URBAN GreenUP

D6.3: Analysis of Replication Potential

WP 6 , T6.2 & T6.3

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Table of Contents

List of Tables

List of Figures

0 Introduction

This report is Deliverable 6.3 of the Urban GreenUP project. The Report fits under Work Package 6, and covers Tasks 6.2 and 6.3. Work Package 6 is concerned with Replication and Clustering.

The H2020 funded Urban GreenUP project is premised on the delivery and testing of a substantial number of Nature-Based Solutions (NBS) in 3 lead cities: Izmir, Valladolid and Liverpool. Beyond this first round of NBS delivery, the project team anticipates a long-term, systematic delivery of NBS in each partner city on the project. Each city will prepare a plan that outlines how it will implement a selection of NBS to confront their particular set of urban challenges, such as flooding, urban renewal or heat – the project calls these Renaturing Urban Plans (RUP). In this way, the project will test the capacity for 'replication' of a wide range NBS within follower and frontrunner cities.

NBS that work well in one part of the world cannot be assumed to work in another. It is therefore important that each city adopts NBS that are appropriate to their particular context. That is why an analysis of replication potential is an important analytical step for each city, as part of the development of a Renaturing Urban Plan.

This report outlines a systematic, transparent and iterative model for analysing replication potential in cities. This model is then applied to each partner city, to enable preparation of a RUP. The report does this by developing and implementing a robust model to identify a set of NBS that are likely to match each city's unique challenges and capabilities, as an important early input to all RUPs.

Accordingly, the report has two components:

- An outline of the replication model, used to determine replication potential (Chapter 1);
- Application of the model to each partner city, with assessments of replication potential in each city (Chapters 2-8). Chapters are ordered to reflect our first round of follower cities (Mantova and Ludwigsburg) then our second round of followers (Quy Nhon and Medellín) and finally our frontrunners (Izmir, Liverpool and Valladolid).

1 Development of the model

This chapter describes the development of our model for replication analysis, which is a methodology for determining the replication potential of NBS in each partner city.

1.1 Conceptual foundation: understanding differences between cities

In seeking to determine whether NBS that are effective in one city will be effective in another very different city, the team started this process by seeking to define what the key differences are.

A review of the Characterisation Reports for each partner city (D6.2) enabled the team to identify the most important differences between participating cities. The table below summarises these differences, and how they are conceptualised in the replication analysis.

Variable	Why the variable matters	Implications for a RUP	Implications for replication analysis
Climate and geography	Different climatic zones and geographies produce different climate challenges. They also determine which species are appropriate for NBS, and how they need to be established and maintained. Finally, they are key determinants of the remnant ecosystems that may exist in the city.	These are key considerations when defining the challenges that should be prioritised in each city. Climate is also an important consideration in site, species and substrate selection, as well as in how plants are maintained and irrigated.	The model must allow cities to specify their own challenges and weight their importance. Site, species and substrate selection are design-phase considerations, which are important but can be resolved at the project level (not at the strategic level). The same is true for specification of maintenance and irrigation.
Built form	Built form and land use allocation is critical in determining how much space is available for NBS, and the degree to which space can be reallocated. It also may already include some NBS (typically parks and street trees).	Different precincts will have different scope for NBS implementation, and it is important to select appropriate NBS, while recognising that almost all NBS will require some reallocation of space or change in how land is managed.	Matching NBS to specific sites is partly a matter of negotiating reallocation of land use, and partly a matter of taking advantage of what is available. Much of this happens at the project scale, so the role of strategy is to ensure that the replication analysis identifies a diversity of NBS options that can match a range of built forms.
Organisational culture	Different cultures within organisations will determine the degree of cooperation and innovation that is possible. Risk aversion, path dependence and internal conflict are very common barriers to NBS.	At the strategic level, culture will be important in determining how diverse and unfamiliar the strategic portfolio of NBS are. Teams with cultures that are less collaborative and/or more risk averse will struggle with NBS that require cross-organisational cooperation or will require trial-and-error experimentation.	The analysis should identify attitudes to risk and collaboration within the organisation. This enables the city to acknowledge areas to work on in terms of organisational culture, while also selecting NBS that can be delivered within the existing culture in the short to medium term.

Politics	Politics can be a major determinant of the viability of an NBS program, both due to budget allocations but also because of the authority that political support provides when teams try to navigate their NBS program through internal approval processes.	To commit to NBS delivery at scale, especially for major NBS with longer timeframes, it is important to have reliable political support that is also reflected in the organisation's executive team. Where political stability or support are lacking, smaller, less visible, less innovative, short-term NBS are more likely to succeed.	The analytical model should factor in levels of political support, but also whether it is stable, and whether the executive team is similarly supportive.
Public participation	Successfully engaging the public in decisions around NBS can generate a sense of community ownership of NBS projects. This can translate into improved political support, as well as less opposition when land uses are reallocated (e.g. when roads are narrowed or closed).	For many NBS, engagement skills are very important, and cities need to develop an engagement strategy that corresponds to the NBS that will be selected. Cities may also elect to involve citizens in development of the RUP itself. When working with the NBS projects in the private realm, such as green roofs and walls, advanced skills in engagement and negotiation are especially important.	The analytical model should identify attitudes and skills in public participation, both as a means to identify areas that need work but also as a way of selecting NBS that are appropriate to current levels of engagement capacity.
Budget	Implementing NBS in urban settings is often more costly than expected, as existing materials and land uses often need to be reconfigured. Different materials, design approaches and regulatory regimes can add or reduce costs, but up-front costs are often significant, and maintenance funding is critical.	It is tempting to design a RUP to fit existing budgets, but this may not result in the outcomes required to adequately address the challenges a city faces. Work Package 7 offers a range of avenues to supplement budgets, enabling the NBS a city needs. Of course, the plan should factor costs into their ambitions, but it should be acknowledged that these will vary from site to site.	The team advocates a planning approach driven by outcomes, to which costs must be adapted - rather than the other way around. In this respect we do not include cost as a primary determinant of whether an NBS is viable. However, the tool does offer a range of NBS recommendations, so cities have options as they determine what they can finance.
Jurisdiction	The size and capacity of local governments varies widely in our project, with cities ranging in size from thousands to millions of residents. Some jurisdictions are large and centralised with extensive powers, others are subject to a high degree of control by regional governments. The scale of the problems to be confronted varies accordingly, as does the government's capacity and independence as they seek to address these issues.	Cities should be pragmatic about their extent of influence as they design a RUP - they may need to partner extensively to deliver some or all of their NBS, or they may require significant approvals. Selecting NBS that are entirely within a city's control can be easier, especially to get short-term results, but relationships across institutions are important in many cases to achieve more substantial results.	The analysis should determine levels of support and cooperation from external organisations, noting that some NBS will require this, and most RUPs will be enhanced by working on building these connections.

Strategies, processes and regulations	The idea that NBS can be used to address urban issues is familiar to some cities, and less familiar to others. This may be reflected in existing strategies, such as climate adaptation or open space plans. In some cities, there may be a few existing processes that define how NBS are to be approved, but this is rare. Legal frameworks regulating urban land use are usually not well-suited to NBS delivery and can be barriers.	RUPs may be able to leverage the support of existing strategies; if these do not exist, they may need to invest more time up front in educating the public, executives and politicians on the value and utility of NBS. Most cities will need to work on their approval processes and some will need to reform significant legal barriers.	Facilitating NBS delivery through reforming strategies, processes and regulations can be a valuable part of a RUP, but also a reason to select some NBS over others, especially in the short term. The analysis seeks to identify the current situation.

Table 1.1 Differences between participating cities and conceptualisation in the replication analysis

The conceptual work above forms the basis for the analytical framework the team developed in order to make recommendations regarding replication potential. The framework has two major elements, which correspond to the two fundamental questions in determining which NBS are the best for a city's RUP, explained in more detail below:

1. What is the city's current capacity to implement NBS?
2. What does the city want to achieve by implementing NBS?

1.2 Understanding the Capacity of cities to deliver successful NBS programs

The peer-reviewed NBS literature suggests a number of the key factors that determine successful NBS adoption, including political support (Chaffin et al., 2016), internal alignment between departments (Qiao, Kristoffersson, & Randrup, 2018), appropriate species selection (Norton et al., 2015), maintenance (Liu & Jensen, 2018), and community engagement (Frantzeskaki, 2019). Matters of institutional inertia and 'path dependence' also feature significantly in many papers (see for example Matthews, Lo, & Byrne, 2015). In this report, these are conceptualised as 'success factors' for NBS delivery. These success factors all relate to organisational governance, which underlines the critical role of governance as a determinant of success or failure of NBS programs (Boulton, Dedekorkut-howes, & Byrne, 2018; Brown, 2005; Kabisch, Stadler, Korn, & Bonn, 2016; Kronenberg, 2015; van der Jagt et al., 2017). Beyond the peer-reviewed literature, the team noted a strong qualitative framework for NBS delivery in local government also gave strong focus to governance (see for example, City of Yarra, 2018).

To develop a workable model of success factors for NBS that integrated governance, the team built on the base of Deliverable 1.5, which provides a practitioner perspective of the factors that act as barriers to NBS delivery. Following a review of this document, and the initial literature review, as well as our reflections on our own direct experiences in NBS delivery projects, an initial set of NBS 'success factors' was prepared. Table 1.2.Table 1.2 shows the total 21 individual factors that were identified, in 6 groups.

Fundamentals	Access to funding/finance
	Ability to locate or reallocate urban space to NBS
Politics and society	Political support
	Political stability
	Public supportive of NBS
Organisational Capacity	Ability to manage technical projects
	Suitable internal processes
	Access to design skills
	Access to construction skills
	Access to maintenance skills
	Access to knowledge of species and substrates
	Staff capacity/ time to manage process
	Ability to secure private owner consent or support
Organisational Culture	Alignment of departments
	Comfort w innovation
	Willingness to actively involve community
	Willingness to problem-solve
	Attitude to risk
Regulations	Supportive legal frameworks
	Supportive local laws
	Supportive planning system
	Supportive departments in other levels of government

Table 1.2 - Initial conceptual model of success factors for urban greening

While these factors are individually relevant, it was acknowledged that the number of variables was impractically large. The team then revisited the literature, drawing on a selected set of references to identify which factors were most critical, and seeking opportunities for consolidation. Appendix one summarises this analysis.

Through this process the team able to refine the set down to eight critical success factors:

1. Stable executive and political support
2. Suitable internal processes/standards/regulations/policy
3. Staff time availability and motivation
4. Advanced community engagement skills
5. Alignment of internal departments
6. Culture of innovation and risk tolerance
7. Supportive departments in other level of government
8. Access to suitable technical skills

Appendix 2 presents the deletions and consolidations that resulted in this set.

1.3 Understanding the challenges our cities are hoping to tackle

Another critical area of difference between our cities is in the challenges each city is confronting. As part of the city characterisation process for Deliverable 6.2, the team asked cities to identify which issues they hoped to address through their RUP. The response revealed a spread of challenges largely consistent with the Deliverable 1.2 Climate Challenge Catalogue, although some cities opted for more specific framings of their issues. The total number of issues is demonstrated in Figure 1 and Table 1.3.Table 1.3.

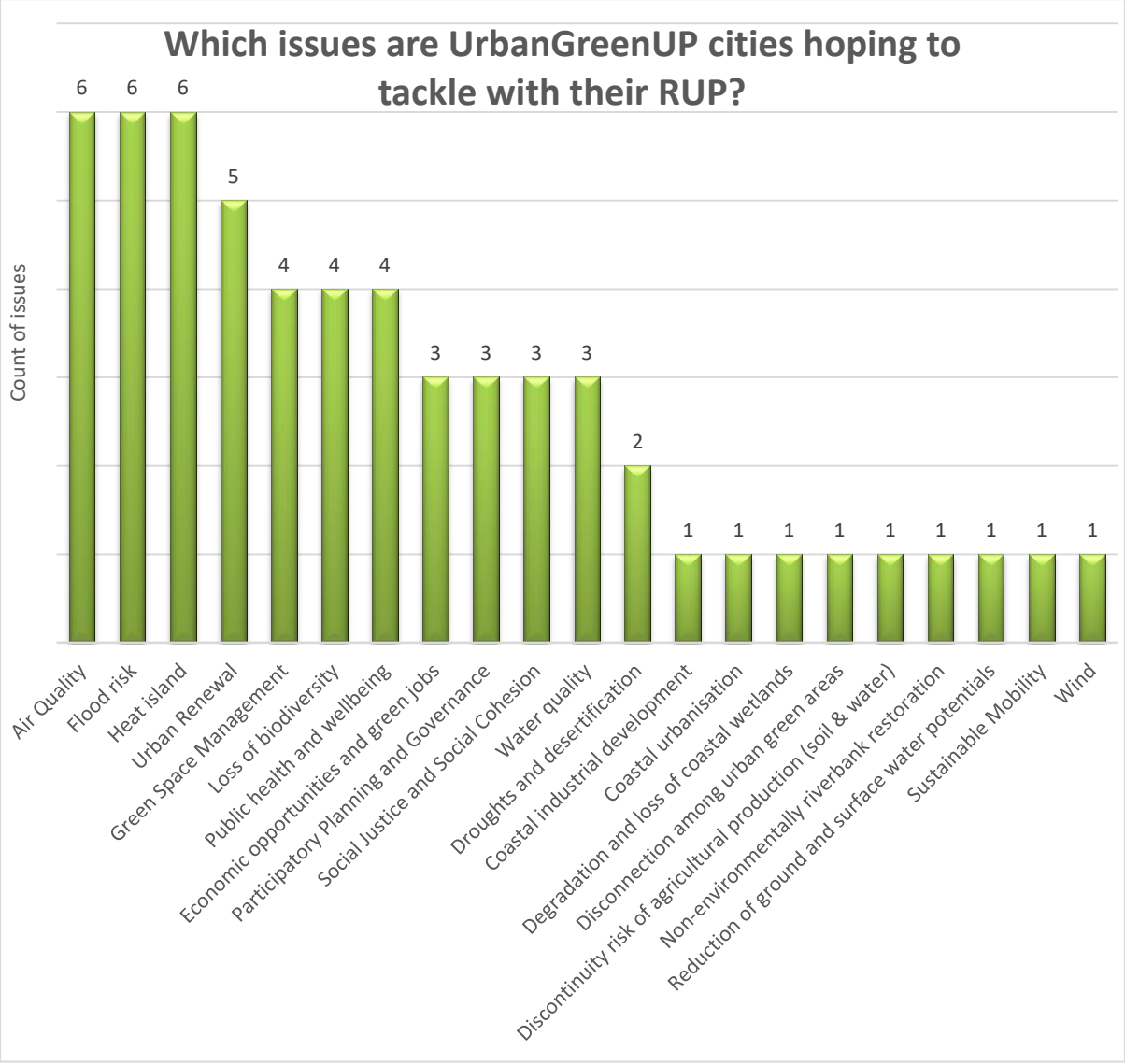


Figure 1 - Counts of challenges nominated by partner cities

Issue	VAL	LIV	IZM	MAN	LUD	MED	BIN	Total
Air Quality	✓	✓	✓	✓	✓	✓		6
Flooding	✓	✓	✓		✓	✓	✓	6
Heat	✓	✓	✓	✓	✓	✓		6
Urban Renewal	✓	✓		✓	✓	✓		5
Green Space Management			✓	✓	✓	✓		4
Biodiversity	✓	✓	✓			✓		4
Public health and wellbeing	✓	✓		✓		✓		4
Economic opportunities and green jobs	✓	✓				✓		3
Participatory Planning and Governance	✓				✓	✓		3
Social Justice and Social Cohesion	✓			✓		✓		3
Water quality	✓	✓		✓				3
Droughts and desertification			✓		✓			2
Coastal industrial development							✓	1
Coastal urbanisation							✓	1
Degradation and loss of coastal wetlands			✓					1
Disconnection among urban green areas			✓					1
Discontinuity risk of agricultural production (soil & water)			✓					1
Non-environmentally riverbank restoration			✓					1
Reduction of ground and surface water potentials			✓					1
Sustainable Mobility	✓							1
Wind				✓				1

Table 1.3 – Issues nominated in each partner city (note: BIN indicates the City of Quy Nhon/Binh Dinh)

Table 1.3 shows how the range of challenges nominated is significant, and each city had a unique set of challenges to face. Furthermore, these challenges are at different levels of intensity in each city. This underlines the need for an analytical framework with the flexibility to acknowledge the different challenges each city. The team selected a framework that integrated common concerns – in this case the tool was built to consider challenges that were priorities for four or more cities.

1.4 Selecting an approach to integrate the key considerations

Tools for assessing NBS exist to guide decisionmaking; in particular there are a number of quite sophisticated American tools for estimating the effects of NBS on stormwater (US EPA, 2019). This kind of tool is also present in other parts of the world, with tools like MUSIC and STORM (Australia) and B£ST (UK) tailored to delivering stormwater advice in development planning (eWater, 2019; Melbourne Water, 2019; Susdrain, 2019). Notably, the tools reviewed all include just a few NBS treatments (between one and eleven NBS). By contrast, the Urban GreenUP NBS Catalogue contains over 40 different NBS.

Similarly, current NBS tools tend to be only focused on one or two types of benefit – these usually are stormwater quantity (ie flood mitigation) and stormwater quality. Tools like iTree Streets do calculate benefits in energy conservation, CO_2 reduction and property value increase, but are confined to a single NBS – street trees (US EPA, 2019). Work conducted by the Horizon 2020 NATURVATION project does offer one example of a review of the benefits of NBS across a large range of benefit areas, for example air quality, coastal resilience, green space (Naturvation, 2019). These literature-based ratings of NBS efficacy are currently available for six very broad aggregated groups of NBS, which is the level at which the literature offers evidence, but offers less insight to the quite detailed set of over 40 NBS in the catalogue.

Our process indicated that a more detailed tool is necessary for Urban GreenUP; the real-world challenges of decision making associated with nature-based solutions (NBS) are seldom simple, with high complexity being the norm for most cities. Choosing between alternative nature-based solutions requires consideration of multiple, sometimes competing goals. Multi-criteria decision analysis (MCDA) is a tool that can cater to this complexity (IPBES,2016), by making explicit the synergies and trade-offs that can occur when developing a plan for using nature-based solutions in cities. The Horizon 2020 EKLIPSE project offers a review of 21 methods for synthesising knowledge for environmental decisions; MCDA is noted as having a number of important strengths, including an ability to integrate quantitative and qualitative data, a value as a deliberative framework for decisionmaking, and a transparent exploratory tool for exploring the impacts of different priorities and courses of action (Dicks et al., 2017).

MCDA helps decision-makers explore the pros and cons of different NBS, using pre-defined criteria to predict the performance of alternative actions and test the robustness of different decisions (Adem Esmail & Geneletti, 2018). The particular ability of this framework to explicitly acknowledge tradeoffs is highly applicable to cities facing multiple challenges of different priority and urgency (Dicks et al., 2017). MCDA provides a systematic methodology to combine a variety of inputs using cost/benefit information and stakeholder views to rank alternatives. One of the main strengths of

MCDA is that it is transparent and replicable, allowing the performance of alternative management approaches to be analysed given the priorities of stakeholders (Adem Esmail & Geneletti, 2018).

With this in mind, MCDA was selected as the approach to replication analysis, recognising that the outputs from MCDA should stimulate discussion/debate among stakeholders and decision-makers, rather than being considered concrete management recommendations. If outputs are counter-intuitive, it may be that objectives and criteria do not truly reflect the values of stakeholders and may need to be re-visited. This in itself is a valuable process that can help build understanding and consensus among stakeholders.

1.5 Building the MCDA tool

Microsoft Excel was used to build two prototype tools for testing by the project team. The tools required cities to fill two core 'forms': a set of questions where cities nominated their challenges and weighted them, and a set of questions relating to governance.

The answers to these questions enabled a quantitative ranking of each NBS in the NBS catalogue.

Firstly, the city's nominated challenges were compared to the ability of each NBS to meet these challenges. So, for example, a city that prioritises flooding and mitigation of the heat island effect would be recommended NBS that have high values for these priorities.

Secondly, the city's governance abilities (or 'success factors') were compared to the requirements of each NBS. NBS that fell within the requirements of each of the eight success factors received higher scores; NBS with one or more shortfalls scored lower, and serious shortfalls substantially reduced scores.

These two steps enable the tool to derive a quantitative score for each NBS, reflecting each city's abilities and priorities. It also automatically flags any key areas of concern in governance, which means that recommendations can be read both as a list of NBS that may be currently viable for replication, but also as a set of recommendations for governance improvements if the city would prefer to replicate more challenging NBS options.

1.6 Testing and refinement

Following a round of testing of the two base prototypes, a number of improvements were made to the tool to improve the quality of its analytical output.

- International experts were surveyed on the benefits of each of the 43 NBS in the D1.1 catalogue.
- The Urban GreenUP team was surveyed to quantify the 'success factor' requirements of the NBS implemented in the project.
- The tool was modified to offer recommendations on a site-by-site scale rather than for the overall city region (as different city precincts have different challenges).
- An added step in the tool allows cities to nominate the NBS they are considering in each precinct, which the tool ranks and provides advice on.
- Comment boxes were added to allow users to input additional commentary or justification for decisions.
- The 'success factors' survey was modified to include a few specific questions, to determine levels of capability for each success factor.

1.7 Use of the MCDA

Following the revisions to the MCDA tool, cities were sent a revised spreadsheet set for their use. Each city filled the MCDA tool successfully, and the tool produced a set of replication recommendations. These form the basis for our individualised city recommendations, which form the bulk of this report.

2 Mantova

2.1 Priorities for Mantova

Mantova nominated two areas for analysis using the MCDA tool:

- Montelungo Parking and Palazzo Te area
- BOMA - Commercial area

Mantova's focus areas show important physical similarities, both with each other and with precincts in other cities. Palazzo Te (Te Palace, Figure 2) is an area with large formal lawns and patches of tree planting, with an adjacent sport field and stadium and a large, paved parking area that has no shade or trees. The BOMA precinct (Figure 3) is a large automobile-oriented commercial area with shops, offices and hotels and very large parking areas. In this respect, there is much to learn and compare between Valladolid's Zorilla Football Area, which is the focus of current demonstration activity.

Figure 2 - Palazzo Te Precinct, showing the large parking area

Figure 3 - BOMA Commercial Area

While the two areas have physical similarities, their placement in the city is quite different, with Palazzo Te near the central city, while BOMA is toward the fringe of Mantova across the lakes from the city centre. This is reflected in the different priorities selected for each area in the tables below.

Montelungo and Palazzo Te Area	
Challenge	**Priority**
Urban Renewal	Equal
Air Quality	Equal

Table 2.1 - Priorities for first precinct

BOMA – Commercial Area	
Challenge	**Priority**
Heat	One
Flooding	Two
Biodiversity	Three

Table 2.2 - Priorities for second precinct

2.2 NBS under consideration

There are number of NBS under consideration at both sites, given their physical similarities. The use of cool or green paving is intuitively appealing, given the large unpaved areas that would likely remain unshaded as tree canopy establishes. The selection of pollinator NBS reflects the biodiversity

focus at BOMA. These sites are large and lack some of the typical constraints in streetscape areas and, in this respect, it is possible that a larger portfolio of NBS could be appropriate.

Montelungo and Palazzo Te Area	BOMA – Commercial Area
Cool Pavement	Compacted Pollinators Modules
Cycle and pedestrian green route	Cool Pavement
Green Pavement and Parking	Cycle and pedestrian green route
Green Shady Structures	Green Shady Structures
Urban Trees	

Table 2.3 - NBS under consideration by Mantova

2.3 Organisational capability

The MCDA tool has identified an overall strong, balanced organisation with two key areas that may be barriers to NBS delivery. These are ideal targets to address through the implementation framework of a RUP. The benefit of a flexible approach like the MCDA tool is that as the organisation works on these areas for improvement, the portfolio of NBS that will become favourable will grow.

Success factors	MCDA calculator's score out of 10	MCDA summary of your capability	Any critical issues
Stable executive and political support	7.3	Competent	No Critical Issues
Suitable internal processes/standards/regulations/policy	3.2	This may be a problem	Not enough policy support
Staff time availability and motivation	3.2	This may be a problem	Not Enough Staff

Advanced community engagement skills	8.4	This is a strength for your organisation	No Critical Issues
Alignment of internal departments	8.5	This is a strength for your organisation	No Critical Issues
Culture of innovation and risk tolerance	8.7	This is a strength for your organisation	No Critical Issues
Supportive departments in other level of government	8.5	This is a strength for your organisation	No Critical Issues
Access to suitable technical skills	9.0	This is a strength for your organisation	No Critical Issues

Table 2.4 - Success factors for Mantova

Three issues were identified as potential challenges to the implementation of NBS in Mantova. Firstly, Mantova's team for NBS delivery is still quite small, which could make it difficult to manage the delivery of complex NBS, particularly for the first few attempts at implementation, when it will be especially challenging and unfamiliar to the organisation. Resourcing to fund delivery of NBS may need to account for staffing and/or consulting support to ensure successful project delivery.

Secondly, Mantova's lack of existing policy support for NBS strongly affected the outcomes of the MCDA , which may suggest a more difficult scenario than the municipality faces in reality. While policy support is currently absent, there is a foundational level of political, executive and institutional support. This will help the team establish pro-NBS policy in the RUP and assist in navigating approvals.

Thirdly, political and executive support in Mantova is an area to work on. While existing support is sufficient to deliver a RUP, there is scope to build executive and political support and understanding, and to establish the team's value within the community to ensure they are resilient to changes in the organisation's leadership.

These are all manageable issues and Mantova is well-positioned to establish an excellent program of NBS delivery, with good support within the organisation, some experience in community engagement, and a positive organisational culture to support new challenges.

Mantova's unique challenge is its UNESCO World Heritage status, which can make even small modifications of heritage areas difficult. It is heartening to see that despite these challenges, the city has scored well in 'supportive departments in other levels of government'. While Mantova will need to work with the Italian government to streamline work within World Heritage areas, there are opportunities outside these constrained areas that can be addressed while negotiations proceed.

One area noted by the MCDA is the common issue of maintenance – while this team is very supportive of the NBS concept, they are similarly resource-constrained and face many competing priorities.

2.4 Recommended NBS

Recommendations from the MCDA tool are presented in Table 2.5 below. As in many cities, tree-based interventions top the list of recommendations, reflecting their relative ease of implementation and wide range of significant benefits. In large parking areas, this is a valuable and valid recommendation, and the suggestion of Urban Catchment Forestry is particularly helpful both to assist with the nominated issue of flooding in BOMA but also as a means of ensuring trees survive their establishment in the hot, harsh microclimate of a parking lot.

Montelungo and Palazzo Te Area		
Top 15 suggested by this tool	Rank	Score
Urban catchment forestry	1	92.4
Urban Trees	2	91.8
Urban Carbon Sink	3	86.4
Pollinator Verges and Spaces	4	81.6
Green Resting Areas	5	80.9
Green Filter Area (air)	6	79.1
Green Façade with climbing plants	7	78.3
Urban Orchard	8	77.9
SUDs	9	77.8
Rain Gardens	10	76.7

BOMA		
Top 15 suggested by this tool	Rank	Score
Urban catchment forestry	1	74.8
Urban Trees	2	72.7
Urban Carbon Sink	3	71.2
Pollinator Verges and Spaces	4	67.6
Grassed Swales and Water Retention Ponds	5	66.9
SUDs	6	65.1
Rain Gardens	7	63.4
Natural Pollinators Modules	8	62.5
Green Resting Areas	9	61.5
Green Filter Area (water)	10	61.3

Floating Gardens	11	76.1	Pollinator Green Roof	11	60.1
Green Filter Area (water)	12	75.7	Floating Gardens	12	59.9
Natural Pollinators Modules	13	75.0	Urban Orchard	13	59.7
Grassed Swales and Water Retention Ponds	14	74.9	Green Roof	14	58.9
Cycle-pedestrian green pavement	15	74.9	Urban Garden Biofilter	15	57.6

Table 2.5 - Top 15 NBS recommended by the MCDA tool

Beyond the basic fundamental recommendation that trees are implemented at scale, the tool offers some good NBS advice for addressing local priority issues. The amenity that can be afforded by pollinator verges, natural pollinator modules and resting areas are promising means of improving the visual complexity and amenity of the greenery in the Palazzo Te area, and softening the hard, grey feel of the parking area. Water-based NBS will also be valuable in this respect. The use of green filter areas and façades is a promising way of supporting air quality, beyond the role that the trees will play. The suggestion of green paving (at 15th position) is likely a bit low in ranking, but only a few points below some of the top 10 options. The large paved area of this site makes this a very promising option; a factor the tool does not account for.

In BOMA, the dual strength of water-based NBS as a means of dissipating urban heat and managing flooding is evident in the rankings provided. Pollinator NBS are also a good option in this location, especially if substantial patches can be established and planted with local habitat flora.

For the NBS under consideration by the Mantova team, as depicted in Table 2.6 below, the tool tended to assign quite low rankings, perhaps reflecting the tool's limited ability to account for site-specific conditions. The Mantova team's consideration of surface treatments is valid, though the low ranking of cool pavements underlines their singular benefit (cooling) unlike NBS that use plants, which tend to offer diverse benefits. Green shady structures are also scored quite low, reflecting their relatively high difficulty of implementation and modest benefits. However, these may still be a good idea in selected sites given their ability to provide shade as soon as they are built (unlike trees, which, while much more beneficial and resilient in the long term, will take some years to offer major benefits).

Montelungo Parking and Palazzo Te Area		
NBS contemplated by team	Rank	Score
Cool Pavement	29	65.2
Cycle and pedestrian green route	16	74.8
Green Pavement and Parking	25	68.3
Green Shady Structures	32	63.7
Urban Trees	2	91.8

BOMA		
NBS contemplated by team	Rank	Score
Compacted Pollinators Modules	22	55.8
Cool Pavement	18.0	56.8
Cycle and pedestrian green route	16.0	57.2
Green Shady Structures	26.0	52.3

Table 2.6 - Scores for NBS under consideration in Mantova

3 Ludwigsburg

3.1 Priorities for Ludwigsburg

The city of Ludwigsburg has nominated three areas for analysis:

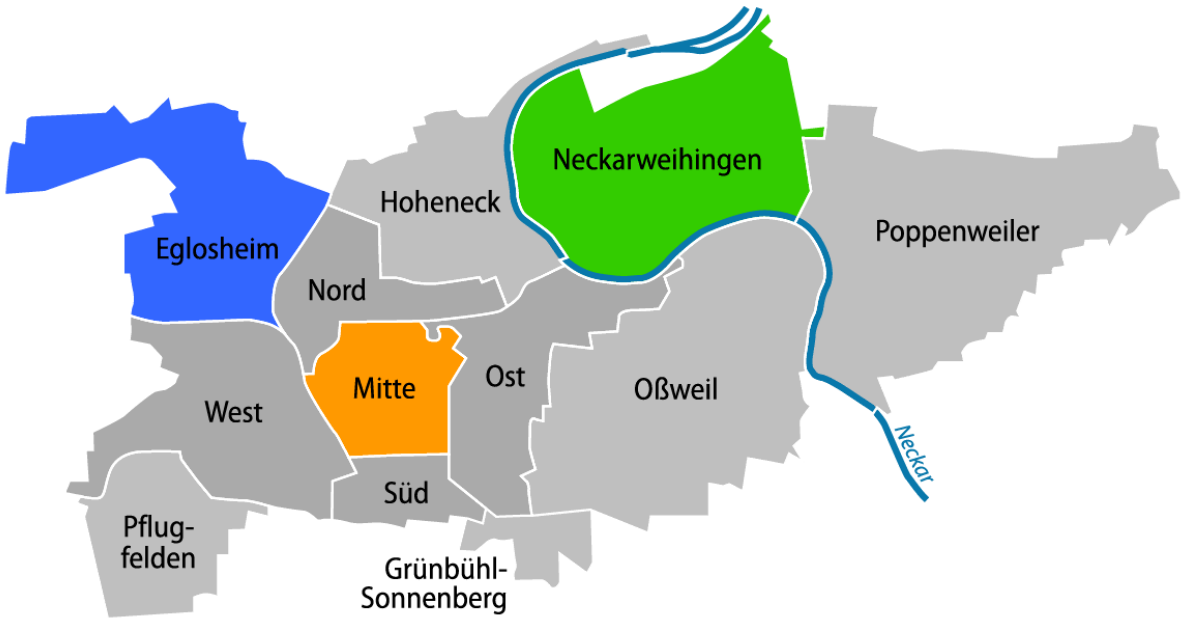
1. Inner City (Mitte)
2. Neckarweihingen
3. Eglosheim

As is common in a number of cities on this project, air quality and heat were nominated as key concerns in the inner city. Urban renewal also features as a common priority for a number of inner-city precincts on the project, and is selected as a third priority by the Ludgwigsburg team – see Table 3.1.

Inner City (Mitte)	
Challenge	**Priority**
Air Quality	One
Heat	Two
Urban Renewal	Three

Table 3.1 - Priorities for Inner City (Mitte)

The other two areas nominated for analysis are both districts within Ludgwigsburg municipality.



The selection of flooding as a singular focus becomes understandable when noting the placement of Neckarweihingen, directly beside the Neckar river. Heat and Biodiversity are prioritised in Eglosheim. Refer to Table 3.2 and Table 3.3.

Neckarweihingen	
Challenge	**Priority**
Flooding	One

Table 3.2 - Priorities in Neckarweihingen area

Eglosheim	
Challenge	**Priority**
Heat	One
Biodiversity	Two

Table 3.3 - Priorities in the Eglosheim area

3.2 NBS under consideration

Ludgwigsburg has a number of pragmatic options under consideration for its inner-city areas, most of which involve greening private property and avoid contesting space in the public realm, but also builds on the city's reasonable amount of street trees and parks. In Eglosheim, the selection of green noise barriers suggests a desire to implement an NBS that not only addresses the nominated priorities, but also mitigates noise. The team does not have any preconceived ideas about their preferred NBS for Neckarweihingen.

Inner City (Mitte)	Eglosheim
Green Shady Structures	Green Noise Barriers
Green Façade with climbing plants	
Green Roof	
Parklets	

Table 3.4 - NBS under consideration in Ludwigsburg (note: none were selected for Neckarweihingen)

3.3 Organisational capability

The results shown in Table 3.5 underline that Ludwigsburg is a well-aligned, technically capable city with good existing NBS. It is well-positioned to build on its strengths. However, our review of the current organisational context suggests a few hurdles which, if resolved, would give the team much greater ability to deliver a successful RUP, drawing on the optimal NBS for the job.

Success factors	MCDA calculator's score out of 10	MCDA estimate of capability	Any critical issues suggested by MCDA tool
Stable executive and political support	2.8	This is likely to be a serious problem	Not enough political support*
Suitable internal processes/standards /regulations/policy	3.7	This may be a problem	Unresolved Legal Barriers*
Staff time availability and motivation	2.7	This is likely to be a serious problem	Not Enough Staff Not Enough Time*
Advanced community engagement skills	8.8	This is a strength for your organisation	No Critical Issues
Alignment of internal departments	9.0	This is a strength for your organisation	No Critical Issues
Culture of innovation and risk tolerance	8.0	This is a strength for your organisation	No Critical Issues
Supportive departments in other level of government	8.5	This is a strength for your organisation	No Critical Issues
Access to suitable technical skills	10.0	This is a strength for your organisation	No Critical Issues

Table 3.5 - Success factors in Ludwigsburg

**Note: low scores are intended as a trigger for conversation and thought, rather than a definitive judgement. While the issues noted may be serious, the tool tends towards severe scores to ensure issues are picked up; if there are problems here, they are likely less serious than the tool indicates.*

Ludwigsburg is technically capable and well-aligned in its delivery and has a positive approach to innovation and its associated risk. It has a modern, inclusive approach to engaging the community, although there is some potential to improve engagement with private property owners. The team is also fairly well positioned to navigate external approval processes. These strengths are all commendable and may in some cases be exemplary within Urban GreenUP.

Three key issues may be of concern for the team. First is political support. While there is a reliable base of executive support in Ludwigsburg, there is a mix of support and opposition to the use of NBS at a political level. Furthermore, there is some uncertainty as to whether future elections would sustain the mixed levels of support that are currently present. Political opposition can be disruptive to NBS projects, particularly larger works.

Second is internal process. It is noted that the city has good standards and processes for even advanced NBS, which suggests a truly facilitative approvals environment. However, some legislation in Ludwigsburg can be obstructive to delivery of some NBS, and this tension remains unresolved. This may be a significant barrier in need of reform.

Finally, there is the typical issue of staff capacity, which poses a threat to NBS delivery in many cities. The key issue appears to be that there are too few dedicated staff to deliver a substantial NBS. Further compounding this issue, there is also a tendency for work to be allocated across very short timeframes, and an absence of a clear project champion, empowered to drive the project internally. The issue of staff capacity could be ameliorated relatively quickly in the short-term by bringing in consulting capacity, but a sustained delivery would likely be more cost-effective and coordinated using new internal staff. In this respect, WP7 is valuable in identifying options for innovative financing streams to fund additional positions.

3.4 Recommended NBS

The tables on the following pages summarise the recommendations the MCDA tool generated for Ludwigsburg. Note that the table below includes a ranked set of 15 NBS for each area, as well as scores and ranks for the NBS that the city is considering. Overall scores are used to provide rankings, and reflect the average of two scores:

1. A score for the suitability of each NBS for addressing the challenges nominated for each area, weighted by the priority of those challenges, and
2. A score for how well the capability areas of Ludwigsburg match the requirements of each NBS.

Please refer to Table 3.6 and Table 3.7 to view the tool's recommendations.

Inner City (Mitte)		
Top 15	Rank	Score/100
Urban catchment forestry	1	59.2
Urban Trees	2	58.6
Urban Carbon Sink	3	54.2
Pollinator Verges and Spaces	4	49.7
Channel Renaturalisation	5	47.5
Green Filter Area (air)	6	47.1
Green Resting Areas	7	46.8
Urban Orchard	8	46.7
Green Filter Area (water)	9	45.9

Neckarweihingen		
Top 15	Rank	Score/100
Floodable Park	1	60.7
Urban catchment forestry	2	58.0
Grassed Swales and Water Retention Ponds	3	58.0
SUDs	4	53.5
Urban Carbon Sink	5	52.5
Rain Gardens	6	51.6
Hard Drainage Flood prevention	7	51.6
Urban Trees	8	50.0
Pollinator Verges and Spaces	9	48.9

Eglosheim		
Top 15	Rank	Score/100
Urban catchment forestry	1	59.8
Urban Trees	2	59.4
Urban Carbon Sink	3	56.1
Pollinator Verges and Spaces	4	53.3
Pollinator Green Roof	5	53.3
Green Roof	6	51.3
Channel Renaturalisation	7	50.8
Natural Pollinators Modules	8	49.9
Urban Orchard	9	48.6

Green Façade with climbing plants	10	45.4	Pollinator Green Roof	10	47.5	Grassed Swales and Water Retention Ponds	10	48.0
Floodable Park	11	45.4	Green Roof	11	46.8	Floodable Park	11	47.4
SUDs	12	44.4	Cycle and pedestrian green route	12	46.7	Floating Gardens	12	47.0
Pollinator Green Roof	13	44.4	Channel Renaturalisation	13	46.5	SUDs	13	46.5
Green Roof	14	44.1	Hard Drainage Pavements	14	44.3	Green Filter Area (water)	14	46.5
Grassed Swales and Water Retention Ponds	15	43.9	Green Resting Areas	15	42.5	Green covering shelters	15	46.1

Table 3.6 - Top 15 Recommended NBS for Ludwigsburg

Review of the NBS Ludwigsburg is considering	Rank	Score/100
Green Shady Structures	21	42.3
Green Façade with climbing plants	11	45.4
Green Roof	14	44.1
Parklets	34	36.3

Review of the NBS Ludwigsburg is considering	Rank	Score/100
n/a		

Review of the NBS Ludwigsburg is considering	Rank	Score/100
Green Noise Barriers	35	35.0

Table 3.7 - Results for NBS nominated for consideration by Ludwigsburg

These scores may appear low, but this simply reflects the tool's very low scoring of three success factors, as observed above. This means that the lists above represent the tool's estimation of what is least difficult if these constraints remain. Of course, the team has potential to address all of the observed issues to some degree, so it may be that they select options from outside the top 15, while resolving to work on any particularly limiting barriers that may currently rank these NBS low.

In the inner city, the tool recommends arboreal NBS above all else. The team may wish to consider whether its existing provision of street trees is sufficient; if not, some element of urban forestry should be considered. A Floodable Park is recommended but may be difficult, unless the large parking area at Arsenalplatz can be reclaimed. The other potentially unsuitable recommendation from the tool is channel renaturalisation, given the Neckar does not pass through this part of the city. The team's interest in green roofs and façades is validated by the tool; the large rooftop carpark above a mall in the central city may offer special promise. While green shady structures are ranked lower, they may be a strong option in dense areas where ground-level greening is not viable. The very low rank of Parklets reflects the tool's low ranking of this NBS to deliver the core objectives of cooling and air quality; with careful design a Parklet could perhaps perform better than ranked, but we encourage the team to consider other higher ranked small greening options, especially Green Resting Areas but also Natural Pollinators Modules. Ludwigsburg's relatively generous footpath widths in this area may be a rare opportunity for verge treatments like Grassed Swales and Pollinator Verges.

The tool's suggestions for the Neckarweihingen are especially robust. The combination of Floodable Parks, Swales and Water Retention Ponds, SUDS and Urban Catchment Forestry has huge potential to reduce flood risk in this area. This precinct has an interesting combination of urban and cultivated space, so this would require a diverse approach. To deliver greening in more urban areas, SUDS and Swales may be best, and the large buildings in this location may also be well suited to Green Roofs. Raingardens across the more residential areas also offer real promise. In the riverfront areas that currently appear to mostly be farmland, there may be potential to establish a network of swales and especially one or more Floodable Parks close to the residential area.

Finally, in Eglosheim, arboreal NBS are strongly recommended by the tool. Street trees are less common in this area, so this could be a favourable strategy. However, policies to ensure that the large number of existing trees in gardens are retained should also be considered, if they are not already in place. The tool recommends a number of complementary pollinator approaches that could serve as verges and understorey in a way that is very complementary to a network of street trees. Green roofs could be an excellent complement to a network of cool, tree-lined streets that have layers of pollinator planting below them to serve as biodiversity corridors. The smaller residential homes are likely less viable for green roofs, but the southern area has a number of buildings with large flat roofs that could host green roofs (indeed, some may already be present; these could be upgraded to support biodiversity better).

4 Quy Nhon

4.1 Priorities for Quy Nhon

Quy Nhon City has nominated two broad areas of focus:

- Suburbs
- Watersheds

In these areas, different priorities were selected, as indicated in the Table 4.1 and Table 4.2 below.

Quy Nhon Suburbs	
Challenge	**Priority**
Flooding	Equal
Urban Renewal	Equal

Table 4.1 - Priorities for Suburban Areas

Quy Nhon Watersheds	
Challenge	**Priority**
Biodiversity	One
Green Space Provision	Two

Table 4.2 - Priorities for Watersheds

Quy Nhon's suburbs require equal attention to be paid to urban renewal and flood mitigation, whereas in the catchments of the city, biodiversity and provision of green space are prioritised. Quy Nhon applied a custom weighting to the challenges in its watersheds, with 'Biodiversity' given 60% priority and 'Green Space' given 40%. The high priority assigned to flooding in the city's suburbs is reflected in flood risk analysis carried out by the city, as exemplified by the map below (Figure 4 - Flood risk in Quy Nhon). It is worth noting that this is an area of significant coastal exposure as well as rainfall often exceeding 2000mm/annum. This is reflected in the large flood-prone areas shaded blue below.

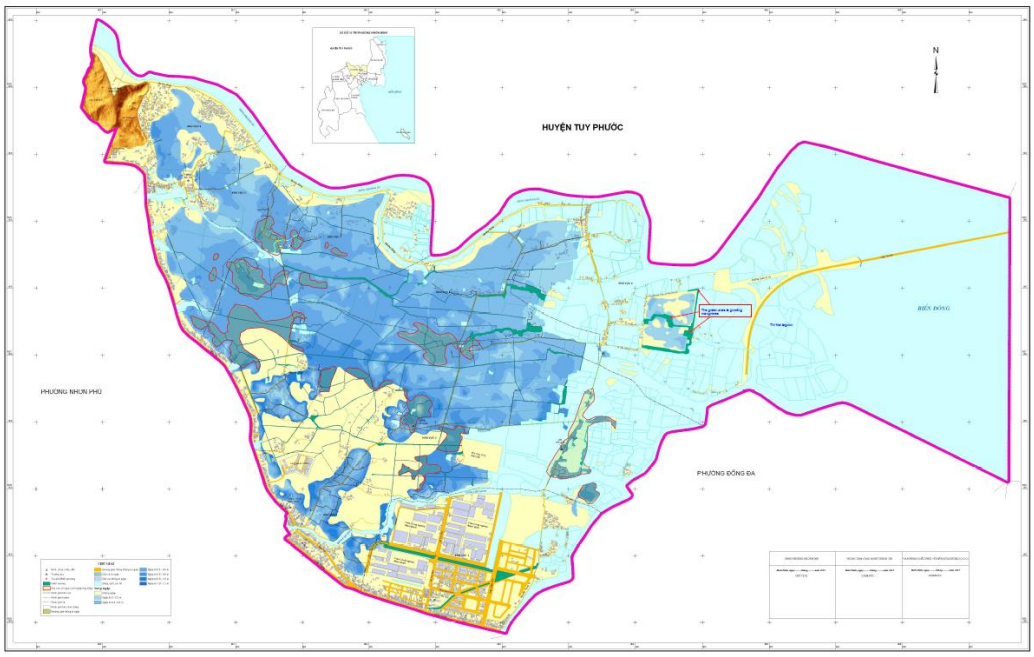


Figure 4 - Flood risk in Quy Nhon

4.2 NBS under consideration

Quy Nhon's early ideas on NBS for these regions are as follows (Table 4.3).

Suburbs	Watersheds
SUDs	Vertical Mobile Garden
Green Filter Area (air)	Enhanced Nutrient managing and releasing soil

Table 4.3 - NBS under consideration in Quy Nhon

4.3 Organisational capability

Quy Nhon's use of the MCDA tool indicates a very positive organisational arrangement, and indeed the city does have strengths in community engagement, and a substantial team. A review of the D6.2 report indicates the city does face some challenges in the success factors below, but overall the team's use of the tool suggests a near-perfect configuration for NBS delivery, as shown in 4. In this respect it may be that the team would prefer to focus on finding financing to build capacity to deliver, rather than invest time in improving internal operations if they deem their existing arrangements close to optimal.

Success factors	Our calculator's score out of 10	Our estimate of your capability	Any critical issues
Stable executive and political support	8.7	This is a strength for your organisation	No Critical Issues
Suitable internal processes/standards/regulations/policy	10.0	This is a strength for your organisation	No Critical Issues
Staff time availability and motivation	10.0	This is a strength for your organisation	No Critical Issues
Advanced community engagement skills	9.2	This is a strength for your organisation	No Critical Issues
Alignment of internal departments	10.0	This is a strength for your organisation	No Critical Issues
Culture of innovation and risk tolerance	9.3	This is a strength for your organisation	No Critical Issues
Supportive departments in other level of government	9.5	This is a strength for your organisation	No Critical Issues
Access to suitable technical skills	10.0	This is a strength for your organisation	No Critical Issues

Table 4.4 - Success Factors for Quy Nhon

4.4 Recommended NBS

Table 4.5 and Table 4.6 summarise the recommendations the MCDA tool generated for Quy Nhon. Note that the tables include a ranked set of 15 NBS for each area, as well as scores and ranks for the NBS that the city is considering. Overall scores are used to provide rankings, and reflect the average of two scores:

3. A score for the suitability of each NBS for addressing the challenges nominated for each area, weighted by the priority of those challenges, and
4. A score for how well the capability areas of Valladolid match the requirements of each NBS.

As Quy Nhon has indicated that they are very strong in all the success factors, the final results represent a set of NBS that offer optimal benefit for the city's set of weighted priorities in each area. However, it is noteworthy that Quy Nhon faces challenges outside the current MCDA framework, including sand drift, coastal erosion, drought and salinization. Therefore, the recommendations below can be taken as suggestions, to be considered in terms of the nominated challenges using the tool, but also factoring in their possible benefit for the additional issues.

In the suburbs, a combination of Urban Catchment Forestry, water NBS and streetscape greening (using swales and pollinator verges) with a few small green spaces (e.g. Green Resting Areas) could offer a good combination of benefits for the city. A cycle and pedestrian green route could be worth considering, drawing on the experience of frontrunner cities. In the watersheds, a number of pollinator approaches can also offer green space and habitat, while trees, green roofs and water NBS could supplement these functions.

Suburbs		
Top 15 suggested by this tool	Rank	Score
Urban catchment forestry	1	94.0
Floodable Park	2	92.3
SUDs	3	90.5
Grassed Swales and Water Retention Ponds	4	90.5
Urban Carbon Sink	5	90.4
Urban Trees	6	90.3
Rain Gardens	7	89.5
Channel Renaturalisation	8	89.5

Watersheds		
Top 15 suggested by this tool	Rank	Score
Urban catchment forestry	1	95.3
Urban Trees	2	95.0
Pollinator Verges and Spaces	3	94.4
Urban Carbon Sink	4	91.7
Channel Renaturalisation	5	90.9
Natural Pollinators Modules	6	90.5
Urban Orchard	7	89.5
Floodable Park	8	89.1

Cycle and pedestrian green route	9	86.7	Floating Gardens	9	88.9
Pollinator Verges and Spaces	10	86.6	Pollinator Green Roof	10	87.8
Green Resting Areas	11	84.6	Rain Gardens	11	87.5
Pollinator Green Roof	12	84.0	Grassed Swales and Water Retention Ponds	12	87.3
Green Roof	13	83.2	Green Resting Areas	13	86.7
Urban Orchard	14	82.7	Green Roof	14	86.1
Hard Drainage Flood prevention	15	81.8	Compacted Pollinators Modules	15	85.4

Table 4.5 - Recommended NBS for Quy Nhon

The NBS nominated by the Quy Nhon team all scored well, with even the lower-ranked NBS scoring above 70 points. The use of SUDS is a recommended approach, and a number of similar stormwater options offer promise in the top 15.

Given the highest-ranked NBS scored over 90, we would suggest that some of these are considered above the lower-ranked NBS currently being considered by Quy Nhon (Table 4.6 below), as they can offer more direct benefits.

Suburbs		
NBS contemplated by team	Rank	Score
SUDs	3	90.5
Green Filter Area (air)	30	74.8

Watersheds		
NBS contemplated by team	Rank	Score
Vertical Mobile Garden	28	75.2
Enhanced Nutrient managing and releasing soil	34	71.1

Table 4.6 - Scores and ranks for NBS under consideration in Quy Nhon

5 Medellín

5.1 Priorities for Medellín

Medellín has nominated two areas for Analysis:

- Distrito 1 (Noroccidente - Volador)
- Distrito 7 (Centro)

These are sub-districts of the City of Medellin. Centro is the city's downtown or CBD. Norrocidente-Volador is a district on a hill in the city's northeast, adjacent to a large park (Parque Natural Cerro el Volador).

The Volador area already has important ecological value to the city. The Medellín team's aim is to connect these with broader urban landscape. Highways have become physical barriers which divide the landscape, and the rivers and streams associated with this area are not visible due to the use of barriers like walls and mesh enclosures that limit visibility. This means that these watercourses are not only a flood risk, but also are unsafe and currently exclude the public from these potential green spaces.

Centro district is sited on an alluvial plain. It suffers high fragmentation of its green spaces, low levels of permeable surfaces and a lack of furniture for rest and recreation in the public realm. The area has densified rapidly without provision of new public spaces, and informal occupation of existing public space is an issue. As a result, the area suffers significant heat island effects and a shortage of green space.

The Medellín team has nominated quite different priorities for each of these areas, reflecting the very different issues in each district. The high priority of connecting the valuable biodiversity of the Volador District is especially noteworthy. Default weights were applied to the priorities below, as presented in Table 5.1 and Table 5.2.

Volador	
Challenge	**Priority**
Biodiversity	One
Public health and wellbeing	Four
Urban Renewal	Three
Air quality	Two

Table 5.1 - Priorities for Volador area

Centro	
Challenge	**Priority**
Air quality	Equal
Urban Renewal	Equal
Public health and wellbeing	Equal

Green Space Provision	Equal

Table 5.2 - Priorities for Centro area

5.2 NBS under consideration

In both areas, a multi-level approach to NBS selection appears to be at work, with a mix of NBS that leverage private buildings, the public realm, support mobility and facilitate community participation. The selection of green roofs, trees, and green corridors for pedestrians and cyclists in both locations is notable. Medellín has recently demonstrated strong expertise in delivering trees and understorey in previously impermeable urban transport corridors.

Volador	Centro
Green Roof	Urban Trees
Urban Trees	Cycle and pedestrian green route
Green Resting Areas	Green Façade with climbing plants
Cycle and pedestrian green route	Green Roof
Community Composting	Hard Drainage Flood prevention

Table 5.3 - NBS under consideration in Medellín

5.3 Organisational capability

Medellín has already demonstrated that it is a high performer in the NBS sphere, with proactive and impressive NBS delivery since the kickoff of the Urban GreenUP project. The team also have a number of clear strengths. However, the tool suggests that there are two areas that may make future NBS projects difficult. The tool is designed to score potential problems very low, to encourage their identification, but the reality is that these are likely not as severe as suggested by the scorings in the table below.

Success factors	MCDA calculator's score out of 10	MCDA estimate of capability	Any critical issues suggested by MCDA tool
Stable executive and political support	2.0	This is likely to be a serious problem	Not enough executive support; Not enough political support*
Suitable internal processes/standards /regulations/policy	6.5	Opportunities for improvement	No Critical Issues
Staff time availability and motivation	2.0	This is likely to be a serious problem	Not Enough Staff*
Advanced community engagement skills	7.2	Competent	No Critical Issues
Alignment of internal departments	7.5	Competent	No Critical Issues
Culture of innovation and risk tolerance	7.3	Competent	No Critical Issues
Supportive departments in other level of government	6.5	Opportunities for improvement	No Critical Issues
Access to suitable technical skills	8.0	This is a strength for your organisation	No Critical Issues

Table 5.4 - Success Factors for Medellín

**NB – these scores are indicative only and are designed to provoke discussion, and do not constitute a definitive judgment of the organisation's capabilities.*

Currently, within the large urban government of Medellín, there are leaders that strongly support the project, and those that are opposed. There is the potential for projects to be disrupted by this opposition, hence the scores applied. This risk is compounded by the potential for political change in Medellín, with elections that may reduce existing levels of political support for NBS. Despite this state of uncertainty, the team has successfully navigated the current environment so a score of 2 is likely to be too low.

As is the case in many cities, the team implementing NBS is small, and currently relies on a single individual to guide a diverse team of specialists. This poses substantial risk of limiting Medellín's delivery of a future RUP. However, the team overall is motivated, skilled and is allocated realistic timeframes, so while staff capacity is a substantial risk at present, it may be quite easy to resolve with additional hires, possibly funded through central budgets, or using some of the innovative financing mechanisms that the team will become familiar with through the work of WP7.

Most cities still lack design and engineering standards for NBS, and Medellín is no exception. It is anticipated that the development of standards for key NBS will ease implementation. Similarly, the city does not yet have processes for NBS approval, which means they must be negotiated individually. This can be slow and uncertain; while negotiation can yield good outcomes, it is not ideal. The challenge is similar for external approvals, where agencies have slow, uncertain approval processes and the objectives of these agencies are not neatly aligned with those of the Medellín NBS team. However, it is noted that senior executives may be able to facilitate introductions to enable negotiations towards a more streamlined process.

5.4 Recommended NBS

The tables on the following pages summarise the recommendations the MCDA tool generated for Medellín. Note that the table below includes a ranked set of 15 NBS for each area, as well as scores and ranks for the NBS that the city is considering. Overall scores are used to provide rankings, and reflect the average of two scores:

5. A score for the suitability of each NBS for addressing the challenges nominated for each area, weighted by the priority of those challenges, and
6. A score for how well the capability areas of Medellin match the requirements of each NBS.

Volador		
Top 15 suggested by this tool	Rank	Score
Urban catchment forestry	1	68.0
Urban Trees	2	64.6
Pollinator Verges and Spaces	3	61.5
Natural Pollinators Modules	4	61.0
Urban Carbon Sink	5	60.4
Green Resting Areas	6	57.6
Floating Gardens	7	56.7

Centro		
Top 15 suggested by this tool	Rank	Score
Urban catchment forestry	1	67.6
Urban Trees	2	65.2
Green Resting Areas	3	63.1
Urban Carbon Sink	4	61.9
Urban Orchard	5	58.6
Pollinator Verges and Spaces	6	58.6
Cycle and pedestrian green route	7	58.5

Urban Orchard	8	56.6	Rain Gardens	8	56.4
Grassed Swales and Water Retention Ponds	9	53.9	Green Filter Area (air)	9	56.2
Rain Gardens	10	53.6	Green Façade with climbing plants	10	55.9
Compacted Pollinators Modules	11	52.9	Natural Pollinators Modules	11	55.7
SUDs	12	52.7	Grassed Swales and Water Retention Ponds	12	55.5
Green Filter Area (water)	13	52.0	SUDs	13	55.0
Green Façade with climbing plants	14	51.9	Floating Gardens	14	53.4
Green Filter Area (air)	15	51.0	Green Filter Area (water)	15	53.0

Table 5.5 - Top 15 Recommendations for Medellín

Volador		
NBS contemplated by team	Rank	Score
Green Roof	20	48.5
Urban Trees	2	64.6
Green Resting Areas	6	57.6
Cycle and pedestrian green route	18	49.2
Community Composting	35	40.5

Centro		
NBS contemplated by team	Rank	Score
Urban Trees	2	65.2
Cycle and pedestrian green route	7	58.5
Green Façade with climbing plants	10	55.9
Green Roof	26	45.5
Hard Drainage Flood prevention	42	20.2

Table 5.6 - Scores and Ranks for NBS under consideration in Medellín

In Volador, the MCDA tool has specified a number of pollinator approaches and small green spaces as biodiversity measures, as well as a number of NBS that can support water quality and mitigate flooding. The team's selection of urban trees and green resting areas is supported by the tool, though it may be even better to design tree planting to serve a stormwater function (as per Urban

Catchment Forestry). The team's plans for Green Roofs and a Cycle-Pedestrian Green Route may have scored lower due to the relative difficulty of these NBS; this doesn't mean they aren't viable, simply that a few of the identified success factors may need a bit of work if these NBS are pursued. Green Roof delivery in particular will benefit from the team's experience with working with private building owners. Composting, while appealing as a means of engaging the community, may not offer the desired benefits in this precinct and alternatives could be considered (e.g. Urban Orchard).

Trees and Green Resting Areas also come highly recommended in Centro, which could be valuable ways of supporting local amenity and promoting urban renewal. There is potential for trees delivery to address a range of objectives (e.g. Urban Orchards are possibly better for involving the community). A Cycle-Pedestrian Green Route, as contemplated by the team, offers good promise in this area, and could be a centre around which a number of NBS are organised, as is contemplated in our Frontrunner cities. Interestingly the tool has recommended a number of stormwater NBS that could help address this area's challenges, which do not relate primarily to flooding; this emphasises the multi-benefit nature of these kinds of NBS and the general value of having lush, well-watered urban vegetation. The team's strong capabilities in private owner engagement will be valuable if they decide to work with Green Façades and/or Raingardens as recommended by the tool.

6 Izmir

6.1 Priorities for Izmir

Izmir has nominated three precincts for analysis:

- Sub Demo A (Reducing Heat Island Effect İn Highly Urbanized Areas)
- Sub Demo B (Creating Agricultural Climate Adaptation Strategy in Sasalı District)
- Sub Demo C (Peynircioğlu Riverbank Restoration and Creating Green Corridor)

Sub Demo A prioritises heat island mitigation, as well as air quality. As is typical in many partner cities' most central areas, these are concentrations of pollution and impermeable space. Izmir's core is densely developed. The need to make this a more welcoming space for both humans and nature is reflected by the selection of Biodiversity and Public Health and Wellbeing as third and fourth priorities.

Highly Urbanised Areas	
Challenge	**Priority**
Heat	One
Air Quality	Two
Biodiversity	Three
Public Health and Wellbeing	Four

Table 6.1 - Priorities for Sub-Demo A

Sub Demo B focuses on a district closer to the edge of the city, which is a growth frontier as Izmir expands. In this area (Figure 5, pictured below) there are still intact farmlands and forested areas, so Biodiversity and Public Health and Wellbeing are prioritised as first and second priorities respectively. Air and Water Quality are nominated as 'Equal' priorities, effectively placing them on the same standing as Public Health (second priority).

Figure 5 - Sasalı District, Izmir

Sasalı District	
Challenge	**Priority**
Biodiversity	One
Public Health and Wellbeing	Two
Water Quality	Equal
Air Quality	Equal

Table 6.2 - Priorities for Sub-Demo B

Sub Demo C is a major river restoration project, with potential to draw inspiration from some of the most famous and successful NBS projects in the world, such as Bishan-Ang Mo Kio Park (Singapore) and Cheonggyecheon Stream (Seoul), both of which centre on river restoration. In this project, flooding is the first priority, as is appropriate in a project that will dechannelize a concrete canal and return it to a semi-natural state. The potential for this stream to act as a key habitat link is reflected in the selection of Biodiversity as second priority. As with Sasalı, Air Quality and Water Quality are nominated as 'Equal' priorities, effectively weighting them the same as Biodiversity.

Peynircioğlu Riverbank Restoration	
Challenge	**Priority**
Flooding	One
Biodiversity	Two
Water Quality	Equal

Air Quality	Equal

Table 6.3 - Priorities for Sub-Demo C

6.2 NBS under consideration

In each of these areas, the Izmir team already has some ideas about the kinds of NBS that may work well; indeed, many of these are currently being tested. These are summarised in the table below. The MCDA tool scores these options, noting their ranking as well as any capability areas in the city that may be required to implement them. By identifying these selections early, cities can consider possible alternatives, and/or work on any success factors within their organisations that may be important to delivering their preferred NBS.

Highly Urbanised Areas	**Sasalı District**	**Peynircioğlu Riverbank Restoration**
Parklets	Grassed Swales and Water Retention Ponds	Cycle and pedestrian green route
Smart soil as substrate	Smart Soil Production	Urban Carbon Sink
Green Shady Structures	Natural Pollinators Modules	Hard Drainage Flood prevention
Green Pavement and Parking	Climate-Smart Greenhouses	Green Fences
		Channel Renaturalisation

Table 6.4 - NBS under consideration in Izmir

In Izmir's most densely-developed areas, the team has selected a suite of treatments that minimise the need to reallocate urban space, by working underground, overhead and by changing surfaces. The exception is parklets, which do replace parking spaces. Izmir's attractive prototypes are under testing now and could potentially benefit from the learnings of San Francisco's successful 'Pavement to Parks' programme.

In Sasali, NBS selection is diverse, showing the team's interest in food production, flood mitigation and biodiversity. The similarly diverse selection in Peynircioğlu indicates the core task of river restoration as well as the potential for trees, vertical greening and a cycle/pedestrian corridor.

6.3 Organisational capability

Izmir presents remarkably strong results in the success factors section of the tool, with no major areas of weakness, as shown in **Table 6.5**.

Success factors	MCDA calculator's score out of 10	MCDA estimate of capability	Any critical issues suggested by MCDA tool
Stable executive and political support	9.3	This is a strength for your organisation	No Critical Issues
Suitable internal processes/standards /regulations/policy	8.0	This is a strength for your organisation	No Critical Issues
Staff time availability and motivation	8.5	This is a strength for your organisation	No Critical Issues
Advanced community engagement skills	8.4	This is a strength for your organisation	No Critical Issues
Alignment of internal departments	9.5	This is a strength for your organisation	No Critical Issues
Culture of innovation and risk tolerance	9.3	This is a strength for your organisation	No Critical Issues
Supportive departments in other level of government	8.0	This is a strength for your organisation	No Critical Issues
Access to suitable technical skills	9.0	This is a strength for your organisation	No Critical Issues

Table 6.5 - Success factors for Izmir

While Izmir is clearly well-equipped to deliver NBS in their current configuration, the MCDA output suggests a few areas of potential growth, which will further refine the operations of the team and make delivery faster and more reliable. These include:

- Briefing and engagement of political leaders to strengthen their support
- Development of standards and internal approval processes to smooth the approval of more advanced NBS
- Streamlining of legal requirements that currently must be worked around
- Development of capacity in working with private building owners (particularly if NBS like Green Shady Structures are desired)
- Internal engagement to build support for NBS in the organisation
- Public co-creation processes to build citizen and business buy-in to NBS projects and facilitate innovative financing approaches and private building NBS.

6.4 Recommended NBS

Table 6.6 and Table 6.7 on the following pages summarise the recommendations the MCDA tool generated for Izmir. Note that the table below includes a ranked set of 15 NBS for each area, as well as scores and ranks for the NBS that the city is considering. Overall scores are used to provide rankings, and reflect the average of two scores:

7. A score for the suitability of each NBS for addressing the challenges nominated for each area, weighted by the priority of those challenges, and
8. A score for how well the capability areas of Izmir match the requirements of each NBS.

The scoring in each set of 15 NBS is a relative score. In some cases, the choice not to nominate four priorities, or assign equal priority to two secondary priorities, means that scores are not fractions of 100 (some may be of 125). This unanticipated use of the tool is not a problem as final rankings still show the relative merit of NBS, but future scoring algorithms may seek to accommodate this approach.

The tool's recommendations are shown overleaf in Table 6.6 and Table 6.7.

Sub Demo A (Reducing Heat Island Effect İn Highly Urbanized Areas)		
Top 15	Rank	Score/100
Urban catchment forestry	1	97.3
Urban Trees	2	96.8
Urban Carbon Sink	3	93.0
Pollinator Verges and Spaces	4	89.0
Pollinator Green Roof	5	85.9
Urban Orchard	6	85.3
Green Roof	7	85.1
Green Resting Areas	8	84.5
Natural Pollinators Modules	9	84.4
Grassed Swales and Water Retention Ponds	10	83.9
Green Filter Area (water)	11	83.6

Sub Demo B (Creating Agricultural Climate Adaptation Strategy in Sasalı District)		
Top 15	Rank	Score/125
Urban catchment forestry	1	107.7
Urban Trees	2	104.6
Urban Carbon Sink	3	101.8
Pollinator Verges and Spaces	4	100.4
Natural Pollinators Modules	5	96.0
Floating Gardens	6	94.9
Grassed Swales and Water Retention Ponds	7	94.3
Rain Gardens	8	94.0
Pollinator Green Roof	9	93.8
Urban Orchard	10	92.8
Green Resting Areas	11	92.6

Sub Demo C (Peynircioğlu Riverbank Restoration and Creating Green Corridor)		
Top 15	Rank	Score/125
Urban catchment forestry	1	107.7
Urban Carbon Sink	2	101.1
Urban Trees	3	100.8
Grassed Swales and Water Retention Ponds	4	98.6
Pollinator Verges and Spaces	5	97.6
SUDs	6	95.7
Rain Gardens	7	95.6
Pollinator Green Roof	8	94.0
Floodable Park	9	93.8
Green Roof	10	92.1
Green Filter Area (water)	11	89.3

SUDs	12	83.0	SUDs	12	92.5	Natural Pollinators Modules	12	89.0
Green Shady Structures	13	82.1	Green Filter Area (water)	13	91.8	Channel Renaturalisation	13	88.8
Floating Gardens	14	81.7	Green Roof	14	91.6	Green Resting Areas	14	87.8
Green covering shelters	15	81.5	Channel Renaturalisation	15	91.6	Urban Garden Biofilter	15	87.8

Table 6.6 - Top 15 NBS recommended by the MCDA tool

Review of the NBS Izmir is considering	Rank	Score/100	Review of the NBS Izmir is considering	Rank	Score/125	Review of the NBS Izmir is considering	Rank	Score/125
Parklets	33	73.4	Grassed Swales and Water Retention Ponds	7	94.3	Cycle and pedestrian green route	17	86.5
Smart soil as substrate	35	70.5	Smart Soil Production	34	78.2	Urban Carbon Sink	2.0	101.1
Green Shady Structures	13	82.1	Natural Pollinators Modules	5	96.0	Hard Drainage Flood prevention	30.0	77.6
Green Pavement and Parking	27	76.5	Climate-Smart Greenhouses	39	73.9	Green Fences	35.0	74.0
						Channel Renaturalisation	13.0	88.8

Table 6.7 - Scores and ranks for NBS nominated for consideration in Izmir

In the urbanised area (Sub Demo A), the value of trees as cooling infrastructure is clear, and the challenge here will be to reallocate space in Izmir's streetscapes to establish good canopy cover to keep streets cool in hot weather and help process pollution. The high recommendation of Urban Orchards suggests a promising area for community involvement, and indeed on a visit to Izmir the team noted that some streets already have fruit trees. Given the tendency for urban space to be quite contested in the city centre, the tool's recommendation of green roofs is promising, both as a cooling approach and to support the re-introduction of biodiversity into the city centre. Larger interventions such as green resting areas, natural pollinators modules and pollinator verges may be difficult in smaller streets but could potentially be more permanent replacements for parklets at locations where space is reclaimed from parking. Green Covering Shelters and Green Shady Structures are good interim shading approaches while canopy establishes. While flooding and water quality is not a priority in this area, the tool's recommendation of SUDS and Urban Catchment Forestry should still be considered, given that plants with access to water on hot days are more likely to survive harsh conditions and provide cooling as they continue transpiring during hot periods.

The tool ranked Parklets, Smart Soils and Green Pavements relatively low. This does not indicate that they are not useful, and indeed they still score fairly well. However, the low scores do indicate that other NBS offer higher levels of benefit, while lower-ranked NBS can play a supporting role for other NBS (for example, Smart Soils can help street trees grow, but do not offer direct benefits).

In the Sasalı District, some areas already have a lot of trees, so these top recommendations may not be quite so relevant in all areas. However, the portfolio of water and pollinator NBS should be considered seriously. While Izmir's NBS choices did not all rank highly, this reflects the fact that some of these NBS are primarily intended to support urban agriculture rather than the selected priority challenges (e.g. Biodiversity, Flooding).

In the Peynircioğlu Riverbank Restoration and Green Corridor, the central NBS (Channel Renaturalisation) ranked well despite its challenging nature, as did the Green Pedestrian and Cycle Route, which narrowly missed the top 15 but still scored well. Tree planting, water-based NBS and pollinator interventions are all recommended to support these core NBS. Green roofs, while recommended, may be less viable here given the team's current lack of experience working with private building owners, and the open nature of the project site. Vertical greening and hard drainage flood prevention are noted as relatively low benefit NBS for this site.

7 Liverpool

7.1 Priorities for Liverpool

The Liverpool team has identified three areas for input into the MCDA tool.

- The Baltic Corridor
- The Business Improvement District
- Otterspool.

In each area, a set of different priorities was nominated, and all were prioritised from one to four. Standard weightings were used. Refer to Table 7.1, Table 7.2 and 3.

The Baltic Corridor	
Challenge	**Priority**
Biodiversity	One
Flooding	Two
Public Health and Wellbeing	Three
Air Quality	Four

Table 7.1 - Priorities in the Baltic Corridor

The hope for the application of NBS to the Baltic Corridor is to create a green link that functions as habitat and a human thoroughfare between retail areas and the waterfront, while addressing localised flooding risks in the precinct.

Business Improvement District	
Challenge	**Priority**
Flooding	One
Heat	Two
Air Quality	Three
Public Health and Wellbeing	Four

Table 7.2 - Priorities in the Business Improvement District

This area hopes to use NBS to introduce both shading and flood mitigation in the central business areas of the city. As this area is high traffic and a concentration of workers and visitors, the NBS must also serve amenity and air quality functions.

Otterspool	
Challenge	**Priority**
Flooding	One
Air Quality	Two
Biodiversity	Three
Public Health and Wellbeing	Four

Table 7.3 - Priorities in the Otterspool area

The Otterspool district faces intermittent flooding issues and has air quality issues at highway intersections. This area will also receive a green cycling corridor with potential for both public health and habitat connectivity benefits.

7.2 NBS under consideration

In each of these areas, the Liverpool team has a few NBS already being considered or tested – these are outlined in Table 7.4. The MCDA tool scores these options, noting their ranking as well as any capability areas in the city that may be required to implement them. By identifying these selections early, cities can consider possible alternatives, and/or work on any success factors within their organisations that may be important to delivering their preferred NBS.

Baltic Corridor	Business Improvement District	Otterspool
Pollinator Walls/Vertical	Pollinator Walls/Vertical	SUDs
Rain Gardens	SUDs	Pollinator Verges and Spaces
Urban catchment forestry	Urban catchment forestry	Green Fences
Green Resting Areas	Vertical Mobile Garden	Green Façade with climbing plants
Pollinator Verges and Spaces	Pollinator Green Roof	Urban Orchard

Table 7.4 - NBS under consideration in Liverpool

In the Baltic Corridor, a vertical green wall is currently planned in an industrial backstreet, with rain gardens, trees and resting areas planned for the preferred pedestrian connection between the waterfront and retain precincts. The focus on biodiversity is reflected in the selection of two pollinator-friendly NBS.

In the Business Improvement District, the use of tree-based SUDs is particularly desired, and interventions that leverage private property are anticipated to play an important role as Liverpool works with local businesses to green rooftops and walls.

Otterspool already has some quality green areas, so NBS reflect the importance of managing regular localised flooding and connecting areas of recreational and habitat value. Vertical greening is promising in some of the more urban areas in this precinct. Non-technical interventions that actively involve the community may play an important role here, for example with the urban orchard NBS (which in this case may function more as a woodlot, but the production principle is the same).

7.3 Organisational capability

Our review of Liverpool's capabilities indicates a progressive organisation with a generally supportive framework, and a few impressive strengths, which we anticipate will be valuable as the organisation gains experience in NBS delivery. Urban GreenUP's demonstration phase has helped bring the organisation into alignment around NBS delivery and most critical areas are well-covered. Two key areas of potential difficulty are identified. Table 7.5 summarises our findings.

Success factors	MCDA calculator's score out of 10	MCDA estimate of capability	Any critical issues suggested by MCDA tool
Stable executive and political support	4.0	This may be a problem	Not enough executive support*
Suitable internal processes/standards/regulations/policy	7.5	Competent	No Critical Issues
Staff time availability and motivation	3.5	This may be a problem	Not Enough Staff*
Advanced community engagement skills	8.4	This is a strength for your organisation	No Critical Issues
Alignment of internal departments	9.0	This is a strength for your organisation	No Critical Issues
Culture of innovation and risk tolerance	7.3	Competent	No Critical Issues

Supportive departments in other level of government	7.5	Competent	No Critical Issues
Access to suitable technical skills	8.0	This is a strength for your organisation	No Critical Issues

Table 7.5 - Success Factors for Liverpool

**In both cases the MCDA algorithm has brought scores down significantly because of these issues, but the city revised the score to 6.0 ('Opportunities for Improvement') following review of the tool's advice. The city's revised score was used by the city to calculate NBS feasibility, rather than the excessively punitive MCDA score.*

Internal alignment is a typical area of difficulty for many organisations, but Liverpool's culture is broadly supportive and well-aligned. While formal processes and design standards to expedite NBS delivery are not yet established, the foundations are there and once these are in place we anticipate that the city will be able to avoid the delay and uncertainty inherent in deliberating greening approvals on a case-by-case basis. External departments appear to be a more difficult space, and executive/political advocacy may be important in clearing barriers and establishing streamlined approval processes where other government agencies must be involved.

Another area of considerable strength is the city's place-based, collaborative approach to involving the community in greening projects. The substantial number of non-technical interventions that Liverpool will deliver in their demonstration project will further bolster their capability in this area. In the Business Improvement District and the Baltic Corridor, working with private building owners will be important to facilitate greening in urbanised areas; this is less of a familiar area for the team but again, we anticipate the demonstration projects will be valuable in this respect.

The two identified areas of difficulty are fairly typical and may not be as problematic as the algorithm suggests. The issue of executive support reflects a past problem; previous greening projects have presented issues of maintenance that were not managed optimally. This has generated a degree of cautiousness amongst some key decision makers. These concerns are legitimate, but manageable and will take care to address. The issue of staff capacity is more challenging, given the extent of austerity measures implemented in recent years in England, which include deep cuts to local government budgets, including environmental programs. Renewal of environmental budgets in the medium-long term is desirable, but in the interim the team may need to engage in innovative ways of leveraging finance.

7.4 Recommended NBS

The tables on the following pages summarise the recommendations the MCDA tool generated for Liverpool. Note that the table below includes a ranked set of 15 NBS for each area, as well as scores

and ranks for the NBS that the city is considering. Overall scores are used to provide rankings, and reflect the average of two scores:

9. A score for the suitability of each NBS for addressing the challenges nominated for each area, weighted by the priority of those challenges, and
10. A score for how well the capability areas of Liverpool match the requirements of each NBS.

Liverpool has been proactive in addressing the recommendations of the tool, so this section represents not only a presentation and critical review of the options from an external perspective, but also includes Liverpool's insights on which of the tool's recommendations are most viable. The recommendations from the MCDA tool follow overleaf in Table 7.6 and Table 7.7.

Baltic Corridor		
Top 15	Rank	Score/100
Urban catchment forestry	1	85.6
Urban Trees	2	80.4
Pollinator Verges and Spaces	3	78.9
Urban Carbon Sink	4	77.9
Natural Pollinators Modules	5	77.1
Green Resting Areas	6	74.1
Grassed Swales and Water Retention Ponds	7	72.6
Rain Gardens	8	70.3
Green Façade with climbing plants	9	70.1
SUDs	10	69.6
Green Filter Area (air)	11	69.3
Floating Gardens	12	69.3
Urban Orchard	13	69.2

Business Improvement District		
Top 15	Rank	Score/100
Urban catchment forestry	1	86.4
Urban Trees	2	79.8
Urban Carbon Sink	3	79.1
Grassed Swales and Water Retention Ponds	4	74.6
Pollinator Verges and Spaces	5	74.6
Green Resting Areas	6	73.0
SUDs	7	72.2
Cycle and pedestrian green route	8	71.1
Green Filter Area (air)	9	70.7
Rain Gardens	10	70.2
Green Façade with climbing plants	11	69.9
Natural Pollinators Modules	12	69.2
Urban Garden Biofilter	13	66.2

Otterspool		
Top 15	Rank	Score/100
Urban catchment forestry	1	85.9
Urban Trees	2	78.9
Urban Carbon Sink	3	77.8
Pollinator Verges and Spaces	4	75.6
Grassed Swales and Water Retention Ponds	5	73.9
Green Resting Areas	6	72.9
SUDs	7	71.0
Natural Pollinators Modules	8	70.5
Green Filter Area (air)	9	70.4
Cycle and pedestrian green route	10	70.3
Rain Gardens	11	70.0
Green Façade with climbing plants	12	69.0
Urban Garden Biofilter	13	66.5

Compacted Pollinators Modules	14	68.4	Urban Orchard	14	65.4	Green Fences	14	65.3
Green Fences	15	67.7	Green Fences	15	65.2	Urban Orchard	15	65.3

Table 7.6 - Top 15 Recommendations for Liverpool

Review of the NBS Liverpool is considering	Rank	Score/100	Review of the NBS Liverpool is considering	Rank	Score/100	Review of the NBS Liverpool is considering	Rank	Score/100
Pollinator Walls/Vertical	33	52.3	Pollinator Walls/Vertical	37	46.2	SUDs	7	71.0
Rain Gardens	8	70.3	SUDs	7	72.2	Pollinator Verges and Spaces	4.0	75.6
Urban catchment forestry	1	85.6	Urban catchment forestry	1	86.4	Green Fences	14.0	65.3
Green Resting Areas	6	74.1	Vertical Mobile Garden	26	57.4	Green Facade with climbing plants	12.0	69.0
Pollinator Verges and Spaces	3	78.9	Pollinator Green Roof	27	56.8	Urban Orchard	15.0	65.3

Table 7.7 - Scores for NBS under consideration in Liverpool

Liverpool is actively testing many of the recommended NBS in these regions, and accordingly struggled to reduce their list of NBS for consideration to the list of just five NBS (the maximum input currently allowed by the MCDA tool). Generally, the tool has identified options consistent with those selected for testing, and in this respect the predictive capability of the tool appears quite good. However, the tool doesn't account for site conditions; in some cases, NBS have been recommended that are already in place, and some are physically unfeasible (at least under current allocations of land use). Liverpool's NBS selections are largely supported by the tool, though pollinator walls are not suggested for delivery at scale given their relative difficulty and modest benefits compared to other options.

In the Baltic Corridor, the tool's recommendations align well with Liverpool's ideas. Trees are a central part of Liverpool's vision for the region, particularly trees that are integrated with drainage functions (i.e. Urban Catchment Forestry). Resting areas and discrete small green patches are also being contemplated by Liverpool as well as recommended by the tool. Vertical greening, SUDS and raingardens are also recommended by the tool and planned by Liverpool. Green Filter Areas (air) are the suggested NBS rejected by the city, on the basis that the Baltic Corridor is a fairly low traffic area. These green filter areas are essentially hedges, and in this respect may be considered for their non-filtration benefits. Nevertheless, this NBS is an exception in a set of otherwise appropriate recommendations.

The Business Improvement District had a few NBS recommended that may be physically impractical under current allocations of land use. Verge treatments (pollinator verges, grassed swales) don't tend to be workable in highly urbanised inner-city areas. Green resting areas also would duplicate existing seating provision, and raingardens have been deemed a lower priority than suggested by the tool with few locations for easy implementation. The suggestion of urban orchard in the central city area also may not be the best fit. However, the recommendations around trees, SUDS, vertical greening, green filter areas (air) and a green route are all supported by the Liverpool team.

The Otterspool area is an example of how the tool's recommendations should be moderated by the presence of existing NBS. While implementation of more of the same NBS need not be ruled out, in this case a few recommendations are already in place for the site. Urban catchment forestry in particular is already in place here, and resting areas are not a priority, nor is the provision of Green Filter Areas (air). However, SUDS, Swales and pollinator verges are possible in these areas and unlike more built-up locations, space is less difficult to find. Vertical greening in the form of fences and façades is supported, as is the tool's suggestion of a green route. The five NBS examples that the team nominated for consideration all scored well under the tool, and they have indicated that, given more selectable options, they may have chosen more options which were calculated to offer high benefit.

8 Valladolid

8.1 Priorities for Valladolid

Valladolid has identified three priority areas for NBS implementation:

- Valladolid City Centre
- Valladolid Zorrilla Football Stadium Area
- Valladolid La Esgueva River (Santos-Pilarica)

The challenges to be addressed in each area differ, reflecting the intersection of site-level issues as well as the broader suite of challenges faced by Valladolid. In each area a different number of challenges were nominated. The Valladolid team used the default weightings for their priority levels.

Valladolid City Centre	
Challenge	**Priority**
Air Quality	One
Heat	Two
Biodiversity	Three
Public Health and Wellbeing	Three

Table 8.1 - Priorities for the city centre

Valladolid's central city is a concentration of buildings, people and vehicles. Accordingly, air quality is a priority in this precinct, driven by policy (the Action Plan for Air Pollution Alerts in Valladolid, 2017). Heat also is treated as a significant issue, reflecting the tendency for built-up areas to be most susceptible to the urban heat island effect. The drive to bring nature back into the city is refected by the selection of biodiversity as a third priority, while public health and wellbeing in this instance is selected as an equal third priority due to the drive for sustainable urban mobility (which further reflects Valladolid's approach to management of air quality, in its desire to shift mobility toward walking and cycling).

Valladolid Zorrilla Football Stadium Area	
Challenge	**Priority**
Flooding	One
Biodiversity	Two
Urban Renewal	Two

Table 8.2 - Priorities for the Zorilla Football Stadium Area

The Zorilla Football Stadium area, pictured below with its associated parking in Figure 6, is a large impermeable area of the city that generates substantial runoff, which is aggravated by the fact that this area lacks drainage infrastructure (e.g. sewers). The selection of the biodiversity as a priority is

due to the low quality of habitat and green space in this location. Urban renewal was selected and assigned equal second priority due to the area being somewhat run down and unattractive.

Figure 6 - Zorrilla Stadium and surrounds

Valladolid La Esgueva River (Santos-Pilarica)	
Challenge	**Priority**
Flooding	One
Biodiversity	Two

Table 8.3 - Priorities for the Esgueva River area

This river's natural flooding occurs regularly and is an ideal issue for management with NBS. Biodiversity was selected as a second priority to improve green space and habitat provision as a complementary action to any measures to combat flooding.

8.2 NBS under consideration

In each of these areas, the Valladolid team already has some ideas about the kinds of NBS that may work well. These are summarised in the table below. The MCDA tool scores these options, noting their ranking as well as any capability areas in the city that may be required to implement them. By identifying these selections early, cities can consider possible alternatives, and/or work on any success factors within their organisations that may be important to delivering their preferred NBS.

Valladolid City Centre	**Valladolid Zorrilla Football Stadium Area**	**Valladolid La Esgueva River (Santos-Pilarica)**

Green Roof	Green Pavement and Parking	Green Filter Area (water)
Green Shady Structures	Hard Drainage Flood prevention	Natural Wastewater Treatment
Hydroponic green façade	Hard Drainage Pavements	Urban Carbon Sink
Pollinator Green Roof	Rain Gardens	Urban Trees
Urban Garden Biofilter	SUDs	

Table 8.4 - NBS under consideration in Valladolid

In the city centre, the Valladolid team is currently considering the above set of interventions as a means of adding greenery on structures, given the difficulty of reallocating urban space in this area, where land use is most contested by overlapping activities. Note that many of the considered NBS involve the use of buildings, many of which would be private property.

Paving is a focus at Zorilla Stadium, given the large paved parking areas. The use of NBS that can aid in retaining runoff will assist in preventing flooding and improving water quality.

Larger NBS for flood mitigation are contemplated for the Esgueva river, though arboreal interventions also are considered for this site as measures to both improve biodiversity but also improve the location as a walking/cycling destination.

8.3 Organisational capability

Our review of Valladolid's capabilities suggests that the small team is capable and has a fairly supportive operating environment. Valladolid has an overall solid capability for NBS implementation, although work in a few key areas would make planning and delivery of NBS substantially easier and faster.

A summary of the MCDA tool's scoring for Valladolid is presented below. As has been emphasised previously, the recommendations of a quantitative decision support tool are indicative only and should serve as the basis for discussion and enquiry rather than as a concrete plan.

Success factors	MCDA calculator's score out of 10	MCDA estimate of capability	Any critical issues suggested by MCDA tool
Stable executive and political support	8.7	This is a strength for your organisation	No Critical Issues
Suitable internal processes/standards /regulations/policy	7.0	Competent	No Critical Issues

Staff time availability and motivation	7.5	Competent	No Critical Issues
Advanced community engagement skills	3.0	This may be a problem	Community historically not involved in project decisions; Lack of skilled engagement guidance
Alignment of internal departments	7.5	Competent	No Critical Issues
Culture of innovation and risk tolerance	7.3	Competent	No Critical Issues
Supportive departments in other level of government	6.5	Opportunities for improvement	No Critical Issues
Access to suitable technical skills	9.0	This is a strength for your organisation	No Critical Issues

Table 8.5 - Success Factors for Valladolid

Valladolid's key strengths are currently their technical capability to deliver advanced NBS and the present level of leadership support. The Valladolid team enjoys the technical backing of a number of specialist engineering and horticulture firms as part of the Urban GreenUP project; it is noteworthy that this is not internal expertise and any future replication of NBS would need to budget for ongoing support from these consultants. Executive and political leaders are strongly in favour of NBS, perhaps noting the community's expressed interest in NBS via participatory budgeting processes. However, there is potential for this to change following elections.

The MCDA tool indicates community engagement may be a weak area for Valladolid, though we doubt that the reality is quite as problematic as suggested by the scoring algorithm. We do note signs of a fairly traditional, expert-driven approach to engagement that is less inclusive than the 'co-creation' model encouraged by Urban GreenUp, as well as a shortage of specialist engagement expertise in the organisation. However, there are parts of the organisation that have good connections to the community, and the use of participatory budgeting suggests that in at least parts of the organisation there is a culture that does support fairly advanced approaches to community engagement. This is positive, because if the Valladolid team hopes to make significant use of green roofs and walls, they will need to become adept at engaging private building owners.

Valladolid's internal culture suggests the early stages of a group that will mature into high capability for NBS. Key departments are cautiously supportive, but there is likely to be some work in building trust and support as unfamiliar design and engineering tasks can be rejected if they are perceived as risky. In this respect, the role of the demonstration sites is key, both in learning from successes and failures; we note that the current culture may lead to NBS being rejected after a single failure, which may be a missed learning opportunity in some cases. Ultimately consolidating effective NBS designs into design standards will be valuable in reducing risk perception to make processes more efficient and less controversial.

Internal processes of approval reflect a similar caution towards NBS, which is totally normal and typical in most local governments. While the Valladolid team has demonstrated that they can effectively negotiate these approvals, it is not efficient or reliable to have to debate each item on a case-by-case basis in the absence of documented processes. Once through the current ad-hoc approval regime, processes of procurement present a second significant source of delay. While the team has navigated these expertly, there is real opportunity to develop processes that expedite and simplify NBS approval and procurement. The situation in external government departments appears to be similar, albeit slightly more difficult. Meetings/advocacy between executives of related approval organisations may be worth considering.

8.4 Recommended NBS

The tables on the following pages summarise the recommendations the MCDA tool generated for Valladolid. Note that the table below includes a ranked set of 15 NBS for each area, as well as scores and ranks for the NBS that the city is considering. Overall scores are used to provide rankings, and reflect the average of two scores:

1. A score for the suitability of each NBS for addressing the challenges nominated for each area, weighted by the priority of those challenges, and
2. A score for how well the capability areas of Valladolid match the requirements of each NBS.

The scoring in each set of 15 NBS is a relative score; in some cases, the choice not to nominate four priorities, or assign equal priority to two tertiary priorities, means that scores are not fractions of 100 (some may be of 80 or 90). This unanticipated use of the tool is not a problem as final rankings still show the relative merit of NBS, but future scoring algorithms may seek to accommodate this approach.

Valladolid City Center		
Top 15	Rank	Score/100
Urban catchment forestry	1	86.8
Urban Trees	2	83.5
Urban Carbon Sink	3	78.8
Pollinator Verges and Spaces	4	75.5
Green Resting Areas	5	74.4
Green Filter Area (air)	6	72.6
Natural Pollinators Modules	7	72.5
Green Façade with climbing plants	8	70.4
Urban Orchard	9	68.9
Green Filter Area (water)	10	67.1
Grassed Swales and Water Retention Ponds	11	66.5
Urban Garden Biofilter	12	66.3
SUDs	13	65.6

Valladolid Zorrilla Football Stadium Area		
Top 15	Rank	Score/100
Urban catchment forestry	1	87.2
Urban Trees	2	80.1
Urban Carbon Sink	3	79.7
Pollinator Verges and Spaces	4	78.2
Grassed Swales and Water Retention Ponds	5	77.5
SUDs	6	75.3
Rain Gardens	7	74.9
Green Resting Areas	8	74.1
Natural Pollinators Modules	9	74.0
Cycle and pedestrian green route	10	73.4
Urban Orchard	11	68.1
Pollinator Green Roof	12	67.9
Floating Gardens	13	67.6

Valladolid La Esgueva River (Santos-Pilarica)		
Top 15	Rank	Score/100
Urban catchment forestry	1.0	71.6
Urban Carbon Sink	2.0	65.0
Urban Trees	3.0	64.8
Pollinator Verges and Spaces	4.0	64.6
Grassed Swales and Water Retention Ponds	5.0	64.1
Natural Pollinators Modules	6.0	61.7
SUDs	7.0	61.0
Rain Gardens	8.0	60.7
Green Resting Areas	9.0	60.6
Cycle and pedestrian green route	10.0	60.0
Urban Garden Biofilter	11.0	55.9
Pollinator Green Roof	12.0	55.6
Compacted Pollinators Modules	13.0	54.8

Cycle-pedestrian green pavement	14	65.5	Urban Garden Biofilter	14	66.8	Urban Orchard	14.0	54.6
Cycle and pedestrian green route	15	65.2	Floodable Park	15	66.7	Floating Gardens	15.0	54.3

Table 8.6 - Top 15 NBS Recommendations for Valladolid

Review of the NBS Valladolid is considering	Rank	Score/100	Review of the NBS Valladolid is considering	Rank	Score/100	Review of the NBS Valladolid is considering	Rank	Score/100
Green Roof	24	61.1	Green Pavement and Parking	21	62.5	Green Filter Area (water)	18	53.5
Green Shady Structures	28	58.1	Hard Drainage Flood prevention	35	52.6	Natural Wastewater Treatment	42.0	37.3
Hydroponic green façade	29	57.5	Hard Drainage Pavements	26	61.3	Urban Carbon Sink	2.0	65.0
Pollinator Green Roof	22	61.6	Rain Gardens	7	74.9	Urban Trees	3.0	64.8
Urban Garden Biofilter	12	66.3	SUDs	6	75.3	None Selected		

Table 8.7 - Scores and ranks for NBS under consideration in Valladolid

As is the case in many cities, the relative simplicity and effectiveness of trees across a number of areas of benefit means that they are ranked highly as an NBS for Valladolid. We note the very different contexts in which these arboreal interventions need to be established. Tree establishment in central city areas requires an ability to find urban space that may currently be allocated to car parking or footpaths, and may require work with underground services. All of these are possible, though perhaps will require institutional work to enable. At Zorilla Stadium, the use of trees to shade a large car parking area is promising and may be possible to implement without significant compromises on vehicular circulation, although issues of soil compaction and the difficulty of tree establishment in a microclimate should be accounted for. The use of trees to intercept water is a promising way of navigating these challenges. The prospect of streambank reforestation along the Esgueva is especially strong.

The application of verge treatments such as grassed swales and pollinator verges may be tricky in the most inner areas of Valladolid, though this may be possible in areas where significant areas of parking can be reclaimed, or roads can be narrowed. The same is true for green resting areas, urban garden biofilters and green filters (water). Central areas offer reduced promise for these larger treatments given space constraints. Vertical treatments such as green facades and green filters (air) may be easier to implement in the most dense areas. The recommendation of green pavements is promising as a means to introduce greenery and mitigate heat without changing the purpose of the resurfaced areas (e.g. parking, footpath). While green roof treatments did not make the top 15, they only scored a few points below treatments that did – and thus should be considered, while noting that they require strong competencies in community engagement. Hydroponic treatments such as hydroponic green façades scored lower, as the MCDA tool determined these to be relatively difficult to deliver and offer only modest benefits. However, in a highly urbanised setting, their immediate effect and significant exposure may make them worthwhile.

Zorilla Stadium offers a more straightforward set of results, with a range of water-based NBS that may suit the location well. The addition of pollinator treatments and resting areas is a promising means of making the area both more attractive and bringing biodiversity back into the space. The SUDS and raingarden treatments that Valladolid is considering here performed well, and the pavement treatments were only a few points short of those treatments that made the top 15. Community engagement is identified as important in this location to help avoid vandalism and support plant establishment.

The Esgueva river also identifies a number of promising flood mitigation and biodiversity initiatives. The challenge here will be to systematically deliver such a diverse range of greening approaches in a distributed way – this can be labour intensive and the city may favour larger-scale treatments like floodable parks. The common role of rivers as cycle corridors in many cities is underlined by the recommendation of a cycle-pedestrian green route along this river, which could act as a central project focus along which other NBS could be implemented. The potential for biodiversity in-stream (through floating gardens) as well as on the banks (in pollinator NBS) suggests this can be a corridor for people, water and plants, insects and other fauna.

9 Synthesis: a few reflections on the process and possibilities for future use of this kind of tool

A few months after the tool's initial results, we interviewed the teams that had used the tool and sought their feedback. We spoke to seven teams about how they used the tool, their perception of its accuracy, the impact of the results, and whether they'd use it again.

The tool's reception was positive, and our discussions generated helpful and constructive insights. We took three especially important lessons from the feedback we received, as follows:

The tool produces good recommendations, but users want to use it in groups for more impact

Users of the tool found it useful in navigating the difficult balancing of NBS priorities. Almost every user was clear that they would use it again, but that they would also use it differently. We asked our teams to use the tool in a desktop setting; they wanted to use it with other teams inside their municipalities, or even with executives or community members to guide the choice of NBS. This was for three reasons. Firstly, so that the tool's selections would have 'ownership' from the organisation. Second, because the tool offers insights into organisational NBS delivery capacity, which often need to be heard by colleagues outside core NBS teams. Third, because NBS teams felt that other stakeholders might answer questions differently to how they would, and this process of input needed to be a consensus to produce truly useful results.

User-friendliness of this kind of tool is important and could be enhanced

Most users found the tool's results easy to interpret, but had at least one question. A particularly common issue was that the tool recommended NBS that practitioners considered to offer lower levels of benefit than another NBS they had in mind. When we reviewed this feedback, this was generally because the optimally beneficial NBS required high levels of organisational capacity. The tool could be more explicit in showing users that they could have even better NBS, *if* they are able to improve capacity in the deficient areas.

Another point of difficulty was the tool's scoring. At times, NBS in the top 15 were separated by only a few points out of 100. Users found the conflict between the rankings (which were quite definitive) and the scores (which were very marginal) confusing. In future a tool could use groupings to better distinguish NBS; for example all NBS with a score of 90/100 may get five stars, all with 80/100 get four stars and so on.

Finally, the tool's use in Microsoft Excel delivered useable results for each city, but was not without occasional input difficulties. These were easily resolved given our small group of users, but if a tool of this type was built for wider use, it could be built in a refined web-based platform with more detailed 'user experience' testing to make it completely smooth in its functions.

Some teams used the tool with specific sites in mind – future tools could reflect this better

The tool was designed for use early in the RUP process, to help cities identify a palette of NBS interventions that they could then find appropriate sites for. On talking to project teams, they often noted that the recommended NBS were not perfect for the sites they had in mind. What this shows us is that the NBS tool's logic isn't the same as the way practitioners are working. In practice, the generally small teams that deliver NBS are not able to select sites that optimally match a palette of NBS – they are operating tactically and must work with sites as opportunities come up. This could be interpreted in two ways. One is that NBS teams should be more empowered to choose sites that can actually host the optimal NBS to deliver benefit to the city. Another interpretation is that site-level considerations could be factored into the tool, perhaps with a site checklist that would act as an additional input screen to the two inputs already involved in the tool.

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11 Appendices

11.1 Appendix one – literature review of success factors

	patial	Politics and society			Organisational capability								Organisational culture					Regulations			
	Ability to locate or reallocate urban space to NBS	Political support	Political stability	Public support for NBS	Ability to manage technical	Ability to processes	Suitable internal skills	Access to design skills	Access to construction skills	Access to maintenance skills	Access to knowledge of species and	Staff capacity/ time to manage	Ability to secure private owner consent or	Alignment of departments	Comfort w innovation	Willingness to actively involve	Willingness to problem-solve*	Attitude to risk	Supportive legal frameworks	Supportive local laws	Supportive planning system	Supportive departments in other levels of
City of Yarra, 2018	x					x	x		x				x	x								
Matthews, 2015	x	x		x			x		x	x			x	x	x						x	x
Brown, 2005		x		x		x							x	x	x			x				x
Li and Bergen, 2018	x			x	x	x		x	x			x	x	x				x	x			
Chaffin *et al.*, 2016	x		x					x	x			x	x	x		x		x	x			x
Davies and Lafortezza, 2019						x	x	x	x	x					x	x						
Quaio, 2018	x	x					x	x	x			x	x	x	x	x		x	x	x		
Van Der Jagt, 2017	x					x	x									x			x			x
Kronenberg, 2015		x			x				x			x				x						
Dhakal and Chevalier, 2017									x			x			x	x		x	x			x
Frantzesaki, 2019		x		x									x									x

11.2 Appendix two – refining the success factors

Original 21 success factors	Additional factors from literature	Deletions/ consolidations	Reason for deletion	Revised criteria	Reason for inclusion
Access to funding/finance	Supportive strategies/plans	Access to funding	Funding is a separate consideration to organisational capacity to deliver	Stable executive and political support	Consolidated from important components
Ability to locate or reallocate urban space to NBS	Design standards	Ability to reallocate space	Reliant on supportive regulation, org culture, design standards	Suitable internal processes/standards/regulations/policy	Confirmed critical by literature (refer to Appendix One)
Political support	Appropriate urban form	Political stability	Consolidated into stable political and exec support	Staff have time and motivation	Confirmed critical by literature (refer to Appendix One)
Political stability	Clear and quantified benefits	Public support	Duplicates public engagement; often relies on site-level impacts and design aesthetics	Advanced community engagement skills	Confirmed critical by literature (refer to Appendix One)
Public supportive of NBS	Project champion	Ability to manage technical processes	Consolidated into staff capacity/time	Alignment of internal departments	Confirmed critical by literature (refer to Appendix One)
Ability to manage	Executive support	Access to design skills	Consolidated into 'access	Culture of innovation	Confirmed critical by

technical projects			to suitable technical skills'	and risk tolerance	literature (refer to Appendix One)
Suitable internal processes		Access to construction skills	Consolidated into 'access to suitable technical skills'	Supportive departments in other level of government	Confirmed critical by literature (refer to Appendix One)
Access to design skills		Access to maintenance skills	Consolidated into 'access to suitable technical skills'	Access to suitable technical skills	Consolidated from important components (refer to Appendix One)
Access to construction skills		Access to knowledge of species and substrates	Consolidated into 'access to suitable technical skills'		
Access to maintenance skills		Ability to secure private owner consent or support	Consolidated into 'advanced community engagement skills'		
Access to knowledge of species and substrates		Attitude to risk	Consolidated with 'culture of innovation and risk tolerance'		
Staff capacity/ time to manage process		Willingness to problem-solve	Not common in literature; covered by 'culture of innovation'		
Ability to secure private owner consent or support		Willingness to actively involve community	Consolidated into 'advanced community engagement skills'		

Alignment of departments		Supportive legal frameworks	Consolidated into 'supportive internal processes/standards/regulations'		
Comfort with innovation		Supportive local laws	Consolidated into 'supportive internal processes/standards/regulations'		
Willingness to actively involve community		Supportive planning system	Consolidated into 'supportive internal processes/standards/regulations'		
Willingness to problem-solve*		Supportive strategies/plans	Consolidated into 'supportive internal processes/standards/regulations'		
Attitude to risk		Design standards	Consolidated into 'suitable internal processes/standards'		
Supportive legal frameworks		Appropriate urban form	This is a site-level concern		
Supportive local laws		Clear and quantified benefits	Partly covered by 'political and executive support'. This is distinct and important but does		

			not relate to organisational capacity to deliver (business case comes before delivery)		
Supportive planning system		Project champion	Overlaps 'staff capacity/time' and		
Supportive departments in other levels of gov't.		Executive support	Consolidated into 'stable political and executive support'		