

District-scale Green Area Factor 2025

Making the Value of
Green Structure Visible

ARVO Project's Final Publication



District-scale Green Area Factor:
Supporting More Sustainable Urban Planning

Publisher

VALUE – Valuation and strengthening of urban green spaces in landscape planning in cities (“ARVO – Viherrakenteen arviointi ja vahvistaminen kaupunkien maankäytön suunnittelussa” in Finnish) was (10/2023-12/2025) a project to strengthen urban green structures and identify the values they produce in densely built urban areas to promote adaptation. The project was coordinated by the City of Helsinki. The partners in this project were Aalto University, the City of Espoo, the City of Vantaa, and the Green Building Council Finland.

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Summary

This publication presents the district-scale Green Area Factor 2025 (hereafter, GAFD) developed in the *VALUE – Valuation and strengthening of urban green spaces in landscape planning in cities project (ARVO – Viherrakenteen arviointi ja vahvistaminen kaupunkien maankäytön suunnittelussa in Finnish, later referred as ARVO)*. GAFD is a GIS-based tool developed to improve biodiversity and climate change adaptation in urban areas. The publication provides guidance on adopting the GAFD and applying its calculation method. The aim is to promote high-quality planning and maintenance of urban greenery, improve urban sustainability under future climate conditions, support climate change adaptation, and promote both biodiversity and residents’ well-being.

See also other ARVO project’s outputs in English:

- [Finnish anthropogenic habitat types and assessment of their ecological condition](#)
- [More than the sum of its parts – Integrating the use of green area factor tool and biodiversity offsetting for no net loss urban planning](#) (Lähde et al. 2025)

All up-to-date materials related to the ARVO project are available at figbc.fi/arvo



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Introduction

The importance of greenery in urban areas is emphasised as part of climate change adaptation and the safeguarding of biodiversity under changing conditions. Alongside efforts to strengthen green structure, urban space is also subject to competing demands, including floor-area targets, traffic volumes and technical infrastructure. These objectives are often justified numerically, while urban greenery is easily overlooked.

The District-scale Green Area Factor 2025 (here after, GAFD) responds to this challenge by making urban green structure visible as a numerical value within the planning process. The method enables planners to communicate urban-ecological goals — and the impacts of land-use solutions on those goals — to other experts, city management and political decision-makers. With the help of the GAFD, the effects of green structure become part of the technical dimensioning of land-use planning, alongside traffic-volume estimates and floor-area targets.

This publication provides guidance on how to use the GAFD method developed in the ARVO project as part of urban land-use planning. The publication consists of two sections. The first explains what the GAFD is and what role it can play in planning more sustainable cities. It is intended for anyone interested in the topic and explains the background to the values calculated with the method, as well as how the results can be used in land-use planning. The second section presents the logic behind the calculation of the GAFD and its three values. It is intended for readers who want a deeper practical understanding of how the GAFD is calculated.



Photo: Tuuli Kassi

Urban green structures consist of all public and private vegetated areas, for example, parks, the vegetation alongside streets and in yard areas, as well as vegetated roofs regardless of land ownership. Aquatic areas are also included as part of the green structure and form, also known as the blue-green infrastructure.

Urban blue and green spaces produce several simultaneous benefits: an ability to withstand heavy rains and heat waves, the residents' physical, mental, and social well-being, and the prevention of biodiversity loss. The versatility of green structure ensures that these benefits are realized even if some part of the green structure is impaired.

Strengthening urban green structure is essential

The versatility of green structures is key to adaptability. According to the IPCC (2022), Finland is among the regions where warming is occurring rapidly. Heatwaves will last longer; winter rainfall will increase and more often fall as rain rather than snow. Stormwater flooding in urban areas will become more frequent, and rising sea levels will increase flooding in coastal areas (Hakala, 2021).

Climate change increases risks to human health and well-being, property and infrastructure, with densely built cities being particularly vulnerable. Growing cities often respond to housing demand by building more compactly. This increases the extent of impervious surfaces and heat-retaining buildings, often reducing urban greenery.

Diverse green structures play a key role in preparing for the impacts of climate change. They retain and evaporate water, store and sequester carbon, and reduce temperatures during heat waves (Francini et al., 2018; Elmqvist et al., 2015). At the same time, abundant and sufficient urban greenery helps safeguard biodiversity. Green structure therefore serves as a multi-benefit solution for managing risks over the long term.

Finland is well positioned to make greater use of adaptation-supporting green structure and the nature-based solutions it includes, for example in land-use planning, stormwater management and urban development (Finnish Ministry of Agriculture and Forestry (ed.), 2023). The importance of urban green structure in supporting biodiversity and climate change adaptation is recognised. At the same time, the amount of urban greenery is decreasing and becoming fragmented as urban structures become denser (Lahtinen, 2024), which highlights the importance of the quality of green structure. Green structure can be strengthened by reserving enough space for parks, green corridors and other green structure, while also improving the quality of existing and planned green structure. Strengthening green structure is not merely an aesthetic choice, but a necessary means of adapting to climate change and securing the viability of cities.

Background and evolution of the GAFD method

The Green Area Factor originated as a plot-level tool developed in Berlin in the late 1980s (Keeley, 2011). Variants of the plot-level green factor are now used in many countries and cities, with local adaptations preventing full standardisation. In 2017, Stockholm also developed a green factor for public areas, "grönytefaktor för allmän platsmark" in Swedish (Alueellinen viherkerroin 2.0, C/O City project, 2019-2020). Unlike the plot-level tool, the district-scale approach focuses on ecosystem services produced by larger urban areas and their role in climate change adaptation (Table 1).

In Finland, a Stockholm-based district-scale method was first applied in 2019–2020 in the Virtuaalivihreä (Virtual Green) project in Kyläsaari, Helsinki. As part of the that project, *the district-scale Green Area Factor 2.0* publication, which provides guidance on the use of the tool, was translated from Swedish into Finnish. The pilot was considered successful, and the method was then used in the development of Malmi centre, Helsinki, in 2020 (Piirainen, 2021; Lähde et al., 2023). The approach was also tested in the City Garden area of Turku as part of the Canemure project (Rantola, 2021); in Matinkylä, Espoo, as part of the Lähiöpride project (Lähde et al., 2023a; Lähde et al., 2023b); in the centre of Jyväskylä (Väätänen, 2023); and in the Malmi airport area in Helsinki (Hannula, 2023). In addition, the current state of the district-scale method and the requirements for its digitalisation were examined in the B.Green project (Heinänen et al., 2021). The method has since been tested and developed further in several Finnish projects and consultancy assignments, demonstrating cities' interest in the district-scale Green Area Factor.

On the basis of these pilots, steps were taken to establish a national method and tool for land-use planning, leading to the ARVO project and the development of the GAFD. The new method responds to the need for a stronger knowledge base on the quality and quantity of green structure to support land-use planning. The stronger integration of biodiversity as part of the district-scale Green Area Fac-

tor was identified as a key development target. The general principle in the development work has been to consider urban areas, as a whole, as living ecosystems and not just merely built environments. In this view, nature and ecological processes are not "greening" added to the urban structure afterwards; instead, they are seen as the structural and functional basis of the urban structure.

Another key objective of the project was to identify numerical guideline values by applying the method systematically across different urban structures, from dense inner-city areas to near-natural areas undergoing land-use change.



Figure 2. Strengthening the green structure is essential for cities to be able to adapt to the changing climate. Work needs to be carried out at various levels, from policy-making to planning and implementation to maintenance. Illustration: ARVO project.

District-scale Green Area Factor 2025	Plot-specific Green Factor
A method for assessing an area's green efficiency, suitable for assessing both the current state and plans in blocks and public areas	Block areas' green efficiency assessment tool, calculation typically part of a construction permit, can also be applied in connection with local detailed planning
Analytical and descriptive; provides background information but does not set goals in itself. Helps to verify, for example, objectives set for local detailed planning, such as 'not reducing the biodiversity level'.	Obligatory, guiding, connected to implementation
Makes the area-level change in the quality of green spaces caused by a plan visible in a comparable way	Sets the minimum level for the green efficiency of individual plots
The quality of the green area is defined via the habitat types and their ecological condition	Green efficiency is defined by means of the green areas, elements, and their weighting score
Three values highlight the multiple benefits of green spaces: biodiversity, climate resilience, and well-being benefits	Provides a single numeric target value that can be achieved through different implementation methods
Aiming for a national model, tested in major cities and several medium-sized towns	Several differing versions of the tool used in cities. Additions to estimate e.g. biodiversity.

Table 1. Comparison of the District-scale Green Area Factor 2025 and the Plot-specific Green Factor.

The ARVO project

VALUE – Valuation and strengthening of urban green spaces in landscape planning in cities (ARVO - Viherakenteen arviointi ja vahvistaminen kaupunkien maankäytön suunnittelussa; hereafter the ARVO project) ran from October 2023 to December 2025. Its aim was to preserve and strengthen green structure in densely built cities to support climate change preparedness and adaptation. In the course of the project, an updated GAFD method was developed, and it is suitable for assessing both biodiversity and the quantity and quality of ecosystem services as part of land-use planning. This version differs substantially from the earlier tool imported from Sweden and produces three values for land-use planning: biodiversity, climate resilience and well-being benefits. GAFD is therefore a new method developed by the ARVO project that identifies habitat types in the target area. This publication addresses the objectives that the application of the GAFD aims to achieve and provides guidance on how to use it.

The ARVO project also produced the "Current State of Urban Green Structure Planning 2024 review (*Kaupunkien viherakenteen suunnittelun nykytila 2024 -katsaus* [in Finnish])." an impact assessment and national recommendations for strengthening urban green structure (*Arvoa viherakenteelle. Suositukset kasvavien kuntien päätök-*

sentekoon [in Finnish]). These outputs were developed by engaging planning professionals, organising study walks for decision-makers, and arranging excursions and seminars. Sustainability practices in urban planning were examined during the early stages of the project, and the material collected led to a research article on the biodiversity turn in urban planning (see Lähde et al., 2024 [in Finnish]). In addition, an important part of method development was the creation of *the anthropogenic habitat-types* (habitat types created intentionally or indirectly by human activity) classification and ecological condition assessment criteria, in collaboration with the BOOST project and numerous experts.

The ARVO project was implemented by the cities of Helsinki, Vantaa and Espoo, Aalto University and Green Building Council Finland (FIGBC). The associate partners piloting the green factor were Jyväskylä, Järvenpää, Kauniainen, Lahti, Oulu, Porvoo, Salo, Tampere and Turku. The GADF is therefore a result of collaboration between numerous cities. In the pilot areas of Helsinki, Espoo and Vantaa, project staff tested the calculation method iteratively, while associate partners provided feedback and results from their own calculations. Pilot planners from the associate partners tested the calculation method once in their own pilot areas*.

*A full list of ARVO project participants is provided at the end of this publication.

How can I tell what is a sufficiently good value for the GAFD?

There is no single correct answer, as the result depends on the characteristics of the area and the planning objectives, for example in relation to conserving and developing green structure. The GAFD helps planners discuss and verify these objectives.

How does the method developed in the ARVO project differ from the original method developed in Sweden?

The new method includes biodiversity as a separate component, which forms the basis for other benefits. For ecosystem services, the calculation has been systematised and refined on the basis of the latest scientific knowledge.

GAFD makes the value of green structures visible

This section is intended for anyone interested in the development of urban green structure. Land-use planning leaders and municipal decision-makers can learn, how adopting the GAFD helps cities adapt to climate change, strengthen biodiversity and at the same time support residents' well-being. Some values, such as business benefits and direct economic valuation are not included in the scope of GAFD. A more detailed description of the GAFD calculation method is provided in Section 2.

A tool to consolidate complex urban-ecological knowledge

According to the ARVO project's *current state review*, the multiple benefits of green structure — including the ecological and social services it provides—should be made a more visible and valued part of planning. Numerical targets are also needed to guide green structure planning more precisely and consistently. Policy decisions and urban strategies may contain tensions between growth targets and goals for strengthening green structure. These tensions should be reduced so that the objectives do not work against one another. Their reconciliation should be guided more clearly, so that individual planners are not left to resolve conflicts case by case. Planners also face information overload and resource shortages, which makes it harder to introduce new practices.

The review also highlighted the need for more discussion on how adaptation and biodiversity objectives can be addressed at a regional scale, ensuring that green networks continue across municipal and regional boundaries. Decision-makers and the entire urban environment sector need more expertise in green structure. Vegetation in the green structure needs time to grow into the protection cities require, which is why existing, mature urban greenery should be safeguarded effectively.

GAFD can play a significant role in resolving the current challenges related to strengthening urban green structures by making various nature benefits visible in planning and decision-making. The numerical approach and target values produced by the GAFD help prioritise and refine the information that individual planners must manage in their work.

According to the impact assessment of the district-scale Green Area Factor pilot, use of the method deepened expert knowledge, improved internal discussion in planning, and made the values of green structure clearer in the planning process. Its impact on the direction of planning processes and value discussions was significant. The method showed particular potential when preparing and justifying planning solutions. Although similar observations could also have been achieved through tools such as nature impact assessments or planning walks, GAFD offers a more systematic and comparable approach.

Calculations should be implemented as early in the planning process as possible, especially as part of the assessment of alternatives. This enables genuine comparison of the impacts of different solutions and allows the method to guide planning.



Figure 3. Many actions are needed to strengthen green structures. These actions are described in detail in the publication "Viherrakenteen suunnittelun nykytila" (Green structures' planning current state in Finland). Diagram: ARVO project

To support implementation of the GAFD, the ARVO project developed recommendations for decision-making and the management of green infrastructure. The recommendations include measures targeted at municipal land-use management and municipal decision-makers, the implementation of which:

- provides clarity regarding the objectives of cities
- responds to the challenge of measuring green structures and the lack of numerical objectives
- makes green structure a valued part of land-use planning from the outset

- provides green structure planning with sufficient resources to create high-quality urban environments
- elevates green structure as a visible, strategic theme in district-based co-operation
- enhances know-how throughout the urban area field of work, e.g. through training programs
- strengthens decision-makers' understanding of green structure

Making the benefits of urban green structure count

GAFD produces numerical scores for three themes: biodiversity, climate resilience and well-being benefits. The following pages explain why these three themes are essential for the future of our cities. Section 2 shows how the GAFD derives these scores in practice.

Biodiversity

Cities are typically built in the midst of rich natural environments (Secretariat of the Convention on Biological Diversity, 2012). This ensures the availability of diverse natural resources for urban construction, urban food supply, and trade. Although cities are not always seen as biodiversity hubs, they often host a wide range of habitats that support many species (Korhonen et al., 2021; Korhonen et al., 2020; Farinha-Marques et al., 2017; Aronson et al., 2014; Ives et al., 2016). Some endangered species can even fare better in urban areas than in surrounding landscapes where their habitats have fragmented or changed through overgrowth (From, 2005 & Goddard et al., 2010). In Finland, biodiversity is even flourishing in some cities (Ranta, 2014), which further underscores the need to conserve and diversify urban green structure.

In addition to being located in areas that were initially rich in natural features, urban green structures are shaped by the surrounding human-influenced environment. Together with the BOOST research consortium, the project has produced the first comprehensive ecological quality assessment of nature in the built environment in Finland by defining anthropogenic habitat types and ecological condition indicators for them. Studies show that anthropogenic urban habitats can sustain biodiversity as well as, or even better than, certain natural habitat types, and can provide habitats for endangered species (Planchuelo et al., 2019 & Spotswood et al., 2021).

Nevertheless, urbanisation is a major driver of biodiversity loss (Seto et al., 2012; Tiitu, 2014; Hautamäki, 2019), and the land-use and construction

sector contributes substantially to nature loss in Finland (Ruokamo et al., 2023). At the same time, the construction sector depends on biodiverse nature and the ecosystem services it provides (Building Industry, 2023). Halting biodiversity loss cannot be solved by the land-use sector alone; responsibility spans all sectors of society, including political decisions, regulation and resource allocation. It is also important to recognise that, unlike global carbon dynamics, biodiversity loss is inherently local: the loss of a forest in Finland, for example, cannot be “repaired” by planting trees elsewhere.

Addressing biodiversity loss requires systemic change: something the ARVO project supports through the GAFD. The GAFD’s biodiversity score is derived from the habitat-type classification. Leading experts assessed each habitat type’s diversity potential — its intrinsic capacity to support and maintain biodiversity. Realised outcomes depend on the habitat type’s ecological condition and on disturbance from human activities, which can affect the ability of habitats to provide niches and sustain natural processes in built environments. For each habitat type, ecological-condition indicators have been defined. These enable users to identify the current level of biodiversity in a given area and to target measures that strengthen it. For example, the biodiversity value of stormwater wetlands or vegetated roofs can be increased through specific structural features, which the indicator set captures.

Additionally, addressing biodiversity loss is closely linked to ecological compensation, which seeks to offset losses caused by land-use

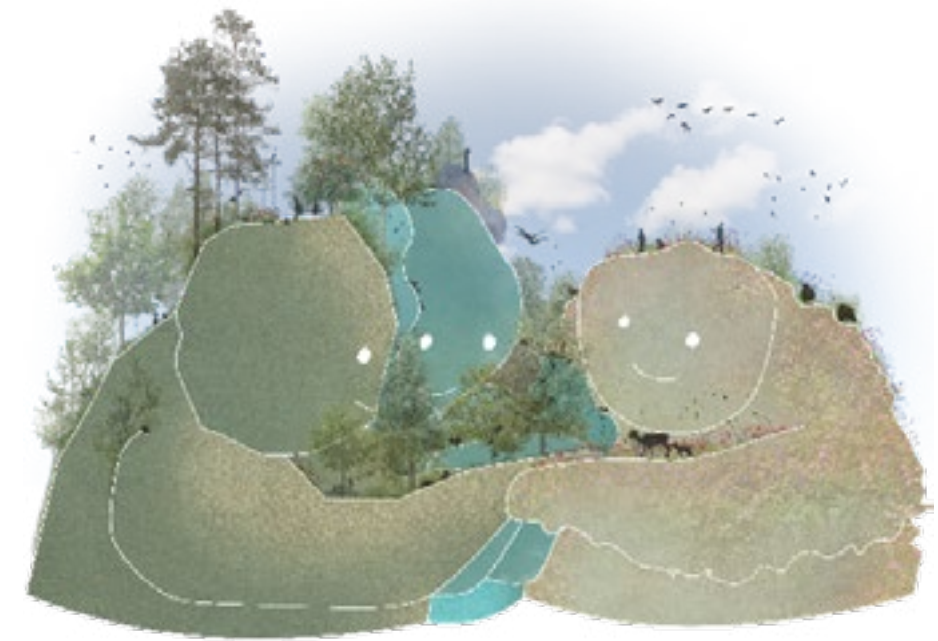


Figure 4. Each habitat type has its natural ability to enhance biodiversity. The diversity of urban nature increases when there is a diversity of habitat types. Illustration: City of Helsinki / Nea Vesterinen and Sara Korkeamäki.

(Jalkanen et al., 2025). Although formal ecological compensation is not applied to anthropogenic habitat types, habitat-type-based planning still enables the calculation of natural-value hectares for anthropogenic green structures. A natural-value hectare is a unit that captures both the quantity and quality of natural values in a given area and can be used to describe overall biodiversity status (Jalkanen et al., 2025). Calculating the hectares of natural value makes it possible, for example, to present the total biodiversity impact of a local detailed plan numerically and transparently (Lähde et al., 2025).

Habitat type-based planning takes into account all nature, not just endangered habitats or protected species. This consideration of ‘ordinary nature’ and making its effects visible and measurable is important, as it also helps to recognise the importance of everyday nature for the functioning of ecosystems (Gaston, 2010), for the well-being of residents, and for halting the overall deterioration of nature. In this way, planning can bolster biodiversity and maintain continuity in the green structure even in areas that lack the most valuable natural sites.

Strengthening biodiversity is important because of the intrinsic value of nature, but it is also signifi-

cant from the human perspective, especially in the urban areas. Extensive evidence shows that accessible everyday green environments improve public health and reduce morbidity (Drakvik et al., 2024; Neuvonen et al., 2019; Neuvonen et al., 2022; Roslund et al., 2020). In addition to the accessibility, the quality of green environments also matters: more diverse nature better supports the immune system and reduces disease risks (Roslund et al., 2022; Donovan et al., 2018; Donovan et al., 2021; Hahtela et al., 2021; Hanski et al., 2021). For background and a fuller description of how these potentials and indicators were derived, see “*Evaluating the benefits of well-being as part of the district-scale Green Area Factor 2025* ([Hyvinvointihyötyjen arvioiminen osana Alueellista viherkerrointa 2025](#))” [in Finnish].”

These benefits are not only limited to health and well-being impacts, but also to adapting to climate change. Diversity enhances ecosystem services such as stormwater management and microclimate regulation (Norris, 2012). The following pages explain how the GAFD makes the value of these key ecosystem services visible in cities.

Climate resilience

In the GAFD, climate resilience is assessed through three ecosystem services: stormwater management, microclimate regulation, and carbon sequestration and storage. These are essential for climate adaptation. For example, in Uusimaa the already substantial risk of stormwater flooding is projected to increase further by 2050 (Gregow et al., 2021). Hot weather is expected to intensify and last longer, which may raise mortality and morbidity (Säyhä et al., 2011; Säyhä et al., 2014; Kim et al., 2018; Kuhn et al., 2020). According to the Finnish Climate Panel, it is important both to mitigate climate change (e.g., by increasing carbon sinks) and to adapt to its impacts (Gregow et al., 2021).

Stormwater management

With climate change, rainfall is projected to increase across Finland. Rainy days are increasing, especially in winter, and heavy summer downpours will intensify. Concurrently, anthropogenic areas and sites impermeable to water have increased (Tiitu, 2018). Green structures in urban areas reduce the amounts of stormwater significantly at the annual level (Valtanen et al. 2014). Vegetation also slows down pollutants and reduces the load entering water bodies (Valtanen et al., 2014). In the GAFD, habitat

types are assigned numerical values that indicate their potential to retain, infiltrate and delay stormwater, as well as to improve water quality. The value derived from the habitat type is specified on the basis of canopy cover, soil permeability, soil water-holding capacity (retardation) and surface topography.

Microclimate regulation

With climate change, winters, in particular, will be milder, and low temperatures will become rare (Gregow et al., 2021). Widening, intensifying, and lengthening of heat waves (Gregow et al., 2021) cause adverse health effects, especially among the elderly and people suffering from long-term illnesses (Näyhä et al., 2011; Näyhä et al., 2014; Kim et al., 2018; Gregow et al., 2021).

Urban form can amplify heat through the heat island effect, where air temperatures in cities exceed those of surrounding rural areas. The heat island effect is caused by excess heat produced by buildings and traffic, and by heat stored in structural elements during the day, which is then released back into the local environment at night. In dense urban areas, the amount of heat stored, and the amount of reflective built surface is large. A built surface also prevents the cooling effect of evaporation. Heat-is-



Figure 5. Stormwater depression in Helsinki along the Hermann shoreline road. Photo: Olivia Mahlio.



Figure 6. Sankt Kjelds Plads in Copenhagen. Photo: Anna Pursiainen.

land effect together with overheating of buildings contributes significantly to heatwave risk (Gregow et al., 2021), and correspondingly, heatwave mortality can be clearly higher than in nearby rural areas (Ruuhela et al., 2020).

Vegetation cools air via shading and evapotranspiration (Grilo et al., 2020). Wooded, multi-layered green areas cool more effectively than open green-spaces (Ilgargård, 2021). On streets, shading is created by, for example, deciduous trees on street sides (Park et al., 2017). In addition to the amount and structure of vegetation, the cooling effect on microclimates also depends on the size and configuration of vegetated areas, local topography, and proximity to water bodies. How cool air can move through the urban structure is also essential.

In the GAFD, each habitat type is scored for its potential to moderate microclimate. Forests and peatlands, for example, have high cooling potential, whereas open habitats have lower potential. Tree canopy is explicitly considered in wooded habitat types because canopy cover enhances cooling through shading and evapotranspiration.

Measures to promote stormwater management and regulation of the micro-climate are, above all, adaptation and preparedness to the impacts of climate change. Carbon sequestration, on the other hand, plays a role, especially in holding back climate change. In nature, a significant part of the carbon is bound in the seas, in the soil, and in vegetation. As vegetation-covered areas are built, carbon dioxide is released into the air from the soil and vegetation. If vegetation-covered areas are set aside from construction, the carbon remains in long-term soil storage.

In the district-scale Green Area Factor, the carbon storage of the vegetation and soil are considered with carbon storage values derived directly from the habitat type. Each habitat type has been assessed for carbon, at best, bound to the soil and vegetation. In addition, canopy cover, indicating the number of trees, is considered for potentially wooded habitat types.

Carbon sequestration and storage

Well-being benefits

Declines in urban green structure are directly linked to poorer human well-being. Deteriorating air quality, more frequent heatwaves and fewer opportunities for nature-based physical activity all contribute to health problems (Pretty et al., 2005). Analogous to nutrient deficiencies, residents of dense cities can experience “nature deficit,” with measurable impacts on health (Haahtela et al., 2023; Roslund et al., 2021; 2022).

In the GAFD, the third score—well-being benefits—captures the health and social effects of green structure across three dimensions: physical, mental and social well-being. The assessment also considers different scales: individual, societal and planetary. Positive effects at the individual level, such as a sense of connection to nature, cascade to broader societal well-being, support ecosystem health and, ultimately, reinforce the functioning of life-support systems.

Physical well-being

Urban nature affects physical health in multiple ways. Proximity to green areas promotes physical activity and reduces the risk and symptoms of cardiovascular, metabolic and respiratory diseases (Lanki et al., 2017; Tyrväinen et al., 2018). Vegetation improves air quality by capturing pollutants and lowering concentrations of particulate matter, ozone and nitrogen dioxide (Diener & Mudu, 2021; Kállay et al., 2022; Vieira et al., 2018). These effects vary by species, site conditions and climate. While vegetation generally improves air quality, some species emit volatile organic compounds that can exacerbate allergy symptoms; overall impacts should therefore be assessed case by case.

Biodiverse ecosystems also support health via environmental microbiomes. Beneficial microbes associated with healthy soils, for example, can strengthen the immune system (Roslund et al., 2021). Diverse outdoor environments are especially important in spaces for children, such as kindergarten and school yards, because early childhood is a critical period for immune development.

Mental well-being

Green environments have a substantial impact on mental well-being. Time spent in nature is associated with lower risks of depression and anxiety (Mueller & Flouri, 2023; Pasanen et al., 2023; Tyrväinen et al., 2007). Particularly restorative landscapes, such as forests, shores and open meadows, reduce cortisol (so-called ‘stress hormone’) and promote psychological recovery (McDougall et al., 2024; Olszewska-Guizzo, 2023). Physical activity in nature and visual exposure to natural scenes also support attention, mood and cognitive performance. Beyond visual qualities, natural soundscapes like birdsong, or flowing water, calm the central nervous system and strengthen the restorative experience (Tyrväinen et al., 2007).

A key component of psychological well-being is nature connectedness: a felt sense of belonging to the natural world. This develops through direct interaction: observing plants and animals, exercising outdoors, or engaging in nature-based activities such as gardening, birdwatching and foraging. Strengthening nature contact through targeted “nature interventions” has been shown to increase environmental responsibility and favour more sustainable lifestyles (Berenguer, 2007; Martin et al., 2020; Salonen et al., 2021).

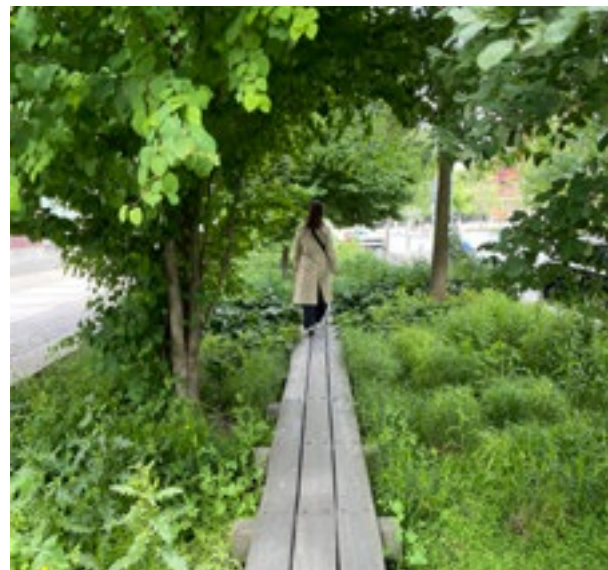


Figure 7. Lövängsgatan in Stockholm is a green, everyday environment that supports well-being. Photo: Olivia Mahlio.

Social well-being

Green environments support social well-being by strengthening place attachment: a sense of belonging to a specific locale (Kuo et al., 1998). Especially accessible and inclusive greenspaces, that are physically and socially welcoming to diverse user groups promote social sustainability efficiently by providing settings for encounters, everyday interactions and community activities (Folke et al., 2016; Huntjens, 2021; Vierikko et al., 2020).

Additionally, urban green mitigates climate impacts such as heatwaves and flooding by cooling surroundings and retaining stormwater. This particularly benefits vulnerable groups — including low-income residents, older adults and people with reduced mobility — by improving safety, comfort and access during extreme events. Safe, welcoming and predictable environments foster trust in place and in other people, thereby strengthening social inclusion and a sense of belonging. Many people also experience community not only with other residents but with the broader ecological web of life (Berenguer, 2007; Salonen et al., 2021).



Figure 8. The planning of the courtyards of Herlev Hospital in Copenhagen focused on improving the well-being of the hospital's recovering patients. Photo: Merete Kemppainen.

GAFD is a habitat type-based method

In the GAFD, all vegetated and aquatic areas within the calculation area are first classified into habitat types. These include both natural Finnish habitat types, such as forests, and human-created habitat types found in built environments, such as parks. As the assessment is refined, each habitat type is also assigned an ecological condition using the method. This enables the calculation of numerical theme-specific values for biodiversity, climate resilience and well-being benefits. The results are computed with GIS-program. A more detailed description of the calculation, with examples, is provided in Section 2.

The GAFD does not produce a single number. Instead, it yields three theme values: biodiversity, climate resilience and well-being benefits. These are calculated first for the current state of the planning area and then for the plan — or for multiple plan alternatives. To create an urban structure that supports climate adaptation and biodiversity, existing green structure should be conserved and/or high-quality new green structure planned. The GAFD makes progress toward these goals visible in numerical terms. It also helps identify where

planning would weaken green structure or introduce qualitatively weak solutions. Finnish cities include both natural habitat types and anthropogenic habitat types. Finland’s natural habitat types are well established (Kontula & Rautio, 2018), and the BOOST project, which advances ecological compensation in Finland, has defined ecological-condition indicators for them (Jalkanen et al., 2025). By contrast, a comprehensive classification for anthropogenic habitat types, related to the concept of “novel ecosystems” (Kowarik, 2011) and

corresponding ecological-condition indicators had not previously been in use. These were developed through expert work jointly facilitated by the ARVO and BOOST projects as part of the GAFD 2025 development. Previous practice in land use and urban planning has classified certain categories of greenspace and evaluated their biodiversity, often for specific site types (Vierikko et al., 2014; Ranta, 2008; Jalkanen & Vierikko, 2022; Jalkanen et al., 2020). The present work provides a comprehensive classification and indicator set that spans every vegetated and aquatic component of the urban fabric, from built and designed areas to linear and spontaneously vegetated sites, enabling comparable assessment of the biodiversity potential of each component.

Defining anthropogenic habitat types

The GAFD calculation is underpinned by a classification of anthropogenic habitat types and associated ecological-condition indicators. This work was conducted with a broad group of experts through six workshops held from November 2024 to September 2025. In summer 2025, the applicability of the descriptions and indicator set was field-tested (see, for example, Puolitaival et al., 2025). Following the fieldwork phase in September 2025, the ecological-condition indicators were further refined. In total, 32 urban-nature experts participated in the workshops, including biologists, consultants, researchers and civil-society actors from both the public and private sectors.

The classification of anthropogenic habitat types has been a key element in developing the GAFD. The habitat descriptions and ecological-condition indicators are also intended for use by researchers, urban-nature professionals, planners and maintenance teams. Identifying distinct habitat types in cities enables targeted improvements through planning and management. For natural habitat types, emphasis typically falls on conservation and guidance of human activities. For anthropogenic habitat types, structural features can be enhanced through design and maintenance to better support biodiversity and to provide climate resilience and well-being benefits.

By identifying habitats, land-use planners gain a comprehensive picture of the green structure within a planning area and are better positioned to influence its multifunctional potential. When habitat types and their ecological condition are mapped, the significance of these areas for biodiversity, climate resilience and well-being benefits becomes easier for the whole planning team to interpret. This clarifies qualitative differences in urban green structure, for example that even an extensive green roof cannot replace the biodiversity value of a lost forest. In this way, the method reduces ambiguity and assumptions and lowers the risk of greenwashing.

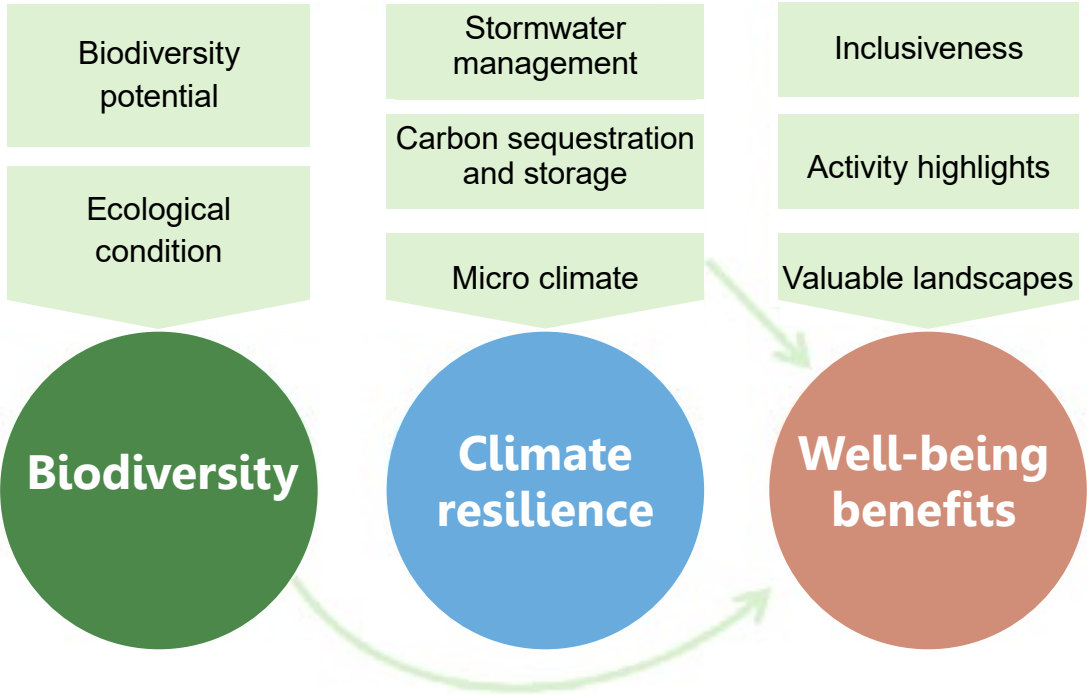


Figure 9. By defining the habitat types and their indicators, one can calculate the thematic values for biodiversity, climate resilience, and well-being benefits. Diagram: ARVO project.



Figure 10. By identifying habitat types, our understanding of the urban nature increases. Illustration of a garden habitat type. Illustration: City of Helsinki / Nea Vesterinen and Sara Korkeamäki.

Applying the GAFD at three levels of accuracy

Plans and zoning instruments vary in their level of detail, so the assessment must scale to different planning stages as well. The GAFD can be applied at three levels of accuracy, depending on how detailed the planning task is. It is most useful for partial master plans, large-scale detailed plans, and major general plans for parks or transport. For smaller sites, the plot-level green factor is usually a better fit, as it captures green structure at a much finer detail (down to individual trees and shrubs). A key aim is that the GAFD provides robust evidence for zoning provisions that preserve or create habitat types, addressing both quantity and quality.

Accuracy level 1 (AL1)

At AL1, the method is applied at a coarse, strategic scale for broad planning areas, typically in an early, sketch-stage process. Habitat types and their extents are identified from GIS datasets, but no field surveys are conducted, and no ecological-condition indicators are assigned. The output is the Area-based Biodiversity Potential (ABP), which represents the mapped green structure in its best plausible ecological condition. ABP helps identify areas where green structure is potentially of highest ecological value — or where value could be enhanced — at a strategic level. It thus provides preliminary evidence on nature impacts and helps minimise adverse effects when setting the direction for land use.

As planning progresses and more precise information becomes available, both the baseline and the plan assessments should be refined. If the planning boundary changes during the process, the current-state assessment must be updated accordingly.

Accuracy level 2 (AL2)

As the data and design accuracy increases, the calculation is then specified to accuracy level 2 (AL2), which can already be used to define the actual district-scale Green Area Factor (AGF). In this

level, an overall assessment of ecological condition is made using available surveys and area datasets, local knowledge and management classifications. At this stage, information is typically still not based on new field surveys.

Accuracy level 3 (AL3)

At AL3, ecological condition (quality) is determined using fieldwork. This level supports very detailed land-use planning, and the three GAFD theme values are correspondingly the most accurate. AL3 enables the calculation of natural-value hectares and supports the application of ecological compensation for natural habitat types. This level is typically applied to the current state, but it can also be used for sufficiently detailed plans.

Typical examples of how the accuracy levels align with planning tasks are shown in Table 4 on page 28.

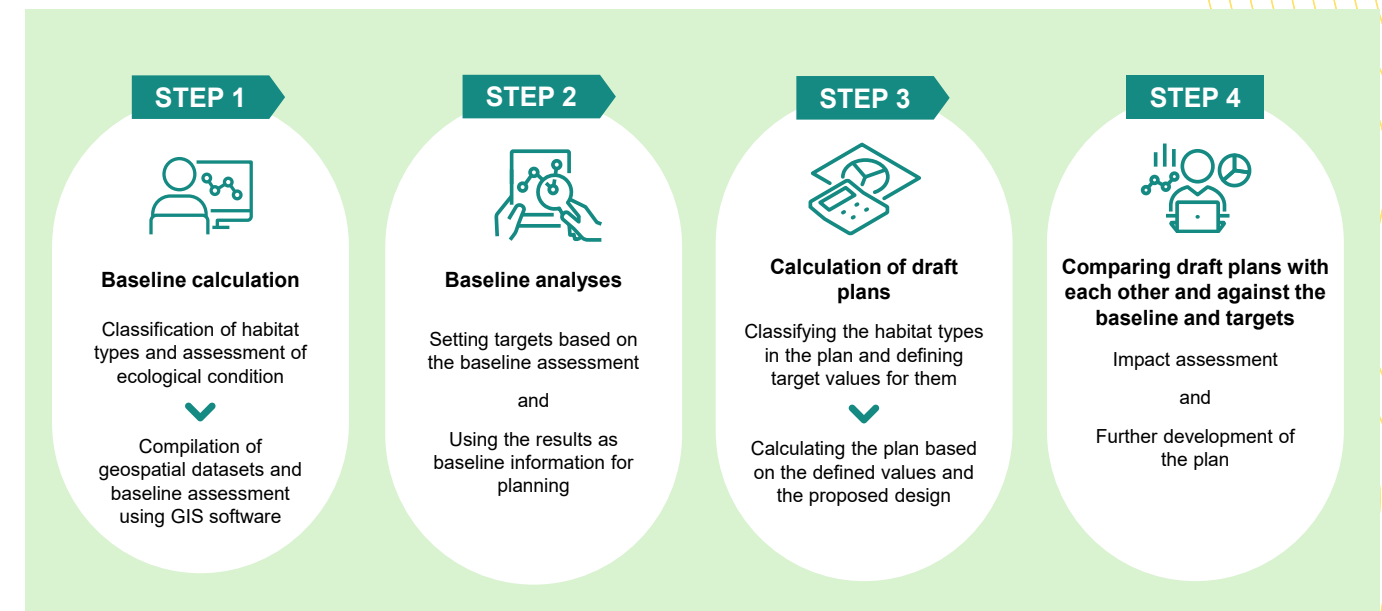


Figure 11. Process diagram of the utilisation of the district-scale Green Area Factor 2025. Diagram: ARVO project. In detail, see: [More than the sum of its parts. Lähde et al. 2025](#)

Utilisation of results

The most effective green-structure decisions are made early in the planning process. It is, therefore, important to keep the GAFD involved in land-use planning from the very beginning. The purpose, therefore, is *not* to calculate the green factor for a pre-planned area afterwards. Instead, the method should run alongside draft planning when defining the extent of land-use change and delineating the planning area. The goal is to identify and compare the effects of the draft phase planning solutions regarding the green structure and to help find the most climate-resilient solutions that best support biodiversity. In this way, the GAFD helps translate strategic climate and biodiversity objectives into concrete, well-being-supporting urban form.

When planning new areas, alternatives are often compared to test development locations and floor-area outcomes. In such comparisons, the GAFD makes visible how options differ in the multi-benefit performance of green structure. Thematic maps produced by the method help identify arrangements that optimise both the diversity and the multiple functions of green structure. It is also important to pay attention to areas with little or no natural benefits. Especially in terms of adapting to climate change, it is essential that the green structure can be found along every street and plot, and that the residents have easy access to it.

In addition, the method can be used to compare specific green structure solutions: what is the effect of turning a lawn area into a meadow or how increased canopy cover improves stormwater management. **The method is not a substitute for nature surveys** as it aims to commensurate and refine the content of nature surveys. Incorporating natural habitat types and their ecological condition into surveys provides more accurate inputs and more robust GAFD results.

Relationship to the plot-level green factor

The GAFD is conceptually similar to plot- or block-level green factors, but they apply at different stages. The GAFD supports land-use planning; the plot-level tool supports detailed planning and implementation, typically at building-permit stage. GAFD results can indicate where green structure should be located or concentrated. If there is little green structure in public areas or if climate adaptation needs are high (e.g., flood-risk areas), the GAFD results should determine higher values for the plot-level green factor regulation, if possible. This matters because uneven or limited public-realm green increases the importance of individual plots and blocks for overall green-structure quality and ecosystem-service provision. Higher plot-level targets can compensate

for area-level shortcomings and help achieve climate-resilience, well-being and biodiversity objectives across the whole area.

Supporting knowledge-based planning

The GAFD is a research-based method that makes everyday urban nature visible and measurable. Its outputs strengthen the strategic evidence base for nurturing urban green structure and align with no-net-loss/non-deterioration goals, ecological compensation and climate adaptation. Methodological uniformity is a strength: it can enable consistent numerical guidance in the future. A shared reference framework allows comparisons across areas (urban districts, detailed-plan areas) and supports development based on common evidence. For this reason, the method should not be fragmented into separate, city-specific variants. While practical app-

lications and new datasets will continue to refine the GAFD, it already offers a robust, comparable way to value urban biodiversity and ecosystem services on a research basis rather than intuition.



Figure 12. Urban nature consists of various natural and anthropogenic habitat types. Illustration: City of Helsinki / Nea Vesterinen and Sara Korkeamäki.

Should planning be aimed at attaining the GAFD of 1.00 for the various values, if this is the best possible result?

No, the GAFD in an urban area cannot, in practice, ever be 1.00. Even in forested areas, the values often remain at 0.70, and in the urban environment, the values have typically been within the range of 0.10–0.35.

Can I calculate the GAFD without defining habitat types?

No, you cannot. The general principle in development work has been to see urban areas as living ecosystems as a whole and not just built environments. According to this line of thinking, nature and ecological processes are not a ‘greenings’ linked afterwards to the urban structure; they are instead its structural and functional basis. The division of the area and the establishment of the calculation of habitat types and their ecological condition supports this objective.

Description of the method: GAFD calculation

This section is intended for users of the method, that is, those who calculate the GAFD in their work. Its purpose is to explain the calculation basis for the GAFD's theme scores: biodiversity, climate resilience and well-being benefits. It describes the method that can be implemented using different tools, such as geographic information system (GIS) software.

Term	Explanation
District-scale Green Area Factor (GAFD)	A calculation method that numerically measures biodiversity and the most significant ecosystem services in the area under consideration. The result is three thematic values. These are calculated by multiplying the surface areas of different habitat types by their total scores, then summing these together, and finally dividing the sum by the total area under assessment. GAFD is designed for larger than plot-specific areas, e.g. with the preparation of a large-in-area local detailed plan.
Habitat type	A habitat type is a delimited area of land or water with certain types of environmental conditions and a natural flora and fauna. Similar term: biotope. Habitat types can be either natural habitat types or anthropogenic habitat types.
Habitat type polygon	Geographic data with geometry of a certain defined habitat type. The vegetated and aquatic areas within the examined site are divided into different habitat type polygons to enable the calculation. The same habitat type is typically found in many different polygons within the area under consideration.
Accuracy level (AL1; AL2; AL3)	The quality-weighted surface area of the green structure in relation to the total surface area can be calculated at three different levels of data accuracy. AL1 produces only preliminary data at a rough level, AL2 produces more detailed data based on GIS analysis, and AL3 produces most detailed data based on a site visit. The GAFD presented in this publication is best suited for AL2 and AL3 and to be used as the method for guiding land-use planning.
Area-based Biodiversity Potential (ABP)	Area-based ratio, which describes at the preliminary level the maximum biodiversity potential of the site under consideration. It is calculated at accuracy level 1, where none of the three thematic values are identified.
Quality-weighted area	The basic principle of the GAFD: the surface area of a green structure is not only measured by its physical size, but also regarding its quality. Values describe the quality of biodiversity, climate resilience or well-being benefits. The polygon's surface area is multiplied by the habitat type's total score. Quality-weighted surface area = Total score x surface area. In the case of biodiversity, the quality-weighted surface area corresponds to the habitat hectares.
Total score	Total score reflects the quality level of the habitat type. It is used in the calculation of the quality-weighted surface area. The total score is usually obtained by multiplying the potential of the habitat type by its quality status (e.g. biodiversity potential x ecological condition). The total scores are calculated for the habitat type polygons when calculating the biodiversity value, the well-being benefit value, and the climate resilience value (stormwater management, micro-climate regulation, and carbon sequestration scores that together make up the climate resilience value).
Three thematic values	GAFD thematic values: 1. Biodiversity 2. Climate resilience 3. Well-being benefits The thematic values describe the ability of the examined site to deliver benefits under these three themes. The total scores of the themes are calculated for each habitat type polygon. The sum of the surface areas weighted by the total scores in each theme is divided by the surface area of the whole site under review. The results of these distributions are the three values of the GAFD, which can be expressed in percentages or decimals (0.00–1.00).

Table 2. Terminology used in the GADF calculation.

Size of the calculation area and its delimitation

The primary purpose of the GAFD is to assess an area where land-use changes are planned. In practice, it is natural to use the boundary of a framework plan, a partial master plan or another plan that covers more than a single block.

It is not recommended to include green-area complexes outside the project boundary in the GAFD if no land-use change is planned for those areas. Including extensive green areas that will remain unchanged can obscure the effects of proposed changes in the overall results and increase the risk of distortion. If the assessment boundary is modified during planning, the GAFD baseline (current-state) values must be recalculated.

As a general guideline, include those green areas that will be affected by the land-use change.

Habitat type classification

The GAFD calculation begins by identifying the entire green structure within the assessment area. It does not matter whether elements are natural or human-made, in private or public ownership, on buildings or on the ground, or how they are maintained; all vegetated and aquatic areas are included.

Next, the green structure is classified into habitat types: natural habitat types and anthropogenic habitat types. Anthropogenic habitat types have been classified, and their ecological-condition indicators defined in the ARVO project; these are described in a [separate appendix](#). All Finnish natural habitat types are presented in the Red List of Habitats final report (Kontula & Raunio, 2018). These materials should be reviewed before classifying data into habitat types.

In the ARVO project, the main categories of the natural-habitat classification were used. This classification also underpins the ecological-condition indicators defined in the BOOST project. Fell habitat types are excluded, since the GAFD is generally applied to urban areas far from fells. Main categories were chosen because finer habitat classes usually cannot be reliably identified from GIS data. Forests are an exception: in the ARVO project, forest habitats were divided into herb-rich forests, rocky forests and pine forests, because national and municipal

forest-management datasets are available. If forest areas in the calculation area cannot be assigned to these subcategories, the higher-level class “forest” can be used.

At present, habitat types are not pre-classified in existing spatial datasets, so classification must be done manually using available sources. In practice:

- 1) Delineate all vegetated and aquatic areas within the assessment boundary, for example from land-cover data or the most detailed municipal datasets available.
- 2) Divide all vegetated and aquatic areas into shapes based on their habitat types using the available sources. For example, use detailed plan data to identify ground-level yards and vegetation on streets and squares, and use maintenance-class datasets and aerial imagery to identify features such as newly established meadows and open parks.



Figure 13. Different habitat types have different capacities to produce biodiversity. For example, in open and wooded areas, biodiversity can be supported by various means, and therefore the identification of habitat types is important. Illustrations from a forested park. Illustration: City of Helsinki / Nea Vesterinen and Sara Korkeamäki.

Natural habitat types	Biodiversity potential	Anthropogenic habitat types	Biodiversity potential
Baltic Sea	1	Forested parks	1
Baltic Sea shorelines	1	Gardens	0,7
Lakes and ponds	1	Shrub vegetation	0,7
Spring fen types	1	Ground-contact yards	0,7
Flowing waters	1	Open parks	0,6
Inland shorelines	1	Novel meadows	1
Peatlands	1	Ruderal areas	0,8
Forests	1	Fields	0,6
Herb-rich forests	1	Road- and railside vegetation	0,5
Pine forests	1	Vegetation of streets and squares	0,3
Rocky-terrain forests	1	Vegetation integrated into buildings and structures	0,2
Bare rock, cliffs, and stony ground	1	Habitats created through industrial processes	0,1
Traditional rural biotopes	1	Artificial wetlands	0,9
		Artificial water basins	0,1
		Artificial shores	0,5

Table 3. The habitats used in the GADF and the related potentials to produce biodiversity (defined in the ARVO project). For example, a forested park in its best ecological condition gets a full potential value of 1, while a field in its best ecological condition gets a slightly lower value of 0.6. The biodiversity potential is always 1 for natural habitats and 0.1–1 for anthropogenic habitats as per the table above.

Calculation areas often contain both natural and anthropogenic habitat types. For example, a BOOST-criteria classification was made for the Vaskitsanmäki city plan area in the Kalajärvi area of Espoo, which has been used in delineating habitat types. The classification also provided direct ecological condition indicators. Later, anthropogenic habitat types were added to this material.



Figure 14. Geographic data based classified habitat types in Kallahti, Helsinki. Picture: City of Helsinki

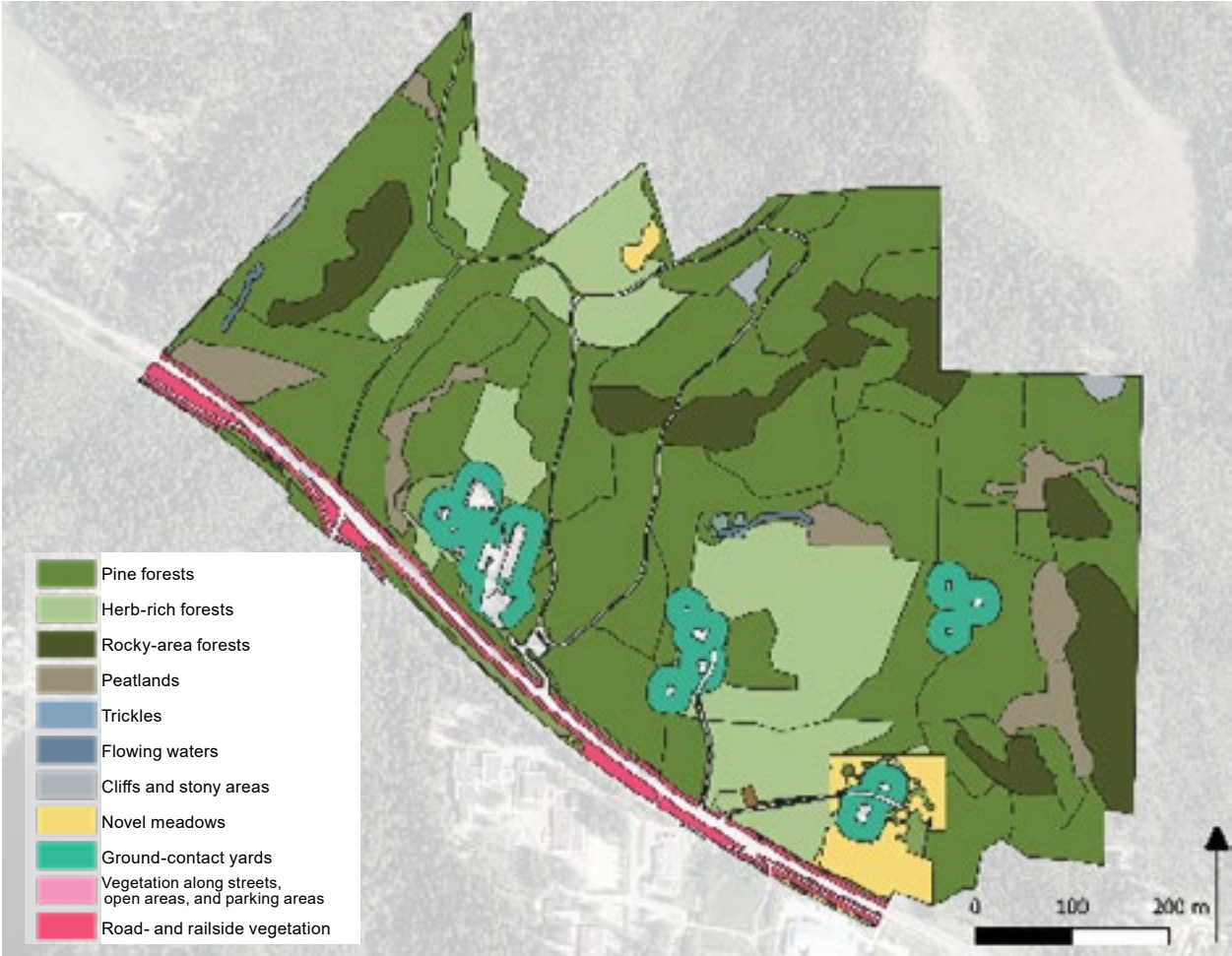


Figure 15. In Vaskitsanmäki, Espoo, mapping of natural habitats was done as field work, after which anthropogenic habitats were identified based on the geographic dataset. Picture: City of Espoo.

Selecting the accuracy level for calculations

The GAFD can be calculated at a preliminary level (AL1) or in greater detail (AL2–AL3). Before classifying habitat types and running the calculation, determine the appropriate accuracy level for the planning boundary. Key questions include: How large is the planning area? What geographical surveys have already been carried out in the area? Within available resources, is it feasible to analyse each vegetated area individually using aerial imagery and other datasets? Accuracy levels were introduced earlier; this section focuses on choosing the level for the calculation. The table below shows how AL1–AL3 align with different planning stages.

Accuracy level 1 (AL1)

At AL1, the assessment relies on coarse spatial data. After the habitat-type classification, the output is the Area-based Nature Potential (hereafter, ANP), which portrays the green structure in its best plausible ecological condition and can set qualitative targets for further planning. AL1 supports rapid screening and a preliminary understanding of an area’s green structure. The boundary can be large, even an entire master-plan area, but AL1 also suits quick reviews of smaller areas.

At AL1, the area’s green structure is classified into habitat types, but using broad units. Very small habitat type shapes are not identified at this accuracy

level, unlike in current-state assessments at AL3. For example, a forested park can be treated as one unit even if other habitat types occur within it. For natural habitat types, it is recommended to classify at least to the level of the main groups: Baltic Sea, Baltic Sea shorelines, lakes and ponds, inland shorelines, peatlands, forests, bare rock, cliffs and stony ground, and traditional rural biotopes. Among anthropogenic habitat types, the most likely to be identifiable at this scale include forested parks, open parks, gardens, fields, ground-contact yards and possibly habitats created through industrial processes. Road- and railside vegetation and vegetation of streets and squares may not be distinguishable in coarse, grid-based source data due to their narrow spatial form. The person doing the GAFD calculation needs to determine the appropriate accuracy of the categorisation in relation to the initial data to be used. Later, AL1 units can be subdivided and refined as plans and datasets become more detailed.

The intent at AL1 is a rough, sketch-stage, flexible appraisal. The full district-scale green area factor is not calculated at this level; only the ANP is pro-

duced. AL1 does not reveal the ecological condition or quality of the green structure, which in reality is likely lower than the potential depicted by ANP. Calculating the three GAFD theme scores requires information on ecological condition by habitat type, among other things, which is not appropriate at this coarse level.

In addition to ANP, simple indicators can be produced at AL1, such as the ratio of vegetated to paved surface area and the relative shares of natural and anthropogenic habitat types. Accuracy level 1 thus creates a preliminary understanding of what types of green structures can be found in the area under consideration, but it does not yet provide precise information on the ecological condition, i.e. the quality, of the green structure. At this stage, it is also useful to identify how harmful impacts of land use can be avoided and minimised (compare with the first steps of the mitigation hierarchy; see [figure 16](#)).

	Colour code:	Suitable	Suitable to some extent	Not suitable			
PLANNING STAGE		AL1		AL2		AL3	
		CUS	PLA	CUS	PLA	CUS	PLA
Regional plan							
Master plan							
Planning principles on map / outline plan*							
Component master plan*							
Reference plans or corresponding for local detailed planning*							
City/local detailed plan*							
General plan (e.g. public utility services plan, park plan / traffic general plan)*							
* = Piloting during the project has been done for these types of plans							
CUS = Current status, PLA = Planning							

Table 4. The applicability of the district-scale Green Area Factor to the various planning phases. N.B! The ARVO project has piloted the calculation of accuracy level 2 for both the current state and the plans, and accuracy level 3 for current state. Accuracy level 1 calculation applicability requires piloting and testing.

Calculation of the Area-based Nature Potential: the sum of the area's vegetated, weighted areas is distributed over the area as a whole:

$$\frac{\sum (\text{Biodiversity potential} \times \text{habitat type surface area})}{\text{Total surface area}}$$

Plan assessment applying AL1

At AL1, plans are typically rough sketches indicating areas that may become plots or streets or be retained as different types of green space (for example, in local detailed plans). The draft local detailed plans often do not specify vegetation for streets, squares or blocks. At this level, the assessment should therefore either focus on the broader green network, or apply simple, principled estimates of vegetation amounts and habitat types for planned blocks, streets and squares. For example, a common rule can be set for all residential blocks, such as: vegetated area equals 20% of the block area, with the vegetated area classified as the habitat type “ground-contact yards.” By classifying both the current state and the draft plan consistently, the change introduced by the plan can be quantified. In this way, AL1 can help set targets for more detailed planning at AL2 and AL3.

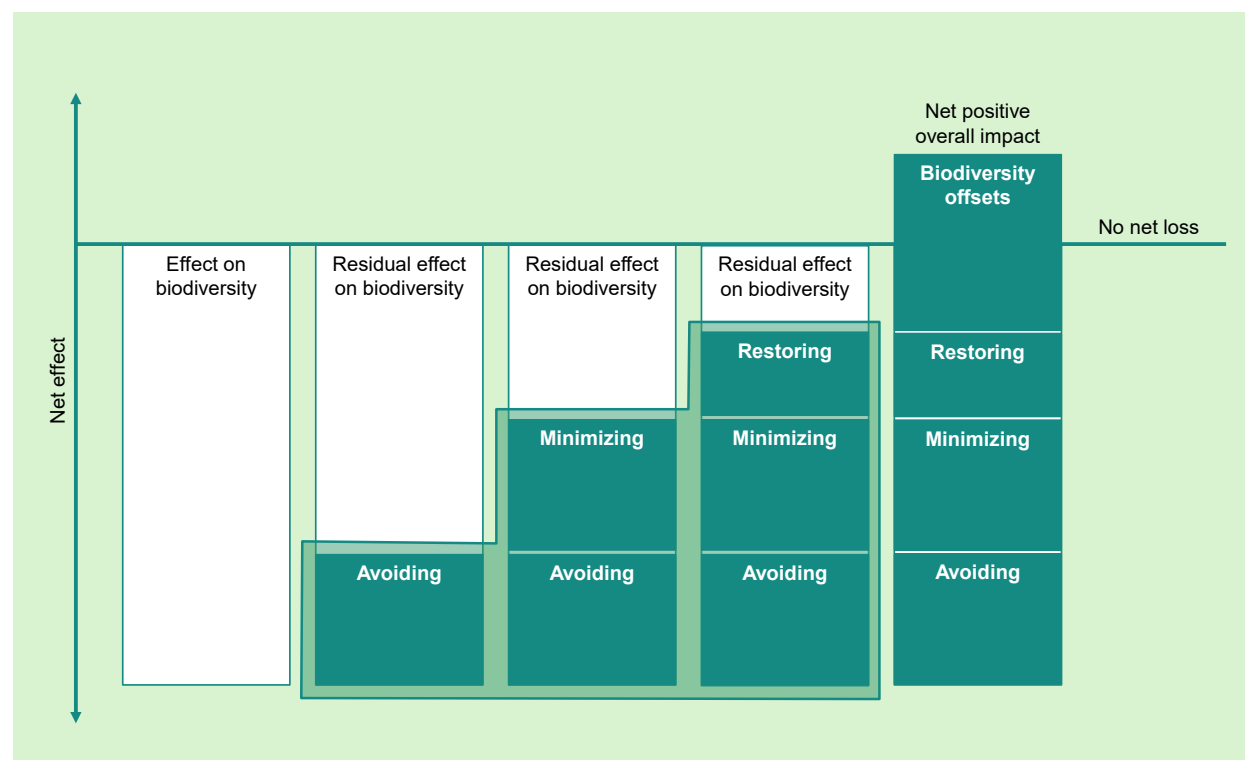


Figure 16. The mitigation hierarchy means that damage to nature is primarily prevented by avoiding, secondarily by minimizing, thirdly by restoring degraded areas within the target area, and only as a last resort there is the compensation of impacts by biodiversity offset measures such as restoration or protection of similar habitat types elsewhere. GAFD helps to verify the initial measures of the hierarchy and for the actual biodiversity offsets there are specific tools and calculation instructions. Diagram: Adapted from Lähde et al., 2025.

Accuracy level 2 (AL2)

AL2 requires more detailed classification than AL1, so the size of the assessment area correlates with the workload for habitat-type classification and ecological-condition assessment. AL2 is suitable for several planning levels, from outline plans to local detailed plans, but the choice of accuracy level should reflect available resources and the precision required.

By crosschecking different available datasets, the area's green structure is divided into shapes by their habitat types. The method recognises 28 habitat types in total: 15 anthropogenic habitat types and 13 natural habitat types (mostly at the main category level). Ecological condition is then assigned to each mapped habitat type using spatial datasets, existing surveys and local knowledge. The three GAFD values are calculated by combining these habitat-specific values with selected spatial datasets.

Source data and digitising rules

Use precise boundaries from prior field surveys or suitable municipal datasets wherever available. Where necessary, derive polygon features from point or line data by buffering and digitising as follows:

- **Individual trees:** 15 m² or 20 m² per tree, depending on rooting-volume constraints. Use 15 m² where rooting volume is restricted, otherwise 20 m².
- **Springs:** 20 m². Do not map an additional immediate buffer; it is included in the polygon.
- **Cliffs:** 5 m buffer, giving a total mapped width of 10 m.
- **Trickles:** 2 m buffer, total mapped width 4 m. Do not map shorelines separately; the immediate surroundings are included in the trickle polygon.

● Creeks and other minor flowing waters represented as lines in source data:

- 0–2 m wide: 1 m buffer on the water surface line (total width 2 m). Map an additional 5 m shoreline buffer on both banks (natural habitat type: Inland shorelines).
- 2–5 m wide: 2.5 m buffer on the water surface line (total width 5 m). Map an additional 10 m shoreline buffer on both banks (natural habitat type: Inland shorelines).

● Flowing ditches are classified as Flowing waters.

- Seasonally dry ditches are not mapped as separate polygons.
- Ditch width is determined case by case from data and expert judgment; creek widths may be used where appropriate.

● Baltic Sea and inland water shorelines are mapped landward from the shoreline according to the habitat type.

- Use a 15 m shoreline zone for flowing waters wider than 5 m, ponds, lakes and the sea. Shoreline rules for smaller flowing waters are as above.
- **NOTE:** In built environments, land uses often extend close to the waterline. Where a field, footpath or similar feature approaches the edge of water, delineate the shoreline habitat polygon to reflect the actual land use at the site, which may produce a narrower shoreline zone than the indicative 15 m.

Assigning ecological condition and calculating scores

After the habitat-type classification, assign ecological condition using the habitat-specific indicator sets. For natural habitat types, use sources such as the BOOST criteria, existing nature surveys, local knowledge and other spatial datasets. Assigning ecological condition enables calculation of the biodiversity value for each habitat polygon and mapping of where ecological condition is strong or weak. The biodiversity value is also used as an indicator for calculating the values of climate-resilience and well-being benefits. Therefore the biodiversity value should be calculated before the other thematic values.

Climate resilience and well-being benefits are calculated on the same principle as the biodiversity score, that is, the habitat-specific potential is multiplied by the average of the indicators. A more detailed description of the calculation is provided in the next chapter. As a result, thematic maps for biodiversity, climate resilience and well-being benefits can be produced, along with their numerical scores, and various charts.

Calculation of the area’s thematic value: the sum of weighted vegetated areas is divided by the total area:

$$\frac{\sum (\text{theme total score} \times \text{polygon area})}{\text{total area}}$$

Assessing Plans at AL2

At AL2, the plans assessed are often either concept or reference plans that may depict land use in considerable detail (for example, architectural competition entries), or draft plans, in which habitat types and factors affecting their surface area or quality are not fully specified. The assessor’s task is to interpret the plan materials and, on that basis, make justified assumptions about the green structure that would result from implementation. In addition to the extent of vegetated areas and the mix of habitat types, the assessor must estimate or assume relevant quality factors. All assumptions and their justifications must be documented with the calculation.

Future ecological condition is evaluated in relation to the site’s current condition and the intended target condition for that site. When determining the quality of new habitat types, consider the purpose of the GAFD application in the case at hand: are the values being used to set a target condition, or to check compliance with a minimum level?

If the calculation is performed for a very early planning stage, when the plan does not yet allow a precise estimate beyond the total vegetated are, the plant cover and canopy cover can be assessed based on, e.g. SYKE’s Carbon map -tool materials that provide estimates for different land-use typologies. However, as planning progresses, the realised land use and especially the ecological condition of new habitat types may diverge from early assumptions, so the calculation should be refined at subsequent stages.

Accuracy level 3 (AL3)

At AL3, the ecological condition of the area’s green structure is determined through field surveys, so this level is best suited to reasonably small assessment areas. Otherwise, there is no restriction on planning context: AL3 can serve as baseline input for land-use planning just as AL2 does. In both cases the GAFD is calculated, but at AL3 it is based on field-verified ecological-condition assessments, whereas AL2 relies primarily on spatial datasets and desktop analysis.

At AL3, it is possible to quantify precisely the impact of land-use change on the area’s natural value hectares and to estimate the amount of biodiversity offset needed to achieve overall no-net-loss (Lähde et al., 2025b). The GAFD can also be used to set a compensation target for potentially lost anthropogenic habitat types. Ecological compensation must, however, comply with legislation. For example, lost natural habitat types cannot be compensated by establishing or improving anthropogenic habitat types.

Assessing Plans at AL3

To compare plans at AL3, each plan must specify, with sufficient precision, all new habitat types within the planning area and their intended ecological condition. This can be demonstrated by describing site-specific structural features and, where relevant, target species compositions. At this stage, it is also possible to identify construction and maintenance measures needed to achieve the plan’s targets. Plans suitable for AL3 are typically accurate detail plans or construction plans.

Is it so, then, that the smaller the calculation area, the more accurate the calculation is?

Not necessarily. If resources allow, habitat types can be surveyed in the field even across a large area, and the GAFD can be calculated accurately. It is better to think that the more detailed the planning, the more detailed the calculation should be.

Calculating the three theme values

At accuracy levels 2 and 3, the GAFD produces three theme values based on the habitat-type classification: *biodiversity*, *climate resilience*, and *well-being benefits*. Once ecological condition has been assigned to the mapped habitat types, the biodiversity value can be calculated. Climate resilience and well-being benefits are calculated using dedicated indicator sets. Detailed descriptions of the calculations and indicators are provided on the following pages.

For each habitat type, subject-matter experts have defined indicators and table values. These describe how much the habitat type can, at best, provide in terms of biodiversity, stormwater management, microclimate regulation, carbon sequestration and storage, and direct and indirect well-being effects. In addition, the three theme calculations use inputs such as canopy cover, wetness index and soil-derived values, as well as composite scores for well-being-related factors.

The GAFD yields three theme scores rather than a single ratio. Each score is reported on a 0.00–1.00 scale (to two decimal places) or, alternatively, as a percentage by multiplying by 100. The following pages describe the calculation of each theme score in detail.

As with other green-area-factor methods, the figures represent the quality-weighted share of vegetated area relative to the total assessment area. The same principle applies to all three theme scores: the area's theme score is calculated by summing the quality-weighted areas of all habitat polygons and

dividing by the total area. The weighted area of an individual habitat polygon is obtained by multiplying the polygon's area by its total theme score.

The climate-resilience score describes the potential of the green structure to deliver ecosystem services relevant to climate adaptation, such as stormwater management and carbon sequestration. The well-being score describes the potential of the green structure to provide well-being benefits; it does not quantify actual use by residents. Realised well-being depends on how much people spend time outdoors and interact with nature.

It is therefore important to note that the precision of the GAFD analysis differs across the three themes. At AL3, the biodiversity score is the most precise because it is based on field-assessed ecological condition, although expert judgement and interpretation of criteria can introduce some variability. Climate-resilience indicators are largely GIS-based, so their values are clear and comparable at all accuracy levels. The well-being score is indicative in nature because, unlike carbon accounting, well-being cannot be assessed from spatial data alone; it also reflects users' subjective experiences and interactions with their environment. While current-state analyses can be detailed, future-state calculations for planned solutions always rely on assumptions about the amount and quality of future green structure. It is therefore important to identify and document the assumptions underlying the calculation and to apply an appropriate precautionary principle.

This is how the calculation proceeds

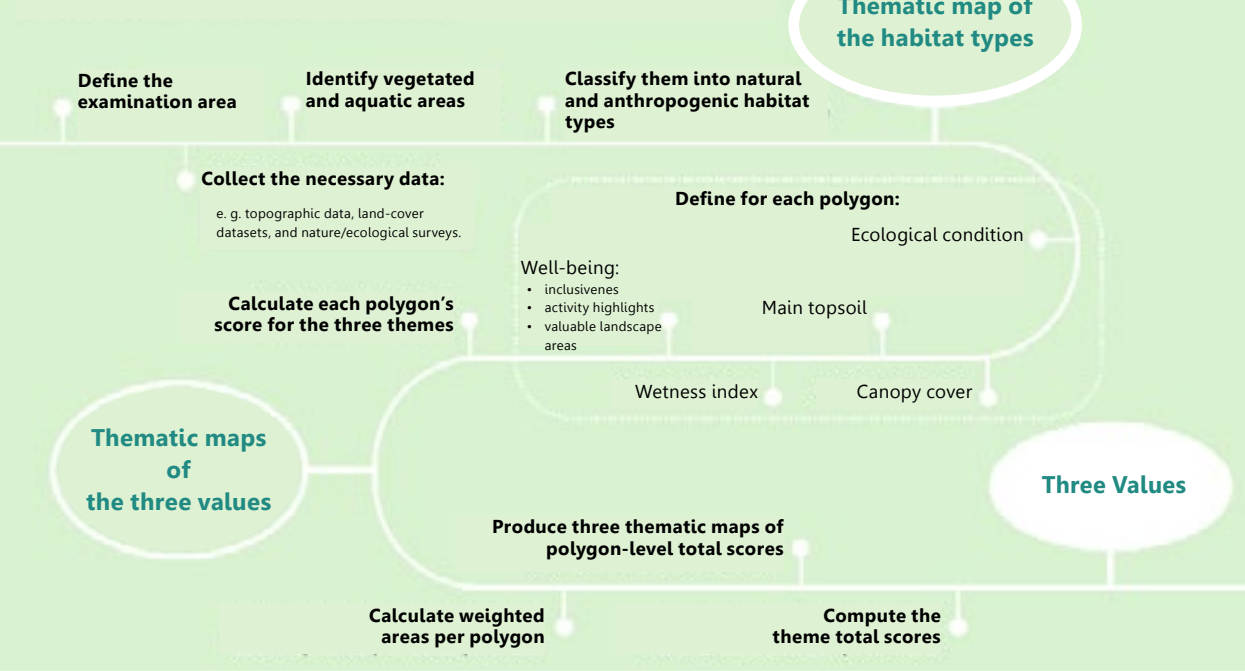


Figure 18. Diagram: ARVO project.

Producing the biodiversity value

The biodiversity value is determined using habitat-specific biodiversity potentials, ecological condition indicators, the surface areas of habitat-type polygons, and the total area of the assessment. Biodiversity potentials are shown in Table 3 on page 26.

First, calculate the total biodiversity points for each polygon by multiplying the polygon area by the biodiversity potential of its habitat type. This yields the biodiversity potential, which is used at AL1.

At AL2 and AL3, calculate the biodiversity-weighted area for each polygon by multiplying its area by the polygon's total biodiversity points (which reflect both potential and ecological condition). The biodiversity score for the whole area is then obtained by summing the biodiversity-weighted areas of all polygons and dividing by the total assessment area.

A simple image helps to illustrate the logic: biodiversity potential shows how large the glass is, and ecological condition shows how full the glass is (see figure 19, page 35).



Figure 19. A habitat type with a high biodiversity potential can be in a weak ecological condition and thus have a poor biodiversity value. Therefore, a habitat type that has a low biodiversity potential, when in good ecological condition, can get an equally good biodiversity value. Diagram: ARVO project.

Is the GAFD made up of three values added together or multiplied by one another?

No. The values are always presented separately, as part of their values are derived from one another. If added together, the effect of a single factor would be amplified in a way that is not appropriate.

Habitat type	Biodiversity potential	Ecological condition	Biodiversity score	Area	Area-weighted biodiversity value
Yard	0,7	0,6	0,42	500	210
Vegetation of streets and squares	0,3	0,7	0,21	200	42
Vegetation of streets and squares	0,3	0,3	0,09	50	4,5
Open park	0,6	0,5	0,3	1000	300

Table 5. Example of calculating the biodiversity value. First, the habitat types' ecological conditions are identified, then multiplied by the habitat type's biodiversity potential, resulting as a biodiversity score. The biodiversity score is then multiplied by the area size of the habitat type polygon in question, yielding an area-weighted biodiversity value that also informs the habitat hectares.

Producing the climate resilience value

The climate resilience theme is divided into sub-themes: stormwater management, microclimate regulation, and carbon sequestration and storage. For each habitat type, subject matter experts have defined potential values for stormwater detention and treatment, microclimate regulation, soil-stored carbon and vegetation-stored carbon.

In addition, the climate-resilience calculation uses the following indicators:

- canopy cover within each polygon
- soil properties affecting infiltration and water-holding capacity
- the topographic wetness index (TWI)

For some habitat types, climate-resilience values are taken directly from habitat-derived table values. For others, the score also incorporates canopy cover, soil type and TWI.

Stormwater management

In calculating stormwater management, habitat type specific values for stormwater detention and treatment are assigned directly to each polygon based on its habitat type. For aquatic habitat types and vegetation integrated into buildings and structures, the total stormwater score is taken directly from the habitat specific table values.

For open habitat types, the score also includes values derived from soil permeability and the

topographic wetness index (TWI). For habitat types that can be wooded, the score further includes a value derived from canopy cover. The grouping of habitat types into watery, open and wooded classes is described with the calculation formulae (p. 38). The principles for deriving the soil, TWI and canopy components are outlined below.

Habitat type	Canopy cover	Canopy cover score	Most common soil type	Soil type score	TWI	Scaled TWI	TWI score	Storm-water delaying potential	Storm-water managing potential	SWM score
Yard	7%	0.1	Clay	0.2	8	0.8	0.8	0.5	0.4	0.19
Street	48%	0.7	Landfill	0.6	2	0.04	0.1	0.2	1	0.28
Street	92%	1	Landfill	0.6	2.5	0.06	0.1	0.2	1	0.34
Open park	-	-	Silt	0.6	23	0.4	0.5	0.5	0.4	0.23

Table 6. The total scores for stormwater management are calculated from the values of different indicators and the habitat type-based potentials of managing stormwater.

Soil type

The soil indicator is determined by the most common surface soil type within the habitat type polygon. Soil types are ranked primarily by permeability, with water-holding capacity also considered, particularly for peat. If a soil type is not listed, the score should be estimated using the most similar soil type available. On stabilised surfaces, permeability is reduced, so these areas receive lower soil scores than comparable natural surface soils.

Soil type	Soil type score
Blocks of rock, large stones, small stones, gravel, sand, water, peat, sedge peat, sphagnum peat	1
Gravel moraine, sand, fine sand	0,8
Sandy moraine, silt moraine, moraine, silt, sludgy silt, fine silt, sludgy silt, backfill	0,6
Clay, clay sludge, sludge, solid rock	0,2

Table 7. Soil type scores used for calculating the stormwater management.

Topographic wetness index (TWI)	TWI score
<0,1	0,1
0,1–0,2	0,2
0,2–0,3	0,3
-	-
0,9–1,0	1,0

Table 8. TWI scores used for calculating the stormwater management scores.

Topographic wetness index (TWI)

The TWI describes an area's tendency to collect and retain water, based on surface elevation and the flow paths derived from it. It is calculated for the assessment area using a digital elevation model (DEM), after which the mean TWI value is computed for each habitat polygon. Polygon values are then scaled to the range 0–1, and scores are assigned according to the scaled value. Because the TWI factor ranks polygons by their relative likelihood of water accumulation within the computed extent, TWI-based values should not be compared across planning areas if the index was calculated with different spatial extents. To improve comparability within a municipality, the TWI should ideally be calculated once for the entire municipality and used as the common dataset for all assessments. If this

is not feasible, the index should be computed over as wide an area as possible to capture sufficient topographic variation. Polygon-level TWI scores are presented in Table 8.

Canopy cover

Values derived from canopy cover are used in the stormwater, microclimate and carbon calculations. In all cases, the canopy component is based on the percentage canopy cover calculated for each polygon. While the same percentage is used as input across themes, the resulting points differ by theme.

For stormwater management, Table 9 shows how canopy-cover points are assigned. The basic logic is consistent across themes: canopy cover below 10% is given a minimum value; the score then increases linearly up to 70% canopy cover, above which the score is 1. The minimum value and the slope of the increase vary by theme, while the endpoint at 70% is 1 in all case.

Canopy cover	Canopy cover SWM score
≤10%	0,1
10–70%	$0.015 \times (\text{polygon's canopy cover} - 10) + 0.1$
≥70%	1,0

Table 9. Canopy cover scores used for calculating the storm water management scores.

Calculating the total stormwater management score for habitat polygons:

For aquatic habitat types (lakes and ponds, flowing waters, spring fen types, Baltic Sea, artificial water basins, artificial wetlands) and **vegetation integrated into buildings and structures**:

$$\frac{\text{value according to the capacity to detain water} + \text{value according to the capacity to treat water}}{2}$$

For open habitat types (fields, novel meadows, open parks, road- and railside vegetation, shrub vegetation, ruderal areas, gardens, bare rock, cliffs, and stony ground, peatlands, and traditional rural biotopes):

$$\left(\frac{\text{value according to the capacity to detain water} + \text{value according to the capacity to treat water}}{2} \right) \times \left(\frac{\text{value according to soil permeability} + \text{value according to the wetness index}}{2} \right)$$

For wooded habitat types (rocky-terrain forests, herb-rich forests, pine forests, forested parks, inland shorelines, Baltic Sea shorelines, artificial shores, ground-contact yards, vegetation of streets and squares, and habitats created through industrial processes):

$$\left(\frac{\text{value according to the capacity to detain water} + \text{value according to the capacity to treat water}}{2} \right) \times \left(\frac{\text{value according to soil permeability} + \text{value according to the wetness index} + \text{value according to the canopy cover}}{3} \right)$$

In the formulas above, values derived directly from habitat types are shown in blue, and values derived from other source datasets are shown in green.

Microclimate regulation (MCR)

In open and aquatic habitat types, the total score for microclimate regulation equals the habitat-type table value for cooling potential. In wooded habitat types, canopy cover is also taken into account. For wooded habitat types, the total microclimate regulation score is calculated by multiplying the potential value by the score derived from canopy cover.

Canopy cover	Canopy cover MCR score
≤10%	0,43
10–70%	0,0095 x (canopy cover - 10) + 0,43
≥70%	1,0

Table 10. Scores determined for canopy cover percentages in microclimate regulation calculation.

Canopy-cover values are derived using the same basic principle as for stormwater management, but with different parameters. For microclimate regulation, the minimum value is 0.43 and the slope of the linear increase is 0.0095. The canopy-cover value used in the total score calculation is taken from Table 10.

Habitat type	Canopy-cover	Canopy-cover score	MCR potential	MCR score
Yard	0%	0,43	0,7	0,3
Street	48,4%	0,8	0,5	0,4
Street	92,4%	1	0,5	0,5
Open park	-	-	0,2	0,2

Table 11. Microclimate regulation's total score from canopy cover is calculated by multiplying canopy cover score with the given habitat type's potential for microclimate regulation.

Calculating the total microclimate regulation score for habitat polygons:

For aquatic and open habitat types (lakes and ponds, flowing waters, spring fen types, Baltic Sea, artificial water basins, artificial wetlands, fields, novel meadows, open parks):

value according to the capacity to cool the climate

For other habitat types:

value according to the capacity to cool the climate

x

value according to the canopy cover

In the formulas above, values derived directly from habitat types are shown in blue, and values derived from other source datasets are shown in green.

Carbon sequestration and storage (CSS)

Carbon sequestration and storage value consist of habitat type -specific values describing carbon held in soils and carbon held in vegetation. For wooded habitat types, canopy cover is also taken into account. These values are added to the attribute table in the same way as for biodiversity, stormwater management and microclimate regulation total scores, and are then used to calculate the total score for carbon sequestration and storage.

Additionally, canopy cover values are derived using the same basic principles as in the previous examples, but with different parameters: the minimum value is 0.25 and the slope of the linear increase is 0.0125. The canopy cover value needed for the total score is derived according to the adjacent table 13.

Canopy cover	Canopy cover score
≤ 0%	0,25
10–70%	0,0125 x (canopy cover - 10) + 0,25
≥70%	1,0

Table 12. Point scores determined for canopy cover percentages in carbon sequestration and storage

Habitat type	Canopy cover	Canopy cover score	Potential soil-stored carbon score	Potential vegetation-stored carbon score	CSS score
Yard	0%	0,25	0,4	0,4	0,17
Street	48,4%	0,73	0,2	0,2	0,28
Street	92,4%	1	0,2	0,2	0,34
Open park	-	-	0,6	0,2	0,40

Table 13. The total score for carbon sequestration and storage comprises canopy cover, potential soil-stored carbon, and potentials of soil- and vegetation-stored carbon.

Calculating the total carbon sequestration and storage score for habitat polygons:

For aquatic and open habitat types (lakes and ponds, flowing waters, spring fen types, Baltic Sea, artificial water basins, artificial wetlands, fields, novel meadows, open parks):

$$\frac{\text{value according to the potential soil-stored carbon} + \text{value according to the potential vegetation-stored carbon}}{2}$$

For other habitat types:

$$\left(\frac{\text{value according to the potential soil-stored carbon} + \text{value according to the potential vegetation-stored carbon}}{2} \right) \times \text{canopy cover}$$

In the formulas above, values derived directly from habitat types are shown in blue, and values derived from other source datasets are shown in green.

The climate resilience total score is calculated as the average of the total scores for stormwater management, microclimate regulation, and carbon sequestration and storage. The area-weighted climate-resilience value for each polygon is obtained by multiplying the polygon area by its climate-resilience total score. The climate-resilience theme value for the assessment area is then calculated by summing these weighted areas and dividing the sum by the total area.

Habitat type	Stormwater management score	Microclimate regulation score	Carbon sequestration and storage score	Climate resilience total score	Area	Area-weighted value for climate resilience
Yard	0,19	0,3	0,17	0,21	198,1	41,67
Street	0,28	0,4	0,28	0,32	189,2	59,8
Street	0,34	0,5	0,34	0,39	802,4	315,6
Open park	0,23	0,2	0,40	0,27	684,7	183,2

Table 14. Example calculation of the climate resilience value. The total scores for stormwater management, microclimate regulation, and carbon sequestration and storage are summed to obtain the climate resilience total score; this result is multiplied by the habitat polygon area to yield the area-weighted value for climate resilience.

Producing the well-being benefits value (WBB)

The well-being value combines the habitat-type specific well-being potential with indicators of well-being benefits. Well-being potential values are derived directly from the habitat type and are listed in the Table 19 on page 46. The indicator set also includes the total biodiversity value (from the biodiversity calculation) and the total microclimate value (from the climate-resilience calculation). Additional indicators are inclusiveness, valuable landscape areas and activity highlights. For background and a fuller description of how these potentials and indicators were derived, see “Evaluating the benefits of well-being as part of the district-scale Green Area Factor 2025 (Hyvinvointihyötyjen arvioiminen osana Alueellista viherkerrointa 2025 [in Finnish])”.

Biodiversity value

Use the same biodiversity values that were calculated earlier (see pages 35–36).

Microclimate regulation score

Use the same microclimate regulation scores that were calculated earlier (see page 40).

Inclusiveness

Inclusive areas include places that are accessible and elements that enable spending time (sitting, resting, etc.) in a given place.

Scoring of inclusiveness:

- Areas where access is prevented (e.g., fenced off) receive 0. As an exception, yards of day-care centres, schools and care homes are assigned 1 for inclusiveness.
- Not all habitat types include the inclusiveness indicator; see Table 19 on page 46.
- A habitat polygon receives 1.0 if it contains, or lies in the immediate vicinity of, elements that enable staying, such as benches, shelters, public toilets, water points or similar amenities. As a general guideline, “immediate vicinity” can be interpreted as within 20 m from the polygon boundary, applied case by case where needed.
- If the area provides limited or no support for lingering, assign 0.3.
- The list of enabling elements is illustrative, not exhaustive, and may be expanded as appropriate.

Inclusiveness	Score
Areas with access blocked	0
No elements enabling staying	0,3
Includes an element enabling staying	1,0

Table 15. Inclusiveness scores.

Valuable landscape areas

Some habitat types (e.g., shoreline types) receive a score of 1 directly for this indicator; see Table 19 on page 46. Since shoreline habitat polygons are often narrow and some near-water areas are anthropogenic, a 15 m buffer is delineated inland from the shoreline to form a separate “shoreline zone.” Owing to proximity to water, these areas receive a value of 1 for both valuable landscape areas and the activity highlights indicator, consistent with natural shoreline habitat types, and in line with the recognition of shorelines as restorative and recreational areas.

Valuable landscape areas include, for example::

- Nationally valuable landscape areas
- Nationally significant built cultural environments
- Regionally and locally valuable landscape areas
- Regionally valuable cultural environments
- Locally valuable cultural environments
- UNESCO World Heritage Sites
- Natural monuments
- Traditional rural landscapes
- Other valued environments
- Cemeteries
- National parks
- National urban parks
- People’s parks
- Minor flowing waters (e.g., creeks)

The list above is indicative and may be expanded to include other comparable categories.

Scoring of valuable landscape areas:

- 0.3 if no significant landscape area is present;
- 1 if a significant landscape area is present.

Valuable landscape areas	Score
Habitat type doesn’t include valuable landscapes	0,3
Habitat type includes valuable landscapes	1,0

Table 16. Valuable landscape area scores.

Activity highlights

These include places and elements that activate people physically, culturally or socially. Some habitat types (e.g., gardens) receive a value of 1 directly for this indicator; see Table 19 on page 46.

Functional highlights include, for example:

- Exercise and outdoor facilities (swimming places, dog parks, fitness stairs, etc.)
- Exercise and outdoor routes (fitness tracks, ski trails, nature trails, etc.)
- Playgrounds and play parks (including yards of schools and day-care centres)
- Prehistoric relics and nationally significant archaeological sites
- Public art and culturally significant sites
- Communal gardens, cultivation box areas, etc.

Scoring of valuable landscape areas: Consider highlights located within the polygon and those directly adjoining it.

- 0.3 If none are present;
- 0,8 if one is present;
- 1 if two or more are present.

As a general guideline, “immediate vicinity” can be interpreted as within 20 m from the polygon boundary, applied case by case where needed. The list of highlights is indicative and may be expanded.

Activity highlights	Score
No activity highlights	0,3
One highlight	0,8
Two or more activity highlights	1,0

Table 17. Activity highlight scores.

Note on specific anthropogenic habitat type:

For the anthropogenic habitat type “habitats created through industrial processes,” the well-being potential is set to 0, as this type does not generate well-being benefits and can, in the worst case, pose risks to physical and mental health.

Habitat type	WB potential	Biodiversity value	Micro-climate regulation score	Valuable landscape score	Activity highlight score	Inclusiveness score	WB score	Area	Area-weighted value for WB
Yard	0,9	0,42	0,3	0,3	0,3	0,3	0,36	198,1	72,2
Street	0,5	0,15	0,4	0,3	0,3	0,3	0,14	189,2	27,4
Peat-land	0,9	0,5	-	1	0,8	1	0,74	802,4	595,8
Open park	0,8	0,3	0,2	0,3	1	1	0,45	684,7	306,8

Table 18. The well-being benefit value is formed from the habitat-type well-being potential and the average of the well-being indicators shown in the table. The resulting well-being total value is multiplied by the habitat-type area to yield the well-being weighted area.

Calculating the well-being benefit value:

In practice, add the indicator values to the attribute table in the same way as for biodiversity, stormwater management and microclimate regulation total values; then calculate the polygon well-being values and derive the area-level well-being theme value.

Calculating the well-being benefit scores for habitat polygons:

biodiversity score

+

micro-climate score

+

valuable landscape score

+

activity highlight score

+

inclusiveness score

5

x

habitat WB potential

x

polygon area

In the formula above, values derived from previous calculations are shown in blue, and values derived from other indicators are shown in beige.

Calculation of the area’s thematic value: the sum of weighted vegetated areas is divided by the total area:

Σ (polygon well-being scores)

total area

Habitat type	Well-being benefit potential	Biodiversity value	Micro-climate score	Inclusiveness	Activity highlight	Valuable landscape areas
Forested parks	1					
Shrub vegetation	0,3			-		
Ground-contact yards	0,9					
Gardens	0,9				1*	
Fields	0,5					
Open parks	0,8					
Novel meadows	0,8					
Ruderal areas	0,3			-		
Vegetation of streets and squares	0,5					
Road- and railside vegetation	0,2					
Vegetation integrated into buildings and structures	0,5					
Habitats created through industrial processes	0	0	0	0	0	0
Artificial water basins	0,7					
Artificial shores	0,9				1	1
Artificial wetlands	0,7					
Baltic Sea	0,9		-	-	-	1
Baltic Sea shorelines	1				1	1
Lakes and ponds	0,9		-	-	-	1
Flowing waters	0,9		-	-	-	1
Inland shorelines	1				1	1
Peatlands	0,9		-	-	1	1
Traditional rural biotopes	1				1	1
Bare rock, cliffs, and stony ground	1		-			
Herb-rich forests	1					
Pine forests	1					
Rocky-terrain forests	1					
Forests	1					
Spring fen types	1		-	-	1	1

*except commercial plant nurseries, which receive a direct value of 0

Table 19. Well-being benefit potentials and given indicator values for each habitat type. Anthropogenic habitat types are shown in purple, and natural habitat types are shown in green.

Recommendations for using the results

The GAFD produces numerical values, thematic maps and diagrams. These must always be considered in the context of the planning area, so expert judgement is an important part of interpreting the results. It is advisable to produce current-state GAFD values as baseline information as early as possible. Thematic maps are particularly useful for supporting planning, while GAFD numerical values serve best for setting targets and for evaluating and comparing plans. Using the thematic maps for the three values makes it possible to identify priority areas and the most multifunctional parts of the green structure. It also helps to outline gaps in the area’s green structure that should be addressed.

User feedback collected from experts in the 12 pilot cities indicated that, at the plan stage, comparative GAFD calculations are most useful in clearly defined planning cases where the effects of alternative solutions can be examined. In future use, it is worthwhile to link the method to general objectives, such as “do not weaken the current state” or “improve the current state,” which gives verification of the objectives clearer meaning in the calculations. As typical values for different urban typologies become better defined, opportunities for comparison will increase and may also support setting numerical target values. In addition, based on the current-state assessment, it is possible to set objectives for minimising loss of natural values or for increasing them, depending on the baseline and the area’s specific characteristics.



Figure 20. Although it is important to identify habitat types, natural processes occur also across their boundaries. Illustration of an open park: City of Helsinki / Nea Vesterinen and Sara Korkeamäki.

In a densifying urban structure, where additional space is difficult to find and many functions compete for it, improving the quality of the available green structure becomes more important, without excluding quantitative increases. Rather than focusing only on total green area, the GAFD directs attention to eco-efficient area, which depends on both quantity and quality. The effectiveness of the green structure can also be improved by enhancing its ecological condition, that is, by improving quality. The thematic maps produced with the method should be interpreted and discussed, for example, through the following questions:

- Are the benefits provided by the green structure distributed evenly across the area?
- Where are benefits produced the most?
- Are there gap or shadow areas in terms of benefits?
- Where would it be particularly important to add green structure?
- Where would weakening the green structure cause the least harm?
- Where can the green structure most effectively achieve multifunctionality?
- When comparing the current state and the plan, has the mitigation hierarchy been followed?

For the **biodiversity value**, it is useful to focus on:

- How do land-use changes affect habitat types: which ones will be removed and what will replace them?
- When calculating the GAFD for a plan, what assumptions about future ecological condition are realistic? Assumptions can be refined through discussions with the parties responsible for subsequent planning.
- Over what timescale will the planned habitat types develop to reach the desired ecological condition?
- Can planning identify and suggest ways to improve ecological condition?



Figure 21. Winning proposal “Walk Around” in the Leppävaara architecture competition, one of the pilot areas. Image: Arco.



Figure 22. Three theme maps produced on the basis of the winning entry in the Leppävaara competition. The theme-values are presented as percentages.

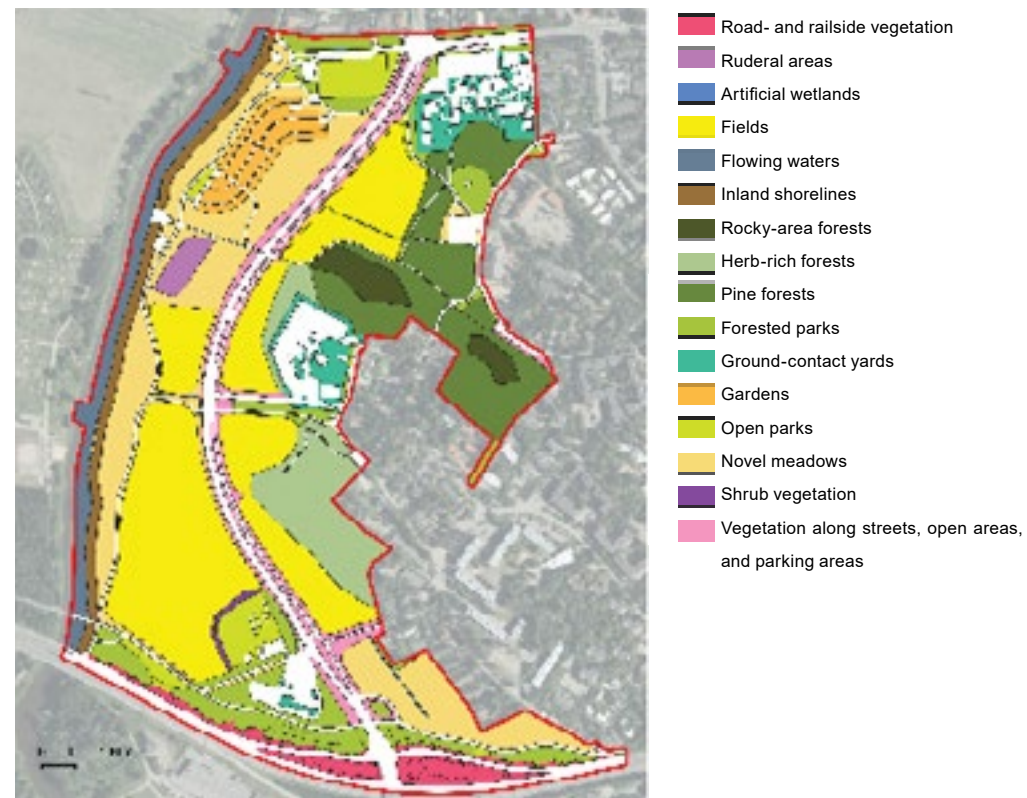


Figure 23. Habitat types identified from the current state of Pukinmäenranta pilot area. Image: City of Helsinki.



Figure 24. Pukinmäenranta pilot area's calculation was based on the detailed plan dataset. Image (general plan for public outdoor spaces): City of Helsinki

For the **climate-resilience value**, it is useful to focus on:

- Which factors surrounding the area influence the microclimate and thus climate-change adaptation (e.g., extensive forest areas or large heat-absorbing paved areas), and how does this affect the local demand for the relevant ecosystem services within the assessment area? Can planning provide solutions to meet this demand?
- How will the area and its green structure be used? For example, will there be substantial recreational use by people coming from outside the area? Is it likely that green areas will be used exceptionally heavily during heatwaves, and how can planning prepare for this?
- Which green areas are on private land or otherwise inaccessible to broader groups of visitors, for example during a heatwave?
- When examining the thematic maps, pay particular attention to vulnerable population groups and the accessibility of the green structure. In planning, consider ways to strengthen green structure and canopy cover in the immediate vicinity of schools, kindergartens and assisted-living facilities.

For the **well-being benefits**, it is useful to focus on:

- Are the well-being benefits provided by the green structure distributed evenly across subareas, and are there enough high well-being value areas relative to expected greenspace use?
- Where is well-being potential high – and why?
- Where does well-being potential remain low? Do these areas include, for example, schools, kindergartens, assisted-living facilities or presence of other vulnerable groups?
- Are there areas where the calculated well-being potential is high, but actual use is hindered by factors such as noise, barriers to access or safety concerns? Can planning improve the situation?
- Also review areas where benefits seem evenly distributed – does any component remain weak (e.g., landscape, biodiversity, inclusiveness, microclimate)? Can planning improve this?
- Which elements are missing from the green structure to enable staying, support psychological restoration or increase functional opportunities?



Figure 25. Thematic values (from left to right: biodiversity, climate resilience, and well-being) calculated for the Pukinmäenranta pilot area plan. Image: City of Helsinki.

Material produced with the GAFD should be cross-checked against other available studies. In particular, use:

- noise studies (can noise reduce expected well-being effects?)
- population and socio-demographic data (are there groups with special needs among users, and how do they relate spatially to areas with low well-being potential?)
- participation data (have residents or other user groups been engaged, and do the calculated results align with their experiences?)
- climate-resilience results, especially thematic maps, cross-checked with flood-risk maps and urban heat-island analyses for the same area
- ecological network studies

The GAFD is calculated for a defined area, but natural processes typically operate across human-made boundaries. For stormwater, consider the wider hydrological network and catchment systems. Similar stormwater measures are not appropriate everywhere; in some places volume control is the priority, in others water quality. Biodiversity should likewise be assessed in relation to the broader ecological network and the traits of local species.

Green structure should be preserved and developed with local characteristics in mind (for example, functional needs, townscape, cultural history), rather than automatically prioritising only those habitat types with the highest biodiversity potential.



Figure 26. Diverse habitat types are mutually supportive and produce a wide range of benefits.
Illustration: City of Helsinki / Nea Vesterinen and Sara Korkeamäki.

Conclusions

In the future, it will be important to continue utilising the GAFD, to collect data collaboratively and to set target levels for different land-use typologies. The project enabled only preliminary reviews on this topic. A more detailed analysis would require a broader dataset, which will hopefully be available in the future. In addition, applying the GAFD to an entire city in its current state was identified as a further research need. This would provide more detailed information on differences between neighbourhoods and urban typologies, and it would also help to address challenges related to defining assessment boundaries.

Following the strong methodological development achieved in the ARVO project, it would be worthwhile to invest in a digital tool or user interface to make the method easier to use and to enable rapid comparison of planning scenarios, even though calculations are already feasible with current GIS tools.

Strengthening urban green structure requires broad, cross-sectoral cooperation. We hope that continued development and use of the GAFD will also help to advance that collaboration.

Acknowledgements

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At the end of this publication, you will find the names of everyone involved. In total, 133 people participated in the project. **The biodiversity turn will be achieved together!**



Figure 27. ARVO project team, pilot planners and associate partners on an excursion in Jyväskylä. Photo: Maija Bergström.

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