Compact Urban Green Space

Pattern atlas

Menno de Roode

Why should one have to *visit* the park, shouldn't the city *be* the park?

after Beatley, 2017. p. 29 in *Handbook of biophilic city planning and design*

What is compact urban green space?

As cities are getting denser and larger, space for conventional green features, such as parks, is diminishing. Cities without green alienate people from nature, deteriorate ecological systems and ultimately harm our own well-being. Limited open areas and many sealed surfaced in today's compact cities raise the need for a new green space paradigm that fits in an increasingly dense urbanized landscape. A paradigm in which green space is not limited to large open spaces at ground level, but one where greenery is truly integrated with built structures. Additionally, the rationale of using green space should go beyond pure aesthetic purposes. Too often greenery in cities and on built structures is treated as mere architectural decoration, ignoring its potential to functionally solve urban challenges. Green space should improve the quality of life for all people and nature.

Compact urban green space represents this new paradigm and is found throughout many scales and in countless forms. This atlas introduces a selection of the possibilities this new way of approaching green space offers.

How to use this atlas?

This atlas consists of a collection of compact green space patterns. Each pattern starts with a problem statement that justifies its relevance. Scientific and professional literature is used to further understand the problem and solution. An image on the left page illustrates how the pattern could look like and a schematic drawing on the right page explains the working principle. The image and schematic drawing are mere examples of the spatial manifestation of a pattern and not a blueprint or one-fits-all solution. The social and ecological context should in the end impose the form. Some green space patterns are divided into sub-patterns to demonstrate this variety. For instance, 15. Rooftop habitat has been divided into 15a. Marsh, 15b. Brownfield, 15c. Herbaceous, and 15d. Forest. These and other examples are grounded into the context of the Dutch city of Rotterdam, which makes this atlas notably relevant for well-developed Western European cities.

Patterns relate to each other and should operate in a network. The atlas starts with the smallest pattern and moves gradually to larger scales. Patterns get a place in this network because they consist of other (smaller) patterns and because they are embedded in other (larger) patterns. For instance, 21. Green street consists of patterns such as 5. Open pavement, 10. Adopted planter and 6. Urban tree. On the other hand, 21. Green street is embedded in 29. Multi-level pedestrian network and 31. Wildlife corridor.

Scoring

Patterns are evaluated on two topics: their contribution to human and non-human life. An 0-5 score system based on scientific theories is used for this.

The concept of well-being is a well-defined subjective indicator of the quality of human life. Well-being consists of different aspects, such as one's health, the state of social development (the amount of recreation, education and safety) and the feeling of belonging[1]. For each type, icons are used to refer to a certain score:

No added value

Weak contribution to one of the three aspects

Strong relationship with improvement of one of the aspects

Strong relationship with improvement of two aspects

Strong relationship with improvement all three aspects

Improvement of all three aspects and also inclusive, especially for vulnerable groups

The concept of ecological resilience is used to value non-human life. Ecological resilience refers to the degree in which an ecosystem can sustain itself over time, especially after external disruptions such as the introduction of pests or a changing climate[2,3]. At least three aspects make

an ecosystem resilient. High biodiversity, a large carrying capacity (how many organisms can the ecosystem support?) and fitness (how well are the organisms adapted to the environment, do they fit in?)[4]. The following icons are used to indicate the ecological value:

No added value

Weak contribution to one of the three aspects

Strong relationship with improvement of one of the aspects

Strong relationship with improvement of two aspects

Strong relationship with improvement all three aspects

Improvement of all three aspects and attracts endangered and vulnerable species

The two scores combined provide a clear picture of the value of a specific green space pattern on its own. This value will substantially increase when a green pattern is embedded into larger patterns. Hence, one should always strive to achieve larger patterns by combining smaller ones.

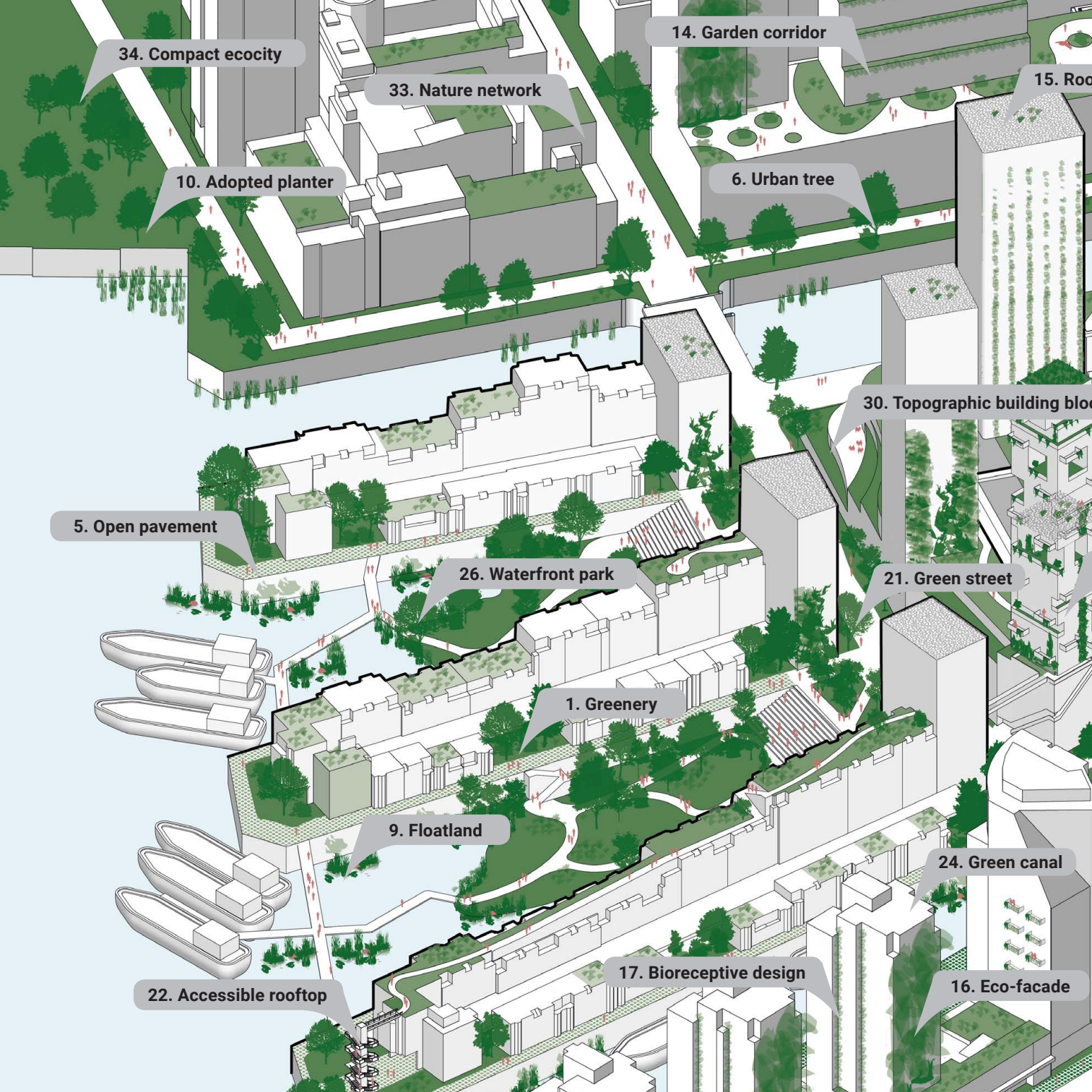
References and further reading

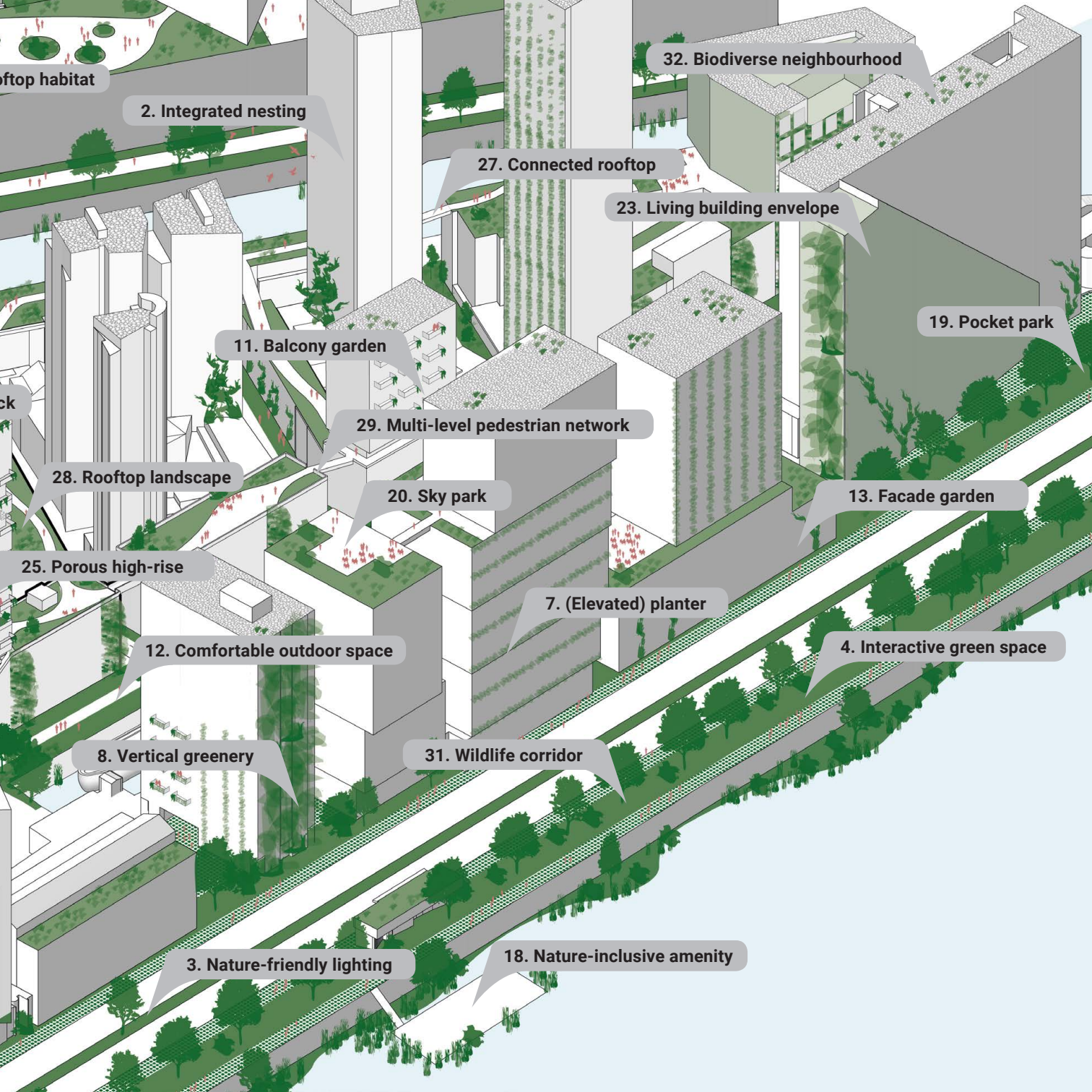
[1]. Ecocity Builders (2020) Quality of Life – Ecocity Standards. Available at: https://ecocitystandards.org/socio-cultural/quality-of-life/

[2]. Alberti, M. (2008) Advances in Urban Ecology, Advances in Urban Ecology. doi: 10.1007/978-0-387-75510-6

[3].Holling, C. S. (1996). Engineering resilience versus ecological resilience. Engineering within ecological constraints, 31(1996), 32.

[4]. Neuman, M. (2005) 'The compact city fallacy', Journal of Planning Education and Research, pp. 11–26. doi: 10.1177/0739456X04270466.


34. Compact ecocity
33. Nature network
14. Garden corridor
15. Roo
10. Adopted planter
6. Urban tree
30. Topographic building bloc
5. Open pavement
26. Waterfront park
21. Green street
1. Greenery
9. Floatland
24. Green canal
17. Bioreceptive design
16. Eco-facade
22. Accessible rooftop


ftop habitat
2. Integrated nesting
32. Biodiverse neighbourhood
27. Connected rooftop
23. Living building envelope
19. Pocket park
11. Balcony garden
ck
29. Multi-level pedestrian network
28. Rooftop landscape
20. Sky park
13. Facade garden
25. Porous high-rise
7. (Elevated) planter
12. Comfortable outdoor space
4. Interactive green space
8. Vertical greenery
31. Wildlife corridor
3. Nature-friendly lighting
18. Nature-inclusive amenity

Compact urban green space

Object scale

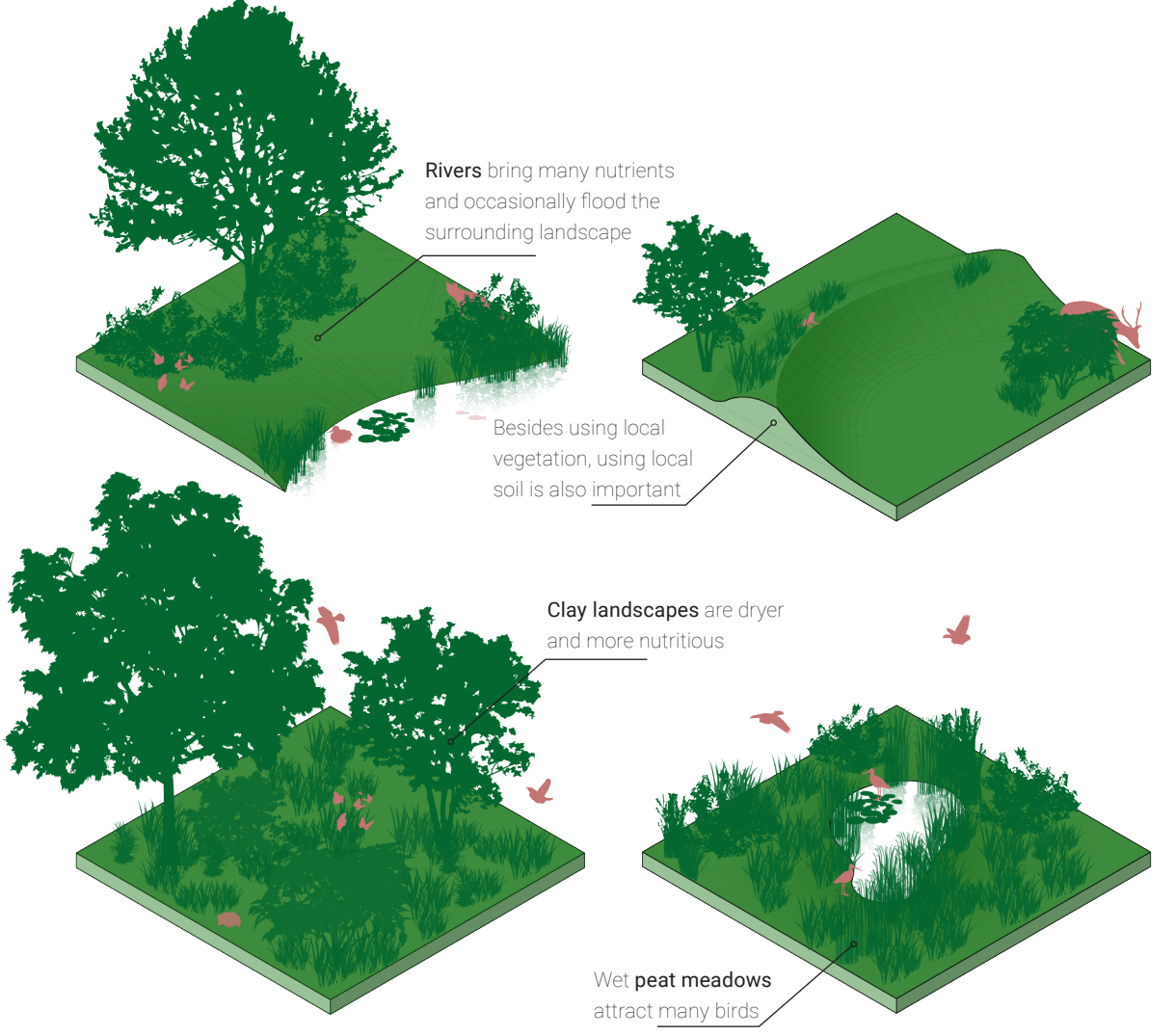
Building and street scale

Neighbourhood scale

City scale

1a. Greenery (nature-based)

Too often urban green space fails to benefit the native ecological system as it is monotonous, consists of exotic species and prioritizes aesthetic and geometric compositions. Designed green space is much more valuable for native biodiversity when it reflects natural and local ecological conditions such as vegetation structure, species composition and soil type[1]. This will result in urban green space with similar characteristics as the natural environment outside the city. For instance, the city of Rotterdam borders four main natural biotopes. These biotopes can be replicated into the city to attract species that already are present in the area. Furthermore, this method mitigates the current homogenisation of species in cities worldwide. It fosters unique urban biodiversity linked to the natural environment the city is located in[2].



Greenery (nature-based) is embedded in

4. Interactive green space *5. Open pavement* *7. (Elevated) planter*
9. Floatland *12. Comfortable outdoor space* *8. Vertical greenery*

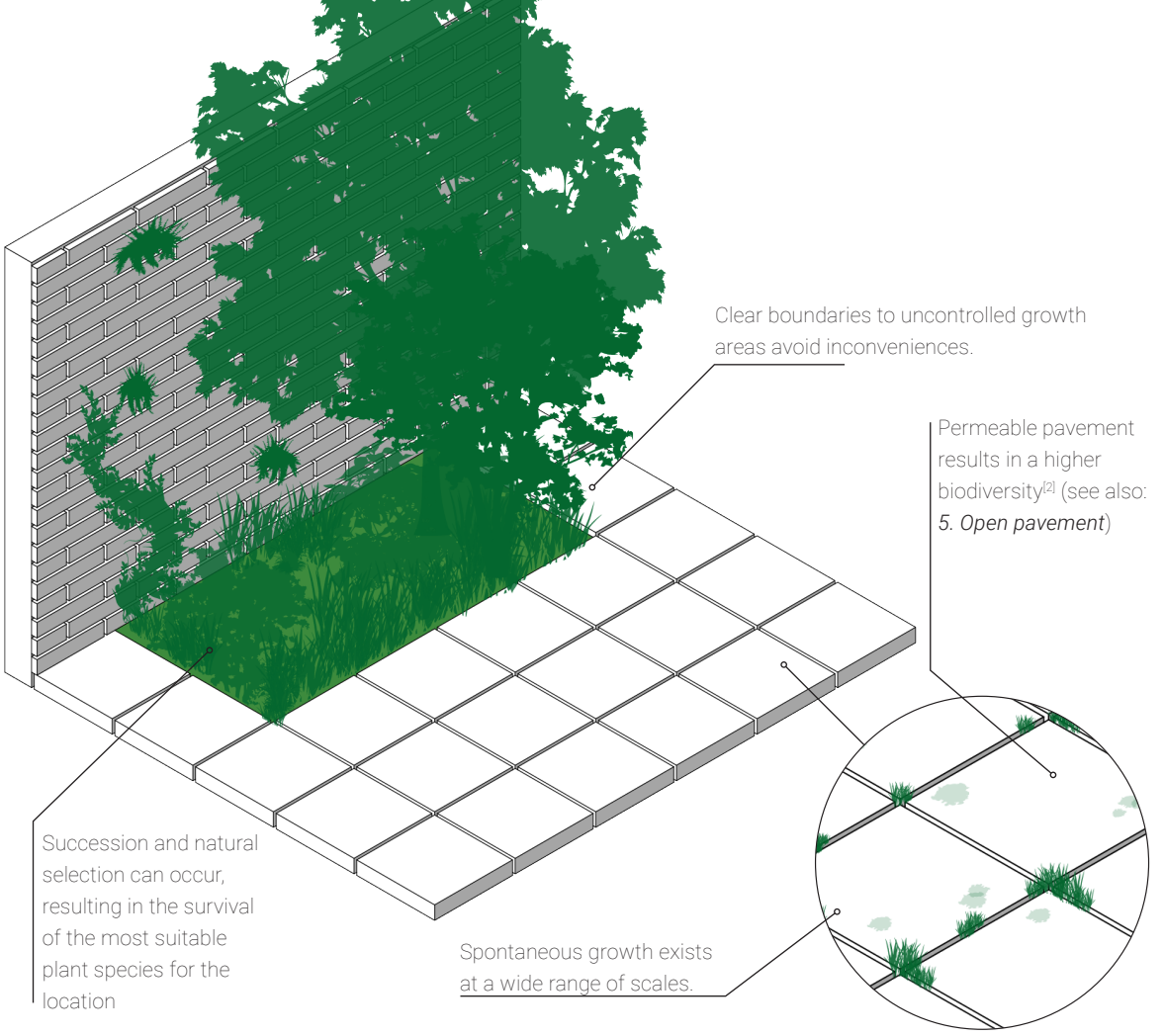
References and further reading:

[1]. Brenneisen, S. (2003). The Benefits of Biodiversity from Green Roofs œ Key Design Consequences (Doctoral dissertation, Dissertação de Mestrado. Iowa State University).

[2]. McKinney, M. L. (2006). Urbanization as a major cause of biotic homogenization. Biological conservation, 127(3), 247-260.

1b. Greenery (spontaneous)

The anthropocentric nature of cities impedes unplanned and uncontrolled green space. However, obsessive maintenance and control hamper processes that naturally increase the ecological resilience of an area. It would be beneficial to allocate space for the spontaneous development of vegetation[1,2]. This provides space for natural processes to occur, such as succession and natural selection. In the end, these processes are much more effective in selecting a suitable plant species for a specific location when compared to a selection based on human knowledge. To avoid inconveniences associated with the lack of control, selective areas may be appointed as “natural development sites”, for instance, 50% of a building wall. Clear borders of these areas and the opportunity for people to retract from them further diminish potential inconveniences.



Greenery (spontaneous) is embedded in

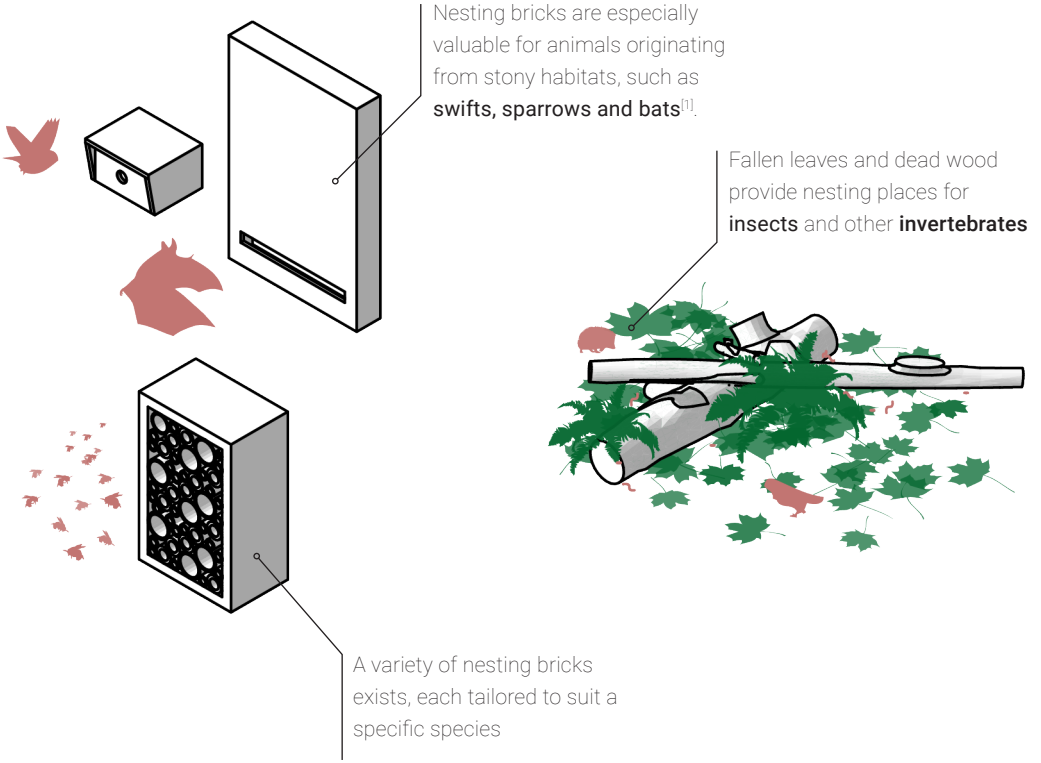
4. Interactive green space *5. Open pavement* *7. (Elevated) planter*
9. Floatland *8. Vertical greenery* *12. Comfortable outdoor space*

References and further reading:

[1]. Chen, C., Mao, L., Qiu, Y., Cui, J., & Wang, Y. (2020). Walls offer potential to improve urban biodiversity. Scientific reports, 10(1), 1-10.
[2]. Bonthoux, S., Voisin, L., Bouché-Pillon, S., & Chollet, S. (2019). More than weeds: Spontaneous vegetation in streets as a neglected element of urban biodiversity. Landscape and urban planning, 185, 163-172.

2. Integrated nesting

Urban structures provide little space for species others than humans. Small interventions, such as integrating nesting places, can change buildings into great habitats that support other species too. Nesting facilities exists in a variety of forms and can easily be incorporated into a the architectural design of a building. Examples include nesting bricks for birds and accessible cavity walls for bats[1,2]. Besides nesting integrated in built structures, nesting places for insects and soil fauna can also be created with the provision of leaves, wood and other organic debris[3]. Nesting requirements vary depending on species. The consultation of ecological experts can help in getting to know these requirements and ensuring nesting spaces are used.



Integrated nesting is embedded in

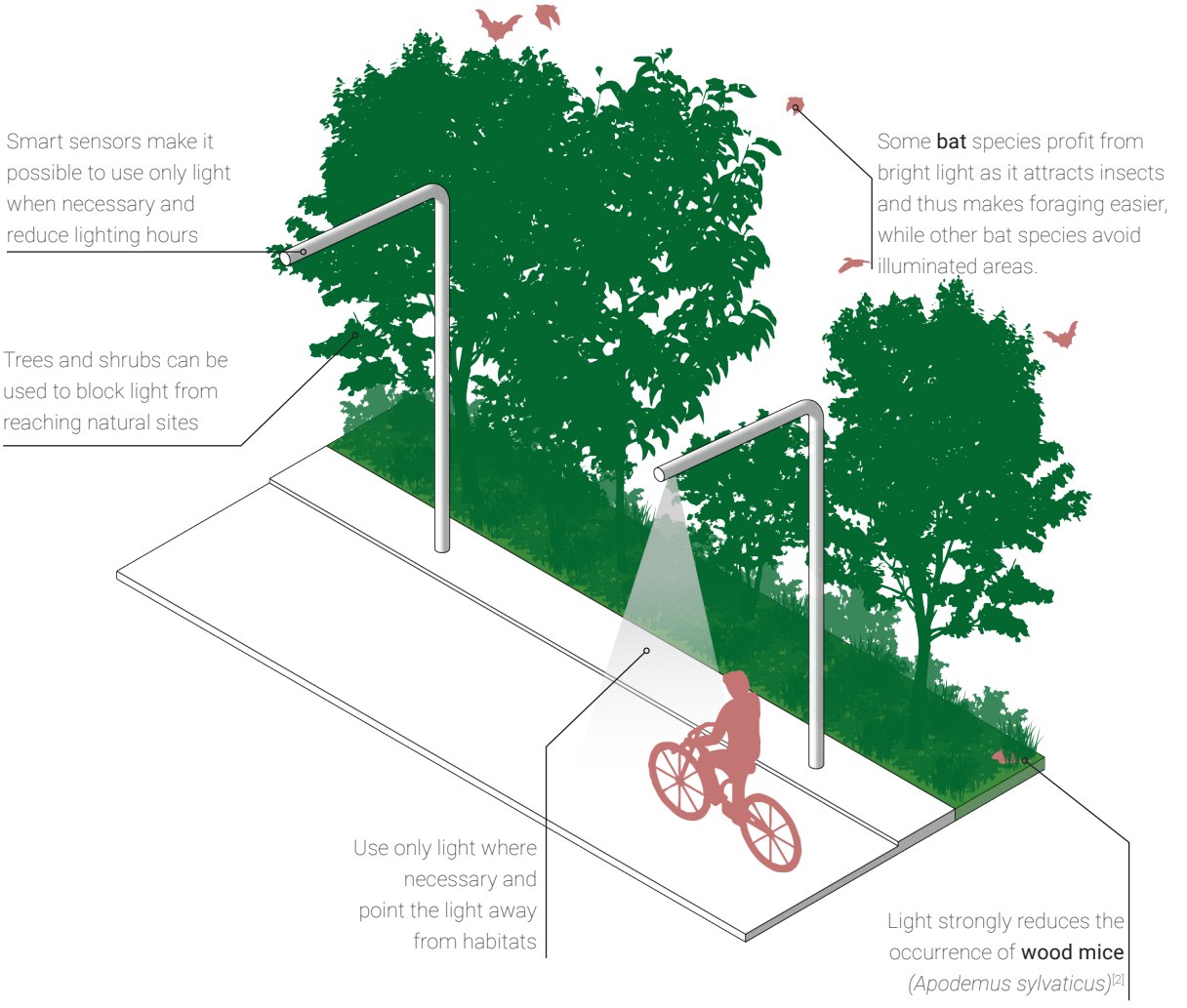
13. Facade garden
6. Urban tree
15. Rooftop habitat
24. Green canal
16. Eco-facade
9. Floatland

References and further reading:

[1]. Vogelbescherming Nederland. (n.d.). Natuurinclusief bouwen. bouwnatuurinclusief.nl/oplossingen/architecten-gevels
[2]. Bouw Natuurinclusief. Retrieved March 30, 2021, from https://
[3]. Kooijmans, J. L. (2009). Stadsvogels. Tirion Natuur, Baarn.

3. Nature-friendly lighting

Light pollution in cities disrupts the natural day and night rhythm and disturbs many species. As lighting increases safety and comfort, complete darkness is undesired. Nature-friendly lighting can still provide this safety while also mitigating ecological interference. To make a lighting plan nature-friendly, light should in the first place be reduced by using it only when and where absolutely necessary. Narrow beam angles with little scatter and smart sensor technologies can help to limit the ecological disturbance of light while still maintaining safety[1]. Strategic placement of vegetation and built structures can further mitigate light scatter toward habitats. Behaviour and occurrence of species also relates to the colour of the light, with red and warm colours being the least disruptive[2].



Nature-friendly lighting is embedded in

12. Comfortable outdoor space

23. Living building envelope

References and further reading:

[1]. Zoogdier Vereniging. (n.d.). Factsheet vleermuizen verlichting. Bouw Natuurinclusief. Retrieved March 31, 2021, from https://bouwnatuurinclusief.nl/images/global/Factsheets-maatregelen-vleermuizen-VERLICHTING-digitaal.pdf

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4. Interactive green space

Simply the presence of green space is not enough to positively impact well-being. Green space becomes much more valuable for people when they can interact with it. There are many ways people can interact with nature, ranging from seeing or hearing it, to actively participate in it (e.g. by gardening). Numerous studies point out that interacting with green space improves well-being[1]. The effects range from stress reduction related to views of green space to an improved feeling of belonging associated with gardening[2]. Furthermore, accessible green space provides many recreation possibilities, see also *18. Nature-inclusive amenity.* Green space can be designed in such a way that it facilitates the positive interactions and mitigates the negative interactions, such as blocking views. Engagement of local communities in the design and planning process may help to define the desired types of interaction[3].

Interactive green space contains

1. Greenery

Interactive green is embedded in

10. Adopted planter *11. Balcony garden* *13. Facade garden* *14. Garden corridor*

References and further reading:

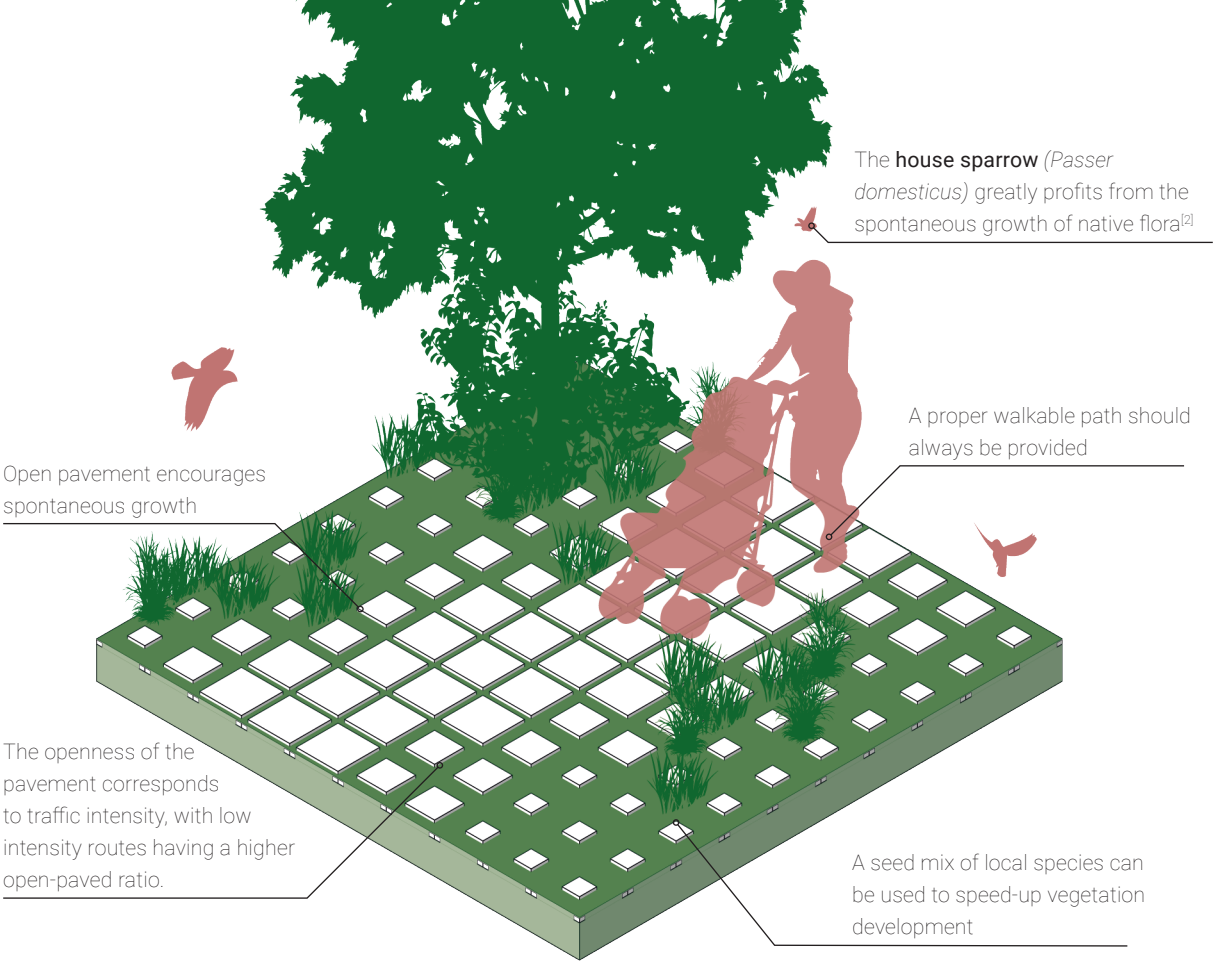
[1]. Beatley, T. (2017). Handbook of biophilic city planning & design. Island Press.

[2]. Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. Journal of environmental psychology, 11(3), 201-230.

[3]. Oh, R. R., Richards, D. R., & Yee, A. T. (2018). Community-driven skyrise greenery in a dense tropical city provides biodiversity and ecosystem service benefits. Landscape and Urban Planning, 169, 115-123.

5. Open pavement

Paved surfaces reduce the availability of habitats for urban wildlife, contribute to the urban heat island effect, increase noise pollution and disrupt the natural water cycle. Open pavement is an inexpensive solution that mitigates these effects. The openings between the stones allow vegetation to grow and increase the soil quality, while maintaining walkability and accessibility. Plants produce seeds and attract insects, a food source for various other animals[1,2]. Since open pavement can be hard to traverse for less mobile users as elderly, it is important that alternative pathways are provided. Ideal locations to apply this pavement type are low traffic areas, such as parking lots and tram lanes.



Open pavement contains	*Open pavement is embedded in*	
1. Greenery	*19. Pocket park*	*21. Green street*

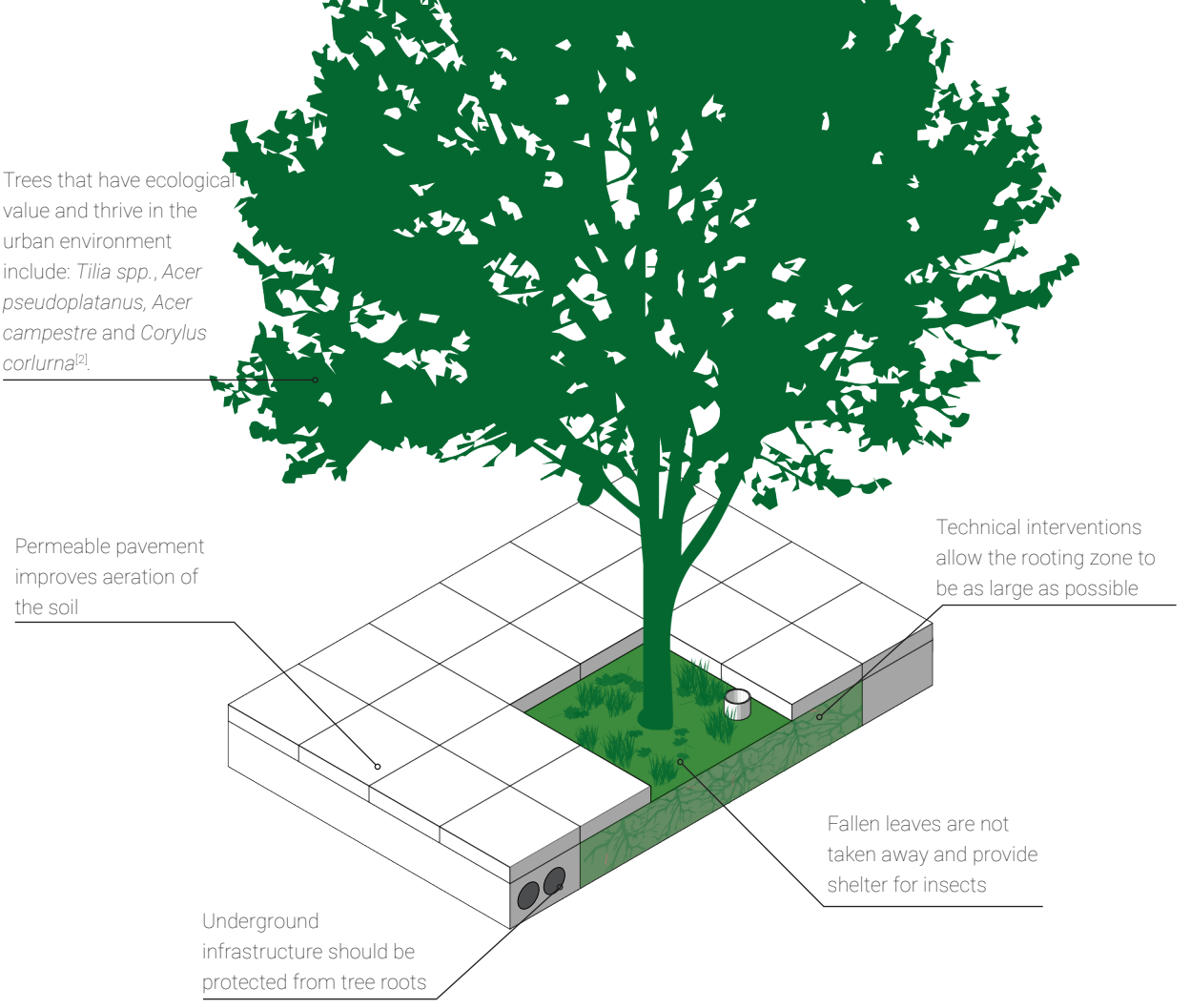
References and further reading:

[1]. Bouw Natuurinclusief. (n.d.). Halfbestrating houdt ruimte groen. Retrieved March 31, 2021, from https://bouwnatuurinclusief.nl/blogs/halfbestrating-houdt-ruimte-groen

[2]. Checklist groen bouwen. (n.d.). Halfbestrating als bron van voedsel. Retrieved March 31, 2021, from https://www.checklistgroenbouwen.nl/maatregelen/maatr-details/halfbestrating

6. Urban tree

Sealed surfaces and intensive land use in compact cities pose obstructions for natural forests to develop. Large trees however, are essential to the functioning of natural environments. When properly designed and planted, trees in urban settings can take on these functions. Urban trees provide many benefits, from cooling the environment and reducing stress to offering nesting places and food for various animals[1,2]. Large urban trees have the additional benefit that they can create meaningful space and attain monumental value over time[3]. Besides the ecological value, a tree species selection should also be based on its ability to thrive in the urban environment. Specific technologies, such as root bunkers, are available to increase the root space of trees while also protecting existing underground infrastructure.



Urban tree includes	***Urban tree is embedded in***
2. Integrated nesting	##. Name of typology ##. Name of typology ##. Name of typology

References and further reading:

[1]. Jiang, B., Li, D., Larsen, L., & Sullivan, W. C. (2016). A dose-response curve describing the relationship between urban tree cover density and self-reported stress recovery. Environment and behavior, 48(4), 607-629.
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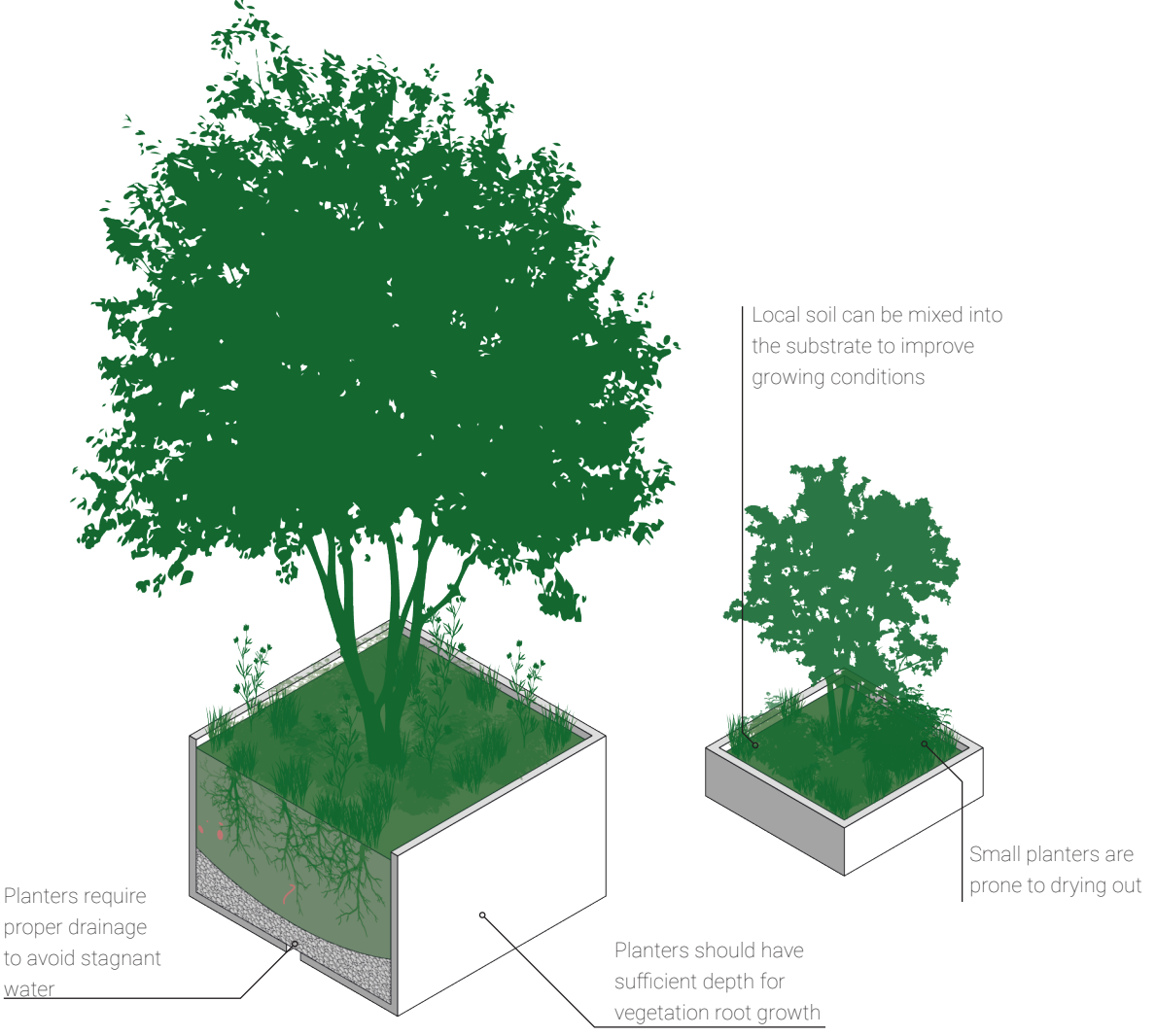
[3]. Gemeente Rotterdam. (n.d.-a). Monumentale bomen | Rotterdam.nl. Retrieved April 1, 2021, from https://www.rotterdam.nl/wonen-leven/monumentale-bomen/

7. (Elevated) planter

Impermeable surfaces are not always removable, hampering the realisation of green space. While the development of green space directly into the local soil is preferred, (elevated) planters serve as a viable alternative to create green space on impermeable surfaces and structures. Planters provide vegetation with sufficient rooting space and offer the possibility for green space to be elevated, as opposed to be confined to the ground level. The required depth of the planter depends on the type of vegetation, varying between 10cm for small grasses and herbs to 150cm for medium sized trees[1]. Substrate in the planter can be mixed with local soil to improve the soil biodiversity. As the soil in planters is not connected to the ground water table, attention should be paid to proper irrigation. Planters should always have proper drainage to avoid them getting filled up with water.



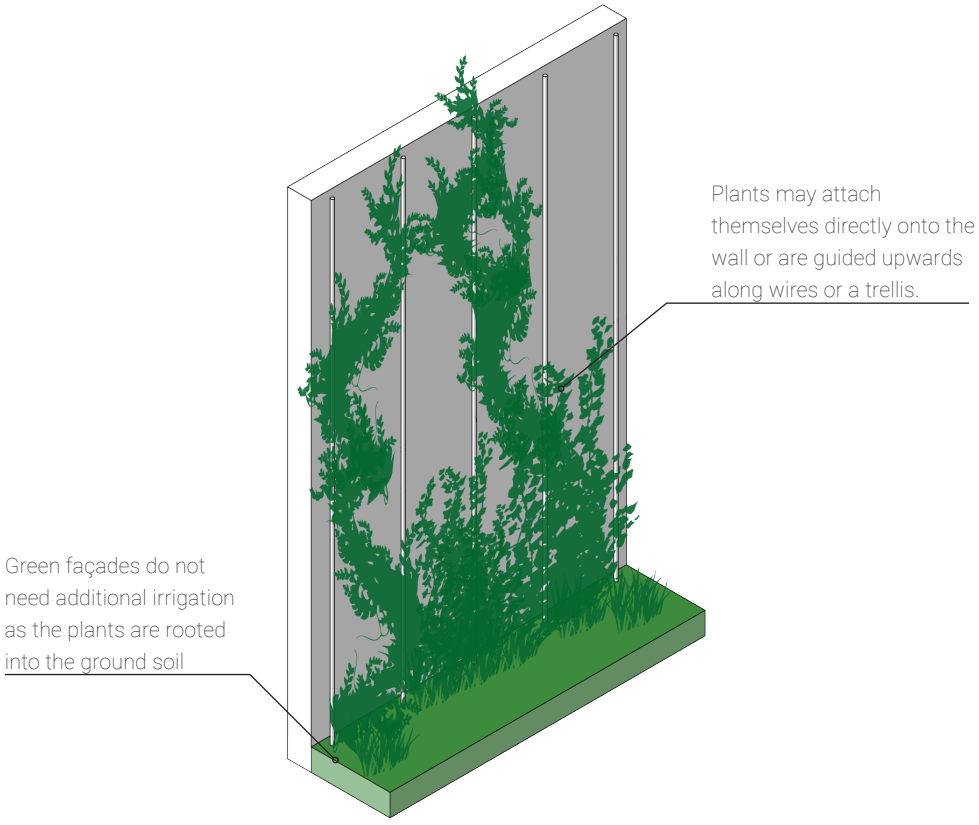
(Elevated) planter contains	*(Elevated) planter is embedded in*		
1. Greenery	*11. Balcony garden*	*14. Garden corridor*	*15. Rooftop habitat*

References and further reading:

[1]. Steed, H. (2015). Greening the vertical garden city: the planning, design, and management of planting in high density tropical cities. Straits Times Press Pte. Limited.

8a. Vertical greenery (green facade)

While built structures in cities make increasingly more use of the vertical dimension, green space is still predominantly confined to the horizontal ground level. Green façades are the first step in creating a multidimensional green structure as they offer a simple and cost-effective way of greening vertical surfaces and improving ecology and well-being. Vegetation in a green facade grows autonomously in the soil and thus does not need additional irrigation. Various benefits related to green façades have been documented for both well-being and ecology. For instance, viewing a green façade causes stress reduction[1]. Furthermore, green façades have a cooling performance and can reduce air and noise pollution[2]. When native climbing plant species are used, the facade itself attracts insects and becomes a food source for various animals[3].



Vertical greenery contains

1. Greenery

Vertical greenery is embedded in

8d. Vertical greenery (structure) *13. Facade garden* *16. Eco-facade* *17. Bioreceptive design* *24. Green canal*

References and further reading:

[1]. Elsadek, M., Liu, B., & Lian, Z. (2019). Green façades: Their contribution to stress recovery and well-being in high-density cities. Urban Forestry & Urban Greening, 46, 126446.
[2]. Radić, M., Brković Dodig, M., & Auer, T. (2019). Green facades and living walls—a review establishing the classification of construction types and mapping the benefits. Sustainability, 11(17), 4579.
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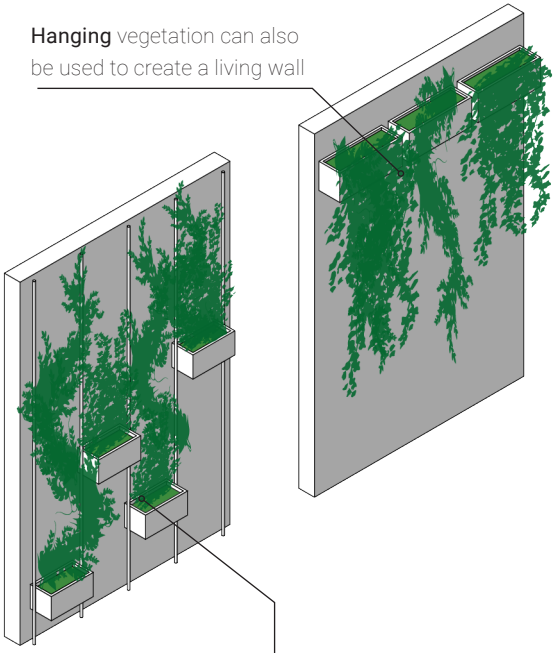
8b. Vertical greenery (living wall)

While built structures in cities make increasingly more use of the vertical dimension, green space is still predominantly confined to the horizontal ground level. Living walls transform ordinary stony walls into soft green surfaces that reduce the temperature at the street level, enliven building aesthetics and create a habitat for flora and fauna. Living walls consists of vegetation that, in contrast with green façades, does not root in the soil underneath the wall but in a growing medium on the wall itself. This technique requires additional irrigation and makes the system more complex, but does also result in a better cooling performance and possibility to use a more extensive plant palette[1]. Living walls can also improve safety by reducing crime[2]. Similarly to green façades, the plant selection determines the ecological value. Hence, a native plant palette is desired (see *1a. Greenery (nature-based)).*



Hanging vegetation can also be used to create a living wall

Climbing plants can be placed in wall-bound planters when a wall is too high for a green facade. This facade type attracts mainly species that naturally occur around cliffs and dry habitats.[3]

Vegetation roots freely in the felt of a **felt pocket** living wall. This type requires regular irrigation. This facade type attracts mainly species that naturally occur around waterfalls and in moist habitats[1,3].

A living wall with **planter** modules is the most heavy and requires a sturdy construction.

Vertical greenery contains

1. Greenery

Vertical greenery is embedded in

8d. Vertical greenery (structure) 13. Facade garden 16. Eco-facade 17. Bioreceptive design 24. Green canal

References and further reading:

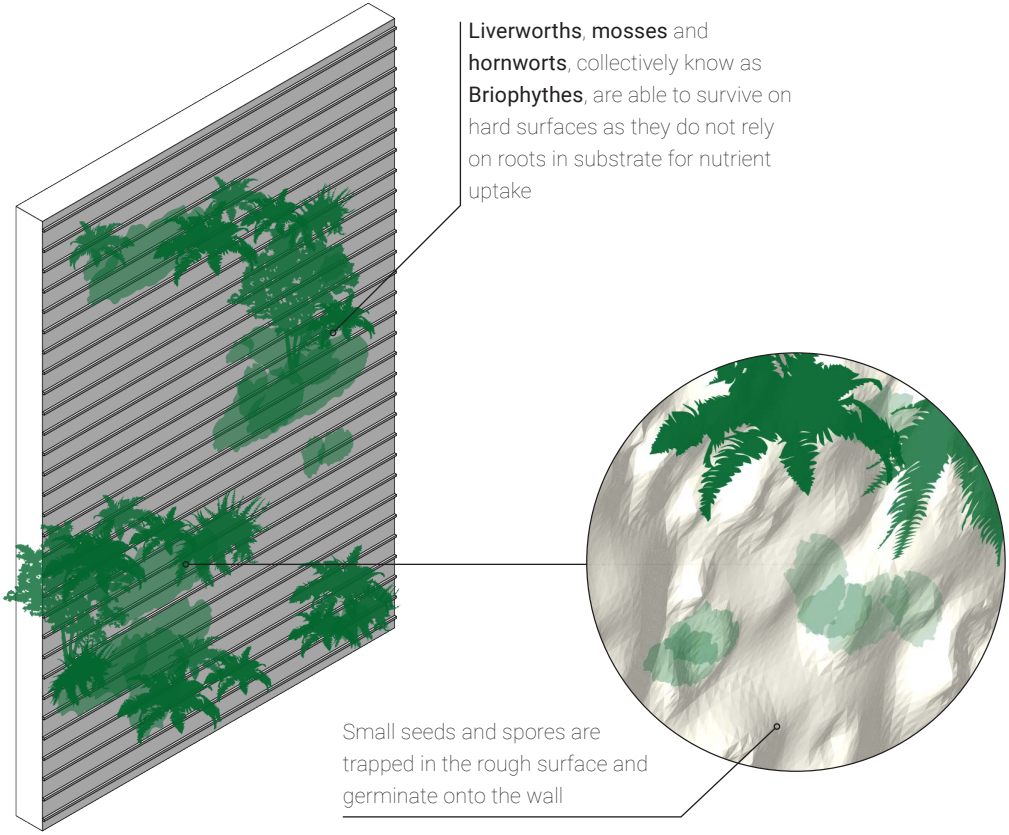
[1]. Blanc, P. (2008). The vertical garden: From nature to the city. WW Norton & Company.

[2]. Radić, M., Brković Dodig, M., & Auer, T. (2019). Green facades and living walls—a review establishing the classification of construction types and mapping the benefits. Sustainability, 11(17), 4579.

[3]. Madre, F., Clergeau, P., Machon, N., & Vergnes, A. (2015). Building biodiversity: Vegetated façades as habitats for spider and beetle assemblages. Global Ecology and Conservation, 3, 222-233.

8c. Vertical greenery (bioreceptive)

Built structures in cities are often harsh and provide little ecological value as most building materials currently used are not receptive for spontaneous growth of vegetation. Bioreceptive surfaces, on the other hand, allow for the development of vegetation directly onto the wall itself. Bioreceptive surfaces have material properties that encourage biological development. Porous materials that retain moisture and are slightly acidic are the most effective in promoting spontaneous development[1,2]. Since moisture is imperative for biological development, bioreceptive surfaces are more effective when embedded in designs that create moist growing conditions or placed close to water, such as quay walls. See also *17. Bioreceptive design* and *24. Green canal*.



Vertical greenery contains

1. Greenery

Vertical greenery is embedded in

8d. Vertical greenery (structure) *13. Facade garden* *16. Eco-facade*
17. Bioreceptive design *24. Green canal*

References and further reading:

[1]. Chen, C., Mao, L., Qiu, Y., Cui, J., & Wang, Y. (2020). Walls offer potential to improve urban biodiversity. Scientific reports, 10(1), 1-10.

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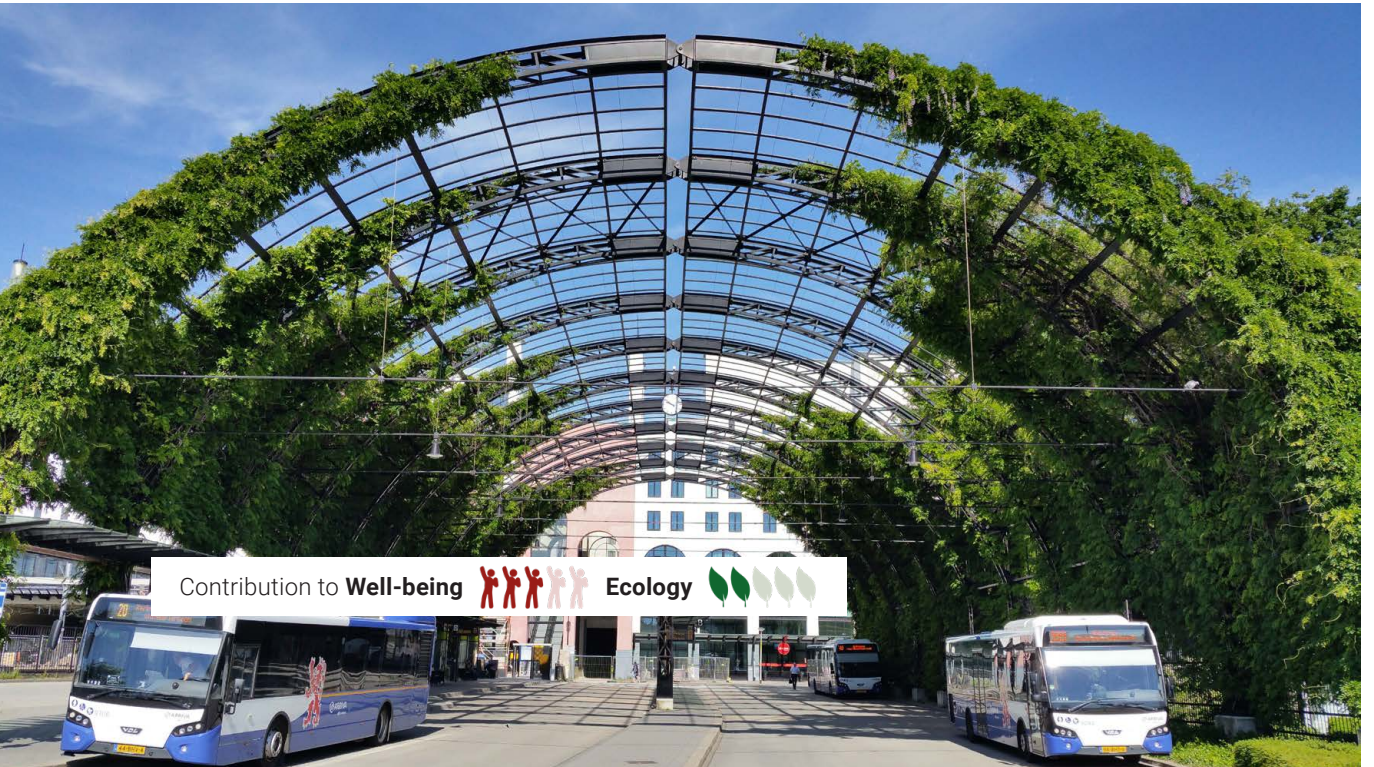
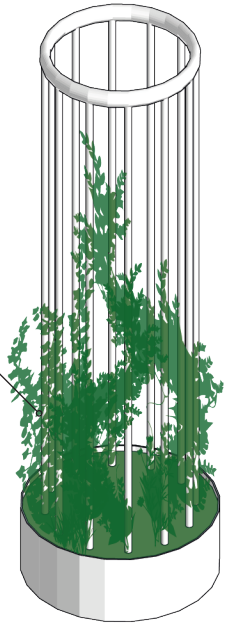
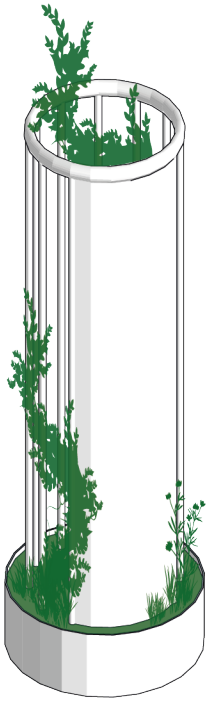
8d. Vertical greenery (structure)

In small and paved spaces it is not always feasible to plant urban trees. Yet these are often the locations that would profit from green features the most. They often severely suffer from the urban heat island effect and do not provide space for biodiversity. In such cases, vertical green structures can provide much green surface area on a small footprint. Green structures can be designed in a variety of shapes depending on the context and desired effect. Vegetation on the structures consists of climbers that ideally adhere to the '1. Greenery' pattern. Structures can be combined with existing buildings or may even form new buildings.



Ivy *(Hedera helix)* blooms and gives fruit at moments when other plants are not yet active and thus has a high ecological value. Furthermore, this evergreen climber provides nesting places year-round[1].





Vertical greenery contains

1. Greenery

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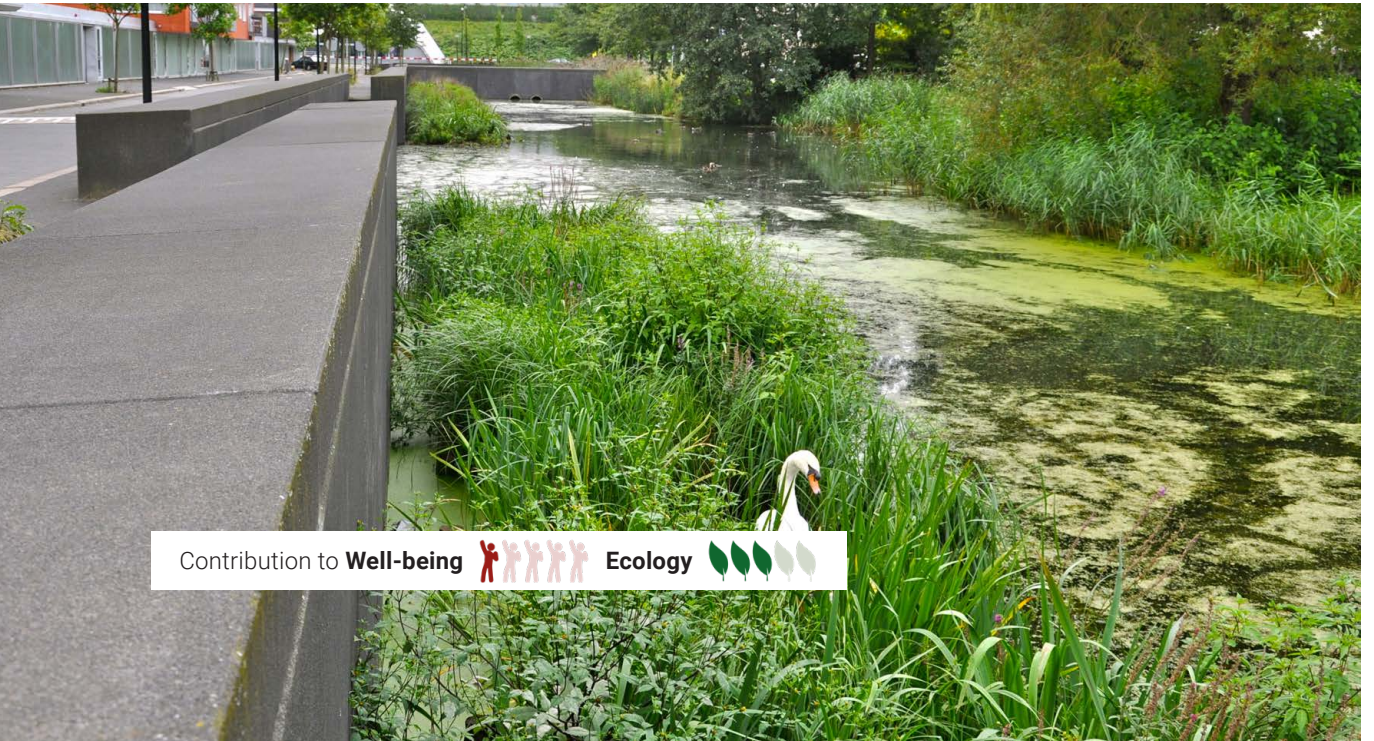
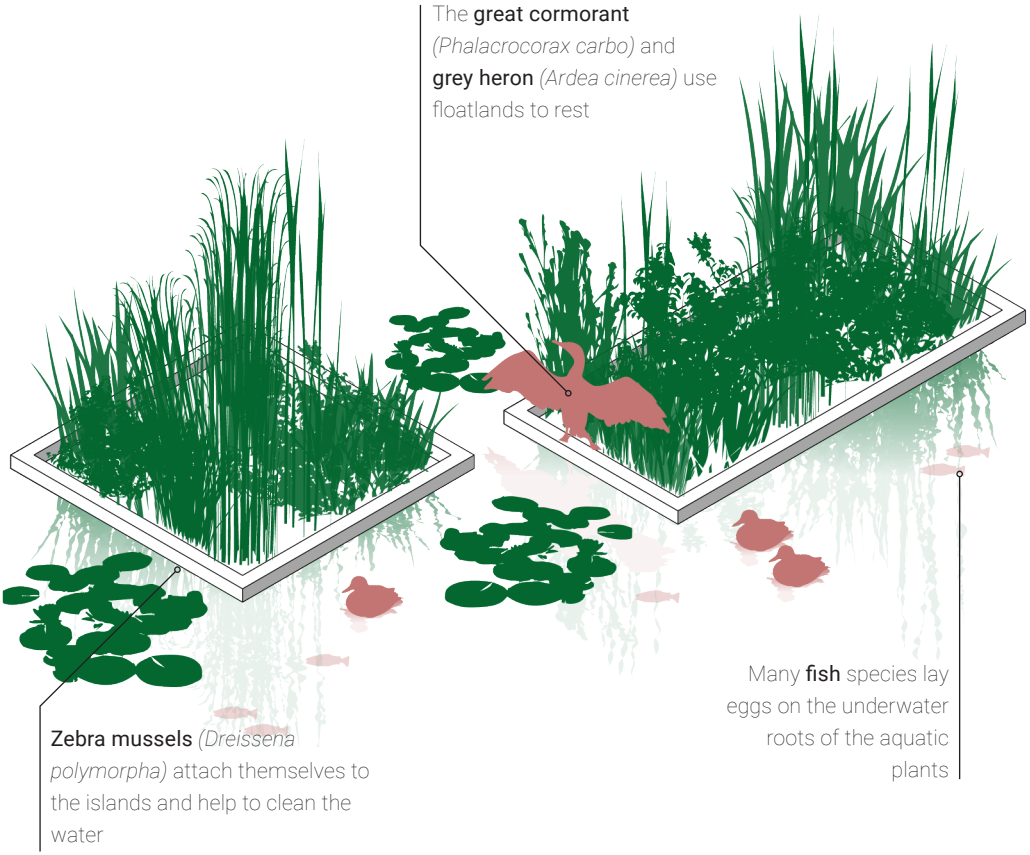
[1]. Bouw Natuurinclusief. (n.d). Groene gevels voegen natuurkwaliteit toe. Retrieved March 31, 2021, from https://bouwnatuurinclusief.nl/blogs/groene-gevels-voegen-natuurkwaliteit-toe

9. Floatland

Dense urban environments often do not have the space for a gradual transition between water and land. This transition zone is an important ecological component, however, as it accommodates many aquatic plants in natural environments. Floatlands simulate this zone and provide a habitat for many aquatic species. These floating island with aquatic plants create both above and below water a valuable habitat[1]. Additionally, the vegetation roots in the water and filters it as a result. Especially the yellow iris *(Iris pseudacorus)* has been found to effectively remove phosphorus and nitrogen from the water[2]. To avoid safety concerns, floatlands should be placed in such a way that they are inaccessible for people.





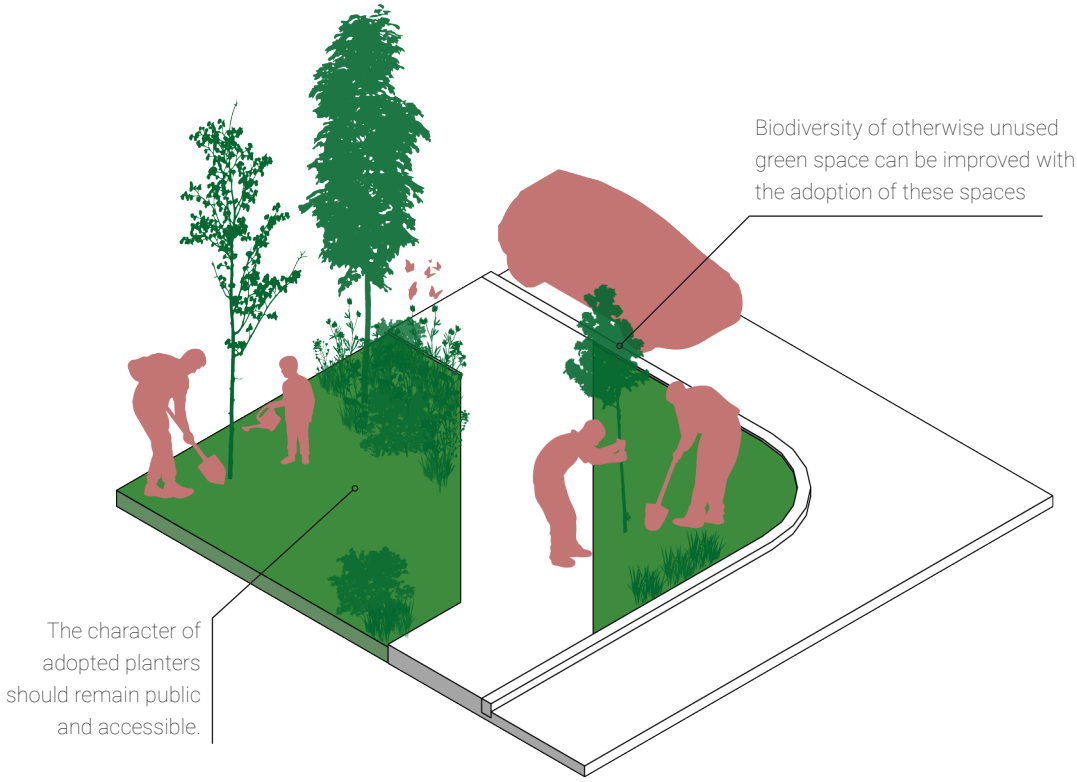
Floatland contains		*Floatland is embedded in*
1. Greenery	*2. Integrated nesting*	*24. Green canal*

References and further reading:

[1]. Kooijmans, J. L. (2009). Stadsvogels. Tirion Natuur, Baarn.
[2]. Vlek, H. E., Verdonschot, R. C. M., Verdonschot, P. F. M., & Dekkers, T. B. M. (2013). Floatlands veelbelovend als waterzuiveraar in stadswateren. H2O online.

10. Adopted planter

Maintaining public green space can be expensive and cumbersome for municipalities. At the same time, many people in dense cities do not have access to a garden. Local communities could adopt the maintenance of unused and overlooked informal green spaces, which makes green space also more diverse. Green space that is cared for by the community improves the belonging of inhabitants to the neighbourhood and contributes to an attractive urban environment. Research demonstrates that community stewardship of green space relates to a higher survival rate of vegetation and thus contributes to the sustainability of the space over the long-term[1]. It is important that the character of the adopted green space remains public, so it other people can still enjoy it too[2].



Adopted planter contains	
1. Greenery	*4. Interactive green space*

Adopted planter is embedded in		
21. Green street	*19. Pocket park*	*20. Sky park*

References and further reading:

[1].Jack-Scott, E., Piana, M., Troxel, B., Murphy-Dunning, C., & Ashton, M. S. (2013). Stewardship success: How community group dynamics affect urban street tree survival and growth. Arboriculture & Urban Forestry, 39(4), 189-196.

[2]. Gemeente Rotterdam. (n.d.). Zelfbeheer | Rotterdam.nl. Retrieved March 31, 2021, from https://www.rotterdam.nl/wonen-leven/zelfbeheer/

11. Balcony garden

Private gardens are not common in compact and dense cities, which prevents urban dwellers from gardening. Gardening however, is an important activity that increases personal belonging while also increasing biodiversity and green coverage[1]. Green balconies do not take up much space but still make gardening and being outside possible, even in dense cities. Green balconies have the potential to contribute to the green structure of a city. As with many initiatives, the value for ecology depends on the plant species used and the maintenance of them[2]. Ideally the greenery on the balcony follows the pattern of *1. Greenery*. People will have to be informed and guided towards how they can transform their balcony into a green space that does not only improves personal well-being, but also adds ecological value.

Balcony garden contains

4. Interactive green space

7. (Elevated) planter

Balcony garden is embedded in

25. Porous high-rise

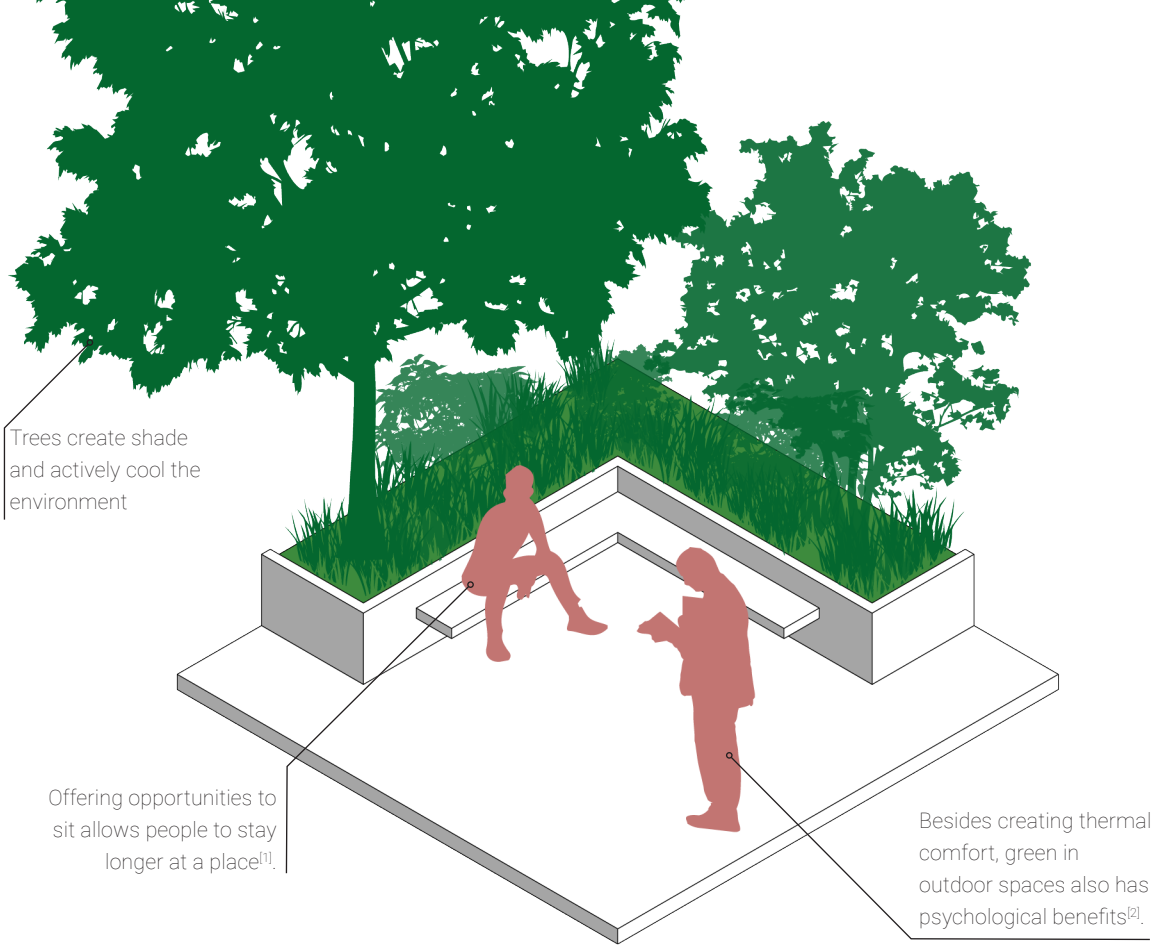
References and further reading:

[1]. Brook, I. (2003). Making here like there: place attachment, displacement and the urge to garden. Ethics, Place & Environment, 6(3), 227-234.

[2]. Krzymińska, A., Bocianowski, J., & Mądrachowska, K. (2020). The use of plants on balconies in the city. Horticultural Science, 47(3), 180-187.

12. Comfortable outdoor space

Spending time outside is the most direct way of experiencing nature. But when outdoor space is not inviting and comfortable, being outside becomes more of a burden than a pleasant experience. Comfortable outdoor space invites people to experience the greenery in their city and fosters social connections[1]. Greenery can help creating this space. Trees provide shade and create a comfortable micro-climate. Shrubs and flowers provide coverage for strong winds and also have aesthetic values[2]. Additionally, outdoor furniture such as chairs and tables can be used to further increase the quality of the public space.



Comfortable outdoor space contains

1. Greenery *3. Nature-friendly lighting* *6. Urban tree*

Comfortable outdoor space is embedded in

18. Nature-inclusive amenity *22. Accessible rooftop* *24. Green canal* *21. Green street*

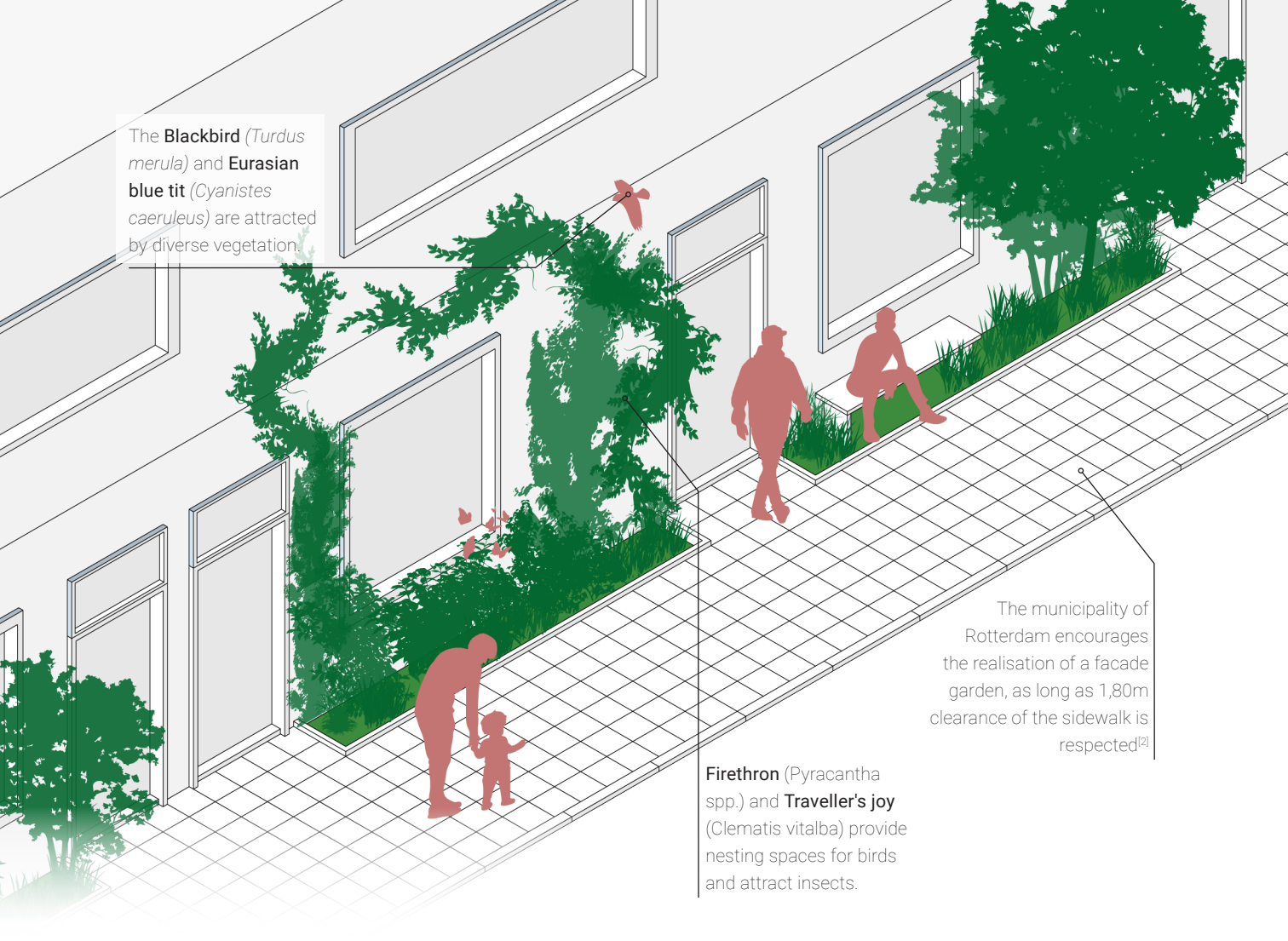
References and further reading:

[1]. Gehl, J. (2011). Life between buildings: using public space. Island press.

[2]. Lafortezza, R., Carrus, G., Sanesi, G., & Davies, C. (2009). Benefits and well-being perceived by people visiting green spaces in periods of heat stress. Urban forestry & urban greening, 8(2), 97-108.

13. Facade garden

In narrow streets space for front gardens is limited. But merely stony façades in streets trap heat and have a very limited value for biodiversity. Facade gardening does not take up much space and can improve biodiversity as well as diversifying monotonous building façades[1]. Constructing a facade garden involves depaving a small area along the facade of a building. Vegetation can be planted in this strip and can be combined with vertical greening onto the facade itself. When vegetation follows the pattern of *1. Greenery,* a facade garden offers many ecological benefits and creates habitats for many species. Facade gardens are usually narrow, but sufficient space should always be available for pedestrians. The maintenance of facade gardens is usually the responsibility of the owners the building it is attached to[2].



Facade garden contains		
2. Integrated nesting	*4. Interactive green space*	*8. Vertical greenery*

Facade garden is embedded in	
21. Green street	*23. Living building envelope*

References and further reading:

[1]. Kooijmans, J. L. (2009). Stadsvogels. Tirion Natuur, Baarn.
[2]. Gemeente Rotterdam. (n.d.). Geveltuinen | Rotterdam.nl. Retrieved April 1, 2021, from https://www.rotterdam.nl/wonen-leven/geveltuinen/

14. Garden corridor

Building corridors are often narrow and designed solely to facilitate movement of residents. However, these corridors could potentially facilitate informal green space and serve as a high-density replacement for ground level facade gardens. Garden corridors are community-driven gardens in the sky and offer many benefits when compared to formal vertical greenery[1]. Bottom-up initiatives can significantly increase biodiversity, as people pick a wide variety of plant species. Garden corridors are most successful when there is sufficient space in the corridor for planters and when light is abundant. As maintenance of the vegetation is done by residents, additional guidelines may be necessary to ensure escape paths remain safe and unobstructed.

Garden corridor contains

4. Interactive green space

7. (Elevated) planter

Garden corridor is embedded in

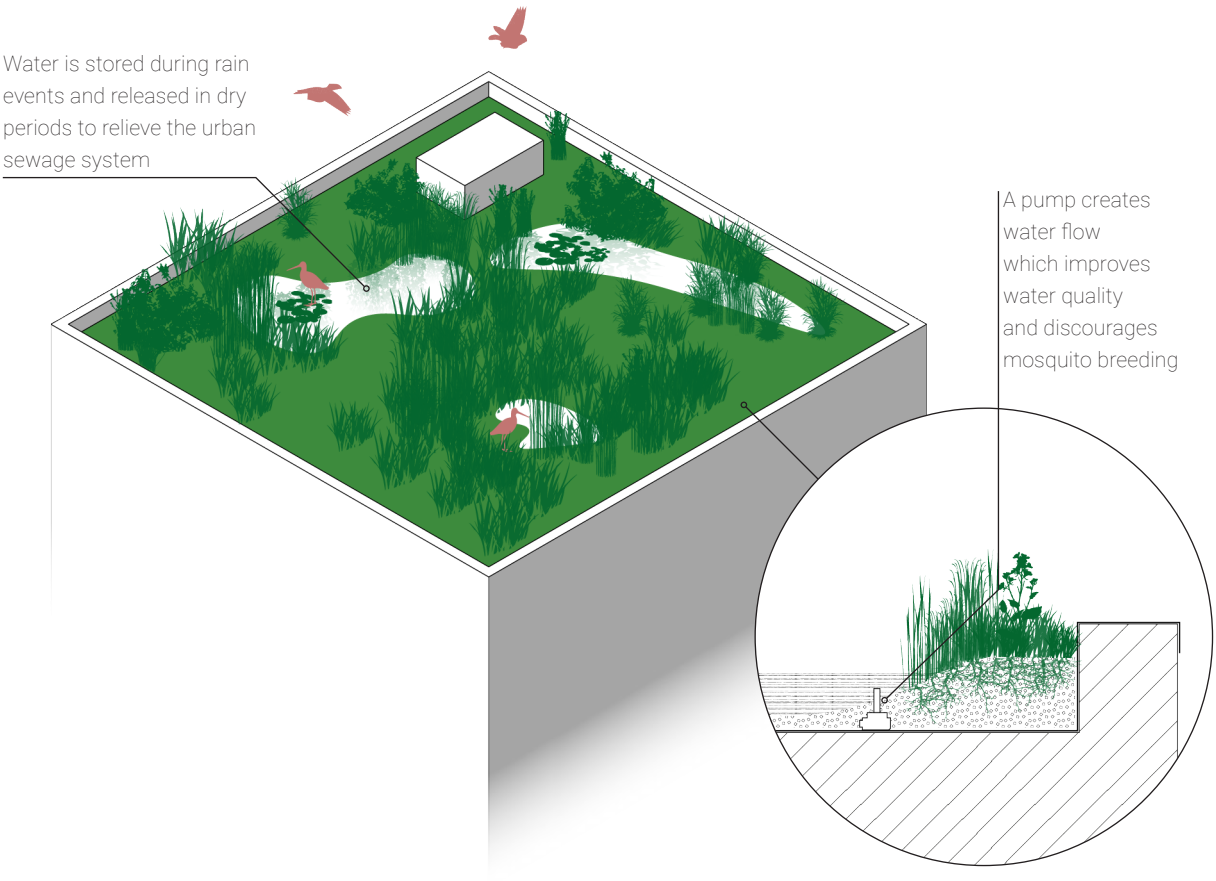
25. Porous high-rise

References and further reading:

[1]. Oh, R. R., Richards, D. R., & Yee, A. T. (2018). Community-driven skyrise greenery in a dense tropical city provides biodiversity and ecosystem service benefits. Landscape and Urban Planning, 169, 115-123.

15a.Rooftop habitat (marsh)

Even in dense and compact urban areas, rooftop space remains mostly underused. Transforming rooftops into habitats for wildlife does not only benefit local ecologies, but adds many opportunities to address other challenges. A marsh rooftop habitat acts as a water buffer that relieves urban sewage systems while also creating an aquatic habitat[1]. The water level of the rooftop is dynamic and depends on the current and forecast weather[2]. As with any water body, mosquito breeding should be avoided. A continuous water flow and the inclusion of natural predators, such as fish, will mitigate mosquito nuisance. The open water and regulated water level on this rooftop are comparable to the polder landscape that can be found outside Rotterdam. This type of rooftop habitat is heavy and can only be retrofitted on building roofs constructed for large loads, such as parking decks[2].



Rooftop habitat contains

2. Integrated nesting *7. (Elevated) planter*

Rooftop habitat is embedded in

20. Sky park *23. Living building envelope* *22. Accessible rooftop*

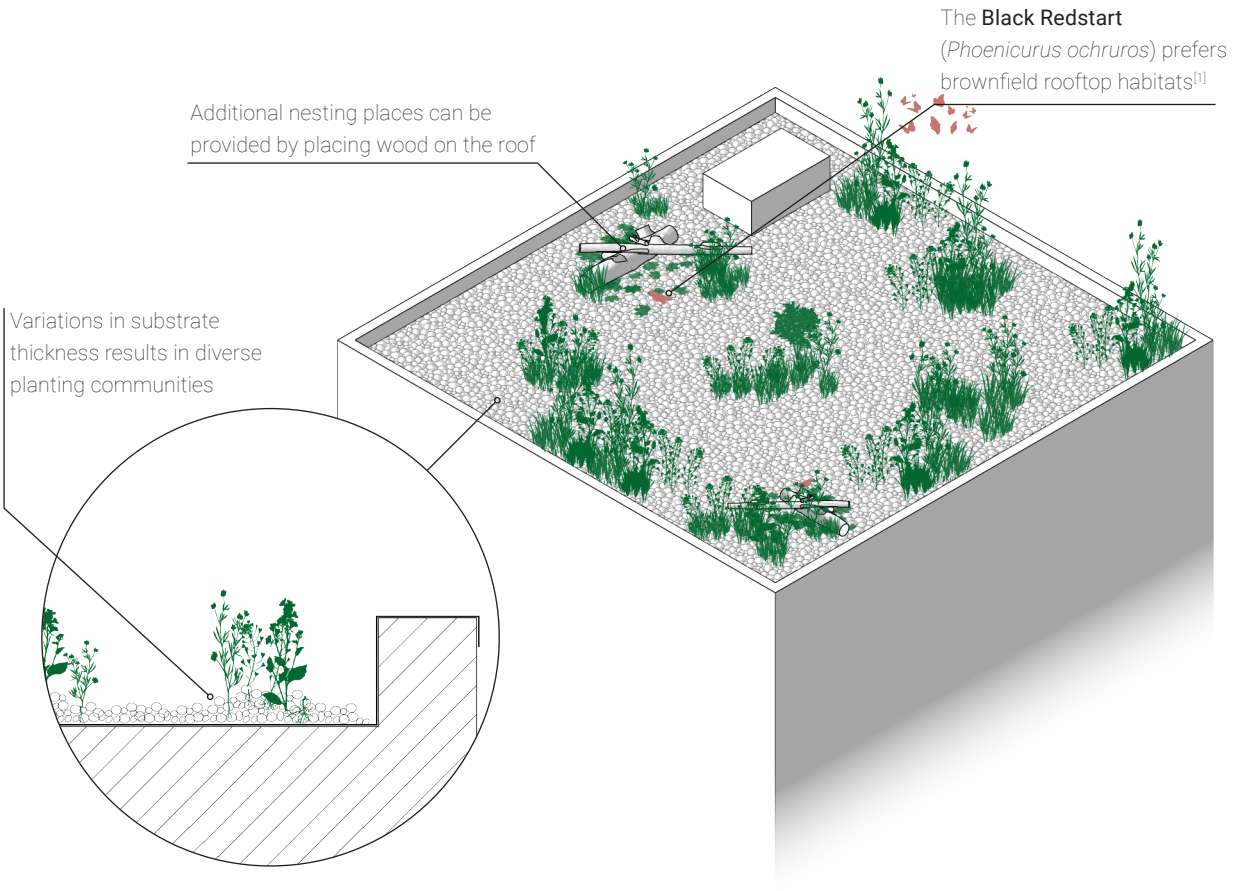
References and further reading:

[1]. Shafique, M., Kim, R., & Lee, D. (2016). The potential of green-blue roof to manage storm water in urban areas. Nature Environment and Pollution Technology, 15(2), 715.

[2]. MetroPolder company. (2021, 21 januari). MetroPolder company | Watermanagement op daken. https://metropolder.com/#polderdak

15b.Rooftop habitat (brownfield)

Even in dense and compact urban areas, rooftop space remains mostly underused. Transforming rooftops into habitats for wildlife does not only benefit local ecologies, but adds many opportunities to address other challenges. A brownfield rooftop is a light-weight green roof with pebbles and spontaneous vegetation. This resembles a brownfield, an important and valuable urban habitat for insects[1,2]. Various insects and birds are attracted by pioneer vegetation that grows on these brownfield roofs. Because this type of rooftop habitat is light-weight, it can be used at rooftops that do not have a large carrying capacity.



Rooftop habitat contains	
2. Integrated nesting	*7. (Elevated) planter*

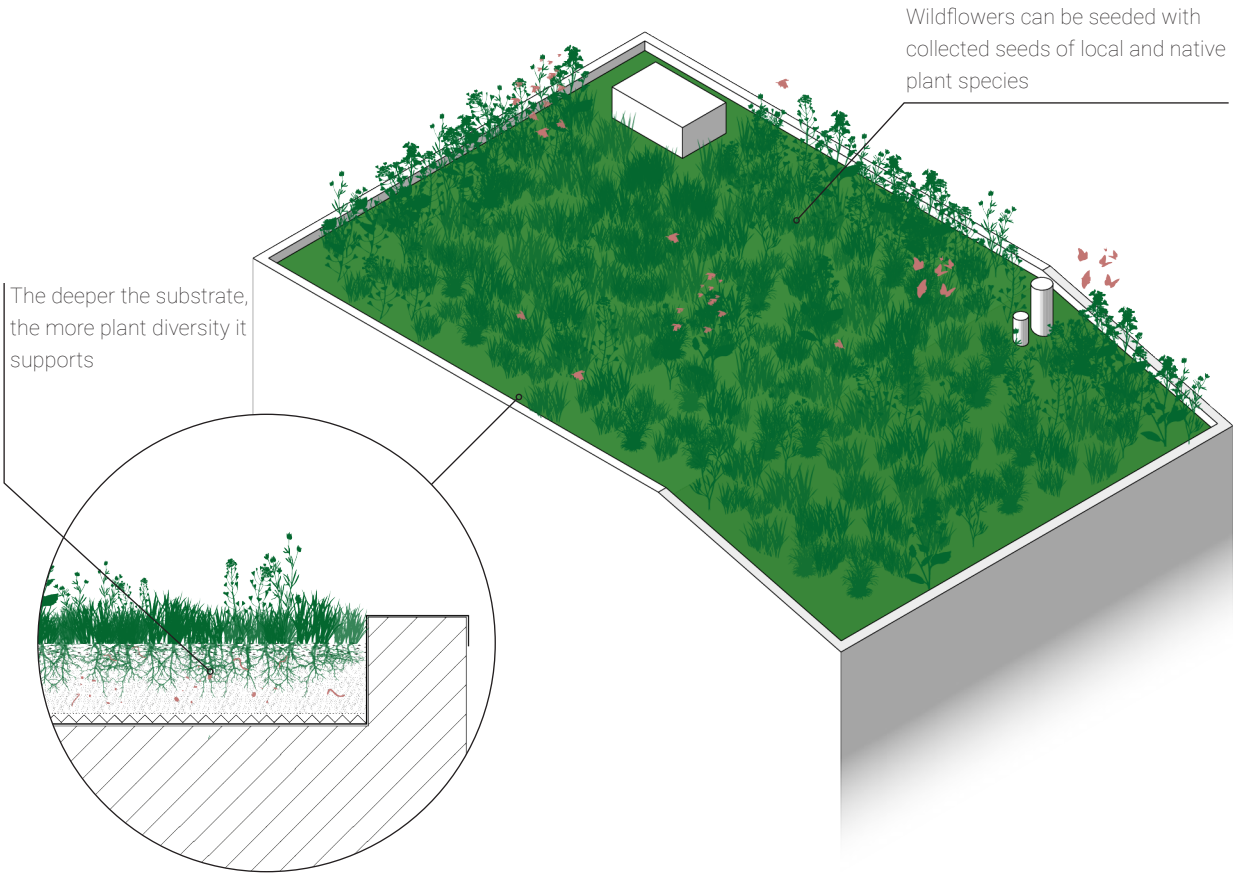
Rooftop habitat is embedded in		
20. Sky park	*23. Living building envelope*	*22. Accessible rooftop*

References and further reading:

[1]. Kooijmans, J. L. (2009). Stadsvogels. Tirion Natuur, Baarn.
[2]. Dusty Gedge (2020). Green Roofs. https://dustygedge.co.uk/index.php/category/green-roofs/

15c.Rooftop habitat (herbaceous)

Even in dense and compact urban areas, rooftop space remains mostly underused. Transforming rooftops into habitats for wildlife does not only benefit local ecologies, but adds many opportunities to address other challenges. Rooftops covered by vegetation lower temperatures inside the building and act as an additional insulation layer. When this vegetation consists of herbaceous wildflowers, the rooftop habitat offers an habitat for flying insects[1]. The ecological value of an herbaceous roof is strongly related to the hight of the roof, with lower roofs attracting more insects. This makes a herbaceous rooftop habitat suitable for three-story buildings or lower[1,2]. While substrate does not have to be deep to allow herbaceous growth, deeper substrates do result in higher plant diversity[3].



Rooftop habitat contains	
2. Integrated nesting	*7. (Elevated) planter*

Rooftop habitat is embedded in		
20. Sky park	*23. Living building envelope*	*22. Accessible rooftop*

References and further reading:

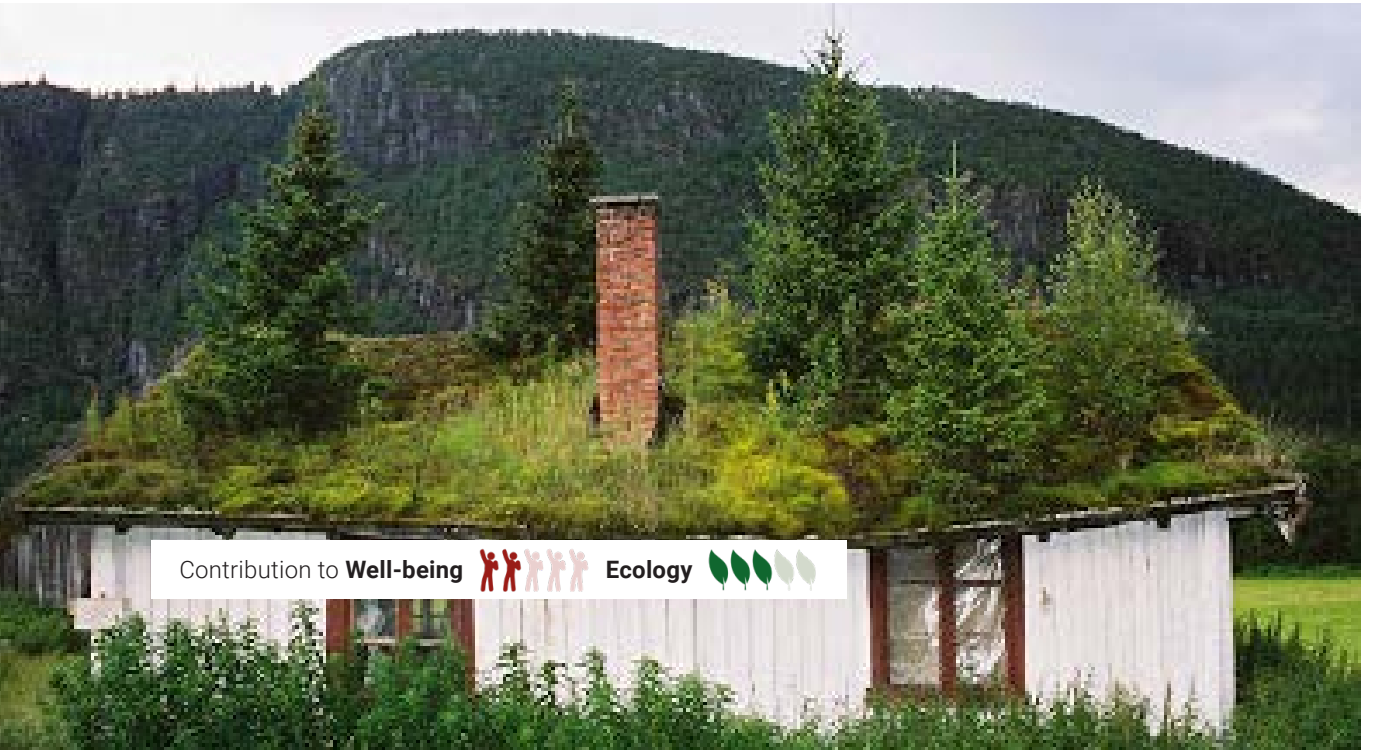
[1]. Dromgold, J. R., Threlfall, C. G., Norton, B. A., & Williams, N. S. (2020). Green roof and ground-level invertebrate communities are similar and are driven by building height and landscape context. Journal of Urban Ecology, 6(1), juz024.

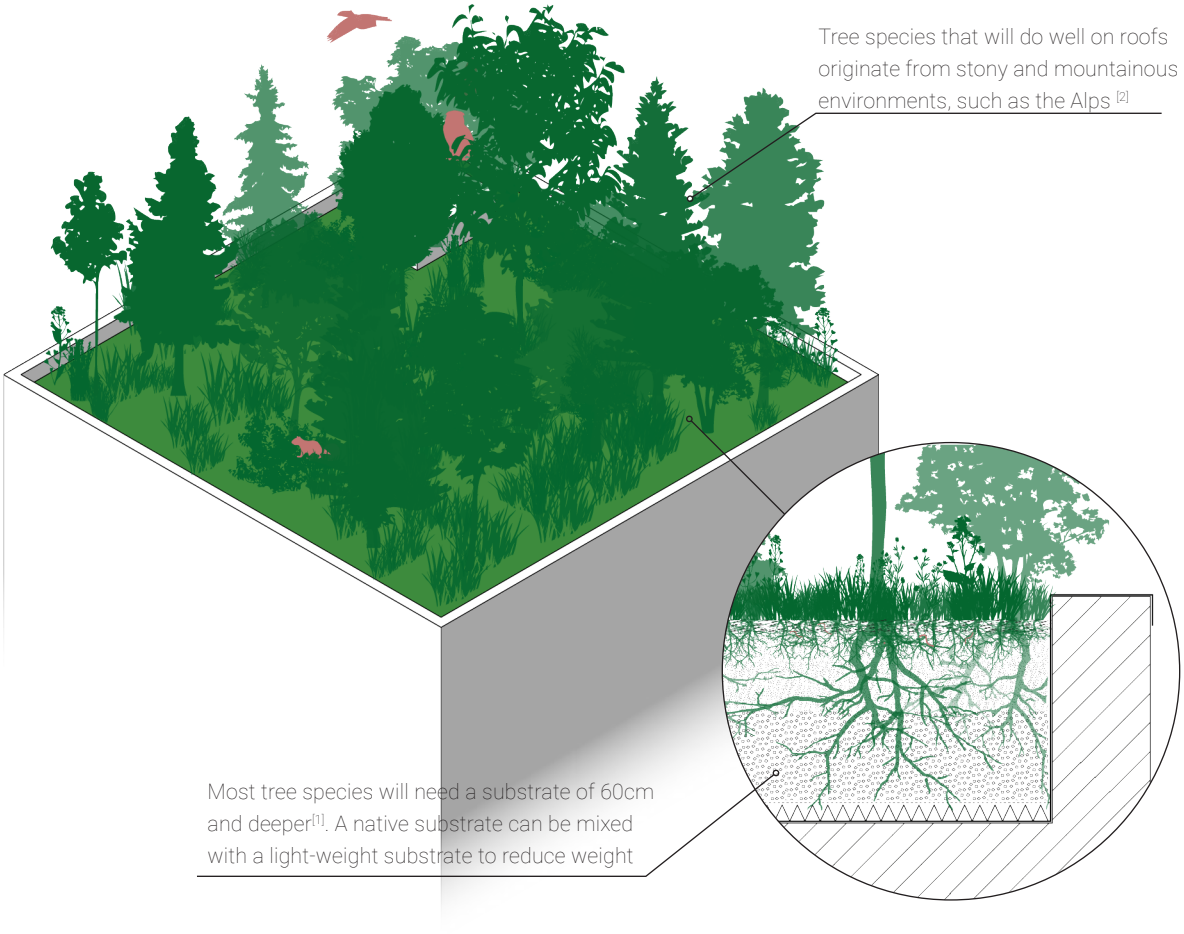
[2]. Mills, W. P., & Rott, A. (2020). Vertical life: impact of roof height on beetle diversity and abundance on wildflower green roofs. Journal of Urban Ecology, 6(1), juaa017.

[3]. Madre, F., Vergnes, A., Machon, N., & Clergeau, P. (2014). Green roofs as habitats for wild plant species in urban landscapes: First insights from a large-scale sampling. Landscape and urban Planning, 122, 100-107

15d. Rooftop habitat (forest)

Even in dense and compact urban areas, rooftop space remains mostly underused. Transforming rooftops into habitats for wildlife does not only benefit local ecologies, but adds many opportunities to address other challenges. A rooftop forest consists of climax vegetation that provides food and nesting spaces for many species. Furthermore, the trees can cool the climate outside and inside a building. This reduces energy demand and increases thermal comfort. Not all tree species can handle the harsh growing conditions on rooftops. Trees that generally do well originate from dry and stony habitats[2]. As trees need sufficient rooting space, this type of rooftop is rather heavy. As a safety measure, trees should be anchored securely and not be planted directly at the edge of a rooftop[1].





Rooftop habitat contains	
2. Integrated nesting	*7. (Elevated) planter*

Rooftop habitat is embedded in		
20. Sky park	*23. Living building envelope*	*22. Accessible rooftop*

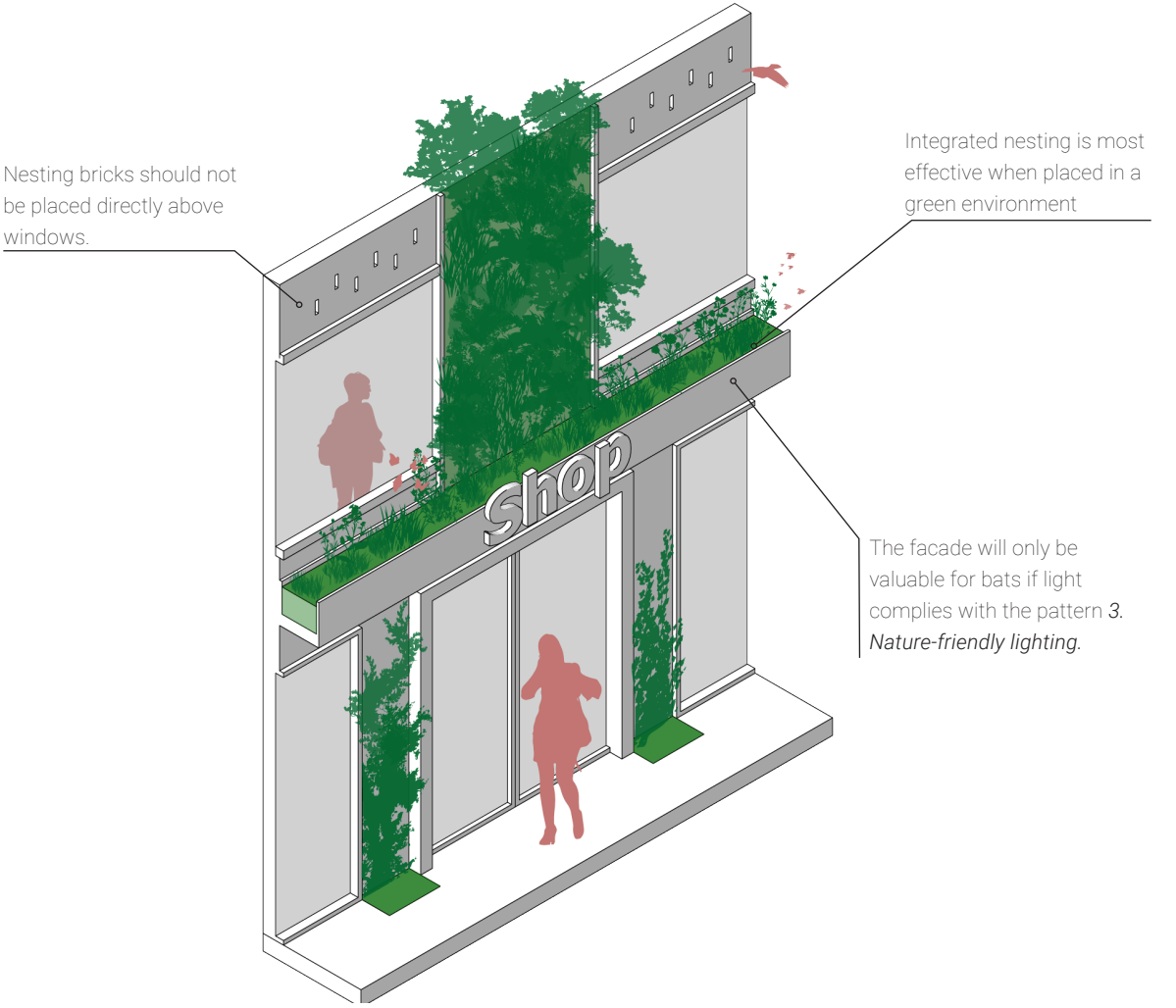
References and further reading:

[1]. Steed, H. (2015). Greening the vertical garden city: the planning, design, and management of planting in high density tropical cities. Straits Times Press Pte. Limited.

[2]. Lundholm, J. T. (2006). Green roofs and facades: a habitat template approach. Urban habitats, 4(1), 87-101.

16. Eco-facade

While integrated nesting can attract species when used independently, it becomes much more effective when combined with vertical greenery into a eco-facade. An eco-facade combines nesting with shelter and food into a full-fledged habitat[1]. Furthermore, the use of vertical greenery mitigates the urban heat island effect by providing cooling right at the street level[2]. Vertical greenery contributes to a comfortable urban micro-climate as it is close to the street level. The combination of nesting places and vegetation has a high ecological value. Nesting integrated into the facade should fulfill the requirements for the targeted species. Most birds and bats prefer nests that are located at least four metres above the ground. To avoid nuisance caused by bird droppings, nesting bricks should not be placed directly above windows[1].



Eco-facade contains		
3. Nature-friendly lighting	*2. Integrated nesting*	*8. Vertical greenery*

Eco-facade is embedded in	
21. Green street	*23. Living building envelope*

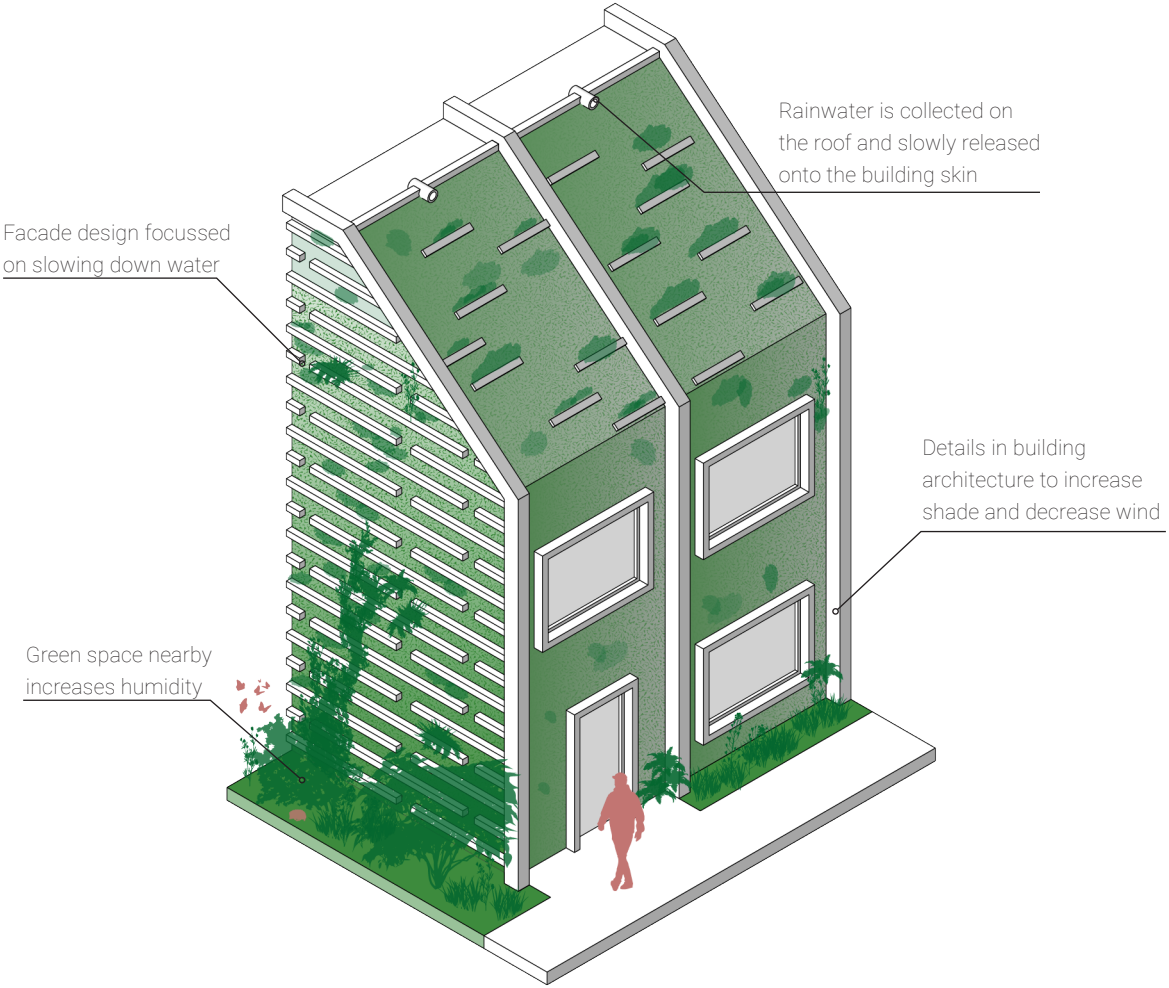
References and further reading:

[1]. Bouw Natuur Inclusief. (n.d.). BNI Woonwensen. BNI Woonwensen. Retrieved March 30, 2021, from https://bouwnatuurinclusief.nl/images/global/BNIWoonwensen.pdf

[2]. Alexandri, E., & Jones, P. (2008). Temperature decreases in an urban canyon due to green walls and green roofs in diverse climates. Building and environment, 43(4), 480-493.

17. Bioreceptive design

Environmental conditions in urban environments are often dry and hostile to plant growth. Bioreceptive materials are the first step in promoting spontaneous growth, but materials on their own will not always create suitable growing conditions for vegetation. Bioreceptive design is architectural design that optimizes the growing environment for vegetation on the building skin. Building shape influences environmental parameter such as temperature, moisture and solar exposure in many ways. Cavities and porous surfaces create shade and moist environments that promote plant growth[1]. Water flow can be designed to slowly percolate down a facade. Bioreceptive design aims to design environmental conditions to promote vegetation growth, such as the retainment of moisture and protection of harsh wind.



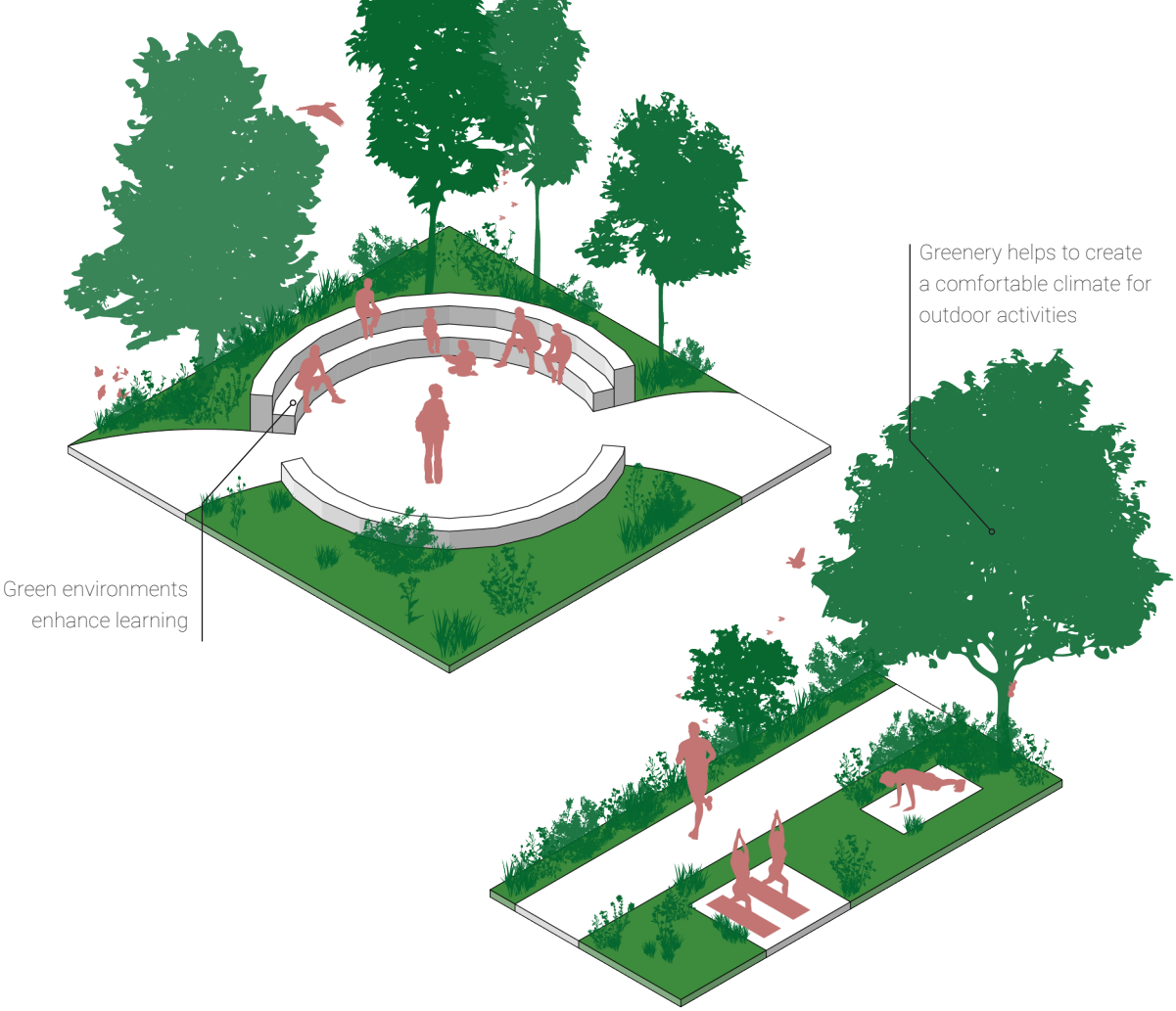
Bioreceptive design contains	***Bioreceptive design is embedded in***
8. Vertical greenery	23. Living building envelope

References and further reading:

[1]. Klein, Milou (2020). Bioreceptive facade design. Student thesis, TU Delft.

18. Nature-inclusive amenity

Amenities in dense cities, such as playgrounds, sport parks and schoolyards, are often paved and devoid of natural elements. This is unfortunate, as we know that greenery can improve the quality of these spaces by cooling the environment, creating a restorative environment and provide human-nature interactions[1]. A nature-inclusive amenity is an amenity embedded in a natural environment that fosters a human-nature interaction. There is much evidence that spending time in green environments has positive effects on someone's health[2]. Nature-inclusive amenities are places that promote biophilic interactions and let people interact with the green environment around them. This ranges from green schoolyards and outdoor classrooms to sport facilities surrounded by greenery.



Nature-inclusive amenity contains	*Nature-inclusive amenity is embedded in*		
12. Comfortable outdoor space	*19. Pocket park*	*20. Sky park*	*28. Rooftop landscape*

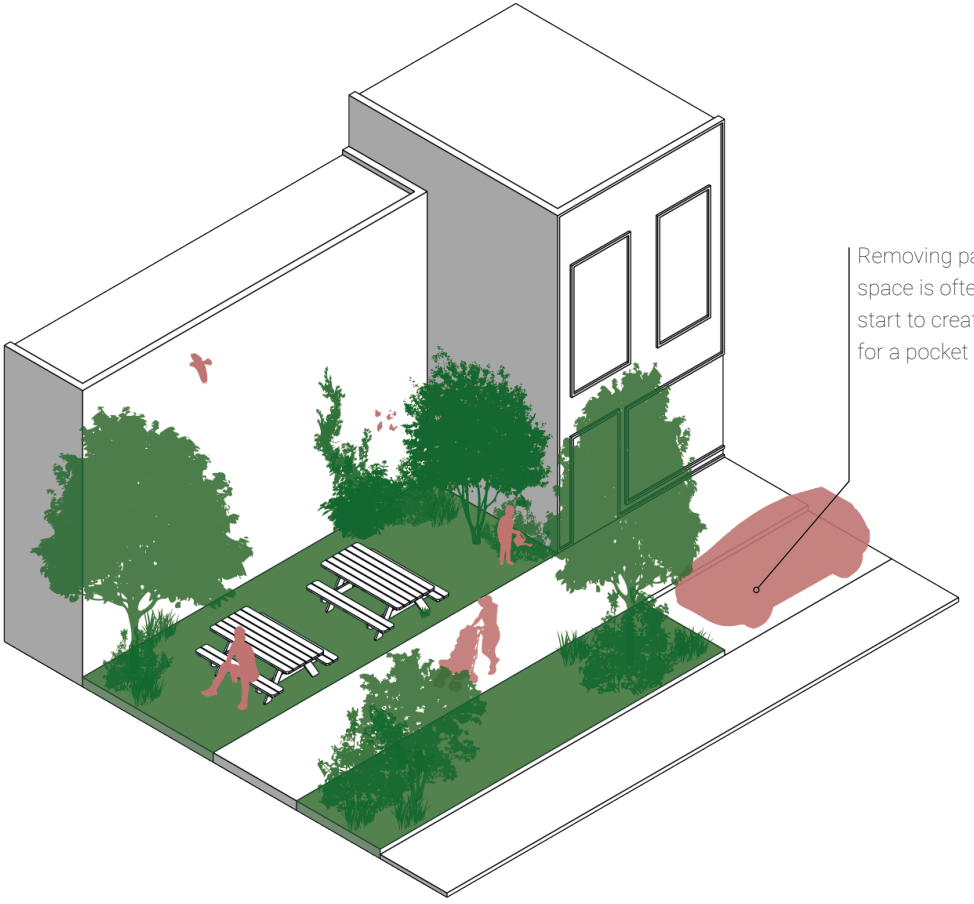
References and further reading:

[1]. Beatley, T. (2017). Handbook of biophilic city planning & design. Island Press.

[2]. Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. Journal of environmental psychology, 11(3), 201-230.

19. Pocket park

Large urban parks have many benefits, but they also take up a lot of space. Small parks are no replacements of these large green areas, but could supplement the green network in a city where large parks are not feasible. Pocket parks are small parks that are realised in streets, on vacant lots or other under-used urban spaces. They provide qualitative green space close the people's home and act as stepping stones for species movement. Space for pocket parks in cities can often be created by reducing the amount of parking spaces and redesigning existing street networks. Since pocket parks are located close to people's homes, empowering citizens throughout the planning, design and construction and maintenance phases can increase the positive effects these parks have on the surroundings[1].



Pocket park contains		
5. Open pavement	*10. Adopted planter*	*18. Nature-inclusive amenity*

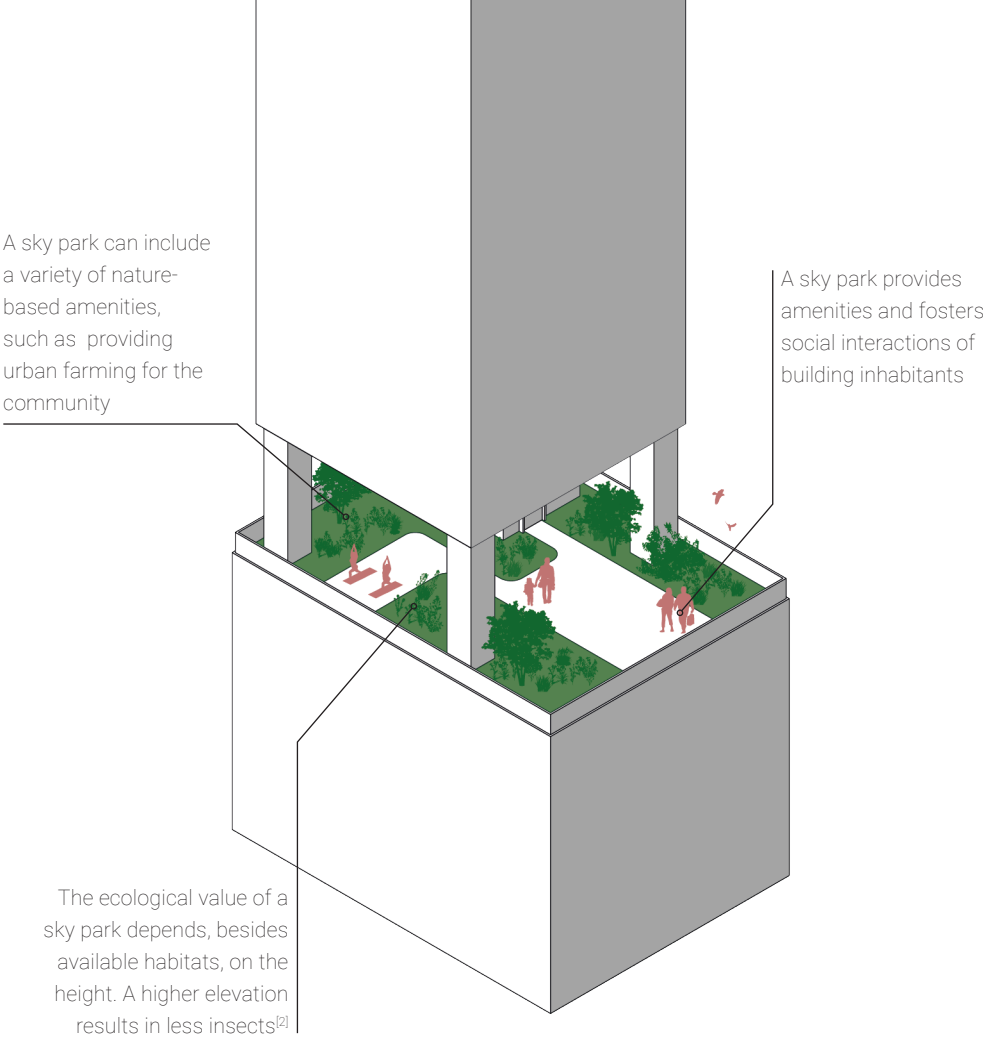
Pocket park is embedded in	
21. Green street	*26. Waterfront park*

References and further reading:

[1]. Andersson, E., Barthel, S., Borgström, S., Colding, J., Elmqvist, T., Folke, C., & Gren, Å. (2014). Reconnecting cities to the biosphere: stewardship of green infrastructure and urban ecosystem services. Ambio, 43(4), 445-453.

20. Sky park

In dense urban areas with little open spaces at the ground, rooftop space can relieve the pressure on the public space at the ground level. A sky park is the private development of a recreational park on top of a building. Sky parks do not only offer recreation space for people, but can also provide habitats for other species[1]. At higher elevations, the connection of rooftops with the public space on the ground gets lost. In such cases a sky park is a suitable development option to provide communal outdoor space for residents in the same building.



Sky park contains

10. Adopted planter *15. Rooftop habitat* *18. Nature-inclusive amenity*

Sky park is embedded in

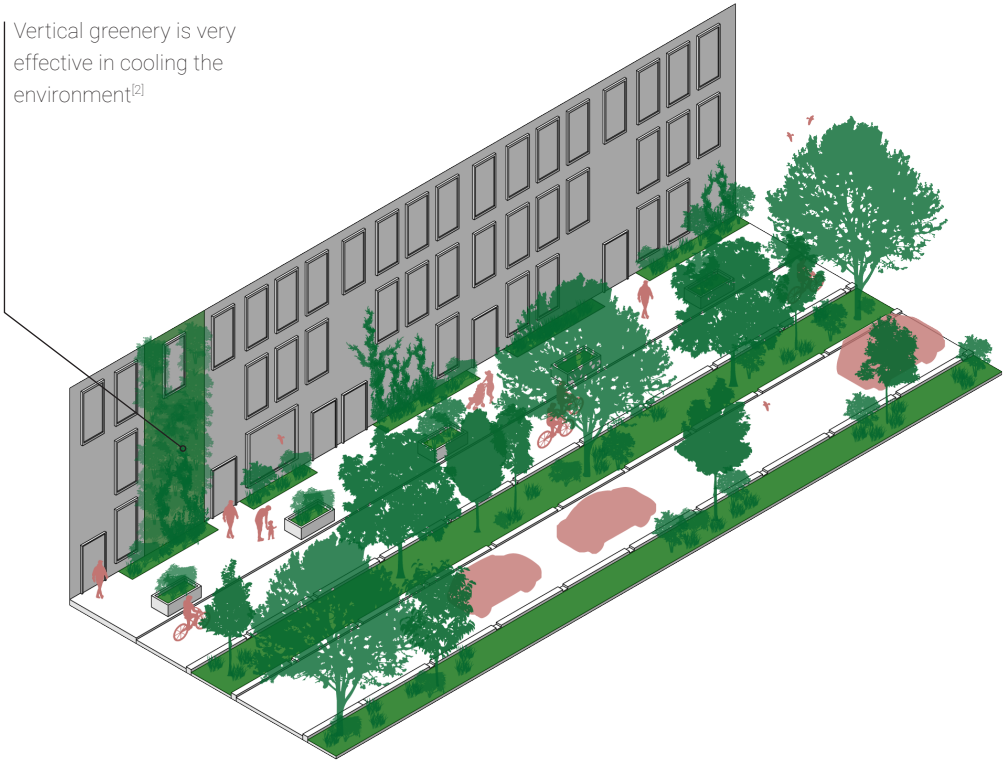
25. Porous high-rise

References and further reading:

[1]. Beatley, T. (2017). Handbook of biophilic city planning & design. Island Press.
[2]. Mills, W. P., & Rott, A. (2020). Vertical life: impact of roof height on beetle diversity and abundance on wildflower green roofs. Journal of Urban Ecology, 6(1), juaa017.

21. Green street

Of all urban elements, streets are among the ones that have the most interaction with people. Today many streets prioritize car traffic over pedestrian traffic. More greenery in streets increases thermal comfort, encourages walkability and brings green space right to people's doorstep[1,2]. In narrow streets the patterns of vertical greenery and facade garden can be used to introduce green space. In wider streets, adopted planters, pockets parks and urban trees can be used. Depaving streets and removing parking spaces has the additional benefit that storm water runoff can infiltrate into the soil and recharge the water table. These measures result in streets that not only are much more inviting to people, but also serve as corridors for wildlife.



Green street contains

5. Open pavement *8. Vertical greenery* *13. Facade garden*
16. Eco-facade *12. Comfortable outdoor space*

Green street is embedded in

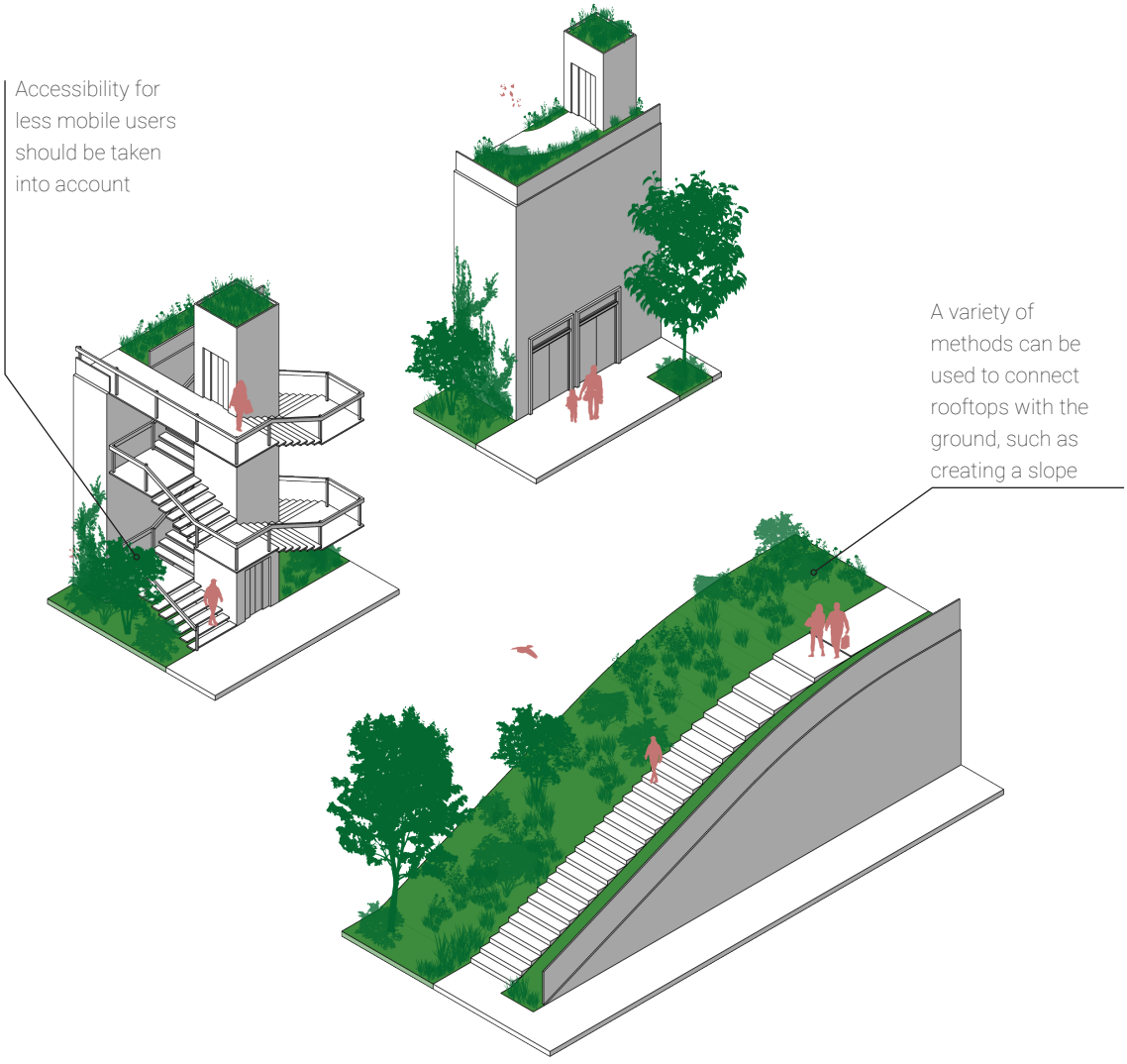
29. Multi-level pedestrian network *31. Wildlife corridor*

References and further reading:

[1]. Gemeente Rotterdam (2020) Rotterdam Loopt 2025.
[2]. Alexandri, E. and Jones, P. (2008) 'Temperature decreases in an urban canyon due to green walls and green roofs in diverse climates', Building and Environment. Pergamon, 43(4), pp. 480–493. doi: 10.1016/j.buildenv.2006.10.055.

22. Accessible rooftop

The activation of rooftops and transformation of rooftops into spaces for people and habitats for wildlife creates new elevated green spaces. These green spaces will become much more valuable for the city when they are easily accessible and when they are connected to the public space at the ground level[1]. A variety of methods can be used to increase the accessibility of a rooftop, such as creating outdoor or indoor stairs or altering the form of a building[2]. Sloping a building down towards the public space ensures a good connection between different elevations and increases the accessibility for humans and other species.



Accessible rooftop contains

12. Comfortable outdoor space

15. Rooftop habitat

Accessible rooftop is embedded in

27. Connected rooftop

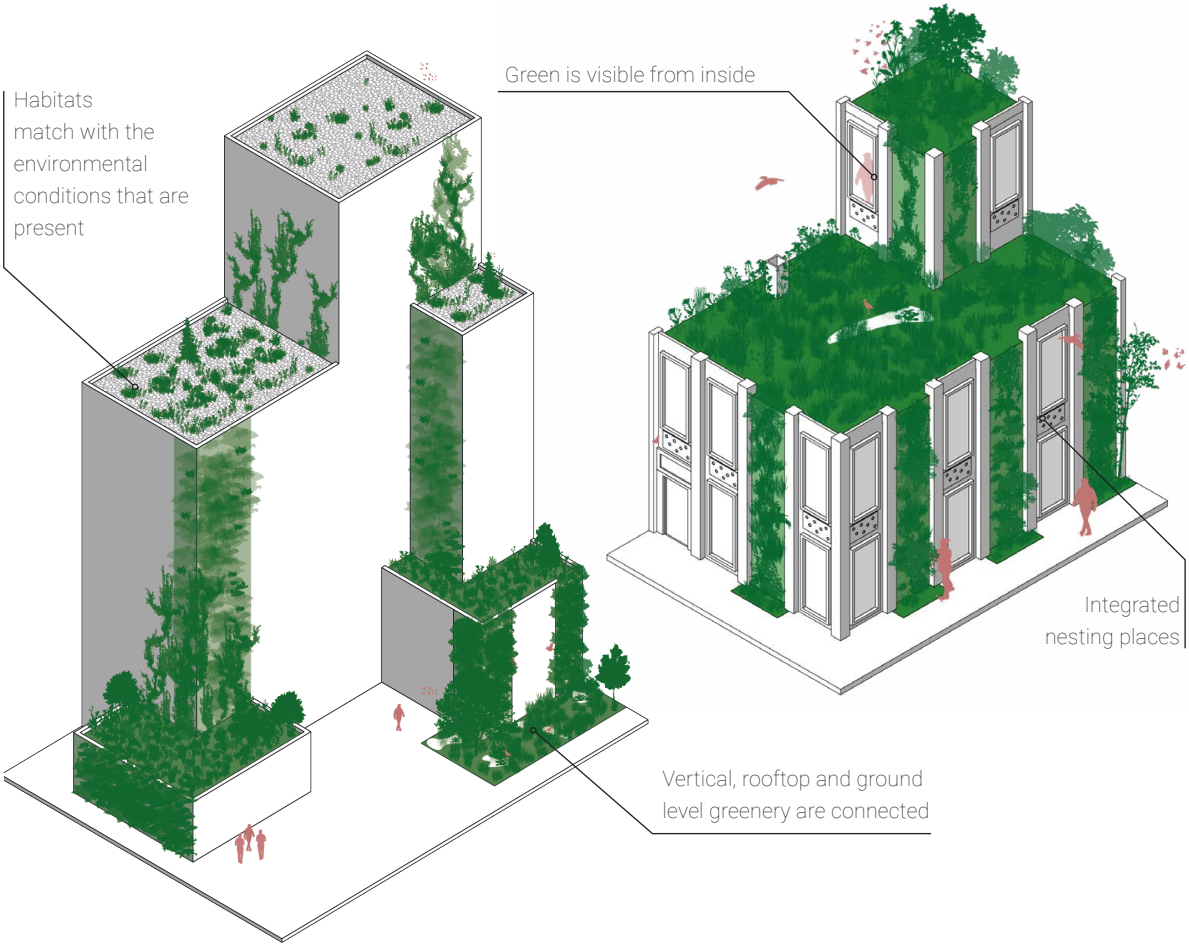
References and further reading:

[1]. Mesimäki, M., Hauru, K. and Lehvävirta, S. (2019) 'Do small green roofs have the possibility to offer recreational and experiential benefits in a dense urban area? A case study in Helsinki, Finland', Urban Forestry and Urban Greening. Elsevier GmbH, 40, pp. 114–124. doi: 10.1016/j.ufug.2018.10.005.

[2]. Willemsen, E., & Tillie, N. (2018). Reconnecting green: Towards a multi-dimensional biophilic city. In Proceedings IIFLA conference (pp. 1130-1138).

23. Living building envelope

Buildings in our cities provide shelter to humans, but form obstacles for species other than humans. Greenification of the building envelope does not only provide shelter and food for wildlife, but also increases indoor thermal comfort for people. Habitats on a building should be linked to environmental conditions and do no have to be uniform for the whole envelope, just as a natural mountain consists of different habitats depending on abiotic conditions like elevation and shade. Green façades and rooftops can be connected to form large habitats that attract a greater amount of biodiversity[1].



Living building envelope contains

13. Facade garden *16. Eco-facade* *15. Rooftop habitat* *17. Bioreceptive design*

Living building envelope is embedded in

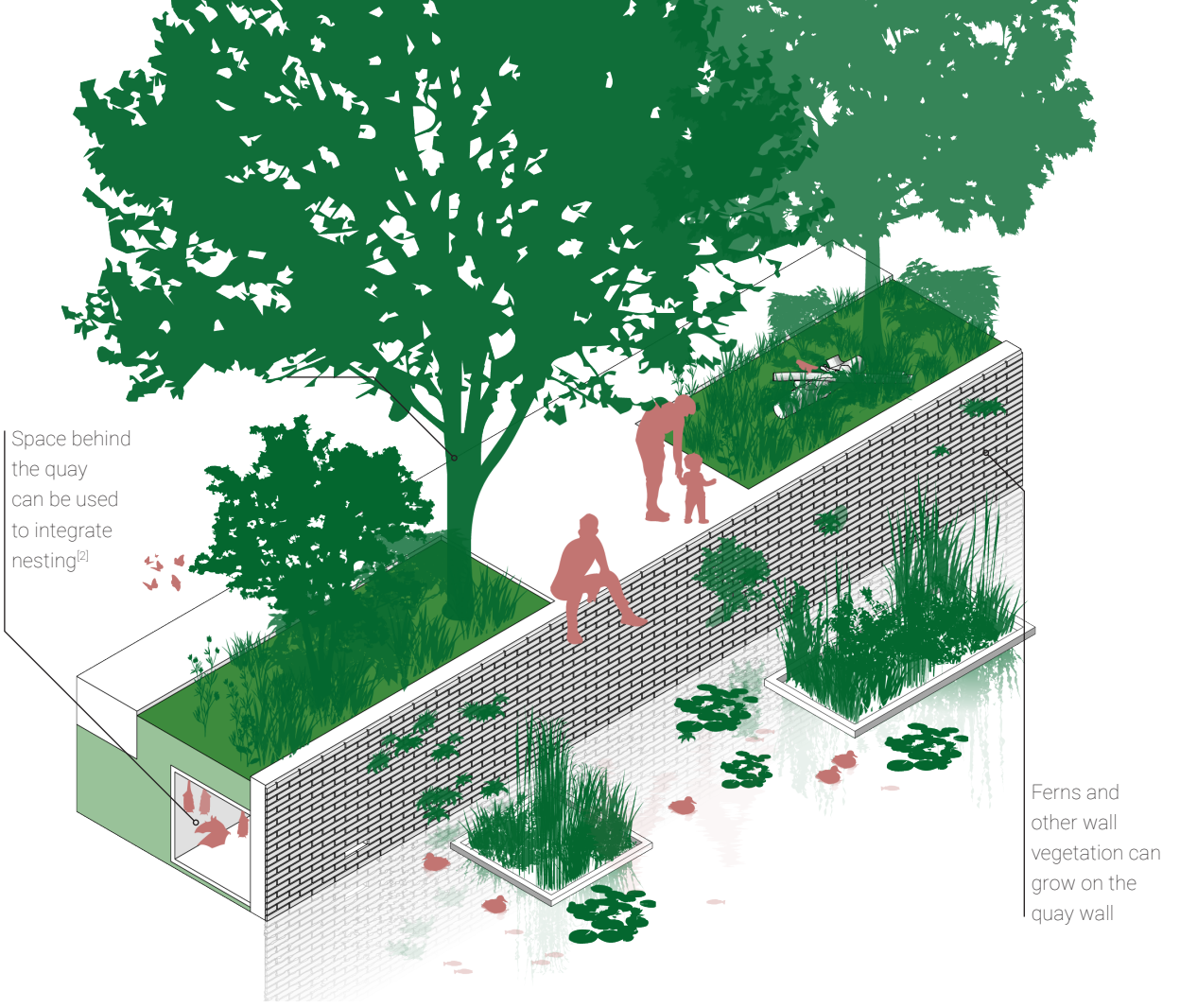
25. Porous high-rise

References and further reading:

[1]. Williams, N. S. G., Lundholm, J. and Scott Macivor, J. (2014) 'Do green roofs help urban biodiversity conservation?', Journal of Applied Ecology. Edited by R. Fuller. Blackwell Publishing Ltd, 51(6), pp. 1643–1649. doi: 10.1111/1365-2664.12333.

24. Green canal

The stony waterways in cities only result in a fraction of the potential biodiversity that naturally occurs at the border between water and land. However, space constrains may limit the realisation of gradient banks. The pattern of the green canal can be used to create a pleasant and ecologically valuable environment[1]. Greenification of a canal is often a combination of providing the right opportunities for plant growth and limiting human intervention. If the quay wall is made out of bioreceptive material, plants can colonise the surface. Nesting bricks for birds can be included in the canal wall too, such as a bat room[2].



Green canal contains		
8. Vertical greenery	*9. Floatland*	*12. Comfortable outdoor space*

Green canal is embedded in	
26. Waterfront park	*31. Wildlife corridor*

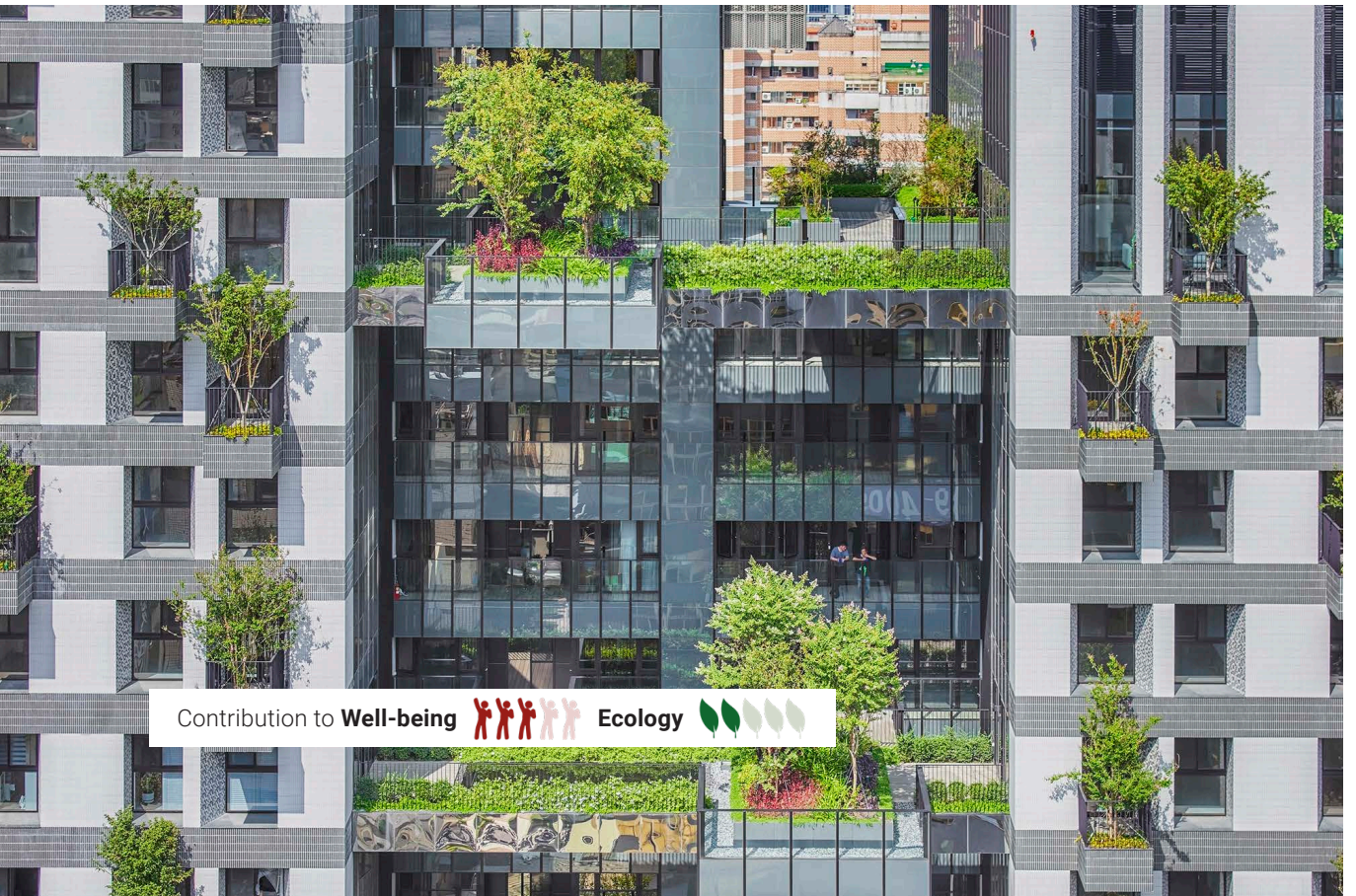
References and further reading:

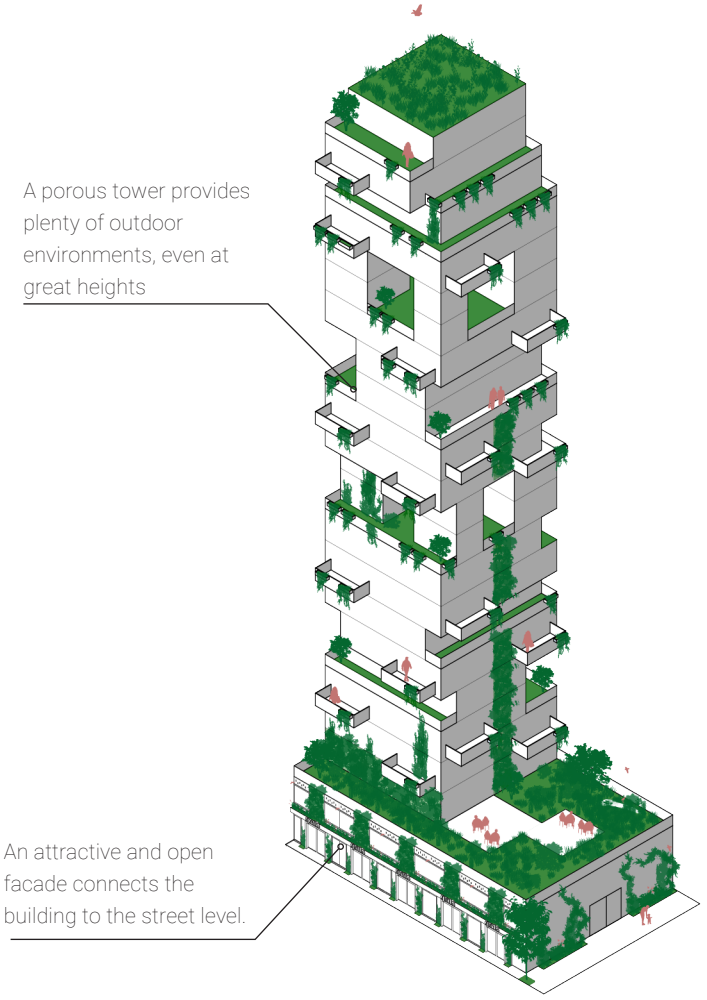
[1]. Green Quays (n.d.) Green Quays. Retrieved April 6th, 2021, from https://www.greenquays.nl/

[2]. Checklist groen bouwen. (n.d.). Vleermuisruimte achter kademuur. Retrieved March 31, 2021, from https://www.checklistgroenbouwen.nl/maatregelen/maatr-details/vleermuisruimte-achter-kademuur

25. Porous high-rise

The large and anonymous apartment towers of today are more constraining people's interaction with the outdoors than fostering it. A porous high-rise is a high-rise building designed to foster human-nature interaction. Living so close to natural features increases well-being[1]. This can be done by promoting outdoor activities and making faculties such as sky-parks, balconies and green corridors an integral part of the building's design. These measures also increase the biodiversity within and around an otherwise habitat-obstructing tower.





Porous high-rise contains

11. Balcony garden *14. Garden corridor* *20. Sky park*
23. Living building envelope

Porous high-rise is embedded in

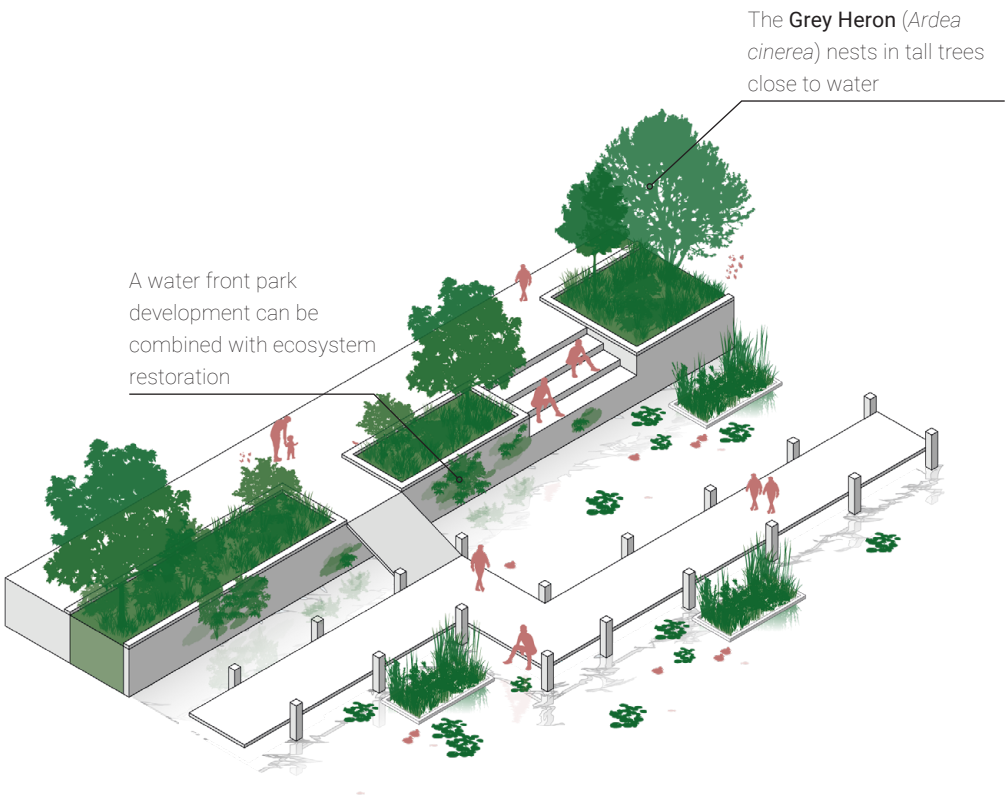
30. Topographic building block

References and further reading:

[1]. Beatley, T. (2017). Handbook of biophilic city planning & design. Island Press.

26. Waterfront park

In many cities people do have access to a park within 300 metres, which is recommended by the WHO[1]. As parks take up valuable space in the urban environment, the realisation is not always possible. Making use of under-used spaces, such a space on water in a waterfront park allows recreation to be combined with aquatic ecosystem restoration and will improve the spatial quality in the city for people and nature. The size of the waterfront park may range from tidal river parks that span large areas to activated waterfronts that provide a place to recharge for local citizens.



Waterfront park contains	
19. Pocket park	*24. Green canal*

Waterfront is embedded in	
32. Biodiverse neighbourhood	*33. Nature network*

References and further reading:

[1]. Annerstedt van den Bosch, M., Mudu, P., Uscila, V., Barrdahl, M., Kulinkina, A., Staatsen, B., ... & Egorov, A. I. (2016). Development of an urban green space indicator and the public health rationale. Scandinavian journal of public health, 44(2), 159-167.

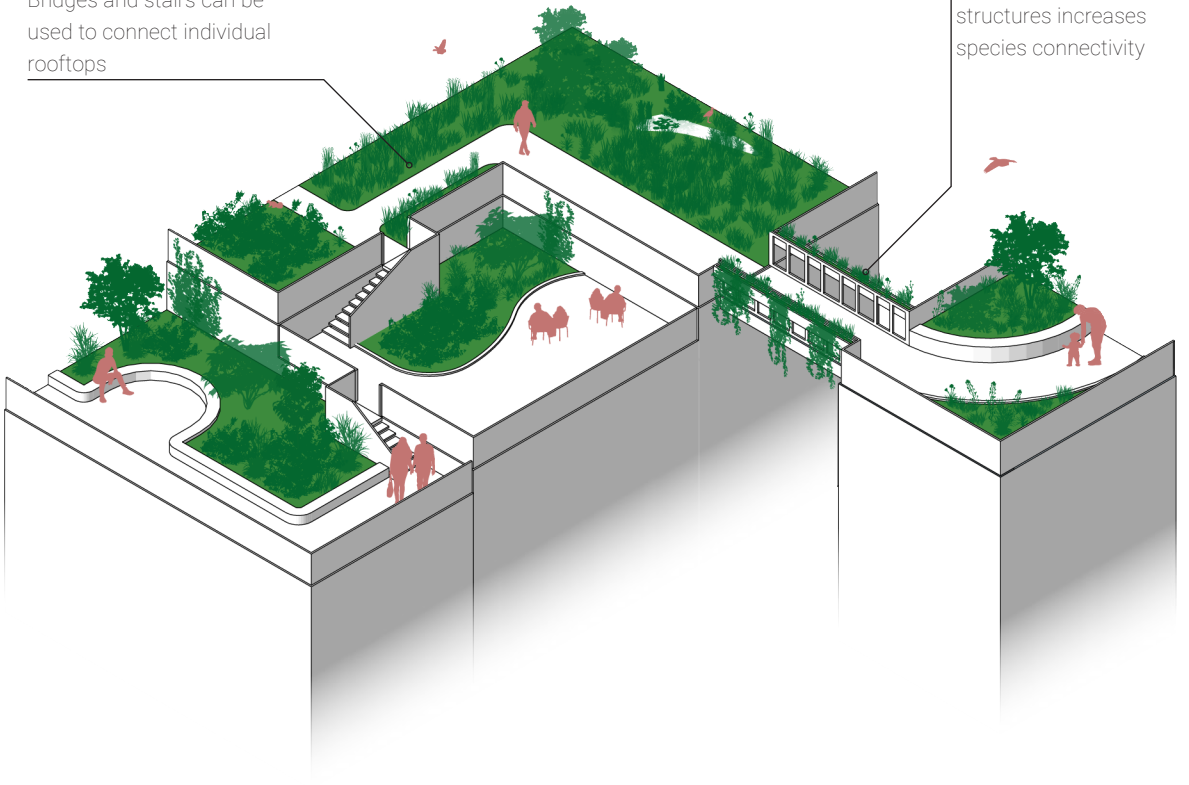
27. Connected rooftop

Activating the rooftops is a good start to create a multilevel green structure. Connecting multiple rooftops of neighbouring buildings will further contribute to the creation of a second ground level. Additionally, rooftop habitats that are connected provide more value for biodiversity and are also likely to be more easily accessible to humans. Connecting rooftops can provide additional pedestrian routes in a city, and provide a new experience and view for the inhabitants. Ultimately this pattern can contribute to a better walkability and connectivity when it is embedded in the pattern of *29. Multi-level pedestrian network.*

The **European goldfinch** (*Carduelis carduelis*) prefers rooftops with young trees and specific plants such as the **dandelion** (*Taraxacum officinale*)[1]

Bridges and stairs can be used to connect individual rooftops

Connecting the green structures increases species connectivity



Connected rooftop contains

22. Accessible rooftop

Connected rooftop is embedded in

28. Rooftop landscape

29. Multi-level pedestrian network

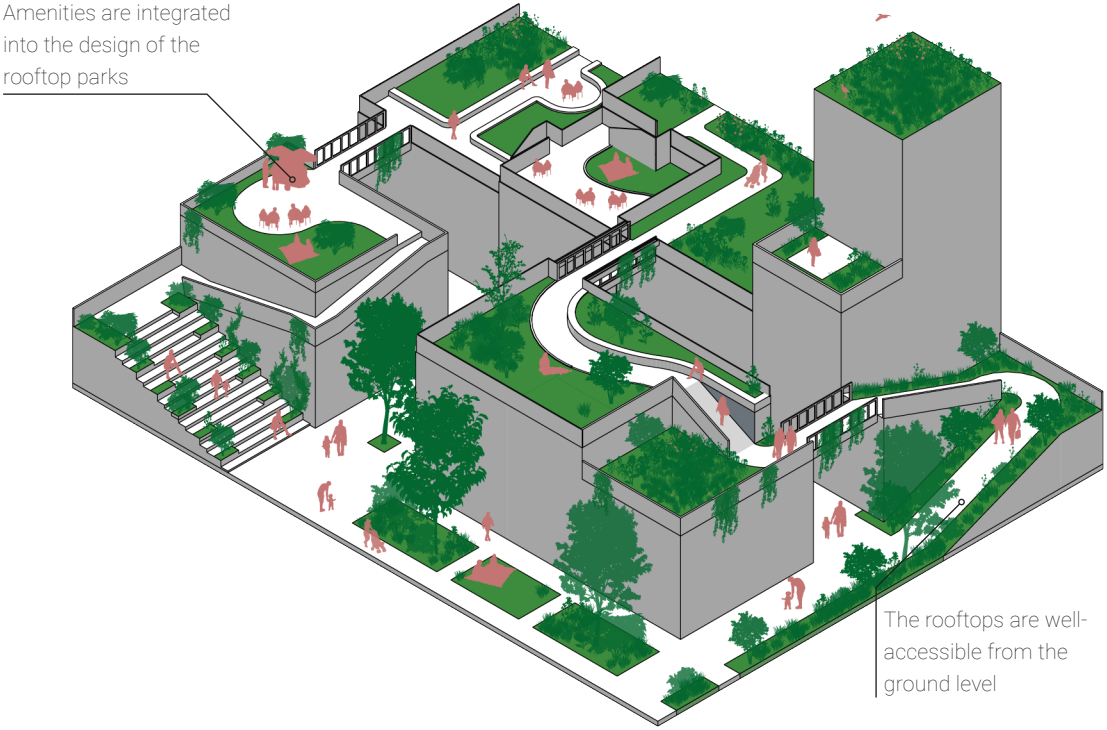
References and further reading:

[1]. Kooijmans, J. L. (2009). Stadsvogels. Tirion Natuur, Baarn.

28. Rooftop landscape

Connected and accessible rooftops become much more valuable when they are programmed with amenities and offer opportunities for recreation. This results in a rooftop landscape that offers additional quality to the city while not taking up valuable space at the ground level[1]. The rooftop landscape pattern is all about programming the space on top of the roofs as an additional to public space on the ground level. Ideally combined with the pattern of *18. Nature-inclusive amenity,* rooftop space in cities can be activated for people and nature. As the carrying capacity of a rooftop has be generally high, this pattern is most suitable for newly constructed buildings.

Contribution to **Well-being** **Ecology**



Rooftop landscape contains

18. Nature-inclusive amenity

27. Connected rooftop

Rooftop landscape is embedded in

30. Topographic building block

References and further reading:

[1]. Gemeente Rotterdam (2019) Programmaplan Multifunctionele Daken 2019-2022. Retrieved from: https://rotterdam.notubiz.nl/document/7994933/1/s19bb019909_3_58561_tds

29. Multi-level pedestrian network

Large infrastructure can obstruct pedestrian routes and degrade the spatial quality. It also poses a barrier for species movement. For these specific cases, a multi-level pedestrian network could provide the additional connectivity required to enhance walkability. This network is not a replacement of the ground level network but enhances it where needed. It may connect public transportation on the ground with the elevated rooftop parks. Since an elevated network requires a large investments, this pattern is especially suitable for redevelopment projects where the elevated infrastructure is already present, such as abandoned railway lines or former high-way passages.

Multi-level pedestrian network contains

21. Green street

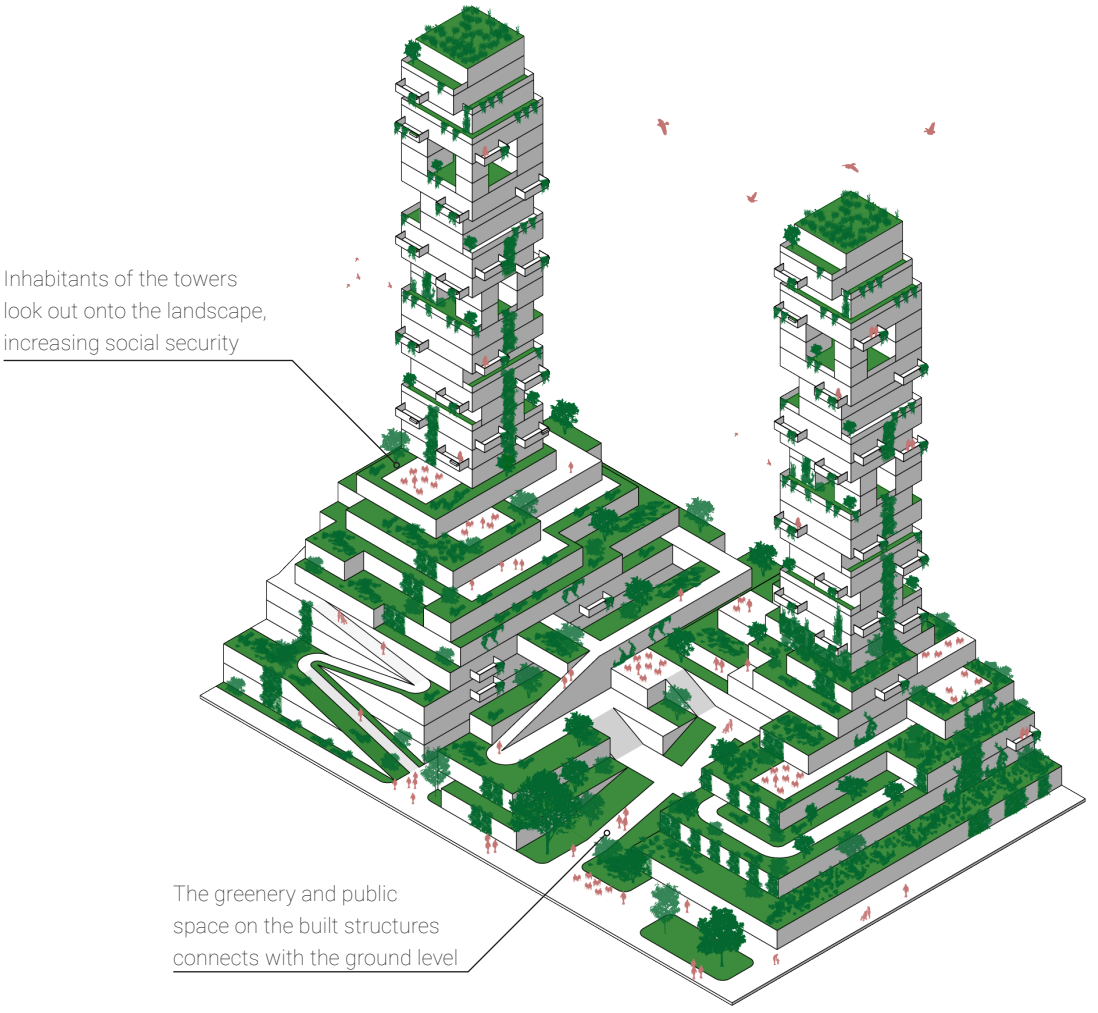
27. Connected rooftop

Multi-level pedestrian network is embedded in

32. Biodiverse neighbourhood

30. Topographic building block

In the past centuries, the shape of a house has changed little, even though our understanding of well-being and the environment has improved greatly. The need for greenery close to people and in cities can be realised with topographic building blocks. In a topographic building block, urban structures are used to recreate natural landscapes, such as mountains and valleys[1]. The added benefit of adding the pattern of *25. Porous high-rise* on top of *28. Rooftop landscape* is that the residents of the tower can gaze on the landscape below. This does not only improve the view, but also increases social security. The lowest levels of the topographic building block can be made publicly accessible, while the higher levels could serve as private and communal gardens for the residents. The pattern is best used for new buildings as it relies heavily on the architectural form and is therefore hard to retrofit on existing buildings.



Topographic building block contains

28. Rooftop landscape

25. Porous high-rise

Topographic building block is embedded in

31. Wildlife corridor

32. Biodiverse neighbourhood

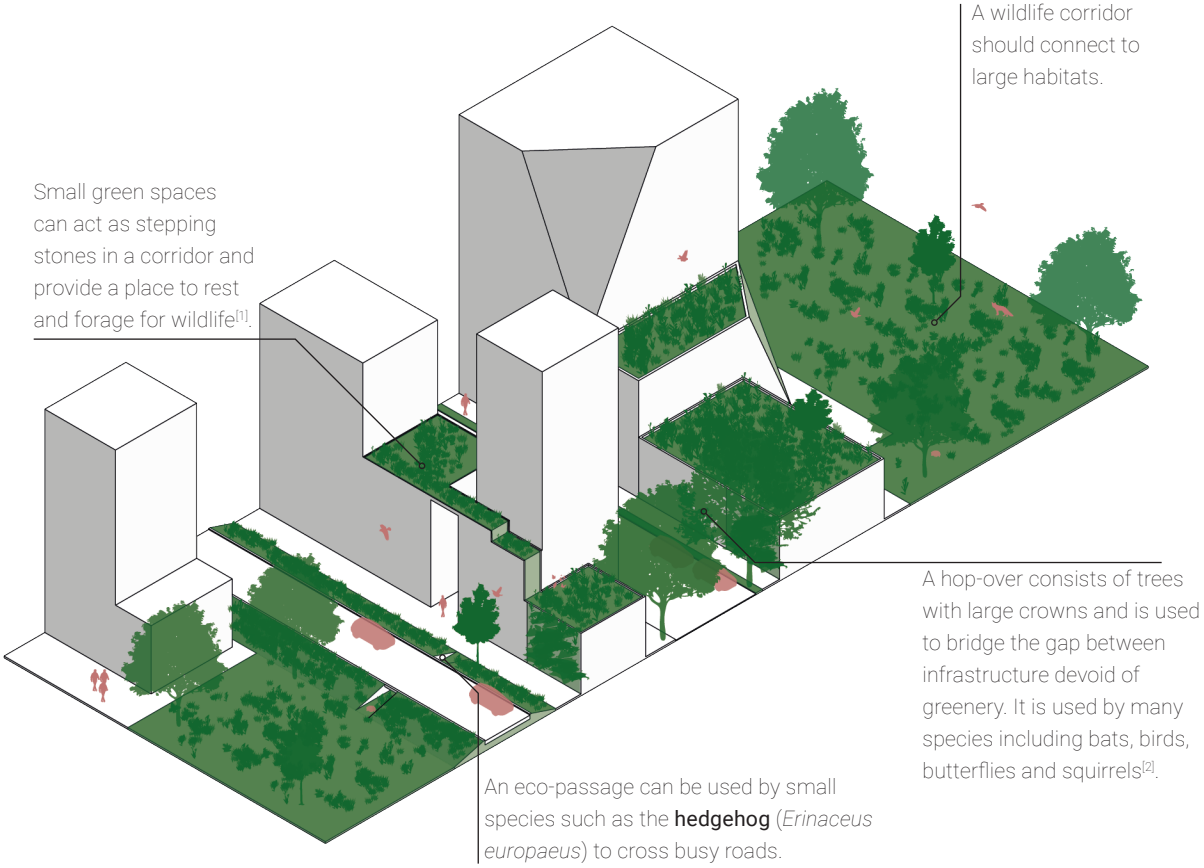
References and further reading:

[1]. Wong, M. S., Hassell, R., & Yeo, A. (2016). Garden city, megacity: rethinking cities for the age of global warming. CTBUH Journal, (4), 46-51.

31. Wildlife corridor

Ecological zones that are high in biodiversity become more resilient to disturbances when species of the zone can interact with species in other zones. A wildlife corridor facilitates movement between ecological zones and connects large and small habitats with each other. A variety of measures can be used to improve connectivity between habitats, such as hop-overs and eco-passage. A wildlife corridor also consists of patterns that improve the quality of green for people, such as *21. Green street* and *24. Green canal*. A corridor is the most effective when the vegetation structure and species composition used throughout the corridor resembles that of the natural habitats that the corridor leads to. Besides vegetation, corridors may also be formed by water ways, unpaved or open soil structures and dark areas devoid of light pollution.

Contribution to **Well-being** **Ecology**



Wildlife corridor contains

21. Green street *24. Green canal* *30. Topographic building block*

Wildlife corridor is embedded in

33. Nature network

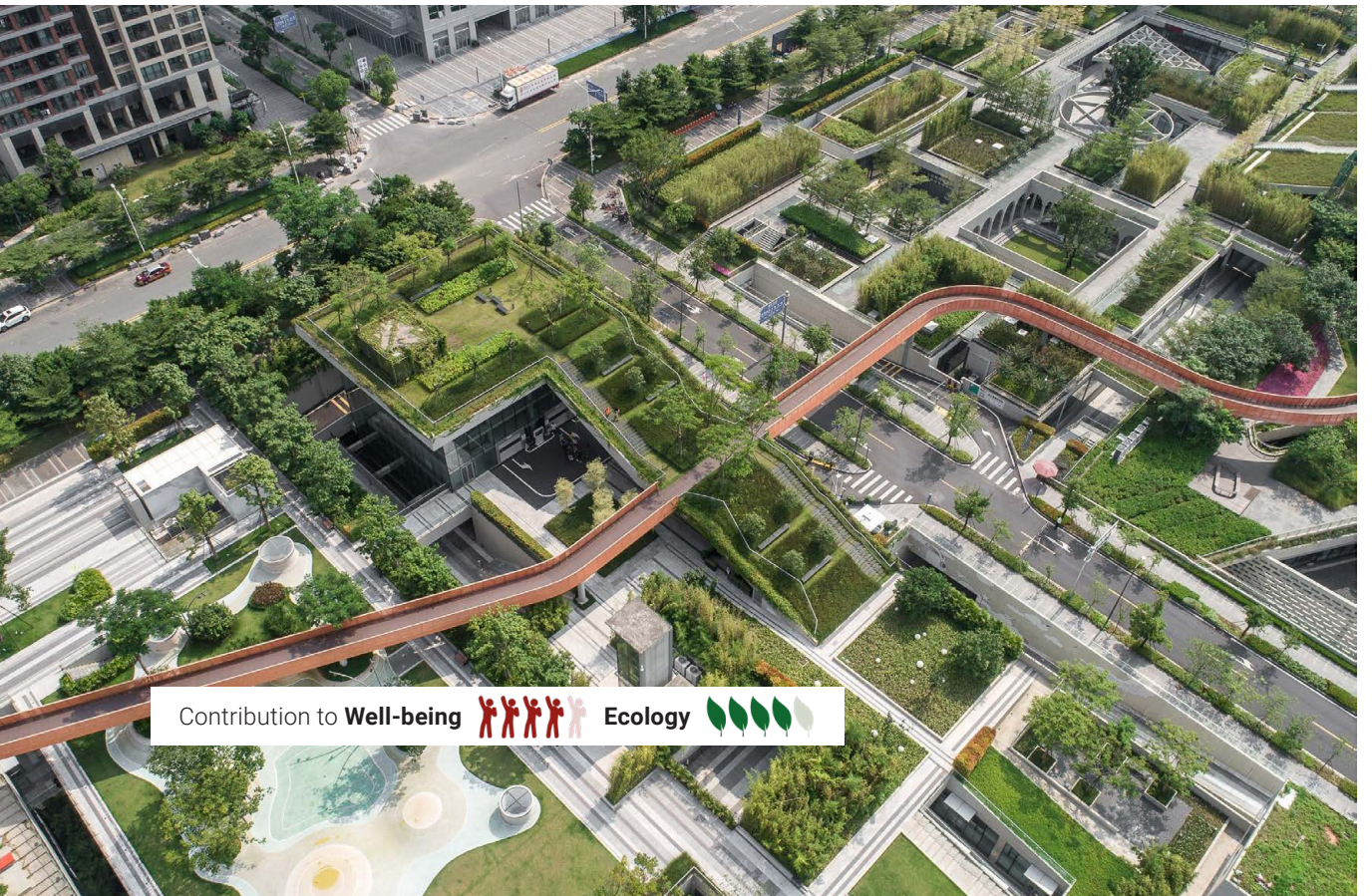
References and further reading:

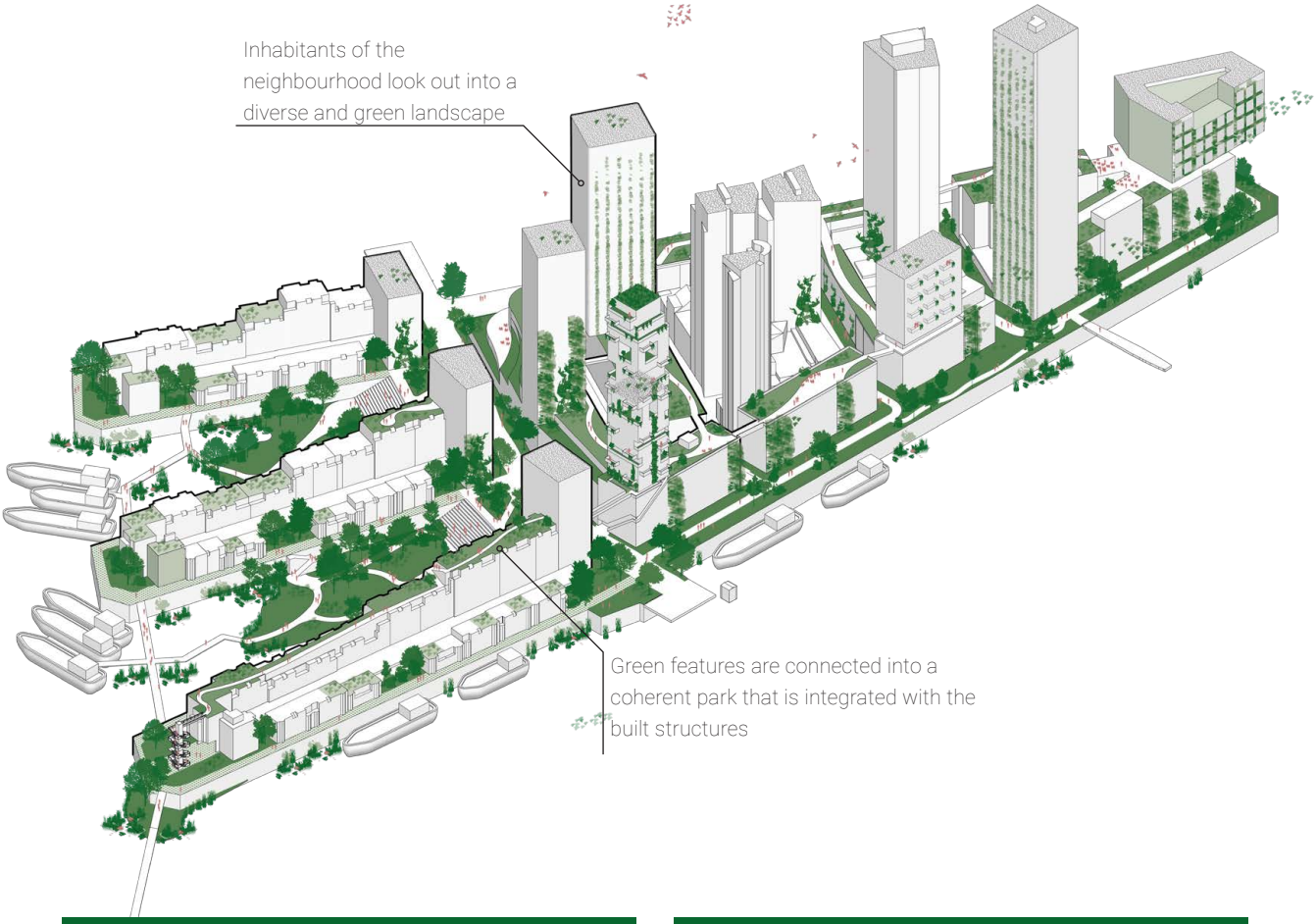
[1]. Dramstad, W., Olson, J. D., & Forman, R. T. (1996). Landscape ecology principles in landscape architecture and land-use planning. Island press.

[2]. Vlaamse Overheid (n.d.) Ontsnippering. Retrieved from: https://wegenenverkeer.be/natuur-en-milieu/ontsnippering

32. Biodiverse neighbourhood

While large parks can provide a human-nature interaction, they are often located at a distance from people's homes. A biodiverse neighbourhood is a neighbourhood that celebrates nature and provides an immersive urban nature experience for its inhabitants[1,2]. It is a neighbourhood designed as a park or natural reserve that also provides housing for people. Inhabitants of a biodiverse neighbourhood enjoy rich nature experiences. They can explore, play, and learn in the outdoor environment.





Biodiverse neighbourhood contains

26. Waterfront park *29. Multi-level pedestrian network* *30. Topographic building block*

Biodiverse neighbourhood is embedded in

33. Nature network *34. Compact ecocity*

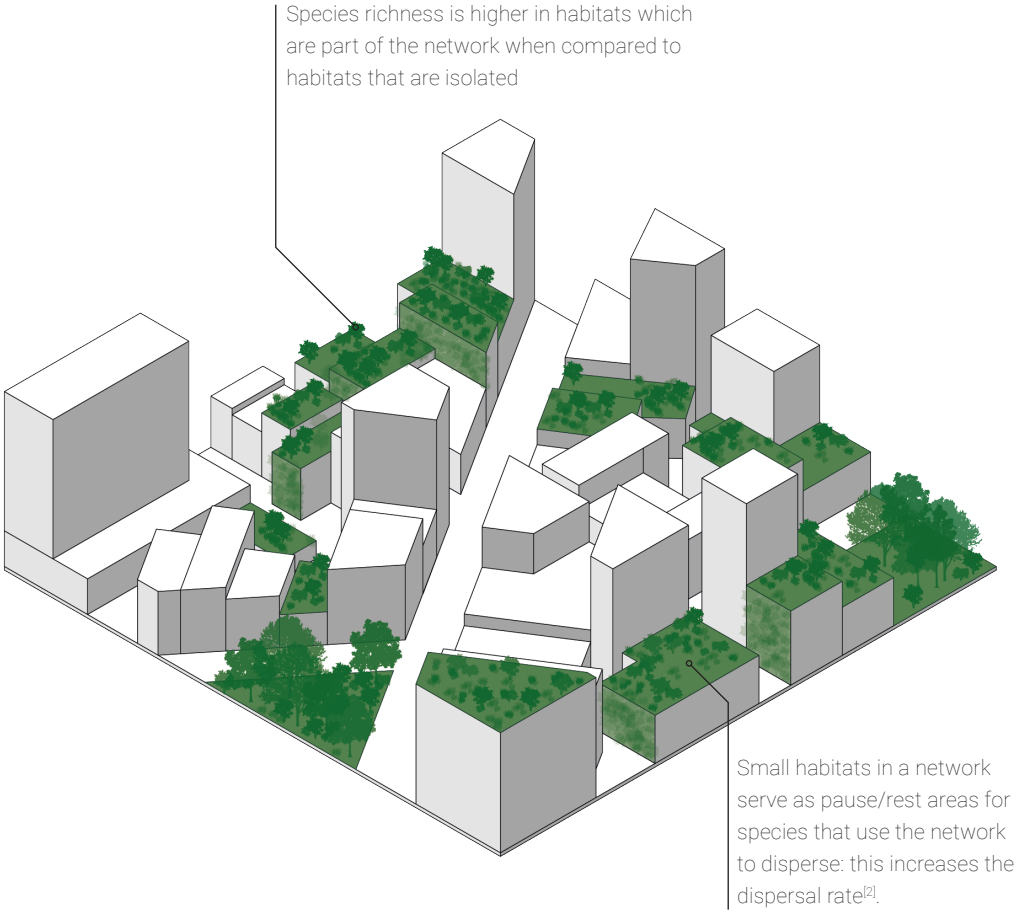
References and further reading:

[1]. NATIONAL PARK CITY FOUNDATION (n.d.) Let's make more cities National Park Cities. Retrieved from: https://www.nationalparkcity.org/

[2]. Beatley, T. (2017). Handbook of biophilic city planning & design. Island Press.

33. Nature network

A single wildlife corridor can be vulnerable to disruptions, just as an isolated habitat. Combining multiple habitats and corridors into a network will create a much more resilient natural system[1]. A nature network consists of multiple wildlife corridors that provide connectivity between small habitats and large biodiversity zones. Small habitats in a network serve as rest areas for dispersing species. A nature network becomes more resilient when loops or alternate routes are present. These reduce the negative effect of gaps and disturbances and increase the efficiency of species movement. Furthermore, at locations where multipe wildlife corridors intersect, biodiversity is likely to be higher[2].



Nature network contains

26. Waterfront park *31. Wildlife corridor* *32. Biodiverse neighbourhood*

Nature network is embedded in

34. Compact ecocity

References and further reading:

[1]. Jim, C. Y. (2004) 'Green-space preservation and allocation for sustainable greening of compact cities', Cities. Elsevier Ltd, 21(4), pp. 311–320. doi: 10.1016/j.cities.2004.04.004.

[2]. Dramstad, W., Olson, J. D., & Forman, R. T. (1996). Landscape ecology principles in landscape architecture and land-use planning. Island press.

34. Compact ecocity

Most current urban environments degrade environmental quality and are associated with numerous health and other well-being concerns[1]. An ecocity on the other hand, is a city that nourishes healthy ecosystems and promotes positive interactions between people and nature. Green space in an ecocity is distributed equally and abundantly[2]. As opposed to spread out development, compact development fosters a more sustainable lifestyle and also has a smaller spatial footprint in the landscape[3]. An ecocity can take a variety of forms, depending on the context. The presented patterns of this atlas provide only the beginning of valuable green space types that should be combined and used together to create more green, sustainable and just cities.

Compact ecocity contains

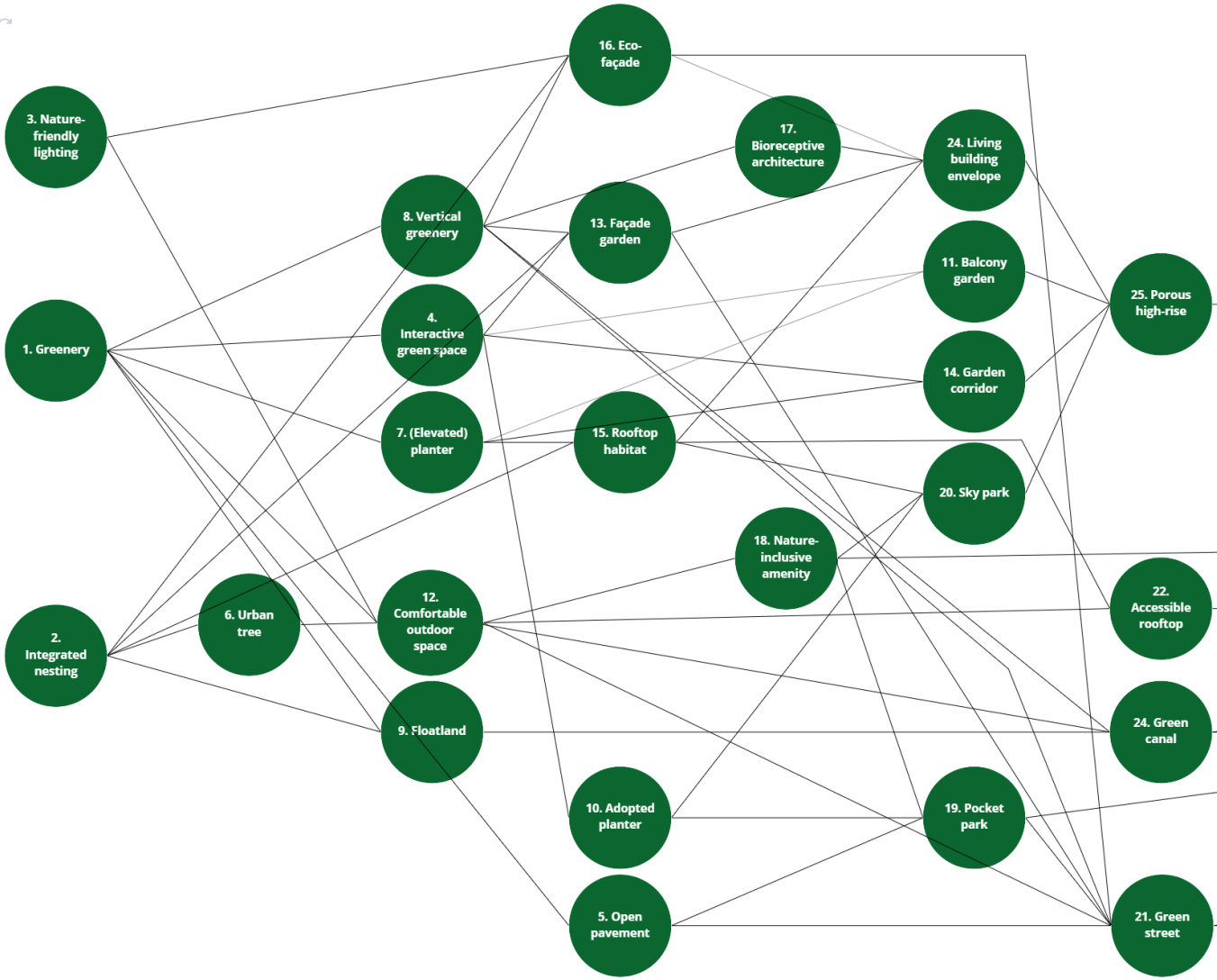
33. Nature network *34. Compact ecocity*

References and further reading:

[1]. McKinney, M. L. (2002) 'Urbanization, biodiversity, and conservation: The impacts of urbanization on native species are poorly studied, but educating a highly urbanized human population about these impacts can greatly improve species conservation in all ecosystems', BioScience. Narnia, 52(10), pp. 883–890. doi: 10.1641/0006-3568(2002)052[0883:ubac]2.0.co;2.

[2]. ECOCITY BUILDERS (n.d.) What is an Ecocity?. Retrieved from: https://ecocitybuilders.org/what-is-an-ecocity/

[3]. Jenks, M., Burton, E. and Williams, K. (1996) The Compact City: A Sustainable Urban Form?, The Compact City: Oxford: E & FN Spon. doi: 10.4324/9780203362372_compact_cities_and_sustainability:_an_introduction.


16. Eco-façade
3. Nature-friendly lighting
17. Bioreceptive architecture
24. Living building envelope
8. Vertical greenery
13. Façade garden
11. Balcony garden
25. Porous high-rise
1. Greenery
4. Interactive green space
14. Garden corridor
7. (Elevated) planter
15. Rooftop habitat
20. Sky park
18. Nature-inclusive amenity
22. Accessible rooftop
6. Urban tree
12. Comfortable outdoor space
2. Integrated nesting
9. Floatland
24. Green canal
10. Adopted planter
19. Pocket park
5. Open pavement
21. Green street

Small scale

Pattern network

The relations between different patterns is visualised below. This pattern network shows how small patterns can be combined into larger patterns and how larger patterns can be dissected into smaller patterns.

List of figures

Unlisted figures courtesy of the author

This atlas is part of the 'Compact nature in compact cities' graduation project by Menno de Roode. Supervision by Dr. Ir. N.M.J.D. (Nico) Tillie, Dr. Ir. R.M. (Remon) Rooij, and Dr.Ir. M. (Marc) Ottele.

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