are assessed using the Physiologically Equivalent Temperature (PET) comfort index. The analysis showed that for the overall period the outdoor conditions were outside the comfort range as defined for tropical climate, i.e. $PET < 30\text{ }^{\circ}\text{C}$. The spaces shaded by plants had longer periods of thermal comfort.

Green Parking lots, Kobe Japan**Locality and Climatic conditions & urban space**

The specific parking lots which are under examination belong to a public parking space managed by Hyogo Prefecture and are located near Kobe City Centre (Takebayashi and Moriyama, 2009) Kobe has a humid subtropical climate that is mild with no dry season, constantly moist (year-round rainfall). Summers are hot and muggy with thunderstorms. Winters are mild with precipitation from mid-latitude cyclones. Seasonality is moderate. The urban heat island mitigation effect from changing asphalt-covered parking areas to grass-covered ones was estimated by the analysis of surface temperature decrease and the surface heat budget.

The site is located in the residential area of the central ward, Kobe City. The southern side of the site is open, facing the road, with a five-storey building adjacent to the western side and a two-storey building adjacent to the northern side of the site. The size of each parking lot is $5.3\text{ m} \times 2.5\text{ m}$, and the access aisle is approximately 7.4 m wide; thus, the size of the site is approximately $56\text{ m} \times 18\text{ m}$.

Actions

The mitigation technology applied is changing the surface from asphalt to grass. Various types of grass have been laid without removal of the older asphalt surface. The urban heat island mitigation effect from changing asphalt-covered parking areas to grass-covered ones was estimated by the analysis of surface temperature decrease and the surface heat budget. In addition, the appearance of the parking lot, the growth of grass, the effects from the weight of a car and the heat radiated from its engine, and the costs of construction and maintenance were also considered.

Results

The urban heat island mitigation effect and the thermal environment improvement effect were estimated by observing the mean surface temperature of the parking lot by using an infrared camera. The tendency for the mean surface temperature of a parking space to decrease with an increase in the green coverage ratio was confirmed, but the mean surface temperature of parking spaces varied greatly depending on the other materials used in addition to grass. From the analysis of the surface heat budget for representative parking spaces, the sensible heat flux was reduced from around $100\text{-}150\text{ W m}^2$ in the daytime to around 50 W m^{-2} during the night, in comparison with asphalt.

Chapultepec Park, Mexico City**Locality and Climatic conditions & urban space**

Chapultepec Park is a very large park in the western part of Mexico City. Its surface area is about 525 ha . The Park includes a number of recreational activities such playgrounds,

fountains, a zoo and artificial lakes. Moreover, a cemetery and museums exist inside its area. Surveys have revealed that the condition of trees in the park (many of the same old age) is declining at an alarming rate and air pollution has created canopy openings. In recent years, however, the city authorities have undertaken a park renovation program including the planting of trees. Chapultepec Park is a very large park in the western part of Mexico City. Its surface area is about 525 ha. The Park includes a number of recreational activities such playgrounds, fountains, a zoo and artificial lakes. Moreover, a cemetery and museums exist inside the park area.

Actions

Studies concerning the performance of the park revealed that the condition of trees in the park was declining and air pollution has created canopy openings. A planting of trees and park renovation program was initiated.

Results

The temperature difference between the park area and the nearby urban site in Mexico City are 3-4 °C. The smaller thermal inertia of the wooded area results in a higher heating rate at the park during the morning and at midday hours.

1.7 Mitigation: stabilizing greenhouse gas concentrations through NBS

The processes described above help to adapt to the growing effects of climate change, here namely floods and heat waves. Not only some devices are a way to adapt, meaning to cope better with the effects of climate change, but also to help mitigate climate change by stabilizing the concentration of greenhouse gas in the atmosphere.

All the NBS presented below, especially the ones involving woodlands, are relevant to foster climate change mitigation.

Indeed, urban forests are a way to store and sequester carbon, capture gaseous and particulate matter: these processes allow a better atmosphere quality, and on the whole, urban forests bring a high number of benefits: visual amenity, well-being, cool islands, opportunities for outdoor recreation, etc. (Brack, 2002).

However, those benefits are not automatic, greening a city by creating urban forests or planting more trees must be done according to thorough evaluations and examinations of potential trade-offs:

- mitigation of climate change through carbon storage using vegetation can bring disservices for people if the concerned vegetation releases volatile organic compounds for instance.
- The increase of property value, which can be a side effect of the plantation of vegetation in an area is likely to lead to gentrification processes.

1.8 Discussion

The various NBS used to adapt and mitigate described above are not simple and uniform in the impacts they produce. They are complex, and like any object, can become out of hand. Indeed, trade-offs exist and need to be taken into account

when considering any implementation. To illustrate this trade-off problem, ecosystem services can be relevant: human management choices result in changes in the services provided by the ecosystem. Trade-offs might happen when the provision of one ES is reduced as a consequence of increased use of another, sometimes unintentionally. Such trade-offs are related to space scale and temporal scale issues, as well as reversibility (Rodriguez et al, 2006).

As we tried to show when reviewing various ways to cope with heat stress, flood risk and reduction of greenhouse gas in the atmosphere through plantation of green areas, trade-offs are likely to appear and identifying them is essential to have the most complete view of the potential outcomes of a measure. It raises the issue of implementation of NBS: to achieve their multiple goals and strive towards sustainability and resilience,

For instance, if we refer to NBS involving the plantation of woodland, the process needs to be thought carefully. Indeed, planting trees may be relevant for the absorption and reduction of air pollution but might increase the release of biogenic volatile organic compounds, that contribute to smog or ozone formation. Tree species need to be analyzed and assessed in their particular location before any implementation, otherwise it can lead to serious counterproductive effects (Livesley, 2018).

NBS have a potential which can be fully realized with the establishment of a relationship between all relevant stakeholders: policy makers need to be aware of all risks (social, environmental, economic) before putting in place any measure with a specific goal.

IV) Issues of implementation of NBS to adapt and mitigate climate change in inhabited territories.

To understand NBS and related issues of implementation a bit further, we examine briefly some of the salient matters related: governance models and scales issues, participation and local trust, technical considerations, knowledge and communication.

1.9 Finding the right level(s) of action

Environment has become a public issue over time due to the increased scientific evidence of climate change impacts among other. Environmental issues then became subject to state regulations through policy, law, fiscal and economic tools... They present specificities which can't be handled only through traditional public action: the long-term perspective they imply, the (numerous) spatial scales they entail, the transversal nature of the stakes implies a evolution of traditional public action (Lascoumes, 2018).

These observations made for environmental stakes at large are relevant when referring more precisely to NBS implementation:

The need for long term vision towards resilience instead of the short-term research of quality is pointed out when referring to NBS barriers of implementation

(Deliverable 5.1), as well as the need for different scales of implementation to achieve multiple benefits (Deliverable 5.2).

The stakes related to NBS are not embedded in traditional territorial and administrative subdivisions: the state itself can no longer be the sole level of analysis, thus there should be an interpenetration of spatial scales from local to global (Lascoumes, 2018).

Such premise goes along with one of the NBS principles stated by the IUCN: “are applied at the landscape scale”, which does not always fit with administrative frontiers. To go even further, the bioregionalist concept is interesting to convene when referring to spatial scales.

Bioregionalism means “a life-territory, a place defined by its life forms, its topography and its biota, rather than by human dictates; a region governed by nature, not legislature” (Sale, 1985).

“Often described as a river basin or as a watershed, it is a natural framework for economic and political decentralization and self-determination” (Roseland, 1997).

This body of thought, although theoretical, envisions an alternative way of thinking the territorial space organization.

The territory and its management as they are conceived nowadays are potential barriers to the vast implementation of NBS. They require a shift in decision-making and public action trajectories, often led by silo thinking.

Termeer et al. (2010) have developed an interesting framework to deal with sustainable management. Public goods, which are non-excludable and non-depletable (Encyclopædia Britannica), are often involved for such a management, which makes it quite impossible to match with the usual frameworks; thus it could be relevant to inspire from the proposed framework when referring to forms of governance for NBS: after having pointed out the lack of fit between the traditional governance system and the reality of ecological issues, it stresses two improved ways of governing.

To deal with the issue of scale, multilevel governance involves a displacement of state power and control to: international instances - region, cities, communities - civil society and non-state actors.

Governing becomes a matter of interactions between different kind of actors (public, private...) at different levels.

Adaptive governance adds the dimension of uncertainty and then flexibility to deal with potential mismatches between scales and unwanted outcomes.

The holistic dimension of NBS indeed requires an interaction between scales:

“Improving the functional and spatial connectivity of these landscapes is a prerequisite to its ability to mitigate and adapt to climate change and in turn to increase the value of the goods and services that ecosystems provide (Grimm et al., 2008; Hodgson et al., 2009) thereby moving towards achieving urban sustainability. A solution to this challenge lies in developing GI approach that considers the landscape as an overall blanket of inter-related ecosystems in which single components interact with each other through a multitude of elements (Weber et al., 2006) (Ranjha, 2016).

On a horizontal line, it is necessary to distribute the financial means correctly between the different relevant services. Often, the renaturation projects have their financing restricted to a sole service (green spaces for instance), even though they are likely to bring benefits in multiple domains. Valorizing NBS as multibenefits and emphasizing their relevance would be a way to gain financial support from other services in collectivities. Conceived like this, NBS would become a more holistic object.

The Grüner Ring Leipzig allows the cities involved to finance projects through the redistribution of each city's contribution.

Described the way they are, such structures of governance also seem to take into consideration what can be a potential barrier: the mistrust and potential reluctance of locals when it comes to NBS projects on their territory. Characterizing the displacement of power to all forms of stakeholders at different scales implies involving the locals to the processes, which can ultimately increase the will to participate in projects of implementation of NBS.

I.10 Culture and participation: come to terms with locals' expectations

Urban planning, implementation of NBS, processes of renaturation most of the time happen in inhabited territories. It raises the issue of inclusion and participation of locals because they are the first concerned by potential NBS projects. However, the presence of nature is not always welcomed for different reasons:

Various NBS measures include the increasing presence of nature in cities (vegetal walls or roofs, plantation of trees, introduction of retention basins...). Green spaces may convey a feeling of unsafety in certain cases: in the very densely populated areas, such a feeling exists, whereas in less urbanized and rural areas, the green spaces are more likely to bring a feeling of safety (Maas et al, 2009).

In different contexts indeed, this feeling may appear, sometimes for very specific reasons: in the eco-district Clichy-Batignolles, Paris, the new law court is to be constructed, and a tension between the objective of renaturation and the security issues related to terrorism appeared. In this context, nature was an obstacle for surveillance and ultimately public safety.

In other contexts, it offers many places to hide for children, which is seen as something dangerous as it becomes less easy to keep a close watch on them (interviews for the OASIS project, see part 3).

There are also risks related to tree species, bringing more pollen and allergies in some areas as well as a possible reluctance to the closeness of nature. (conceived as more than some natural elements).

More generally, the topic of hygiene is likely to be a problem: for instance, reintroducing nude soils instead of concrete or asphalt to reduce the absorption of heat poses a cultural problem: urban dwellers are used to a "clean" environment, and in this perspective, a nude soil is likely to be seen as dirty (Groves, 2011)

All those barriers (most of them being cultural barriers) are as many opportunities to reshape the relationship between urban dwellers and nature. Instead of staying in a paradigm of domination and control of nature, such processes of introduction of

nature could contribute to building a new alliance, understood as a condition for the living (Paris Forum, Chris Younès).

It is an unprecedented occasion to change our ways of life towards more simplicity, happy frugality.

Communicating and informing about any project is also crucial, and to win people, integrate them in the process and show them how they can benefit from it seem to be a good way to proceed. And even more, involving people in urban projects has practical advantages: it can mean less involvement of public authority for the maintenance of layouts, and it responds to a public need to participate in projects. The implication in projects is also likely to favor more respect towards the environment people live in (Pauleit et al, 2017).

One uptake in the deployment of processes to adapt and mitigate climate change would be to make people understand the benefits nature can provide. People have capabilities and can be a part of projects to enhance their own environments and lives (Paris Forum, day 2).

Projects involving nature-based solutions for CCAM are an opportunity to renew public action, in dialogue with locals and associations (Project Capadapt, Paris Forum).

Managing risks of floods in the Netherlands: making the case for multilevel governance and participatory implementation of NBS (Climate Adapt).

To avoid flood risks in Nijmegen and its surroundings, the national government largely funded a program to increase safety around the river and increase urban quality. During the process, stakeholders and the local community were involved. As the project implied that some people had to move from their houses, discussions were more than necessary.

To make the project acceptable, the plan meant to be participatory: through newsletters, the locals were informed and were invited to participate in creating the plan.

Also, to make it relevant, it meant at coordinating forces between national, regional and local levels.

What was at the beginning a problem became an opportunity and contributed to limit the flood risk while enhancing urban quality through a multilevel governance and participatory processes.

The potential barrier to the project was clearly the potential reluctance of locals to accept it, but through this process of co-construction, they could claim ownership, and in the end the project allowed to reconnect people with their city and create a new identity around the river.

I.11 Making technologies available: market strategies

Making the case for NBS also supposes to make them economically valuable: a market strategy is important so as to convince decision makers, market actors to turn to NBS. Available technical devices need to be made more accessible and known to be taken over.

We can then note different stakes related to the implementation of NBS to foster climate change adaptation and mitigation. Thinking of those stakes implies having a sensible approach considering the existing porosity and interconnections. The trajectory sought is also important, if we consider NBS in larger frame of (re)naturation: building a new alliance between nature and city, reconsidering the shape of territories and their connections, developing solidarity to increase resilience of people and places in a context of potential collapsing (Servigne, 2015).

Part 2: qualitative and quantitative surveys with experts and stakeholders on NBS

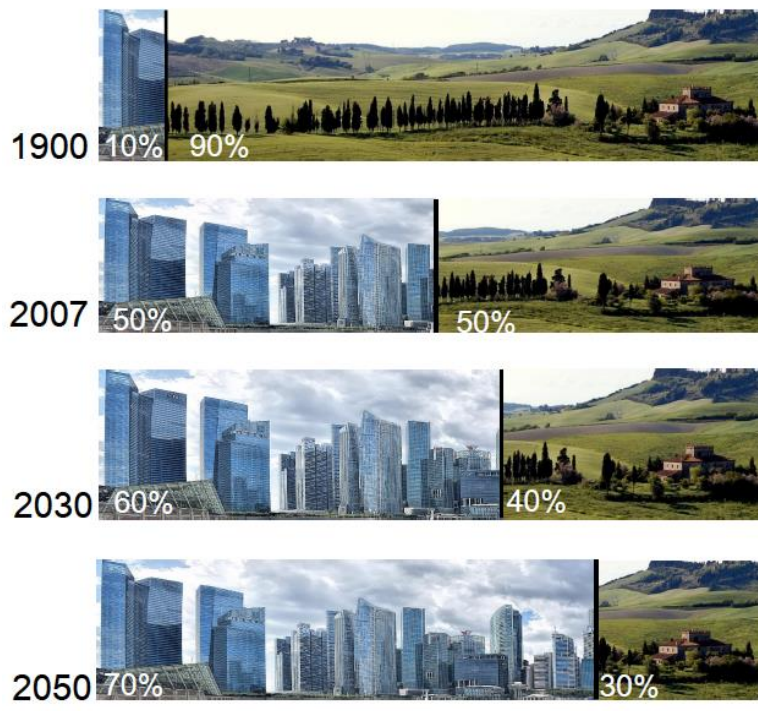
The first part was mainly based on literature and gave a general overview on NBS for CCAM as well as some information on the potential stakes to tackle when implementing them. To be more thorough, we now intend to analyze more in depth the barriers and uptakes with the help of experts' views: technicians, scientists, policy makers, engineers. The first section is based on a qualitative survey led by CSTB, and the second section consists in a quantitative analysis. Both help determining uptakes and barriers, as well as possible strategies to implement NBS at a larger scale.

I. Qualitative Survey with Experts and researchers on NBS to face Climate Change

Introduction

The consequences of climate change, according to the IPCC, are plural. Extreme weather events (storms, heat waves, droughts, heavy rainfall, fires, etc.) are becoming more frequent. In Europe, this development is reflected in two major developments: Northern Europe is becoming wetter, Southern Europe is becoming drier, raising a serious problem for agriculture and water supply. The seasons have also become unstable which also has consequences for agriculture, flora and fauna. The sea level is rising and generating coastal erosion that threatens millions of people living near the coast. Glaciers are also melting massively, endangering many people and creating a new water supply problem. Finally, according to the IPCC, biodiversity is under pressure: pollution, deforestation, habitat loss, overfishing, etc. These developments combine and create knock-on effects. For example, in Greece, in the suburbs of Athens, drought-related wildfires in the summer of 2017 burned the trees and their roots, which constituted a natural barrier, which led to floods and mudslides in autumn after intense rains.

At the same time, urbanization is spreading, making today that men are mostly urban (53%) and will be, according to the United Nations projections, 65% by 2050. This urbanization waterproofs soils, making them poorly adapted to this new climate.



Nature helps to face climate change. The natural solutions for the climate, resulting from the natural, forest and aquatic environments, according to the National Academy of Sciences (PNAS) allow a carbon absorption, an improvement of the quality of the air, grounds, water, while preserving biodiversity. Thus, it is estimated that plants and soils currently absorb 20% of CO₂ worldwide. Trees have the greatest potential for CO₂ absorption and are considered a true carbon sink (2.5 kg / yr / tree) while controlling the effects of heat (evaporation, absorption of light rays, etc.) and cold (protection of cold winds) improving the quality of water, air, soil and plant biodiversity but also faunistic.

Therefore, to adapt the inhabited territories to the evolutions linked to climate change, it is important to develop natural environments, especially forests, pastures and agro-agriculture lands, wetlands, but also to consider, given the urban extension without previous, a renaturation of urban spaces. The aim is to preserve and extend the forests that now cover 30% of the land, in order to limit the agricultural and livestock lands that generate CO₂ and methane. For the American NGO, The nature conservancy, it would require a reforestation of the grasslands and a limitation of the breeding.

What can the NBS, and even more so the "urban naturation", in the face of these growing climatic hazards? Can they create more resilient and quality living environments? How can nature solutions be deployed in public policies and development of inhabited areas?

1. Qualitative Survey analysis

This approach proposes an analysis of a qualitative survey with researcher, experts, cities (20 interviews) who work on hazards and NBS conducted by CSTB in 2018-2019 (cf. the list of respondents in the annex)

This survey questioned the issue of NBS to face climate change. The stakes are to identify the barriers and levers for NBS deployment in public policies. The main barriers are cultural. It needs a paradigm shift in relation to the nature of our civilizations, which can be based on a more holistic acceptance of Nature and build on policies initiated by sustainable development.

The topics for the survey are:

Qualitative Survey:

- Definition of NBS
- Field of research and expertise in NBS
- NBS on which the respondent is currently working
- Relevance attributed to NBS
- Differences between nature innovations and technological innovations
- NBS Stakeholders in France: institutions, research programs, networks, etc.
- Method to conciliate NBS and urban (re)naturation
- Contribution of changes of a nature to the change of urban setting, urban quality
- Contribution of innovations to urban resilience and adaptation to climate change
- Contribution of NBS to quality of life, well-being
- Barriers and uptake for local deployment of NBS
- Current action interesting to be valorized in the context of the European Think Nature project

2. Identification of stakes relative to NBS

2.1 Revamp the relationship with Nature in inhabited areas

The NBS contribute to an ecological urban design that refers to the richness of biodiversity but especially the wealth of ecosystems, their functioning (Clergeau, 2018) as a lever for adaptation of living environments to climate events while providing a qualitative environment for well-being. It means to consider Nature (one nature) as the founding categories of the world, through the four elements: water, earth / soil, air and fire / energy that opens to earth life. It implies a holistic vision of nature that can change the foundations of a transformation of inhabited

environments in relation to the intelligence of nature likely to reduce vulnerability to climate issues and events.

While biodiversity policies have afforded the growth of green and blue infrastructure and reserves for biodiversity, experts believe it is important to scale up and make NBS deployment a more holistic approach to revamp the city in its ecosystemic links with nature, as the basis of ecology and even of ecosophy (Guattari, 1989), at the articulation of environmental, social and mental ecologies. For Guattari, "the ecological concern does not only concern the natural environments, the built-up area or the physical territories, but also a reinvention of the individual and collective "existential territories", in the light of the inseparable link between humanity and the biosphere, both are tributaries of the increasingly complex "technosphere" that surrounds them (Manola, 2018).

This new urban paradigm, which tends towards a conciliation between nature and culture, nature-city, entails and rests on a new apprehension of relations between human beings, nature and the city. In this emerging socio-urban ecology, nature and culture form a continuum where humans and non-humans are closely related, interdependent and co-present (Feld and Basso 1996, Descola and Pålsson (1996). This paradigm involves to gather this relationship. It supports the question posed by Marcel Poéte (1919) on the link of the city to its geo-morphological site or more recently of Uzzel and Rätzzel (2009) for which the concept of environment traditionally distinguishes the built environment of the so-called "natural" environment and is considered too segmented even though the notion of nature, for example, is in itself also a constructed notion (because emanating from distinct forms of relationships) (Depeau and Ramadier, 2015, chap1).

2.2 Extend sustainable development policies for human settlements design adapted to climate risks

The challenges of the sustainable city have begun to raise environmental awareness and the mobilization of green technologies. They aim to preserve the resources of the planet and to control the continuous urbanization of the world. Environmental techniques are mobilized to limit the adverse impacts of urbanization for the survival of the human species and to correct the ecological effects of the pursuit of economic and urban growth. These choices reconfigure metropolises and their urban models towards the protection of the environment but also economic competition. They lead to renew the urban factory by mobilizing new green technologies and limiting fossil fuels. Sustainable urban development is thus primarily concerned with environmental technologies and less with the benefits of nature. It does not put into perspective the societal, individual, ecological and urban issues that inhabited environments pose. It therefore needs to be expanded to revamp the basics of ecological planning based on renaturation and resilience, but also sensitive, to improve the quality of life and well-being of city dwellers.

With the ambitions of sustainable cities, environmental and technical legislations have emerged. They aim to limit the energy consumption of cities, especially buildings (lead, low carbon, RT2012, ...), act on travel (promotion of soft mobility, electric vehicles, etc.), promote the production of green energy (wind turbines, solar

panels, etc.), recover rainwater, limit pollution and promote the protection of natural environments (water, biodiversity, etc.).

Because of this protection of nature, greener urban policies are implemented. Green and blue infrastructures are deployed to protect corridors and reservoirs of biodiversity. They are thought as places of reception of the biodiversity. In the urban space itself, if the benefits of the plant continue to be praised and the development is planted, these remain primarily emblems, not to say urban trademark of appearance more sustainable development (Bailly, 2015). The greening of urban projects is most often an ornament and not a way to reconsider the urban environment and the well-being of city dwellers. It does not make it possible to revamp living environments and even less to adapt cities to the needs of adaptation to climate change.

This consideration of nature dissociate with the city and urban projects is explained by the legacies of an urban thought built on a city and countryside opposition and on a demand interpretation of a centered nature. on functions and not a need for landscape. These cultural dimensions make it a major obstacle to the deployment of Nature Based Solutions and, more broadly, strategies for renaturing living environments.

3. Identification of levers for the deployment of NBS

3.1 *The concept of NBS*

Despite plethora and vague definition, an interest of the NBS term introduce an idea of innovation that offers perspectives and tools for elected officials and professionals.

NBS is a recent European expression that is inappropriate. Experts and researchers prefer the term Nature. NBS can be interesting, however, to refer to the ecosystem services of nature, but tends to reduce nature to its utility without considering the other dimensions that surround it.

The term renaturation seems more consensual even if it does not refer to the same meanings depending on the disciplines (delivery to the state of nature of a riverbed for ecologists, reintegration of nature in the city (park, etc.).

3.2 *Policy, governance, territorial development levers*

Vehicles of thinking and intervention at new scales

- NBS allows reasoning on a large scale and especially at the urban and territorial scales. Feedbacks show the favourable impact of NBS if it is deployed on a large scale and in a sustainable manner in territorial strategies. There are areas favourable to the development of renaturation projects, especially the peri-urban area where there is an extensive low-density urbanization with many empty spaces (parking area, warehouse that can mutate or accommodate green roofs).

- Growing interest in the issue of nature for professional and public policies, in particular through acculturation to the environmental issue and understanding of the multifunctionality of biodiversity that afford views for new nature's ambitions.

Ex: "The decision must be political. Goals from a European directive with more global objectives"

- **Agricultural transition.**

Ex: "Many farmers are ready for an agricultural transition facing the CC. Public policies have to support them especially with the NBS".

- **Develop links between the city and rural areas**

- **Attractiveness of territories**

Ex: Biodiversity and nature offer opportunities for development and attractiveness for the territories. This requires developing an educational approach.

Ex: "The challenge at the Direction de la nature of Bordeaux is to demonstrate that Nature has a value, in the same way as economic land or land to urbanize to make housing".

Ex: "The quality of life and environmental quality go through nature. This is a fairly recent awareness, though, which is still a little stammering, which is not yet apparent in the indicators. We also fight, for example, quite simply, for very simple things. There are indicators of attractiveness, like all metropolises, which are essentially indicators related to the economic component, the number of dwellings produced, etc., and not necessarily to the number of hectares of natural space per inhabitant

3.3 Economical levers

The growth of differentiated management has shown interest in terms of management and cost of urban renaturation.

The existence of a market is a key factor in the possible development of NBS.

Project financing and requests for proposal are vehicles for the development of an economic sector for NBS. Ex: « I am in contact with a design office that won a project in the town of Miramas and would like to insert a principle of gray water recovery".

Incentive measures. The Label or programs as the PIA (Future Investment Program) are evaluated as effective incentive measures.

3.4 Regulatory framework

Regulatory framework can be a factor for the development of NBS by imposing them.

For example, in Yvelines in Ile-de-France (France), the revision of the PLU (French tool of urban planning) was an opportunity to impose a thickness of substrate (20% of the envelope of a building must be planted). This is also what has been applied in the PLU in Grenoble.

Other example, the regulation can facilitate them by acting on the constructability of natural areas. Bordeaux has thus made land unbuildable to accentuate the potential of NBS.

3.5 Quality of life, atmosphere and landscape as levers

NBS are consensually described as quality of life factors in a global approach. They offer landscape perspectives and act on atmospheres, more particularly in cities.

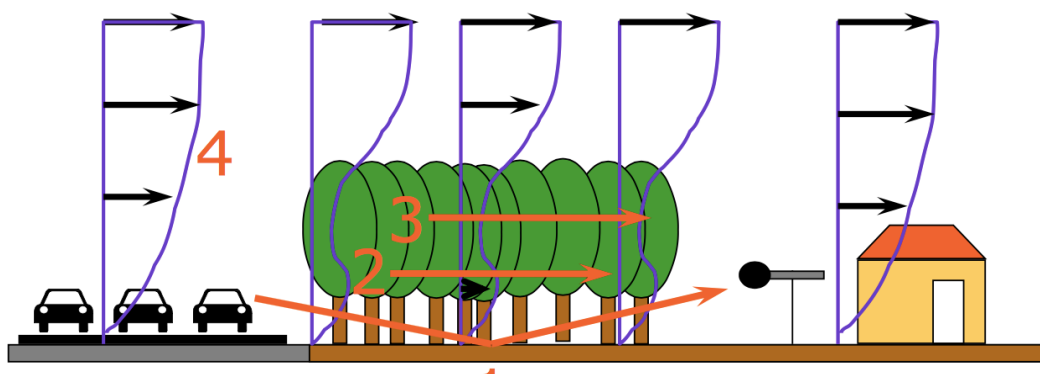
- Aesthetics of nature elements is highlight

Ex: *"It's nicer than seeing the black concrete roofs"*.

- Impact on the sound environment of the places.

Ex: The city of Bordeaux is developing its noise and environmental prevention plan by questioning the question of resilience and quality and living conditions for its inhabitants. *"How can nature be a solution for noise nuisance and, in the best case, cross, precisely, solutions with air pollution, thermal comfort, etc.?"*

Jérôme Defrance describe several NBS and their impact on level of sound. He explains how some forms of mound make it possible to diffuse the noise. The porous mounds absorb sound (by vegetation).



Forests have a climate and sound screen effect. The trees broadcast the sound nearby and reduce the atmosphere of a few decibels.

The vegetated screens along a circulated street reflect the sound nearby (zone of diffraction - down about 15 db).

The casing of the frame is related to the reverberation of noise on the facades. The greening of the facades absorbs the reverberation of noise and lowers the noise a little. The plant softening the reverberations.



3.6 Citizenship and social relationships

NBS brings aesthetic benefits, well-being and participates in a social dynamic by promoting the involvement or even the collective reinvolvement of public space.

Ex: In Bordeaux, the city emphasizes that social demand of nature has increased in terms of presence of space of nature that of mobilization in spaces of nature. Volunteers propose deasphalting portions of streets to plant and manage street gardens themselves.

3.7 Enhancing of local operations and trials

Feedback from experimental sites where pilot operations have been conducted provides a pedagogical dimension and allows for communication about the benefits of NBS.

Ex: The actions of the Pariculteurs in Paris are considered as strongly motivated locally but also in a wider way through the mobilization of the national and international networks that the Parisian initiative has generated.

3.8 Cultural lever

Because of public awareness, growth of knowledge about CC and NBS benefits to face, regional government emphasize the need to develop nature in the city and the NBS to satisfy citizens and professional demands.

Ex: The city of Bordeaux develops a policy that integrates the NBS (but without naming them) to satisfy the expression of a demand in terms of leisure but also the concern of the farmers who care about the impact of their activity on their environment.

3.9 Combating the effects of climate change and natural hazards

Market gardening is an activity that is highly adapted to flood risk, since there are very few people on the farms

3.10 Enhance networking

NBSs are factors of synergy at different scales. For example, they enabled the agglomeration of Bordeaux to create partnerships with universities and local partners to create modeling tools (AS landscape graphs) and decision-making at the local level.

3.11 Technical Lever

For several stakeholders, NBSs often have more technical feasibility than grey technologies.

4. Identification of barriers

We have identified many brakes which concern both the knowledge, the design, the implementation and the management of the NBS

4.1 Barriers relative to knowledge

The first obstacle is linked to the lack of knowledge of the NBS term and the confusion of definition that is linked to it. We observe quite contrasting meanings, being associated for one with green technologies, for others with the nature, or with strategies of greening. In this sense, the terms "nature", "renaturation" and "ecosystem services" appear to be more shared. This confusion of the vocabulary explain that the lexicon associated with the NBS appears confused also. For example, the term resilience does not have the same meaning across disciplines.

Resilience is a concept with different meanings in different disciplines. This appears to be a source of confusion. Resilience as such is a value-neutral concept that is shaped by the challenge encountered and by the aspect under consideration.

In ecology resilience is the capacity of an eco- system to respond to (severe) disturbances and to return to a healthy equilibrium state.

In psychology resilience is seen as the capacity of a person to deal with simultaneous multiple challenges in an organised manner ('no panic').

In a socio-political context resilience is the capacity of society to respond in an organised and participative manner to hazards, large scale challenges and/or catastrophes.

Cf. Paris Forum 2019

This lack of knowledge also concerns the contributions of NBS compared to grey technologies. NBSs appear as complementary technologies when they could substitute them. Thus, today it is known that the management of rainwater at the source (or plot) is more effective than technical water regulation systems, especially in the event of exceptional floods related to climate change. will subject our societies to unknown situations.

4.2 Barriers related to public policies

NBS unknowns or not wellknowns

NBS appears, by ignorance, rarely mobilized by public policies and professionals of planning or territorial development. The scientific knowledge is however numerous but remain inappropriate because of not understanding the benefits for their territory.

Ex: For example, the project to identify refreshing places in Paris may have seemed counterintuitive.

Lack of strategy of naturation

Public policies do not display any strategic issues of (re)naturation and tend instead to mobilize NBS as a complement to spatial transformation projects, giving an environmental and greener image. NBSs appear as an attribute: a green roof here, a valley there, etc., without coherence or impact on the environment. Ecosystem services appear to be poorly perceived, as are the benefits in terms of urban quality and the welfare of NBS.

In Paris, decisions are mainly decided in advance. So, questions related to the vegetation and/or the type of material used are not heard.

Lack of expanding pilot experimentations

In fact, the projects of exemplary references appear little known and mediatised outside the academic circles and the experts of the environment.

Professional cultures do not expand their development.

Thus, planning or water management services have to develop their skills to integrate the intelligence of nature into their professional practice.

Organizational brakes and their consequences

Local governments are marked by weak organizations that are struggling to adapt to major strategic changes.

This mode of operation maintains silo action, hinders the identification of suitable technical solutions and explains for an expert that the problem of cooling cities is treated in Paris in terms of water resources or social link.

NBS also questions budget organizations, leading to budget transfers that can be a source of tension, not to say power conflicts between services. In this way, the networks belong to the green services departments of local authorities and no longer to the water management services. It can even call into question the assignment of taxes. In Paris, for example, there is a sanitation tax that may no longer be needed if the natural management of rainwater is favored, which would make a shortfall for the operation of these services calibrated for the design and maintenance of networks and water tanks.

4.3 Cultural barriers

Cultural barriers are plethora and limit the involvement of public policies. The representation of the inherited city is predominantly mineral. A renatured living environment is often valued but also criticized because it can be associated with the perception of:

Inconveniences

- Dirty (mud, dead leaf, etc.),
- Disturbance of walking (soft ground, etc.),
- New aesthetic codes of a spontaneous nature breaking with a landscaped nature and mastered by always accepted.
- Health risks (mosquitoes, disease),
- Natural risks and associated fears. For example, following river bed renaturation projects with flood expansion zones

Lack of awareness

For example, the use and management of water constitutes an important cultural obstacle, link to regulations brakes. An expert emphasizes that when heat waves occur there are conflicts around the filling of the pool and the use of fire hydrants that pose security problems. It suggests a new apprehension of the use of water. To start by not to impose that the water is systematically potable as it is the case in Paris.

Urbanization and continuous waterproofing

Problem of green washing (mapping with green) in urban projec. Transition from the map to the project tends to erase the green projects. Renaturation need to be a dimension of the urbain project. It will be also an opportunity to change the scale of NBS (not one-off projects or case by case project but a renaturation project wich combine several NBS).

4.4 Technical barriers

Technical constraint

Ex : vegetalization of building raise the problem of weight of the earth on roof in renovation situation. And after, *“the roof is alive and the living raises maintenance problems”*.

Integration or opposition of grey technologies and NBS

Ex: a system of depollution of wastewater by biological and natural techniques (bacteria, plants, the living) becomes a tool of bacteriological treatment is opposed to the chemical approaches of treatment of the water (often used for drinking water).

Complexity of design and management

Ex: green walls impose technological complexity for management and maintenance.

4.5 Regulatory barriers

Regulation can be a brake since it prevents or limits several uses, transformations and evolutions. Regulation has a controlling role. One of the limitations of NBS is that they are less controlled than grey solutions.

Ex: in France, the recovery of greywater is possible with a prefectural exemption. The prefect decides with the regional health agency.

Ex: Roof gardens generate a rise in the building. It must coincide with local regulations (Local Urban Plan)

Ex: The conversion of former agricultural lands into NBS - situated in a flood zone - is subject to the rules defined by a regulatory tool, the PAPI (Flood Prevention Action Program).

4.6 Health related barrier

NBSs generate social and health intolerance to fauna and flora.

Ex: green roofs bring allergens but also insects and rodents, spiders. Some people are afraid to open their windows and let in wildlife. They expose themselves to problems related to indoor air quality.

Ex: Vegetation can have a negative impact on air quality by disrupting the dispersion of pollutants in the streets with the foliage of trees.

4.7 Financial barrier

The cost of land

Lack of market

NBS remain a risk for manufacturers. Either they develop the NBS while waiting for the evolution of the regulations, or they wait for the regulations to evolve and to develop the NBS.

NBS are more expensive than gray technologies

Ex: A green facade or a green roof are more expensive than bitumen or gravel. In addition, the cost of setting up and maintaining is high.

Ex: In England, water is managed by private companies. Cities cannot freely adopt NBS.

Ex: The Mayor of London wanted to create a bridge on the Thames (London Thames Garden) with an oasis but the cost was deemed too high.

4.8 Noise and atmosphere

Ex: In England, NBS have been made in the field of mine water. The old mines (inactive for 100 years) have become natural parks. The treatment centers are very noisy and disrupt the atmosphere expected in the countryside.

4.9 Available space (ground)

Solutions that use less energy require other types of infrastructure that require more space.

Ex: Passive solutions take much more space than active ones. This is not a problem in the countryside but in the city.

4.10 Local ecological characteristics

Ex: the composition of the soil makes it sometime impossible to implement NBS.

4.11 Temporal perspectives

Political time is not the same that natural rhythm, project time, etc.

II. Quantitative analysis: identification of barriers and drivers for the implementation of NBS used for CCAM

The present section provides a description of the main barriers and drivers identified by the stakeholders and organisations who participated in the surveys carried out in previous phases of Think Nature project (i.e. tasks T5.1 and T5.2). This introduction explains the reasons for the separation made between barriers and drivers.

The implementation of NBS is a response to the progressive climate change impacts on the planet and on urban areas. These solutions are facing however a certain number of barriers, which report to a present situation that affects their application and development. Meanwhile, drivers are the main subjects to work on, in order to overcome barriers and to find processes for the correct implementation of NBS at different levels.

It is therefore crucial to focus and understand firstly the existing barriers to green and blue infrastructure projects, before even thinking of solutions. On the other hand, drivers can then be the starting point for NBS, if they are able to manage and eliminate the negative effects of barriers. For example, the lack of technical knowledge is certainly a barrier but sharing it between the scientific communities and people can also be a driver to adapt and minimize climate impacts on natural ecosystems.

The section presents the barriers to the implementation of more effective NBS in the scope of climate change adaptation and mitigation. They were aggregated in three different categories: firstly, the cultural barriers, then the governance & technical issues and finally the communication & knowledge barriers. The drivers for the NBS implementation will then be discussed, dividing them into the same categories used for the barriers.

1. Identification of barriers

It is interesting to note that barriers to NBS implementation come through many ways. From the survey analysis, it appears relevant to separate them in three different categories. The first one is related to the human behaviour and has a cultural basis, despite the evolution of the environmental concerns.

The other two categories are related to the social and policy actions towards NBS, of course the governance and technical barriers and finally the communication and

knowledge issues. On the other hand, we cannot forget the diverse territorial scenarios for NBS application and their problems.

1.1 Cultural barriers

The first barriers category identified is cultural, in the sense that the society is not organized to change collective behaviours yet, even if people are getting progressively aware of their pressure on natural ecosystems. Potential social barriers appear as a new technology has to fit in the daily culture and routines of the end-users. In many examples, a short-term vision and individualistic approaches are human understandable defences to protect themselves against unexpected costs. In fact, it often happens that people do not feel the urgency to act when immediate results are not visible. The impact can be financial, but also cultural, in the sense that they might not impact only the individual, but a community in its entirety. People agree for the necessity to change patterns, but mainly if that does not affect them directly (i.e. *NIMBY* concept).

Similar barriers in the form of prejudices are common among construction companies: these may affect the readiness of adopting and implementing NBS in various projects. Communication at various levels, and education for the different actors in the construction field are needed, which points again to the need of a community of practice for NBS. Other strong prejudices against novel solutions that challenge the traditional urban construction may also constitute further barriers to the adoption of NBS. Several developers and companies of the construction sector are still not aware of the NBS benefits and actually only introduced them in a response to the consumers' demand.

Some companies think about biodiversity as a way to engage their employees and the community, and to promote healthier ways of living. But most of them can't pay for secondary benefits, architects and engineers have to "sell" green infrastructure as a direct result to their scheme.

Other barriers may be in the form of conventional traditions and routines as they can hinder adopting and implementing NBS in many ways. Traditions are linked, e.g. with societal and organizational cultures and structures, as well as ideological issues and perceptions of citizens. Organizational traditions and routines should be modified to become drivers to effectively transfer and process the information for implementing NBS. Traditional understanding and perceptions of nature may be both drivers and barriers for adopting NBS, depending on the context. The perceptions of nature - what kind of nature is considered acceptable, aesthetically pleasing etc. - are intertwined with local traditions and cultural contexts.

For example, NBS favouring biodiversity, 'wild designs', are sustainable and can also be cost-efficient because of the low maintenance. However, negative perceptions

and preferences for wild nature in cities may cause resistance for NBS with biodiverse vegetation, as they are, e.g. seen as a signal of neglect. However, the change of attitude requires knowledge of the benefits of these natural elements.

Besides, both cities and rural areas might be exposed to important dangers when nature is only considered as an economic resource. Landowners of protected sites i.e. react against the value of biodiversity when there is no long-term benefits. The rental of natural areas for wood exploitation is often an economic option, but may cause erosion, forest fires and negative effects in a climate change context.

The mono functionality of woodland produced in many cases by the forest industry made negative impacts on biodiversity, which does not prevent the effects of heat pressure and climate change. It is necessary to understand the benefits of local species in agricultural land and to promote small scale economies, in order to provide more sustainable solutions together with a reduction of the ecological footprint in hinterlands.

1.2 Governance & technical barriers

Public management tools are in general increasingly developing towards participating models and solutions including private engagement. However, they also represent governance barriers to the implementation of NBS, in relation to technical policies. They reflect how divided responsibilities and unadapted legislations can impact the effectiveness and operativity NBS.

The most important barrier is probably that municipalities and planning authorities operate in silos: skills are not shared among departments. For example, the department in charge of the deployment of solutions to a specific problem such as flood risk, might not have the skills and competence to appreciate the multifunctionality of NBS, e.g. also benefits in terms of air quality, because this skill is in another department. This results in compartmental skills and knowledge in local and national authorities which might represent a barrier to the adoption of NBS as an alternative solution to grey infrastructure.

We can also observe a lack of coordination between the European, National and Regional governments. Strategies and programmes for climate change, which might include the implementation of NBS, frequently involve local authorities. But the latter do not usually possess the resources to deal with assessment and monitoring actions. There is a lack of confidence in the horizontal cooperation for bottom-up projects: local stakeholders are a source of initiatives, but in many cases, they don't have the financial or technical support from the upper levels of public administration to carry out properly the project.

Another barrier to the uptake of NBS is that they are not properly “packaged” as a product, including also a set-up for maintenance (e.g. smart technologies). A NBS would be a more effective solution if it is presented with a system/framework to maintain it, with also the related operational costs. This way it would be easier to compare it to its grey equivalent in function.

There are also several barriers related to the interplay with policies, market, knowledge and tradition, such as:

- the creation of a technical solution may need extra support in terms of policies,
- a new NBS may need change of regulation to become legally feasible
- interplay of spatial policies with technical policies
- the lack of ready to use technologies and ready to apply scientific results and concepts can make the adoption of NBS challenging even if a certain policy receptiveness exists
- NBS can be expensive technologies

Policies could also be barriers if in the form of coercive regulations which ban the use of available materials for NBS. As such, existing policies may need to be updated to avoid to be the actual barrier to the adoption of NBS as an alternative to mainstream grey solutions. Other policy barriers are the availability of “inventories of existing NBS” to be used to reveal spatial gaps and the maintenance cost of NBS: a potential solution to these barriers is a proper spatial maintenance plan which would highlight the proximity of trees as thus foster more effective maintenance plans. These result in the difficulty in implementing high level decision making and in demonstrating the importance of NBS as a multifunctional tool to achieve multiple impacts.

A critical barrier is the lack of appropriate local and national financing mechanisms for NBS. At national level, there is no adequate financial support for cities as this is complicated to apply for them (requiring additional administrative staff and time resources). More importantly, it requires co-financing to, which many cities, especially small ones, cannot afford. The silos structure of city councils also prevents the collaboration and sharing of resources between different departments, which creates a financial barrier at local level: budgeting programmes are based on allocating costs on the specific activities related to a department or elements of infrastructure, rather than on the functions or services which might involve several departments. This silos approach doesn't reflect the multifunctionality of NBS compared to mainstream solutions.

NBS projects require in many cases a large scale approach. Public authorities therefore have to gather funds from outside their own geographic authority (local or regional), which can represent an administrative barrier as well.

Private owners, on their side, do not have a clear incentive in investing in alternative solutions, when they do not see a direct economic return. Some companies already know that they can engage consumers for their commitment to sustainable development, thus receiving a social acceptance, but the policies may also need to consider tax benefits. In fact, the practices in urban planning are starting to include the global services for cities and benefits provided by natural areas and NBS, but however may need a complementary regulation of tax policies.

The lack of a critical mass of companies providing all the elements in the commercial value chain is another barrier which hinders the implementation of a really aggressive marketing campaign in favour of NBS. This is further aggravated by a limited selection of ecologically sustainable materials for landscaping and the use of NBS.

Finally, a global issue that can be observed regarding governance and technical barriers is a lack of communities of good practices for NBS. Policy makers at all levels, city planners, local authorities, private investors, etc. do not have access yet to reliable sources of information to tackle NBS and climate change adaptation.

1.3 Communication & knowledge barriers

The third group of barriers identified is related to the communication and global knowledge around NBS. Research organisations have provided numerous evidences of climate change, but have not provided an appropriate assessment and collection of evidence of the benefits, performance and functionalities of various NBS: the lack of this kind of assessment represent another important barrier. Citizens, as well as public authorities and private stakeholders, need a solid definition and better communication tools, in order to solve the cultural and governance barriers.

As NBS is new as a concept and also as regards the concrete systems, a significant barrier is the lack of knowledge that creates the so called “fear of the unknowns”: this combined with legislative gaps is one of the main barriers to the uptake of NBS. The concept of NBS is not yet widely known and the evolving terminology is confusing practitioners. This lack of knowledge combined with jargon and the use of abbreviations, are seen as barriers and point the finger to the need for a standardisation of terminology related to NBS to avoid confusion. The lack of common language may hinder successful cooperation in many ways, e.g. by causing conflicts and misunderstandings. As such, a clarification of the relation of NBS with other existing concepts may help to remove the confusion.

The lack of knowledge amongst market actors of the possibilities of NBS for business and the insufficient access to knowledge affect accepting, adopting and implementing NBS. Access to the knowledge is often a bottleneck even though the knowledge existed, e.g. in the academic literature.

People, and especially policy makers, need to realize that NBS produce many benefits. This can be achieved through relatively simple communication and evidences. However, many examples show that the scientific information doesn't always reach the right people. We can generally observe a gap between researchers and politicians in this regard. People have to realize that NBS achieve economic, social and environmental improvements and we need to show it effectively.

Finally, vertical hierarchy and silo-thinking create rigid hierarchical relationships and poor communication and hinder the adoption and effective implementation of renaturing urban plans. Silo-thinking may have an effect on how well the multifunctionality of NBS is considered, e.g. due to the language and terminology used in different sectors. Complex and inherently cross-sectional nature of NBS implementation challenges the traditional ways of e.g. organizing municipal activities that do not optimally support the efficient operations but limit the tray of choices for actions.

2. Identification of drivers

In order to overcome these barriers, the analysis of the surveys released previously within the ThinkNature project enable also to outline the main drivers for NBS implementation. The deep study of such drivers can provide a wider approach to face climate change adaptation and mitigation. As presented for the barriers, the drivers are aggregated in the three same categories.

2.1 Cultural drivers

It is rather hard to establish a complete list of drivers that would enable to overcome cultural barrier presented previously. The main idea relies in educating populations on the multiple benefits of NBS, whether they are direct or indirect for them. Citizen must understand the services provided by biodiversity or ecosystems, in regard to the increasing risks they are confronted to due to climate change.

The question of safety in the implementation of NBS can be one trigger to increase the acceptance of new methods and may lower down the barriers among practitioners. Near coastal areas for example, where the sea levels rise and expose inhabited areas to higher risks of flooding, citizens do not want to lose land for the sea and, above all, are worried about the dangers that flooding represent. Such situations might ease the implementation of NBS, if proved to be a concrete solution to the problem.

Therefore, it is crucial that the young generations are educated accordingly. This would be a major evolution in order to solve these cultural barriers. The main goal is to explain that the NBS are not just a “decoration”, on the contrary, they offer crucial benefits from cooling places, slowing down rainfall, protecting against storms, reducing heat and dust, creating a better micro climate, etc.

Another cultural driver is linked to a more open mindset towards collaborations between academia and the local municipality. Some research projects at national and European level involve the deployment of NBS and its assessment. The deployment is generally pushed forward by academia for research purposes, but it is usually deployed in real life scenarios on municipality land. This would generate learning for both parties and foster uptake from the municipality as part of future policies. This would allow for experts from different fields to gather around the design of NBS, or solving a problem, to discuss the knowledge gaps and think of effective methods for producing this knowledge. As an example, the H2020 project iSCAPE³ tested the performances of NBS such as hedges in terms of air pollution abatement in Guildford (UK). The findings were then included in the Green infrastructure plans for London City.

2.2 Governance & technical drivers

Policy can act as a barrier to NBS implementation if not properly conceived. But a driver is certainly a political and governance will to reform legislation concerning the promotion of environmental features in projects.

³ Abhijith, K.V., Kumar, P., Gallagher, J., McNabola, A., Baldauf, R., Pilla, F., Broderick, B., Di Sabatino, S. and Pulvirenti, B., 2017. Air pollution abatement performances of green infrastructure in open road and built-up street canyon environments-A review. *Atmospheric Environment*, 162, pp.71-86.

Tiwari, A., Kumar, P., Baldauf, R., Zhang, K.M., Pilla, F., Di Sabatino, S., Brattich, E. and Pulvirenti, B., 2019. 2441. Considerations for evaluating green infrastructure impacts in microscale and macroscale air pollution dispersion models. *The Science of the total environment*, 672, pp.410-426.

Mayor of London, 2019, Using Green Infrastructure to Protect People from Air Pollution, Greater London Authority City Hall.

There are huge potentials to use policies as effective drivers through appropriate laws, norms, strategies, planning instruments, funding programmes, and investment in research to support NBS. The effective use of policy instruments, such as land-use planning, authorisation procedures, information steering, fees, payment facilities (e.g. exemption from storm water charges), tax deductions, jurisprudence, penalties, agreements, persuasive guidance (e.g. expert assistance, and knowledge-based facilitating), obligations to implement NBS along with new construction projects, and investment support may boost the adoption of NBS as an effective alternative to grey infrastructure.

In order to overcome legislation barriers, comprehensive measures should improve environmental policies, for example in the building sector where NBS are often not considered in the technical regulation and permitting legal procedures. The natural engineering and handmade products deserve more recognition in the industry, in order to promote the application of best practices. Legislating policies for NBS could remove the cost barrier that clients see as an issue.

Solutions for climate change adaptation and mitigation should maybe be regarded the same way, people know that they have to pay council tax, fire service, basic infrastructure, etc. Somehow it is important to encourage governments to be more preventative and proactive in their approach.

There are also several policy drivers connected to research, such as: financial instruments to support multi-stakeholder collaboration and capacity building through investing in experimental NBS and research. Joint projects on NBS between authorities and researchers could also promote real-time knowledge transfer. These could be further supported by financial penalty payments for not realising NBS and tax incentives.

The policy drivers which are seen as effective are the ones which would create a critical mass by gathering evidence of cost effectiveness, environmental and ecosystem services and suitable business opportunities behind the implementation of NBS instead of today's mainstream solutions. Local actors and targets could play a critical role in creating a critical mass to drive policies at local EU-wide or global levels. In this context, raising awareness about existing policies could support a higher adoption of NBS. This could be achieved by developing city strategies to meet local needs: this would give the opportunity to be tested on the ground and used as a showcase for other cities for a wider impact. This would only be possible if scientific and practical information of the efficiency of various policy instruments is available internationally, pointing again to a need of a community of practice at local, national and international levels. As such, local creation of norms for key NBS by municipalities as part of co-creation activities with local stakeholders and NGOs may result in concrete guidelines on how to implement and deploy NBSs. This would

be a more important and effective driver than policies, as it would allow for the NBS to be more operational. This should also be aligned with the parallel creation of norms, clear targets, requirements and restrictions.

Policies need substantially to be redesigned to favour the multiple benefits of NBS over grey infrastructure through better land use to remove the conflict between green and grey infrastructure. The multifunctionality of NBS should be highlighted in official documents and strategies of municipalities in order to make evident the benefits of NBS compared to mainstream solutions. This would involve better communication, collaboration and co-design activities to enable the empowerment of urbanites and thus the transformation of unused land into green space and the co-management of existing green space. In practice, it would result in more holistic and far-reaching policies in the form of EU-, national and municipal-level policies, coercive legislation, guidelines, instructions and recommendations, concrete enough local strategies (e.g. stormwater management strategy, green roof strategy, strategies at neighbourhood level,) and plans (e.g. tree- and woodland plan) as well as follow-up and evaluation systems for the strategies.

Other policy drivers are the following:

- co-financing approach
- comprehensive suite of mechanisms, from incentives to statutory regulations
- regulation to promote the use of native regional soils as growing medium
- bottom-up citizens' initiatives
- legal obligations combined with strategic and proactive planning to create or improve green areas
- good integration of urban and green planning
- information about EU funding mechanisms and operational programmes for green infrastructure, nature-based solutions and green areas
- more knowledge and experience or make more exact calculations and better project planning possible
- high engagement of both planning authority and developers

2.3 Communication & knowledge drivers

This third category focuses on the communication to improve the promotion of NBS. It is possible to start with the education as a critical driver in raising environmental awareness, because it can facilitate the change of the general values and attitudes. Popularizing of science, e.g. in major media may increase general awareness of the importance of urban nature, and of the state of the environment and nature in general. The environmental education is particularly important. Most urban children do not interact with the rural experiences anymore, which induces a nature deficit

disorder: the more one is detached from something, the less he will value it. Natural resources are in continuous pressure, and that's why we need to apply concepts like urban footprint and achieve comprehensive chains to link environment, economy and society.

The same gap happens also in the communication of NBS. Key messages should empower the citizens, rather than disengaging them and creating a feeling of despair when looking at climate change. Likewise, the design of green and blue technical infrastructure for the building sector should be improved in terms of aesthetical appearance and maintenance, so that NBS always provide a positive message.

The creation of a community of practice (“umbrella groups”) to share best practice and to create a body of evidence-based findings which could support the values of NBS is a critical driver to embed NBS within the planning system. It would encourage and strengthen uptake by municipal authorities as well as spreading the concepts and values within the architecture and construction sectors. This is relevant to all kinds of NBS; working collaborative across market sectors enables awareness raising, innovation and better investment in NBS. The private sector needs to develop capacity to lead new innovations and generate new knowledge for mainstreaming NBS at a wider level. This would involve the creation of new businesses around the development of materials for NBS, potentially by recycling other discarded materials to promote circularity. Greater promotion and more widespread usage would boost the NBS market, together with a detailed analysis of the benefits that NBS provide to the community, to illustrate the benefits to local administrations and financial institutions. The development of a NBS market would require the knowledge of markets, the ability to harness advanced research and development to deliver solutions and management experience. Incentives to monetize NBS can be developed only by increasing the awareness of policy makers and development agencies which could define economic incentives for their development, and thus catalyse similar projects. This could only be possible with a precise and accurate cost benefit analysis of NBS, accounting for their multiple benefits, to provide an instrument to compare them with the mainstream equivalents.

Moreover, appropriate and innovative financial incentives are considered a key driver for NBS, as well as nature-oriented regulations and new financial instruments dedicated to long-term management of NBS (development & maintenance) provided by local governments.

It is also critical to develop an appropriate communication framework to promote new NBS and their results: the novel systems, their benefits, and establishment methods have to be communicated widely to companies, developers, construction industry etc. stakeholders, to make them understand and adopt those as relevant solutions to urban challenges. As such, cross-sectional networking, cooperation and communication are key to achieve better communication of NBS and attract

investors. Communication needs also to target local communities by involving local residents in NBS projects as part, for example, of citizen science initiative for novel solutions, and also bring good ideas and local tacit knowledge into the agenda. A wide range of forums should be used as more effective and targeted communication tools to inform various stakeholders about NBS, and to support cooperation and collaboration. These would allow to spread and transfer the information and they would be in the form of general-level seminars, conferences etc., but also, e.g. education days going into definite details of a certain NBS or field.

Pilots in real-life scenario as part of collaborative national and international projects between academia, local authority, industry and local community could facilitate the creation of a community of practice because knowledge-production of NBS requires cross-sectional and transdisciplinary cooperation, as in urban areas, single NBS is typically a part of a larger entity and wider land-use policy. This would allow for the continuous engagement of stakeholders with experts from different fields by gathering around the design of NBS, or solving a problem, to discuss the knowledge gaps and think of effective methods for producing this knowledge. A real-life pilot would also allow to generate concrete evidence-based data and knowledge for implementing NBS: what to do, how, when, with whom. Practitioners need knowledge of the availability of various alternatives to produce various benefits/co-benefits, and also practical, detailed knowledge for designing NBS.

Finally, it is critical to recognize, appreciate, disseminate and discuss the multiple benefits of NBS along with making more explicit the monetary value of the benefits of NBS: aesthetic and recreational benefits are challenging to monetize, but these benefits may have considerable effect on the health and well-being of urbanites, meaning savings in the healthcare budgets in the long run. As such, it is imperative to provide positive examples, successful case studies and other references of the performance of the solutions, showing that they really work, as well as concise enough information that is easily digestible, including monetization of the benefits of NBS.

3. Conclusions on barriers and drivers

For a better visibility, a brief summary of barriers and drivers is presented below in the form of a table. It follows the separation of categories mentioned previously, as three different spheres for NBS implementation.

	Barriers	Drivers
Cultural sphere	<ul style="list-style-type: none"> • Social • Prejudices against new solutions • Education • Conventional traditions and routines • Ideological issues and perceptions of citizens • Perception of nature 	<ul style="list-style-type: none"> • Collaboration between academia and local municipality • Promotion of best practices • Increasing the acceptance of climate change and of NBS as a common aspect of our everyday life
Governance & technical sphere	<ul style="list-style-type: none"> • Municipalities/planning authorities operate in silos • Compartmental skills and knowledge • Lack of communities of practice for NBS • NBS not properly “packaged” as a product • Current regulations • Interplay of spatial policies with technical policies • Lack of ready to use NBS technologies • Costs compared to grey equivalent • Coercive regulations • Lack of “inventories of existing NBS” • Lack of financing mechanisms for NBS at local and national levels • Budgeting programs based on costs on item rather than of functions/services • Lack of a critical mass of NBS companies • Limited selection of ecologically sustainable materials for NBS 	<ul style="list-style-type: none"> • Laws, norms, strategies, planning instruments, funding programmes, and investment in research • Land-use planning, authorisation procedures, information steering, fees, payment facilities, tax deductions, jurisprudence, penalties, agreements, persuasive guidance, obligations to implement NBS along with new construction projects • Financial instruments to support multi-stakeholder collaboration and capacity building through investing in experimental NBS and research • Financial penalty payments for not realising NBS • Joint projects on NBS between authorities and researchers • Tax incentives • City strategies to meet local needs • Local creation of norms for key NBS by municipalities as part of co-creation activities with local stakeholders and NGOs

		<ul style="list-style-type: none"> ● Better communication, collaboration and co-design activities to enable the empowerment of urbanites ● Co-financing approach ● Comprehensive suite of mechanisms, from incentives to statutory regulations ● Regulation to promote the use of native regional soils as growing medium ● Bottom-up citizens' initiatives ● Legal obligations combined with strategic and proactive planning to create or improve green areas ● Good integration of urban and green planning ● Information about EU funding mechanisms and operational programmes for green infrastructure, nature-based solutions and green areas ● More knowledge and experience available, to improve calculations and make better project planning possible ● High engagement of both planning authority and developers
<p>Communication & knowledge sphere</p>	<ul style="list-style-type: none"> ● Lack of knowledge ● Legislative gaps ● Evolving terminology is confusing practitioners ● Jargon and use of abbreviations ● Lack of appropriate assessment and collection of evidence of benefits, performance and functionalities of NBS 	<ul style="list-style-type: none"> ● Community of practice ("umbrella groups") ● Body of evidence-based findings ● Capacity to lead new innovations and generate new knowledge for mainstreaming NBS at a wider level ● Creation of new businesses around the development of materials for NBS

	<ul style="list-style-type: none"> ● Lack of knowledge amongst market actors of possibilities of NBS for business ● Vertical hierarchy and silo-thinking 	<ul style="list-style-type: none"> ● Detailed analysis of the benefits that NBS ● Incentives to monetize NBS ● Precise and accurate cost benefit analysis of NBS ● Appropriate and innovative financial incentives ● Nature-oriented regulations ● New financial instruments dedicated to long-term management of NBS ● The novel systems, their benefits, and establishment methods have to be communicated widely to companies, developers, construction industry etc. ● Involving local residents in NBS projects as part, for example, of citizen science initiative ● More effective and targeted communication tools ● Popularizing of science ● Awareness campaigns
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A community of practice for NBS is seen as a driver because knowledge-production of NBS requires cross-sectional and transdisciplinary cooperation, as in urban areas, single NBS is typically a part of a larger entity and wider land-use policy. This would allow for experts from different fields to gather around the design of NBS, or solving a problem, to discuss the knowledge gaps and think of effective methods for producing this knowledge. This could evolve around real-life pilot of NBS as part of collaborative research projects between academia, local authority, industry and local community, which would facilitate the continuous engagement of stakeholders and real-time knowledge transfer.

Real life pilot could also increase the acceptance of NBS by having a positive impact on traditional understanding and perceptions of nature. The perceptions of nature - what kind of nature is considered acceptable, aesthetically pleasing etc. - are intertwined with local traditions and cultural contexts. For example, NBS favouring biodiversity, 'wild designs', are sustainable and can also be cost-efficient because of the low maintenance. However, negative perceptions and preferences for wild nature in cities may cause resistance for NBS with biodiverse vegetation, as they are, e.g. seen as a signal of neglect. However, the change of attitude requires knowledge of the benefits of these natural elements.

As knowledge sharing is of paramount importance for NBS uptake by various stakeholders, a knowledge web-based database is of crucial importance: practitioners and decision-makers need evidence-based, easily available, understandable and ready-to-apply information, reference cases and best practices to learn from. International examples are also helpful, in parallel with cases at the local level. The awareness of the key powerful people in municipal environmental and urban planning sector of the performance of NBS is seen as a driver to overcome knowledge barriers.

For example, from the NBS previously reported, it is interesting to see the ones which have failed seem to be the ones with limited contact with the urban environment, e.g. isolated items within the urban system. This might be due to the harshness of urban environments which might be particularly aggressive towards isolated NBS. These examples might illustrate the often extreme conditions of city environments, and the complexities involved when managing nature in urban areas. NBS in degraded environments have less chances to be successful than the ones integrated in a broader green landscape (e.g. parks).

Insufficient access to knowledge affect accepting, adopting and implementing NBS. Access to the knowledge is often a bottleneck even though the knowledge existed, e.g. in the academic literature. As such, all the solutions to make knowledge more available are seen as drivers: open access publishing, open databases, ‘intermediate researchers’, web-based knowledge hubs with practical information and examples, fairs, seminars, conferences, mentoring programs, further education etc. can be used to ease the availability and usability of knowledge.

4. Policy challenges and recommendations

One of the main recommendations emerging from the stakeholders’ interviews is the need to create a community of practice (“umbrella groups”) to share best practice. This, combined with the development of a body of evidence-based findings which could support the values of NBS, would facilitate the embedment of NBS within the planning system. It would also encourage and strengthen the uptake by municipal authorities as well as spreading the concepts and values within the architecture and construction sectors. This is relevant to all kinds of NBS: knowledge-production of NBS requires cross-sectional and transdisciplinary cooperation, as in urban areas, single NBS is typically a part of a larger entity and wider land-use policy. A community of practice would allow for experts from different fields to gather around the design of NBS, or solving a problem, to discuss the knowledge gaps and think of effective methods for producing this knowledge. Furthermore, working

collaboratively across market sectors would enable awareness raising, innovation and better investment in NBS. Urban planners are often key persons in either hindering or promoting implementation of NBS. Also, architects have a lot of power to decide whether NBS are included in the plans and designs. Landscape architects should master at least the basics of ecological knowledge. Thus, a community of practice might foster the education and training of NBS, targeted specifically for planners and designers.

This points clearly to the need for policies and funding to start pilot projects for knowledge production and developing various designs step by step: this will allow an appropriate assessment and collection of evidence of the benefits, performance and functionalities of various NBS is needed. The lack of this kind of assessment represent another important barrier. It will also potentially foster cross sectorial knowledge as the pilot could be used as a learning and idea exchange platform for various stakeholders. Practitioners and decision-makers need evidence-based, easily available, understandable and ready-to-apply information, reference cases and best practices to learn from. The long time-frame of NBS-projects also means that new knowledge is produced while the NBS are developing over time, sometimes causing changes to the aims set for the projects, and adjustment of the solutions to make use of the new knowledge. Furthermore, NBS are based on living nature, and it may not always function as people might want. To achieve knowledge of the success of living elements, and to optimize the return of investment, long-term follow-up of NBS-projects should be guaranteed and resourced accordingly. In participatory projects with residents the challenge is that voluntary participation may change during the project, as people cannot be forced to join with the same intensity during the whole project. Thus, new 'carrots' should be used, to keep the interest on.

As such, there is a need of appropriate financial support to drive NBS from local experiences to showcase impact and allow for wider replication and also to develop and maintain long-term the NBS. At the moment, incentives are not transparent and understandable by the wider community of practitioners and often co-financing mechanisms bring financial burdens on cities which might not be able to afford them. These financial challenges, combined with difficulties in understanding how to cost NBS, constitute important barriers to the wider uptake of NBS from municipalities as an alternative to mainstream solutions. It is thus important to create support mechanisms for group of early adopters, who are a valuable resource for getting NBS projects going, and also spreading knowledge. They may have a considerable effect on, e.g. changing the traditions of the construction field.

The NBS pilots would also foster the creation of innovation partnerships supported by research organizations, municipalities, companies, umbrella organizations, and the policies at national level that encourage innovation and cooperation in innovating. In NBS-projects with several stakeholders, win-win-situations can be achieved, and different 'carrots' be offered for various stakeholders: references,

visibility and research data for companies, knowledge and new partnerships for authorities, new funding and publication possibilities for universities, etc. This would stimulate the raising of new generations of actors (e.g. urban planners) with up-to-date education of the environmental challenges we face today, and fresh ideas for how to solve them, pave the path for the acceptability and broad use of NBS. Knowledge thus would also expand to totally new fields of expertise which may be needed to solve problems, and develop new techniques etc. Thus, also educational organizations should be sensitive to the societal change and be ready to quickly react to various educational needs. Mentoring programs can be useful for educating experts, as it allows for learning from peers and reflecting the knowledge with everyday work and, e.g. recognizing organizational restrictions. The NBS pilot and the activities with various stakeholders around it would also allow to provide more support for grass-root and citizen science initiatives to increase awareness and sense of ownership for local communities, which is critical to increase environmental awareness and a change of the general values and attitudes. There is a specific need though also for adequate support mechanisms to popularize science, e.g. in major media may increase general awareness of the importance of urban nature, and of the state of the environment and nature in general.

Finally, a cross-administrative approach is needed to understand the various needs of different groups of urbanites, to guarantee equality in NBS supply and demand. The municipal planning systems and guidelines may be outdated, and not able to take NBS into account. A change of these systems and developing new guidelines and instructions for NBS are needed. One example of systemic issue is the equal access to NBS: how to guarantee the geographical diversification of NBS, and access to NBS by vulnerable groups, such as the elderly and long-term hospital patients. There is also a strong need to develop methods for calculating savings in the healthcare budgets in the long run due to the effect on the health and well-being of NBS, often concerning cultural ecosystem services.

Part 3 Paris case study: barriers and uptakes for the implementation of NBS for CCAM

To be more precise about the different NBS for CCAM and their implementation, a special focus is made on Paris' resilience strategy: we first intend to describe such a strategy globally to explain what stakes Paris has to face and will have to face in the next years, what tools the city has at its disposal to come with major events such as floods or heat stress, and what tools and mechanisms it should develop to further its resilience strategy.

Then we focus on one specific project of the resilience strategy: the Oasis schoolyards, intending to adapt the schoolyards to heatstress and which participate to a broader strategy of renaturation.

Thus, this part aims to illustrate in more concrete terms the subject of the deliverable: decision making and policies for NBS and CCAM as well as the uptakes and barriers identified.

I. Paris Resilience Challenge, CSTB

Introduction

To go further, we propose to study an example in detail, the Paris case study. Our goal is to improve the results of Part 1.

The focus is on how to turn barriers into opportunities, and the stake is to understand comprehensively and holistically the issues specifically related to the implementation of NBS to be able to overcome them as easily as possible.

To understand this issues, we studied:

- Review of Paris resilience strategy documents
- Interviews with 10 key stakeholders⁴⁵ involved in Paris' resilience strategy
- Analysis related to projects for urban resilience in the city of Paris and Paris Forum interventions (renaturation strategy, climate change strategy).

1. NBS and Paris resilience Strategy

Paris has long been a global icon and center for economic and cultural activity. The City currently points the way towards innovative urban planning, mitigation and adaptation to climate change. Plenty of steps carried out in Paris already participate to the resilience of the City, as crosscutting strategies to fight against global warming, improve Smart City, fight against situations of major social exclusion, etc. Flooding of the Seine River or a severe heat wave could have serious consequences.

Paris has had an important architectural and green heritage. For example, tree heritage (since Baron Haussmann, 300.000 trees in two woods, to which 100.000 trees are added in the city).

⁴ 10 actors of Municipality of Paris: Sébastien Maire, General Delegate for Ecological Transition and Resilience of the City of Paris, and is former Chief Resilience Officer (CRO), Noemie Fompeyrine résilience project manager, Marie Gantois, chieffe of Climate Change plans, Philippe Jacob, chieffe of Biodiversity strategy, Carine Bernede, Director of Green Spaces and Environment, Alexandre Nezeys, water management, Sabine Romon and Fabienne Giboudeaux, Director smart and sustainable strategy, Cedissia de Chastenet, sustainable and green architecture manager, Lea Vasa, Chieffe of Climate change District 10

Policy of City of Paris has been launched to reinforce nature in the city and revegetation to face climate change and to maintain biodiversity but also to take into account this cultural heritage.

Paris is also facing other challenges, as risk of attack, identified during the 1st phase of the strategy. Workshops, surveys and interviews had helped to define the main strengths and weaknesses of the city and its current ability to face them.

Resilience Strategy⁶ proposes an integrated vision in response to various urban vulnerabilities. It identified six priority challenges, which impact the territory and the resilience of Paris.

1. Social, economic and spatial inequalities, and social cohesion
2. The terror threat and security context
3. Climate Change
4. Air pollution, a challenge for environmental health
5. The Seine and river-related risks
6. Territorial governance

The Strategy contains 35 actions, organized around 3 key pillars:

- An inclusive and supportive city, which supports its residents
- A city developed and built to meet the challenges of the 21st Century
- A transitional city which mobilizes collective intelligence, adapts its functioning and cooperates with other territories

This strategy is linked with the renaturation plan, directed by the green space and environment direction. The targets are to open additional 30ha of green spaces, plant 20,000 trees, reach goal of 100ha of greens roofs and walls, develop urban agriculture and to build new strategic action plans (adapting to climate change, climate, air and energy plan, sustainable food systems plan, biodiversity plan). It is also linked with biodiversity plan and Climate Plan. All together promote nature, NBS and Biodiversity, to face climate change. It an impressive number of actions developed at the same time.

Paris joins cities of the 100 Resilient Cities network, which have adopted this new approach to urban development⁷.

⁶ Paris' Resilience strategy: <https://api-site-cdn.paris.fr/images/95335>

⁷ Municipality of Paris had a private fund by The Rockefeller Foundation to improve its Resilient strategy. *100 Resilient Cities - Pioneered by The Rockefeller Foundation* (100RC) helps cities around the world become more resilient to social, economic, and physical challenges that are a growing part of the 21st century. 100RC provides this assistance through: funding for a Chief Resilience Officer in each of our cities who will lead the resilience efforts; resources for drafting a Resilience Strategy; access to private sector, public sector, academic, and NGO resilience tools; and membership in a global

NBS are a key point of the resilience strategy for The Seine and river-related risks and Climate change priorities.

1.1 Focus on urban heat stress, flood adaptation and water resource protection through nature

A pioneering effort to battle heat waves and the urban heat island effect through an innovative green infrastructure pilot program. Under the proposal in the Strategy, the City of Paris will begin creating green space, green streets, and infrastructure in the courtyards of the city's schools. The courtyards would serve as cooling oases during heat waves, reduce urban flooding risk through better water capture, and provide the community with open space and meeting points to better emphasize social capital.

A second challenge is to face to the effects of climate change on the Seine basin. *“Paris experienced a severe and unprecedented flood in June 2016 and equally extreme and premature low water levels in the same period the following year. For this reason, the Seine was identified early on as one of the priority resilience challenges for the capital”.*

Examples of actions:

- Develop integrated green spaces to respond to climate and social challenges (“Végétalisons Paris”)
- Transform schoolyards into cooling island “oasis”
- Improve knowledge of the underground to reduce risks related to building collapse and flooding, and enhance infrastructure
- Transform public spaces to increase social wellbeing and inclusion through integrated planning, innovation, and a better incorporation of nature
- Explore the city from its roots to its canopy and assess the potential for rooftop and basement development
- Support the watershed's climate change adaptation program to preserve water resources and limit the scale of floods in partnership with rural municipalities

The implementation of such measures required public policies' adjustments to limit the existing barriers.

network of peer cities to share best practices and challenges. www.100ResilientCities.org. The different projects will be financing by Paris. 100resilientcities: www.100resilientcities.org

- Commit in numerous professional and scientific networks to develop the knowledge around NBS (100 resilient cities, Energy cities, C40, Club Ville Territoires et changement, VITEC...)
- Produce crossed diagnoses from diverse fields of expertise. For instance evaluate the potential of areas subject to vegetablization: walls, roofs, facades, fences, by rallying studies on soil quality, etc.
- Mobilize, raise awareness among the Parisian property owners to act beyond
- Adapt the urbanism and local regulation documents to favor vegetalization in every project of spatial evolution (open ground, greenhouses on roofs, building vegetation...)
- Diversify species of plants to sow in Paris by realizing a catalog of relevant species to the Parisian context
- Acquire technical and management skills: technical help, joint ownership to foster vegetation, mobilize startups like Topager and scientific ones from Agroparitech to recycle waste through agriculture or create natural urban ecosystems to avoid soil depletion and guarantee their fertility, regulate stormwater and heat island effect, etc.
- Raise awareness: garden parties, entertaining smartphone apps to value initiatives and foster Paris' greening



Seine, Paris, 2018

1.2 Focus on social cohesion as a key dimension of climate change adaptation

They worked with Jean Jouzel, climatologist, who insisted also to consider social needs.

“Climate change thus already has tangible impacts for Paris and the city needs to mitigate and adapt to these in the short, medium and long-term. For example, our urban infrastructure, networks and services are highly vulnerable to extreme weather events, while our natural environment is under stress from high temperatures and the urban heat island effect, which can also worsen air quality issues in Paris. In this context, the most vulnerable individuals are disproportionately affected: children, the elderly, the sick, and those on the streets. While the 2003 heatwave caused an estimated 15,000 deaths in France - including nearly 1,100 in Paris - the June 2017 heatwave caused 580 additional deaths nationally. This suggests public policies have been effective to some extent, but they may not be the most efficient approach given the increasing frequency and intensity of recurring climatic events and the disproportionate impact on vulnerable populations. This is why action against social exclusion and action against climate change are intrinsically linked, and why solidarity remains a priority for the resilience of the territory”.

Examples of actions:

- Mainstream temporary urbanism (tactical resilience)
- Encourage neighbours, youth and adults to temporarily occupy public spaces
- Support the creation of new community-focused local jobs
- Support initiatives, implementation and co-funding of resilience solutions by individuals and local stakeholders
- Etc.

Their implementation also required adaptations in public policies

- Raise awareness on environment (workshops, garden parties...)
- Support to existing local initiatives
- Citizens’ involvement: license to vegetalize, shared gardens, donation of seeds, compost

1.3 Focus on a multiscale approach

Territorial approach

A city that mobilizes collective intelligence and cooperates with other territories, particularly rural ones

- Define and sign a territorial cooperation pact with peri-urban and rural municipalities, based on common interests and shared actions
- Support the watershed’s climate change adaptation program to preserve water resources and limit the scale of floods in partnership with rural municipalities
- Adopt a sustainable food strategy for the territory

- Develop circular economy, local manufacturing and non-monetary trading
- Etc.

City strategy

- Incorporate resilience solutions in urban planning through regulatory documents and specification

Urban project

- Develop the first resilient and climate-sensitive neighborhood at Saint-Vincent-de-Paul
- Design an exemplary resilient neighborhood at Bercy-Charenton

The holistic and integrated approach to resilience is for municipality of Paris a new way of policy-making. It's interesting to see it need to focus on:

- NBS and renaturation to adapt Paris to climate change
- Larger implication of stakeholders (multi scale) and inhabitants
- Multiscale approaches (Paris and rural periphery)
- Social development (cohesion is an important dimension of the urban resilience to face the environmental risks)

Their implementation also required adaptations in public policies

- Mobilization of all the stakeholders, interviews, focus groups, workshops (...) to have synthesis
- Sharing knowledge: scientific workshop, resilience week (EIVP, city of Paris)
- Supporting innovations by creating the laboratory urban lab which finances a diversity of experimentation life-size urban innovations (example : the group of companies Anima which creating temporary urban forests on wasteland or fields awaiting for new projects ; the startup ubagri, developing an artificial phreatic table to develop kitchen garden on roofs ; MVAW Technology, which develops furniture to depollute the air through vegetalized bio filtration - the microorganisms which develop inside the bio filter as well as to the plant contact transform, degrade and consume gaseous pollutants) Those examples aim at becoming operational references
- Launching urban prototypes based on urbanism experiences and tactic renaturation involving participation of the public. (Example: place de la Nation, by Coloco⁸)

⁸ Coloco : <http://www.coloco.org/projets/reinventons-la-nation/>



coloco | image - Kevin Michels



Source: Coloco, 2018, Parisians are invited to remove asphalt and renature the place de la Nation

The three approaches presented show the need to develop:

- Ability to think systemically in order to multiply the benefits
- Integrated vision in response to various urban vulnerabilities

- Inclusive approach of residents, public institutions and private sector
- Share ideas and innovations; urban experimentation at different scales
- Flexibility: natural and modular spaces and facilities capable of accommodating uses

2. Issues

Paris' Resilient Strategy show the need to:

- **Improve a global approach of Nature Based Solutions with:**

A holistic vision of NBS (ecosystemic)

An articulation between technical and natural infrastructure

- **Bind biodiversity and climate (a city can create habitats and dynamics of living organisms)**

Nature as a living ecosystem

Permeable city to foster species' mobility

Compatibility between social dynamics and living dynamics (nature experience and living habits reconnected to nature)

- **Adapt cities to climate change by an urban and natural development:**

Develop new urban development considering NBS and renaturation as a key strategy for climate challenges and social cohesion.

Anticipate the evolution of urban infrastructure: consider Nature Based Solutions in face of major floods or repeated heat waves.

Anticipate the negative impact of renaturation (diseases, ...) to make a better place.

- **Evaluate social and psychological impact of new environment**

Anticipate the needs of the inhabitants

Social cohesion, initiatives

- **Governance by project and not by direction**

- **Organize global and participative management**

Nature and nature-based infrastructure are becoming recognized as an alternative for Paris. They not only meet specific service targets for water supply or flood management, but also provide a broad array of co-benefits, such as creating new parks and advancing equity and health for underserved neighborhoods.

II. Presentation of the Oasis project and related stakes

1. Motives and origins of the project

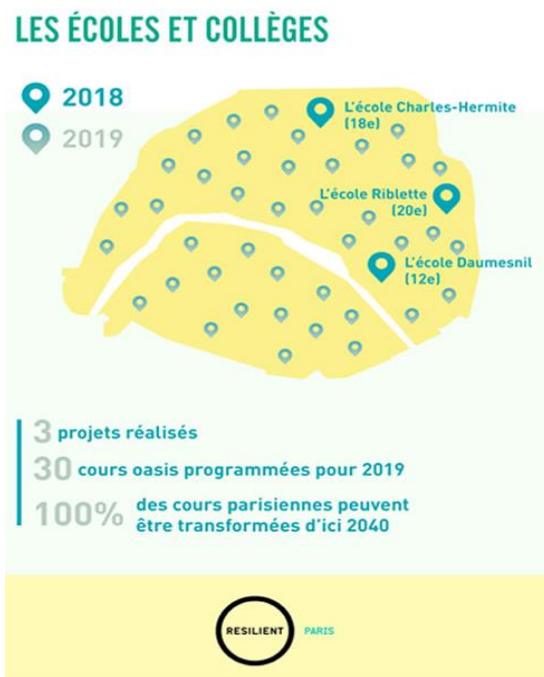
Paris' resilience strategy has different projects including one which is of high interest for this deliverable: the Oases schoolyards Project (Projet Oasis). This project is a part of the climate change adaptation process: to cope better with hazards related to climate change, here especially heat stress, a reorganization of the space and practices is needed and can take different forms. Our special interest here is adaptation to climate change through the adjustment of schoolyards.

1.1 Urban and human resilience facing heat stress as a first entry

Through a series of measures which will be explained in a next part, the project's central concern - on paper - is meant to deal with the heat island effect. Because of climate change, average temperatures are going to increase from 2°C to 4°C, and the average duration of heat waves from one day to 10-25 days. It then appears as essential to adapt our places to create valuable urban areas which fit to this new context in which asphalt is no longer an option as it retains heat. A part of the project then consists in adapting the materials of the schools to avoid a worsening of the conditions in the context of climate change.

Such urban resilience is one condition to human resilience: through the creation of cool places in schoolyards, principal users of a given school (namely children) are spending time in a healthier environment. On top of that, such an area would be beneficial for all the people in the surroundings: the plan is indeed to open schoolyards to the public during week-ends and holidays so that people, especially vulnerable ones (elderly...) can enjoy a cool place during hard periods. It then contributes to the health of the local population.

1.2A multiscale vision to exceed the scale of the schoolyard: from micro local to territorial scale



The project comes within a bigger scope than only the area of the schoolyards; added together, Paris' schoolyards represent more than 70ha and their current asphalt composition contributes to increase the heatwaves effects and intensity. This is why this project is important not only at the scale of each school only, but also at a larger scale to decrease the negative effects they convey and create instead a network of cooler and greener places inside the city. Oasis project is about cooling the schoolyards and ultimately the city itself.

Besides the creation of nicer places inside each school, multiplying this project is then a vector towards a more sustainable Paris facing the future and more frequent heat waves to come.

It shows a clear will from the City of Paris to adapt to the current context of climate change. Such a project is a manifestation of a growing awareness on climate change and its undesirable effects.

1.3 Key measures of the project

- **Soil refurbishment:** old grounds to be replaced with organic mineral-based asphalt with a low carbon footprint. The choice of light colors is meant to reduce ground temperatures and the porosity is chosen with a view to allow water infiltration when possible.
- **Green infrastructures:** vegetation such as green walls, trees, gardens... to create zones of shades but also a space for outdoors activities for children.
- **Water management:** infiltration of rainwaters into the ground to create evapotranspiration (which cools down the temperatures)
- **Playground infrastructures:** recreational games etc.

2. Oasis as a multibenefit NBS:

The Oasis project, centered on the idea of freshness islands, is deemed to be multibenefit: the new layouts it proposes would ideally bring other kinds of advantages next to the island of freshness:

2.1 Biodiversity through more vegetation

Beyond the aesthetic and pleasant, as well as potentially refreshing aspect of vegetation, the plantation of trees, plants, the emergence of kitchen gardens fosters biodiversity. Schoolyards would in this wake constitute a place for different species to develop inside the city.

2.2 Social cohesion, conviviality and solidarity in the neighborhood through new meeting spaces.

Opening playgrounds during week-ends and holidays is not only expected to preserve the health of the most vulnerable by providing them cooler spaces; the expectation is to create new common areas to meet and share, vitalize a neighborhood by encouraging people, associations to gather, organize local events in these new open places. It then surpasses the school scale and should be beneficial for the neighborhood as a whole to create/recreate a community life within an area.

2.3 Pedagogy around environment and CC

Through gardening activities, observation of species, understanding of water cycle, games closer to nature, children will learn from nature. Nature will constitute a part of their lives and education and will help them understand the related stakes of climate change, which impact it will have on human lives from the sensible experience.

3. The implementation required public policies' adjustments to limit barriers

- **A multi-actor governance**

To make this project relevant, school staff, students, parents, municipal directions, architects, green spaces management... are to be involved.

- **A will to co-design and include different actors**

In this project, there is a strong will to involve the school community. (children, parents...)

The involvement of children was wanted for the program: the idea was to give children a place and a role inside the process because they were the first users of the areas so they should have a say and be able to participate to the design of their own playground.

4. From theory to reality: the development of a pilot project

4.1 Principal issues and measures taken

After having focused on the spirit of the Oasis project, it is now essential to pay a closer attention to the three pilot projects which were launched in 2017 in three Parisian schools:

- Ecole Maternelle du 72 avenue **Daumesnil**, 12e arrondissement, Paris
- Ecole Maternelle du 4 rue **Charles Hermite**, 18e arrondissement, Paris
- Ecoles Primaires des 14 et 16 rue **Riblette**, 20e arrondissement, Paris

The project was multiple: as it used the budget for the schools' refectation, it was not only about vegetalisation and resistance to heat stress but also building a more pedagogical space for children so they can learn and play. One of the school (Riblette) was also beneficial from a participative budget.

In each school concerned, the project was multi-actor: the architecture section worked together with the scholar affairs, the green spaces department (...) in order to develop a multidisciplinary expertise.

After a diagnosis of each school's situation regarding the current condition of the schoolyards, some problematics were raised:

- The weakening of the ground due to roots (potentially dangerous for children), the infiltration issues and the mainly black asphalt raised questions about which kind of soil to use.
- Depending on the needs of each school, a variable concern on the role and future place of nature, vegetation in the school (in Charles Hermite school, as the neighbourhood is not very furnished with green spaces, it was quite a concern, whereas in Riblette, the need was less important because of the quantity of green spaces in the area)
- The refectation of the schoolyard is also the occasion to question the disposition and structure of the playgrounds and the infrastructures (benches...)

The measures taken:

- A refectation of the floor: zones of open ground created, new furniture to diminish the heat island effect (brighter colors) and allow when possible the infiltration of water (draining concrete)

- Fountains (pedagogical, and source of water)
- New benches, new games...
- Plantation and removing of plants
- Pedagogical garden

4.2 Identification of drivers and barriers for the implementation of the Oasis schoolyards:

After several interviews with the different stakeholders involved in each school (especially Charles Hermite and Riblette), some common elements can be identified and constitute barriers and drivers for the implementation.

➤ **Drivers**

Real needs:

- Work based on a real need to refresh the area (Charles Hermite)
- Work taking into consideration the different stakes: create shadow, infiltrate water, increase the open ground surfaces, create pedagogical areas...

Governance, coordination and participation

- As the project was launched by the “Mission Résilience” from the city of Paris, which is transversal, a real work was done to **coordinate the different relevant services from the city of Paris**: green spaces, quarry inspection, water services, hygiene laboratory... were consulted and could give their thoughts and advice to make the project move forward and evolve with new ideas, improvements... A genuine **dialogue** was launched between the different stakeholders
- **Voluntarism** from the project leaders (CAUE, SLA, CASPE) good relations between them, **enthusiasm**...
- A concerned and **mobilized educational team**, which allowed thoughts on the pedagogical and playful aspect of the schoolyards
- Good relation with the elected representative of the city of Paris and of the of the arrondissement town hall.
- Cooperation framework: **implication and participation of the pupils** to their schoolyard refurbishment (in Riblette) → creating the good conditions of appropriation, taking into consideration the remarks of the children in an attempt to **co-construct**.
- Communication and information: parents informed by the school director (Hermite)

Technique, feasibility

- The technics and devices are already known

➤ **Barriers:**

Governance

- Despite a dialogue launch, **it is hard to get rid of silo management** (for instance, landscapers from green spaces are not used to working in schoolyards...)
- **Schedule issue:**
 - Not enough time to go through all the elements. For instance, biodiversity not so much taken into account
 - not enough time to take into consideration the children's thoughts (Hermite et Daumesnil), or the parent's thoughts
 - a lot of debates but some of them stayed debates because of the short schedule (playgrounds...)
 - the work had to be launched during the summer holidays, so there was an obligation to consult enterprises soon enough...

Financing

- Budget constraints (not possible to implement every ideas)
- Over cost compared to the initial envelop (because it was planned for an identical refurbishment)

Technic, feasibility

- **Environmental constraint** for the infiltration of water: gypsum pockets...
- Uncertainty on the life duration of a permeable surface. **Path dependency** to known materials
- **Hygiene and security constraints** (taking into account toxic plants, fear of funguses on open ground areas...)

4.3 Recommendations

- More time is needed time to build a participative method

- More time is needed to deepen the cooperation between the city services
- Using feedback from the pilot project to enhance the next schoolyards' refurbishments
- Integrate more the parents in the process, especially in areas where there is an isolation feeling: way to create social bond
- Mobilizing European funds (FEDER)
- Building more partnerships

III. Survey based on a Social-psychological approach of OASIS

To face vulnerabilities that are consequences and manifestations of CCAM, different scale adaptation strategies need to be set up. City of Paris "Oasis" project aims to transform Parisian schoolyards (more than 70 hectares) through renaturation and nature development solutions to adapt climate change. With predictions of the imminence of the increase and frequency of intensity of extreme climatic events, these actions aim in particular to reduce the urban heat island effect and to act at the microclimate level. In summer 2018, work was carried out in 3 pilot schools:

- Daumesnil (12th district),
- Charles Hermite (18th district)
- Riblette (20th district).

Interviews have been conducted with parents and school principals of the two latter so as to explore the relation to nature in urban areas and collect their perception of change in relation to this work.

As for the methodology, interviews of directors and parents from 2 pilot schools and 2 control schools have been conducted, as well as the utilization of interview notes from several organisms (SLA, CASPE, CAUE75, SPSE). At the moment, 9 interviews (3 directors and 6 parents) have been conducted, with Riblette and Charles Hermite as pilot schools and Maraîchers and Cesbron as control schools.

General enthusiasm concerning Oasis project **Nature as a need** | As we can expect, there is a spontaneous and unanimous enthusiasm among the interviewees concerning Oasis project; an enthusiasm linked to a strong desire for renaturation and related to the concern for the population needs. We observe a strong appetite

for nature, as it conveys different representations and consequently provokes different types of emotions.

There are different interpretations of what is nature. The different viewpoints concerning nature reveals that several levels of perceptions of nature coexist, generally exclusive of each other. For some people, nature cannot be found in mineral places, whereas for other people, punctual elements of nature are part of it. The definition of nature itself varies. Although for a few, “the most natural thing here is us, humans”, we can find patterns in the way nature is perceived. The first theme underlied is life and biodiversity.

Fauna and flora (“trees”, “animals”, “birds”) are spontaneously evoked. There is clear association between nature and greening. The second type of evocations of nature are linked to landscapes (“countryside”, “mountains”, “sea”, “lakes”) and revolves around the theme of openness and light (“light”, “openness”, “sun”), with the idea of open areas (“horizon”, “view”).

What is interesting as well is the spontaneous negative definition of nature, as nature is opposed to a perception of different threats (“noise”, “aggressive”, “bad air quality”). All these elements drive us towards a frequent dichotomy between openness and closure. This dichotomy continues at an affective level, closure being related to emotions of physiological arousal (“stress”, “anxiety”) and openness being related to emotions linked to appeasement (“calm”, “tranquility”).

Nature is perceived as well as a privileged space for an experience of sensoriality and it is as such that the absence of nature is linked to an emotional distress. Almost all the senses are solicited during the experience of nature (lexical fields of sense of smell, sense of hearing, sense of sight, sense of touching). Nature is a means of resourcing, allowed by that sensorial experience. During the experience of nature, people feel a “reconnection”, a sort of non-mystic “communion” with nature. Nature. Nature is also a mean to recenter, and an indicator a temporal change (season change).

In relation to all its benefits, a real importance is given to nature: importance of more nature and importance of preserving it. Nature, when not described as “vital”, “fundamental”, “a need”, is always at least said to be “important”.

1. Willingness of commitment from locals

Project Oasis itself generates a willingness of commitment and implication from locals, as it is not only related to environmental matters, but involves social concerns as well. The thinking of schoolyards accommodations is the occasion of a reflection on a more global level among Parisians.

There is a consideration for the schoolyard as a social space. School in fact conveys a social dynamic at a local level. Considering this, it has an initiation potential for a wider commitment into social activities (especially social link and social exchange). In fact, it is a hotspot regarding the informational flow at different levels and between different actors, a privileged place for socialization for parents and children. It appears in the interviews that a link is missing (maybe in the form of an organization, or ad hoc group of actors) to commit parents more, frame their desires

and projects into action. In relation to this, the underlined question is one of communication between the different stakeholders of the district.

Parents' perspective is in fact an interesting one to think locally. We can see a shared positive vision concerning the opening of schoolyards during weekends and holiday. Schoolyard is pictured as a meeting point likely to drain social activities and to influence the district dynamic. The project to open schoolyards is seen as a means to improve wellbeing in the apprehension of the district dynamic. However, the idea of opening schoolyards is always linked to the thought of a regulated opening, in terms of access.

2. The schoolyard as a space to think differently the development and well-being of children

As the most frequent observers of the development of their children, the parents' perspective is also interesting to consider schoolyard as a space to think their wellbeing from a general perspective.

In fact, there is a solicitation to integrate different perspective to think children development. First, there is a solicitation to consider in the nature-based accommodation the awakening of children. In that spirit, accommodations have to fulfill their different needs (whether it is "relaxing", "unwind", they are "social", "playful", "gathering"), considering their needs can change at different times "the young like the old, the girls like the boys, dynamic children like dreaming children, considering that we can be dynamic at a moment and dreaming at another moment".

There is a solicitation for their psychomotor development (with a stress on developing their fine motor skills), with a willing to diversify the playgrounds (and make it a place where they can expand). A different use of the space is proposed at the same time ("climbing wall to use space better", "wooden hut", example of the Jardin des Dunes et des Vents of La Villette for fine motor skills accommodations). There is also a will to make the schoolyard a more colorful place, and therefore a more stimulating one.

Schoolyards as a mirror of social matters | A frequent solicitation is related to social consideration, such as the repartition of space between boys and girls, with the common testimony of a large space used by a majority of boys to play football and the rest of the available space being distributed between the remaining pupils. There is a concern for several social considerations in relation to education, such as equality, harassment, ... Here, a reflection on the role of the role of the staff is suggested several times ("supervisor or animator?").

Beyond the mere idea of the physical experience it can propose, schoolyards are also a privileged place to another approach of learning. More precisely, renaturation is seen as a way to make informal learning. There is a strong willingness of the idea to see from where what we daily eat comes from. The importance of the knowledge on biodiversity is seen in the plebiscite on nature-oriented individual and group projects in school. There is a shared need to restore the continuity between what we consume and where it comes from (relearn the cycle of life and the growing of vegetation "vegetables don't grow in the supermarket"), to make manual learning such as

gardening and to gain a sense of patience and somehow responsibility towards a long-term project (“watering, see it grow”). Concerning biodiversity, renaturation is the occasion to learn in an informal way and to foster intrinsic curiosity. Therefore, there is a potential to learn basic knowledge on nature as well as to reconnect with nature elements for an urban population. There is also an appeal for new practices, such as local gardening practice. Therefore, the initiative of pedagogical gardening is well received, and there is the will to make a use out of it (“aromatic herbs”). The practice of compost is wanted in a perspective to consider new practices regarding waste management.

Finally, education is seen as an uptake to new mentalities. There is a desire from parents to transmit new environmental good habits (“that they set up several things, because us adults, we do not do much, not the maximum”, “it must enter in education to do things like that, because they will not have choice. It is going to be unbearable”). The importance of sensibilization and formation to pro-environmental behaviour is stressed.

3. Several concerns to consider before implementation

Security and hygiene limitations are the most frequent concerns evoked by the parents, especially with the question of the opening of schools.

The question of the security is mainly linked to the opening. The underlying question is the one of the regulation of the access: will there be a control and of what type? If the openness of the schoolyard is welcomed for vulnerable people, the idea of a free-access opening raises fears. In the first case, spontaneous questions concern what is considered a vulnerable person. In the second, what are the modalities of access of the schoolyard and what are the maintenance and logistic solutions linked to the planning and managing of the opening?

The opening of the school raises questions linked to fears of degradations, whether they are voluntary or due to potential misuse of the existing accommodation. Fears concern degradations as well as inappropriate practices inside the schoolyard (alcohol, drug use and possible related waste). In one school in particular, the fear is heightened with the social context of the district (“it can be inconvenient from the security perspective. There are already intrusions in the schoolyard, we already found condoms and needles”).

Security matters are also related to the NBS facilities. A major complain of the parents about the project facilities is the roughness of floor covering (“floor is too rough and damages a lot. It prevents from making activities”; “the floor covering rips all the trousers”; “scrapes the skin” and generated cost “had to buy many pair of shoes”; “environment is important, but the children skin as well”).

Another major concern among the parents is hygiene questions. In fact, there is a perceived need to anticipate on future uses facilities and use of the space. Through the interviews, we can observe an enthusiastic welcoming of the project, as long as a proper management system of health and security issues are set up. As an example, school is pictured as a “sanctuary”, idea that can be incompatible with its use as a free-access garden. A reluctance among parents is linked to a preoccupation for

cleanliness and the perception of children as a vulnerable population (“I don’t want adults to go in the same toilets as my children, children are a bit fragile”). There is a concern with sanitary questions such as disease transmission that can be due to water fountains, along with a preoccupation for maintenance related to cleanliness (water fountains and “salmonella”). There is also a concern for health issues, particularly allergies and the potential of toxicity of plants, with the need of the expertise in the selection of species as well as the development of a legal framework.

Another matter raised is related to additional future maintenance needs for the setting up of Oasis project. There is in fact a general questioning about how to manage new needs that cannot be fully anticipated yet, with a questioning on how and who will take care of vegetation planted in schoolyards (watering) and the question of security in relation to vegetation (trimming of trees, tree diseases). The maintenance of the vegetation excluding school hours, particularly during long periods when the schoolyard is not used, is also to be taken into account.

The underlying question concerns future use of NBS, especially additional costs it can generate due to its setting up (vegetation), misuse whether it is due to the children (e.g. water fountains waste among the children during cold season) or exterior people.

4. Oasis schoolyards in the face of reality: discrepancy between a dreamt oasis and the actual changes

Low perception of change

The Oasis project produced high expectations among the parents, and the outcome appears less visible than expected. It is not possible for now to make an opinion on both the vegetation designing and the effects of the floor grounding and its effects on potential changes in perceived temperature. For some parents, there are few changes (“we know, for the ground, apart from that it seems that there is a garden, but I don’t see it”; “they changed things but there is not a lot”). There is in fact a perception of a discrepancy between the dreamt oasis and the actual accommodations set up among parents wishing for more daring changes (“why not make a whole garden in the surface of the schoolyard”). Some parents state a feeling of disappointment with the perception of little facilities set up (“for the moment, to me, there is not much”) and a disappointment due to the discrepancy between what was planned and the actual realizations (“the idea is good, but the execution is disappointing”, “problem in the finess of execution”).

As for the execution of the project, some difficulties are perceived regarding different elements.

Perceived difficulties in the execution

The positioning of many parents is a willing to take part in the project. A paradox is perceived between decision-makers willing to involve citizens but a lack of information on the follow-up of the project once the concertation phase is over (“it’s a difficult positioning”). Some parents feel a decreasing communication from the stakeholders, as they on the other hand state a willingness to inform themselves and

to be kept involved (“i want to be involved in the project»; «when I am there for technical problems, I have the impression to annoy”).

As for the execution, there is a perception of a global slowness in the execution of the project, due to a perceived excessive precaution posture, with a perception of long and complex procedures, that hinder initiatives and creativity (e.g. climbing wall, health concern and pedagogic gardens).

There is also the perception of a difficult communication between the different stakeholders of the project, and a difficult adaptation to its novelty. Some parents regret the lack of information perceived on the management of the project (“i don’t know what is going on on the side, whether they are overworked, if it is not their culture, if they don’t understand, if there is too much work”, “apparently they were failures, logs weren’t as expected, the stage wasn’t as expected”)

A related question is whether the project is sufficiently directed towards the resilience of the facilities: are they thought to last on the long term? The question is that of the quality of the products chosen but the related reflexion on their layout as well.

5. A lack of consideration of local contexts

When it comes to thinking about the implementation of Oasis project, the main point that stands out is the necessity to personalize and adapt the different schoolyard layout projects to their social and spatial contexts.

6. Spatial matters to think the implementation of Oasis project

Considering spatiality at different levels is important for an accurate implementation of the project regarding its considered uses. The necessity for thinking facilities adapted to future uses is stressed. For example, the needs in terms of nature varies from a district to another, and subsequent future uses of the schoolyards. Considering urban planning of the district from a geographical perspective appears accurate (e.g. the presence of many squares surrounding the schoolyard may influence its future uses). The general apprehension of the district influences the perceived need for nature and vegetation. Namely, the presence of many squares or a park in the surrounding of the school prevents a perception of a use of the schoolyard as a leisure place. In the opposite, a green schoolyard in an area deprived of green spaces foster the perception of the schoolyard as a place where children can play and rest out of school hours.

7. Social matters have also to be taken into account.

One of the main findings of the interviews is the necessity to consider the specificity of the different social contexts for the implementation of Oasis Project. In one school, for which the district is described unanimously as a place where there is insecurity by the parents, the district’s social dynamics are characterized by a withdrawal fostered by a global perception of insecurity.

Considering this, the opening of the schoolyard would create a leisure and resting place for the families, in a place where the already existing green spaces cannot be practiced by the families interviewed. The opening of the schoolyard is perceived as an uptake to an evolution of the social dynamic between the different actors of the school. In this case, the parents are enthusiast at the perspective of the opening of a place where children can play, in a place where few places are perceived as leisure places and where children do not play outside a lot (“my girls, I have never accustomed them to go outside, in the street, to play outside”). Furthermore, there is a perceived impossibility for families to use green spaces nearby as a leisure place (“the only square is ill-reputed”; “there are drug addict, and the problem is that some migrants become drug addicts”).

However, the feeling of insecurity, due to a high perceived criminality, drug consumption, social precarity and prostitution (“very worried”, “district is not very safe”; “there is a lot of toxicomania”, “prostitutes along the boulevard”), makes it hard for families to conceive the leisure potential of their district, for example as a place where to stroll (“the district is neglected”, “the district is dirty”, “we do not want to stroll in the district”, “my son is 6, he has known since last year what crack look like”). The perception of insecurity, even in the school itself (“a drug-dependent man entered in the school”, “the insecurity comes even the school” ; “already intrusions in the schoolyard”), prevents from thinking the district as a place prone to openness. That perception generates a general feeling of withdrawal (“if it is not your family, you lock yourself up”) that hinders a general wellbeing in the relation between the individual and its immediate environment.

This table summarizes the OASIS program:

Dimensions	Barriers	Uptakes
Governance	<ul style="list-style-type: none"> • Difficulty to build common objectives due to communication problems (lack of common knowledge) and diversity of positioning • Difficulty to launch a dialogue with organisms that operate at different levels • Difficulty to exchange information due to different timeframes among actors • Integration of different perspectives made difficult due to time management issues (limitation in the 	<ul style="list-style-type: none"> • Diversity of expertise among stakeholders • Trusting relationship between Riblette’s different executing actors • Implication of the directors • Acceptation and enthusiasm among the parents and directors towards the implementation of NBS in schoolyards • Integration of children in the designing of the project

	<p>consultation of relevant services)</p> <ul style="list-style-type: none"> • Lack of systematic consultation of children in some projects 	
Health	<ul style="list-style-type: none"> • Fears in terms of health with pedagogical gardens (allergens) • Fears in terms of hygiene (soil, water fountains) 	<ul style="list-style-type: none"> • Temperature regulation • Improving of air quality
Security	<ul style="list-style-type: none"> • Need to think the arrangement of space keeping in mind security and children supervision • Potential hazard of biodiversity elements (bees, trees diseases, toxic species) 	
Maintenance	<ul style="list-style-type: none"> • Maintenance related to new needs with NBS (watering, trimming, maintenance outside school hours) • Additional costs caused by the maintenance of the premises in relation to their future use 	<ul style="list-style-type: none"> • Risks of misuse of fountains (water waste)
Social considerations	<ul style="list-style-type: none"> • Necessity of the integration of a social perspective ahead of the implementation of NBS to rethink the space and use of the schoolyard arrangement (equality, harassment, ...) • Necessity of the integration of a reflection on children development and wellbeing in the implementation of NBS to rethink the space and use of the schoolyard accommodation 	<ul style="list-style-type: none"> • Oasis as a springboard to rethink the relation to neighbourhood • NBS project as a mean of initiating another social dynamic and new local projects among parents (NBS as a mean to encourage local initiatives)
	<ul style="list-style-type: none"> • Global lack of knowledge on the technical aspects of NBS implementation among parents (information) 	<ul style="list-style-type: none"> • NBS as a way to adapt and reactuate school accommodations

Conclusion: recommendations

After having reviewed challenges related to NBS deployed for CCAM as well as corresponding barriers and uptakes in various situations, we now intend to give guidelines, recommendations to encourage a larger implementation.

We take the previous main broad categories (cultural, governance/policy, communication and knowledge) used all along the document to structure the recommendations which result from all the observations and analysis made.

Before going deeper into those categories, it is necessary to stress again the basis of NBS to make sense in a new territorial and urban paradigm:

➤ **Holistic approach of NBS et renaturation**

Thinking about renaturing involves a paradigm shift that in return restores nature and the idea of NBS as a whole.

➤ **A change of scale and temporality: (re) naturation and territorial mesh**

For many experts, NBS, reduced to small kind of renaturation (roadside planting, green roof or facade, flowering trees, or other rain gardens ...) do not reduce the hazards associated with climate change. They appear too temporary to be able to have a significant impact.

The naturation of inhabited spaces seems likely to have significant consequences for the mitigation and the adaptation of the territories to the CC if they are linked to a global strategy and if these effects are combined (the parks create freshness islands, reserves of Biodiversity and uses, trees favor CO₂ capture, dunes limit coastal erosion, soil de-waterproofing favor the recovery and storage of rainwater, etc.). It is important to change the scale because we need a global strategy to improve urban adaptation to climate change. It can be accompanied by specific initiatives but these need to be connected to each other and especially in connection with a real strategy of naturation / urban renaturation. It is about thinking a mosaic of natural places ranging from forests, parks, water networks to microplaces that represent green roofs and facades and other flower boxes.

Nature implies "situated action strategies" and a questioning of generic technical innovations. For example, streets combining plants and trees provide more ecological services than just tree planting. Likewise, the valley gutter make sense only in certain situations, such as the corridors that articulate the valleys and gardens.

In the metropolitan territories, the suburban appears strategic. It is easier to renature, a bit dense and with many free spaces. It is the place of urban borders that are ecotone (encounter of ecosystems), and singular urban spaces, where other experiences of the city can be afforded.

Naturation involves considering not only spatial but also temporal complexity. Thus, meteorology is a process that varies in space and time (heat island is understood only with traffic flow, particle flow responds to the flow of the city, etc.).

The issue of naturation (or renaturation of the existing city) is therefore essential to promote more resilient cities. It will also support the transformation of the urban

living environment, with new amenities and especially perspectives of differentiated sensitive experiences.

To go towards such resilience, some recommendations are formulated below.

Culture

- **Better define NBS and urban renaturation issues, think the Nature in link with inhabited places**

The term “NBS” emerged in a 2008 World Bank report to operationalise an approach to nature whose workings offer ecosystem services. The expression “ecosystem-based adaptation” is sometimes used. Conceived of holistically, nature is no longer reduced to a function and goes beyond the concept of an offer of services. As a living environment, it places individuals, fauna and flora at the centre of everything. Furthermore, such a reopening connects humans with their earthly home (Paquot, 2015).

Renaturing schemes radically transform urban landscapes (Clergeau, 2011). This means we must question how we envisage nature and the processes of relationships between humans (and their civilisations), natural and built places, and the living world. This involves thinking simultaneously about the cycle of living things and the life cycle of a place (Magnaghi, 2014) in conjunction with humans and earthly changes. This presupposes a new way of being (in cities) and therefore of perceiving that this is possible, and even necessary. The term “renaturing” is not without ambiguity, but it has the merit of introducing the idea of process and of re-examining the idea of nature with a scope reaching beyond the limits of ecosystem services under the NBS concept. In this respect, the term “renaturing” allows NBS deployment strategies to be defined in a holistic vision. It is used in various disciplines (urbanism, architecture, nature conservation). Renaturing refers to a process of spatial transformation resulting from the expansion of natural habitats (flora, fauna, water...) and the restoration of ecological functioning to inhabited environments. The term considers nature with its environmental, urban, social and sensory properties; as an ecosphere, a habitat and living environment; as ground and topography; as a near and distant landscape...

- **Improve understanding of the links between NBS and Climatic change**

Climate change measurements are too generic. Often, they do not make sense at small scales.

For example, the centennial flood is based on an average. These floods cannot be predicted accurately; they take various forms locally, depending on their intensity, but also on urban configurations, local microclimates, etc. It is therefore important to consider a global adaptation of the city because the scientific predictions are global and their local impact remains largely unknown.

➤ **To get out of a vision idealized of nature**

Experts stress the need to reconcile the positive and negative impacts of nature. They insist especially on the need not to minimize the negative effects that could resurface in a citizen dispute while the NBS are implemented.

Governance and policy

Governance

➤ **Building a community around NBS:**

. Community of practice with various stakeholders, e.g. researchers, decision-makers, companies and local residents to share best practice and create a body of evidence-based findings to support the value of NBS.

➤ **Need for a political impulse (European, national, local politics)**

. Need for policies and funding to start pilot projects for knowledge production and developing various designs step by step: this will allow an appropriate assessment and collection of evidence of the benefits, performance and functionalities of various NBS is needed. The lack of this kind of assessment represent another important barrier. It will also potentially foster cross sectorial knowledge as the pilot could be used as a learning and idea exchange platform for various stakeholders.

. Also, local governments should come up with new financial instruments dedicated to long-term management of NBS (development & maintenance).

➤ **Develop tools allowing the European states to harmonize the naturation policies**

. To plan documents to encourage the spread of territorial strategy (ex: TVB, Biodiversity plan).

. To set planning rules (ex: biotope coefficient (CBS) in Berlin). For example, green roofs are spreading but still with plastic components, a greening without sufficient soil thickness to ensure sustainability of plantations, without refreshing effect, without water storage system, etc.

. To set evaluation rules (ex: Olympic Village of Olympics 2024 in St Denis, France). Importance of the Environmental Declaration Forms (FDE) / ACV (life cycle)

- . To consolidate strategic plans (Climate Plan, Resilience Plan, Biodiversity Plan, TVB, town planning, etc.) that overlap
- . To set accurate territorial objectives (and not only general objectives) (ex the quantified objectives of Bordeaux to double area of green space).
- . To set territorial objectives for projects (ex: 50% de waterproofing).
- . To govern with civil society: mobilizing and sensitizing civil society and deploying more participatory processes.

Local Strategy

- **Define a transversal renaturation strategy (unlike silo actions).**

This assumes:

- . Elaborating a territorial diagnosis and studying how to involve all NBS services and risks. For example, study biological risks as the tiger mosquito proliferates with the increase of water in the city and temperature rises. A sanitary analysis must be carried out from a microbiological study in order to formulate proposals (avoid stagnation of water, avoid some plants, etc).
- . Elaborating a renaturation strategy: diagnosing needs, setting priorities, developing an urban and territorial renaturation strategy
- . Planning budgets: Budgets must go along with strategies. For this, it would be necessary to operate in global cost by integrating from the outset the green and gray options, integrate management fees from the outset and provide for sustainable management by reasoning on the life cycle of places and buildings. For example, this is the case of the green roof of the Beaugrenelle shopping center in Paris. It also need to develop a fund projects
- . Developing new tools and methods to assess the cost of NBS and the savings they may entail to foster their implementation: for example, methods for calculating savings in the healthcare budgets in the long run due to the effect on the health and well-being of NBS, often concerning cultural ecosystem services, should be further developed.
- . Developing a cross-administrative approach to understand the various needs of different groups of urbanites, to guarantee equality in NBS supply and demand. The municipal planning systems and guidelines may be outdated, and not able to take NBS into account. A change of these systems and developing new guidelines and instructions for NBS are needed. One example of systemic issue is the equal access to NBS: how to guarantee the geographical diversification of NBS, and access to NBS by vulnerable groups, such as the elderly and long-term hospital patients.
- . Displaying multiscale and multi-year spatial objectives
 - Territorial strategies of renaturation / recreation of environments

- Prioritize places to preserve (parks, woods, LU), those where there are fewer constraints to invest in priority (water tank, cemetery, ...); Coins and recesses,
- Objectives to the plot (biodiversity, water management, island of freshness ...)
- Regulate the biotope coefficient (as in Berlin), open-air (as in Paris),
- Multi-year program

For integrated assessment: One-goal strategies must be moved beyond an integrated approach. For example, the Eco-district of Bonne in Grenoble is very efficient about energy issues but not at about the NBS (soils are waterproofed, the terraces are in tech, etc.).

➤ **Define new collaborative approaches**

. Making stakeholders come to a shared understanding of NBS, renaturation project to adapt cities to Climate Change.

. Mobilize skills and expertise on NBS and territorial / urban regeneration: new methods of management, occupations, administrative procedures, etc. It necessary to develop collaborative methodology, participative process to elaborate diagnostic, strategy, actions plan, This collective approach can develop a common roadmap of the steps necessary to adapt territories.

. Mobilise the private sector:

- To identify, map and support private sector initiatives (companies, start-ups, foundations, associations, etc.) that can complement the action of public policies
- To offer public-private partnerships to carry initiatives. It is necessary to consolidate the partnership through a multi-year contractual process which guarantees the public counterparts and evaluation modalities integrating all the expectations (environmental, economic, urban, social, etc.). They must contribute to an objective of general interest to guarantee their appropriation by the populations.

. To raise awareness and mobilize the inhabitants

➤ **Propose a flexible action plan and set of renaturation actions to develop a cross-sectoral vision, set political objectives and develop incentive and regulatory tools to achieve them**

- Quick adoption of innovation is a key to get new ideas realized. New action patterns and routines, and possibilities for organizational learning may be needed for creating a platform for effectively adopting and implementing NBS. This, again, is linked with the flexibility of administration and the overall attitude in an organization - is it able to

create positive new traditions and make the new routines business-as-usual.

- Creation of support mechanisms for group of early adopters, who are a valuable resource for getting NBS projects going, and also spreading knowledge. They may have a considerable effect on, e.g. changing the traditions of the construction field.
- In NBS-projects with several stakeholders, win-win-situations can be achieved, and different ‘carrots’ be offered for various stakeholders: references, visibility and research data for companies, knowledge and new partnerships for authorities, new funding and publication possibilities for universities, etc.

Action

- **Combine uses of green and grey solutions**, for example, a better management of rainwater should articulate 3 approaches:
 - Rain gardens and valley gutters
 - Permeability of soils: natural soils, possibly paved on land, avoid bitumen which does not allow water to penetrate the soil)
 - Green roofs (with 10 cm of substrate), participate in the rainwater recovery system
 - For Example, in the Bièvre Valley (Ile-de-France Region), there is a restriction (for a period of 10 years) of flood expansion zones that complements existing basins.
- **Give a priority to the simplicity of proposals both in terms of design and management.** For example, to avoid technological walls and boost non-invasive climbing plants, soil thicknesses on the ground, multistrata soils, alignment trees in the ground that could create a brown frame, a biodiversity underground while de-waterproofing the soil.
- **Develop framed devices: permit to vegetalize, root of tree, shared garden, etc.**
- **Temporary actions with tactical Urban Resilience is an approach to neighborhood building for cities looking to collaborate with key citizen, community, and/or stakeholders in the testing and delivery of resilience solutions that uses short-term, low-cost, and scalable interventions**

Tactical Urban Resilience is an approach to neighborhood building for cities looking to collaborate with key citizen, community, and/or stakeholders in the testing and delivery of resilience solutions that uses short-term, low-cost, and scalable interventions that respond to transportation, public space, and public engagement challenges to catalyze long term change.

Tactical Urban Resilience was developed in partnership with Street Plans Collaborative for cities in the 100RC network. The methodology is a resilience adaptation of the Tactical Urbanism approach to neighborhood building and public space development.

Tactical Resilience interventions help communities come up with creative, low-cost, and scalable approaches to move resilience initiatives from paper to pavement. Outputs from the workshops include an approach for small-scale demonstration projects and a summary report containing lessons learned and priority recommendations.

Tactical Resilience encourages people to work together in new ways, strengthening relationships between residents, local organizations, and government agencies. It also allows people to re-imagine how streets and public spaces could be used. Through this, cities are able to widen public engagement and gather data from the real-world users of streets and other public spaces.

This tool allows for the opportunity to test aspects of a program, project or plan before making a large political or financial investments. It also expedites project implementation and deliver public benefits faster.

Tactical Urban Resilience creates an opportunity for stakeholders to learn about, and then deliver short-term change in neighborhoods. The “learn by doing” approach embeds resilience-building concepts and opportunities at the lot, block, and neighborhood scale, ultimately positioning city and citizens to deliver long-term transformation together.

Source: <http://www.100resilientcities.org/tools/tactical-urban-resilience/>

Communication and knowledge

- **Develop a better knowledge of NBS inputs and renaturation strategies for CC mitigation and adaptation**
 - Manuals on how to deploy NBS
 - a knowledge web-based database to show evidence-based practices, ready-to-apply information, reference cases...

- **Shaping academic programs to take into account new stakes and allow a wider use of NBS:**

. Raising new generations of actors (e.g. urban planners) with up-to-date education of the environmental challenges we face today, and fresh ideas for how to solve them, pave the path for the acceptability and broad use of NBS.

. It is also important to recognize emergent actors: totally new fields of expertise may be needed to solve problems, and develop new techniques etc. Thus, also educational organizations should be sensitive to the societal change and be ready to quickly react to various educational needs. Mentoring programs can be useful for educating experts, as it allows for learning from peers and reflecting the knowledge with everyday work and, e.g. recognizing organizational restrictions.

- **Build new references through projects demonstrating relative to emerging practices of global strategies. The network 100 resilient cities could be an interesting valuation support.**

It's also important to promote knowledge of case studies, exemplary operations through guides focused on this theme. Already many guides exist for biodiversity. It is important to consider the same type of deployment.

- **Encourage and value feedback, pilot experiences to:**
 - **Highlight methodology:** territorial diagnostics, renaturation strategy, actions plans, collaborative governance projects...
 - **Propose perspectives of territorial reorganization by adaptation projects to the CC.** And for that, to overcome the organizational, economic but also technological brakes with an economic approach in terms of overall cost.
 - **Improve the dissemination of scientific knowledge through dedicated websites, conferences aimed at public policies, etc.**
 - Show successful case studies and other references of the performance of NBS, to highlight that they really work and are needed.
 - Allow a "wider" replication of NBS

Different paths can then be followed to enhance the implementation of NBS, which help to mitigate and adapt to climate change in cities and territories. On the whole, the necessary evolution of policies, the construction of new models of governance, the consideration of numerous scales from global to micro-local, the dissemination of knowledge, and the cultural shifts NBS entail are outlined. They add to the recommendations delivered in the previous deliverables and focus more specifically on the topic of climate change adaptation and mitigation. Altogether, they are expected to foster the wide use and knowledge on NBS to tend towards a large scale process of renaturation because only a large deployment will ultimately have a strong effect for adaptation and mitigation.

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ANNEXE

Interviews:

1. Alexandre Nezeys, water management expert, Marie de Paris
2. Gaultier Reynaud, environmental expert, Alto step
3. Noémie Fompeyrine résilience Project manager
4. Sébastien Maire, Chief of résilience - Marie de Paris
5. Marie Gantois, responsable pole adaptation au changement climatique, Mairie de Paris
6. Philippe Moutet, chargé de mission climat et énergie/architecture Fédération des parcs naturels régionaux de France
7. Philippe Clergeau, ecologist, Museum Nationale d'Histoire Naturelle
8. Richard Marquet, environmental expert, ??, Londres
9. Morgane Colombert, heatstress expert, EIVP
10. Pablo Georgieff, landscape architect, Coloco
11. Gaelle Bulteau,
12. Jérôme Defrance, acoustic researcher, CSTB
13. Maeva Sabre, climatologist researcher, CSTb
14. Abdel Lackel, Biologist, CSTB
15. Nicoleta Schiopu, environmental researcher, CSTB
16. Luc Schuiten, architect, Bruxelles
17. Philippe Jacob, ecologist, Marie de Paris
18. Marc Barra, ecologist, Agence Régionale de la Biodiversité, Institut d'Aménagement et d'Urbanisme d'Ile-De-France;
19. Bordeaux Métropole : Direction de la nature, Celine Gerbeau Morin, project manager of Nature, resilience and terrotory development

20. Ricardo Mira, Professor Environmental psychology, Coruna