Green Vision for Wageningen Campus

Facilities and Services, June 2019

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0. Executive Summary

Wageningen Campus is the visible calling card of Wageningen University & Research (WUR) and the companies that have established themselves on campus. WUR wants to show people who visit, work or study on campus that it is the 'Gateway to smart food in a green world' and let them experience it (Source: Wageningen Campus Strategy, 2013). The question is how WUR can demonstrate that the campus is working on themes relating to 'healthy food and living environment' (section 1) through the green surroundings of the grounds. To answer this question, we looked into the background of green spaces on site (section 3) in relation to a number of contemporary green concepts, such as nature, biodiversity and ecosystem services (section 4).

Analysis of the green space on campus shows that the original ecosystem consists of an alder shrub forest on slightly alkaline seepage grounds. Since the early Middle Ages, the area had been made more accessible and arable through reclamation and the straightening and linking of streams and roads. The state government established the first research institutes here mid-last century. The soil was cultivated and enriched for testing, the grounds adorned with decorative shrubs and trees and the nature garden near Lumen was laid out. The design of Wageningen Campus builds on the linear layout of the area and its historical landscape elements such as hedges, wooded banks and drainage ditches.

Expanding this type of connecting ecological zones offers good opportunities to increase biodiversity and strengthen the connection with the surrounding nature. On more intensively used parts of the campus, preference is given to (mixes of) wild and cultivated plants, which not only contribute to biodiversity on campus, but to the experience and appreciation of the greenery by campus residents and visitors as well.

At present, approximately 18,000 people work and study in an area of less than 70 hectares. As a result, pressures on the available space have increased enormously over the past 10 years. This is comparable to a developing urban area and the associated spatial and socio-economic challenges. The 'inhabitants of this city' travel to the campus to contribute to a cleaner, greener and healthier world. Opinions on what is representative of this mission vary from lots of colour and (decorative/utility) trees to fields of wild flowers and brush for native fauna.

The following concept for the further development of green spaces on Wageningen Campus has been formulated (section 2) based on this analysis:

WUR wants to turn Wageningen Campus into a showcase and living lab for a resilient, climate-resistant, liveable and healthy public space, based on the functions and mission of the 'campus ecosystem' – working (together) and studying in the domain of healthy food and living environment – and all related facilities and services. The green component of this campus ecosystem is representative of WUR's expertise. It expresses itself in an innovative, attractive mix of natural and cultural greenery with its natural appearance and high level of biodiversity, which is in keeping with the environment. These green spaces will be constructed and maintained in a commercially responsible and sustainable manner. The development and management of the green spaces will be carried out in consultation with 'residents' and stakeholders of the campus ecosystem and with input from WUR experts from education, research, and business operations.

Principles for the further development of this concept are as follows:

- The Wageningen Campus Master Plan (2009) shall remain the framework for further interpretations, as will legislation and regulations relating to spatial planning, the environment and nature;
- WUR is setting up a 'Going green together (on Wageningen Campus)' platform to stimulate and streamline (new) initiatives for living labs and to offer advice on nature-inclusive projects.
- WUR is developing a monitoring tool and a communication plan to raise the profile of the 'green approach'.

1 Introduction

Wageningen Campus is the visible calling card of Wageningen University & Research (WUR) and the companies that have established themselves on campus. WUR wants to show people who visit, work or study on campus that it is the 'Gateway to smart food in a green world' and let them experience it (Source: Wageningen Campus Strategy, 2013). This is largely due to the greening of the grounds.

Much has changed on campus over the past 20 years. Many WUR units in Wageningen are now located in new buildings on campus, student numbers have increased enormously and many companies have built on the 'business strip'. A bus lane has been constructed and places have been added for organising all kinds of activities. As a result, pressures on the available space have increased enormously.

On the other hand, the call for a 'greener' campus is becoming stronger in connection with the themes of WUR's Strategic Plan 2019-2022: *Humankind is exhausting the planet's wildlife and natural resources, malnutrition remains a global problem, cities are becoming overpopulated and the climate is changing rapidly.* Can we use the green spaces on campus to showcase how we are engaging with these themes and how do we go about that?

Section 2 formulates a green concept for this purpose and sets out a number of principles for the further elaboration of this concept. This concept is based on the story of the development of the campus' green spaces (section 3) and how they relate to a number of green concepts such as nature, indigenous and exotic ecosystem functions and biodiversity (section 4).

Wageningen Campus 2007

Wageningen Campus 2017 (below) / 2019 (above)

2 Green concept for Wageningen Campus

Under the influence of its inhabitants, the land on which Wageningen Campus was built has been vastly transformed over the past millennia, from rugged hinterland to pasture and agricultural land. The linearly divided cultural landscape which has thus been created, with its ditches, canals, hedges and tree-lined roads, forms the basis of the current campus (for a detailed description, see section 3: 'History of green spaces on Wageningen Campus').

At present, approximately 18,000 people work and study in an area of less than 70 hectares. This is comparable to the population density of a highly urbanised environment. The reactions of students and staff to the urbanisation of the campus are in many ways comparable to those of people in other environments that are becoming increasingly crowded and bustling: too much paving and traffic, too few parking spaces, too little greenery. Sometimes reactions are even more intense, because 'campus residents' view the development of the area from their own, often considerable, level of expertise.

This is evident from the satisfaction survey that Facilities & Services carries out biannually. In the 2017 survey, users gave the green spaces on campus an average of 7.5 (in 2014: 7.1). The result for Lumen and Gaia, however, is 5.7 and 6.5 respectively, while the other locations score between 7.7 and 8.5. Radix sits somewhere in between with a 7.2 (Source: Wageningen Campus product report, Customer Satisfaction Survey 2017). Comments vary from 'Unworthy of WU' and 'Getting more and more beautiful, but a bit bare in terms of trees and flowers' to 'Walking around campus is a feast for the eyes!'.

Beyond this discrepancy in the perception and appreciation of green spaces, the 'campus ecosystem' – the human-inclusive system of cooperating parties – is confronted with the general problem of urbanisation. Accessibility, parking, litter, graffiti are some of the frequently voiced complaints and reports. WUR's Strategic Plan 2019-2022 states: 'A new paradigm is needed for efficient planning and management of the urban environment. This paradigm shift must ensure that ecosystems and services are maximised, the ecological footprint of the cities is minimised and their ability to adapt to the changing climate and demographic and socio-economic conditions is increased.'

2.1 Showcase and living lab public environment

By considering the campus ecosystem as a developing urban area, the development and management of the green spaces on Wageningen Campus will be placed within the perspective of 'nature for the public space'. Biodiversity in this context means the creation of robust flora that accommodates a wide variety of life and fits in with the growth conditions and functional requirements of the area (see section 4: 'Green concepts and the campus' for a detailed explanation). Maintenance is simple and is carried out in accordance with 'smart' management plans, which are socially, ecologically and economically sound. The flora is adapted to differences in the experience of users and takes safety, public health and connection to the surrounding rural area into account.

The nature gardens at Lumen and Atlas differ slightly from the previous principle. They provide space for vulnerable flora as an expression of WUR knowledge in the field of nature development. The experimental garden, 'The Field', can be seen as a showcase for agricultural nature, but also as a living lab for urban agriculture and user participation. These special green elements distinguish the campus ecosystem from an average urban environment or business park.

The above translates into the following concept for the further development of the green spaces on Wageningen Campus:

WUR wants to turn Wageningen Campus into a showcase and living lab for a resilient, climate-resistant, liveable and healthy public space, based on the functions and mission of the 'campus ecosystem' – working (together) and studying in the domain of healthy food and living environment – and all related facilities and services. The green component of this campus ecosystem is representative of WUR's expertise. It expresses itself in an innovative, attractive mix of natural and cultural greenery with its natural appearance and high level of biodiversity, which is in keeping with the environment. These green spaces will be laid out and maintained in a commercially responsible and sustainable manner. The development and management of the green spaces will be carried out in consultation with 'residents' and stakeholders of the campus ecosystem and with input from WUR experts from education, research, and business operations.

In order to further develop this concept, a number of principles have been formulated:
- The Master Plan and zoning plan based on it will continue to form the framework for the layout of Wageningen Campus (and, by extension, for the green and blue structures as well);
- WUR acts within the framework of existing legislation and regulations, but also influences them with the development of knowledge;
- WUR thinks positively and critically about plans for the surrounding rural and urban area and their impact on Wageningen Campus' green spaces;
- WUR wants to continue playing a pioneering role in nature-inclusive spatial development;
- WUR will draw up management plans and guidelines to ensure that nature and biodiversity are taken into account as much as possible when carrying out work;
- In order to further develop the green concept in consultation with various stakeholders, WUR will mobilise all relevant knowledge, make it physically and virtually visible (showcases), streamline initiatives (living labs), and give integrated form to communication and interaction with users and stakeholders ('Going green together (on Wageningen Campus)' platform).

These principles are further elaborated in the following sections.

2.2 Framework for further development

The Wageningen Campus Master Plan (2009) and all related decisions will continue to guide the locations and the intended function of the green elements at each location. This is characterised by the linear structures of watercourses, wooded banks, hedges and tree-lined roads, supplemented with low-growing flora for a feeling of openness and long sightlines. This multifunctional nature forms the facade of the basic infrastructure, which is embedded in the municipality's structural visions and zoning plans.

WUR thinks positively and critically about plans for the surrounding rural and urban area that affect Wageningen Campus, such as better access to Wageningen Campus (Campus route) and the Ede-Wageningen knowledge axis. Locations on campus that form part of this planning process are some of the related procedures and activities, such as nature value research, the MER (Environmental Impact Study) procedure and meetings and design studios organised for the public. Decision-making on this issue forms the framework for further development of the green spaces on campus.

WUR respects the (cultural-historical) nature values present on campus and the relationship of campus green spaces to the surrounding landscape. However, it does reserve the right to apply a 'contemporary or unconventional twist' here, if new insights and innovative ideas from 'residents' and stakeholders of the campus ecosystem give cause to do so. Of course, such 'twists' would always be within the limits of legislation and regulations, such as the nature conservation act, the environmental act and general local regulations (APV, Municipality of Wageningen). WUR will continue to influence legislation and regulations by providing society and politicians with knowledge about green development and management in relation to the major issues of our time.

2.3 Working together on green spaces

In order to issue a statement on how green space can support and strengthen public space functions, WUR is marshalling all its knowledge on this theme in living labs. For example, it encourages experts in the field of green cultural spaces and indigenous ecosystems to work together on the question of how to incorporate biodiversity on campus and how to anticipate climate change, as well as the residents'

experience of the green spaces. Not only by planting new things, but especially by utilising the campus as a research and educational resource.

This has happened regularly in recent years. Tree experts and forest ecologists, for instance, have made a selection of species that suit the growing conditions on campus. These are comparable to urban areas and the climate stress faced by European forests. The 'twittering tree' at Orion tells the story of how this affects its growth. Students learn how to identify the flora and fauna in ponds, nature gardens and flower meadows in practical courses. For those interested, an overview of all activities in which (WUR) expertise is involved in the design and maintenance of green spaces and in making the knowledge and ambitions of WUR visible is available (20190213_Wageningen Campus Living Lab).

In order to stimulate and streamline new initiatives, WUR is setting up a 'Going green together (on Wageningen Campus)' platform. The platform consists of representatives from education, research, value creation, and business operations who, within the framework of the green concept, coordinate initiatives and activities and influence funds and budgets. The platform is building up a network within the WUR community for advice and the establishment of links for the purpose of arriving at joint projects. This network consists of green specialists and/or (WUR) representatives of existing bodies and initiatives that have something to say on the theme. For instance, Green Office Wageningen, WEnR garden committee, CSR green project, the WUR 'Metropolitan Solutions' and 'Biodiverse Environment' programmes, and the Delta Plan for Biodiversity Recovery.

2.4 Visible impact

The impact of the activities to develop the campus as a showcase of greenery in the public space depends on the visibility of the results. WUR gives physical, communicative and interactive form to this visibility.

Design and layout

In the case of 'physical' visibility, WUR responds to users' perceptions of green space. An average user associates a 'green living environment' with colour and trees. More rugged areas interspersed with tidy shapes and surfaces give a feeling of clarity, safety and tranquillity. Flower meadows are beautiful in June, but less so when they have finished flowering. The more intensively used parts of the campus are therefore particularly suitable for special, flowery (ornamental) plants with a natural appearance. The habitats of wild flora and fauna, such as flower meadows and linking ecological zones, fit better on the campus' periphery, where the fauna can also find peace and sufficient space.

A special form of dealing with green space in public spaces is nature-inclusive spatial development. Here too, WUR wants to play a pioneering role. This can be witnessed in the 'greenest parking deck of the Netherlands' and the first bio-asphalt cycle path. The 'Going green together (on Wageningen Campus)' platform can serve as a link to combine relevant WUR expertise to advise on future projects, such as the 3rd education building, Dialogue Centre, the redesign of intersections and the expansion of bicycle parking facilities.

Green management and maintenance

What also catches the eye and what people pay attention to is how the green space is maintained and managed. Drained watercourses, dying trees in withered grassy plains or interventions in the greenery to widen paths or construct buildings are, according to many people, not evidence of knowledge of (ecological) green management. However, WUR has drawn up specific management plans and guidelines for various sites and activities in order to take stock of nature and biodiversity as far as possible when carrying out the work. These include the management plans for nature gardens, the General Technical Programme of Requirements for building activities and the requirement for the landscaper to work in accordance with the code of conduct for the sustainable management and maintenance of green spaces.

Management measures are the result of weighing up different and often competing interests and factors. For example, for reasons of sustainability, watering and (organic) fertilisation of the campus is only carried out in extreme cases. Feasibility and cost considerations play a role in the search for methods to keep pavements free of weeds and tackle invasive exotic species without (legally permitted) use of biocides. The 'Working together on green spaces' platform can give an impetus to working together on management plans to incorporate changing insights and innovative materials and methods in green management and maintenance.

Monitoring and communication

Many of the living lab activities are not immediately visible, such as observations with sensors, bird ringing, soil and water research and the reports of formal nature value research. However, these activities provide interesting information about the campus' greening ups and downs. By integrating the often separate data files into a widely accessible and interactive monitoring tool, residents and other interested parties can follow developments. Potentially with the possibility to offer observations (citizen science).

Information boards can provide background information on what people are seeing, but are susceptible to theft and damage. Smart campus concepts, such as virtual walks, offer interesting alternatives that do not interfere with the layout and existing objects can be updated more easily.

WUR is drawing up a communication plan that includes these and other actions. The aim of the plan is to generate impact in the market and society, but also to make campus residents aware of the how and why of the green spaces on campus and constructively contribute to thinking about and working to promote biodiversity and a vibrant living environment.

3 History of green spaces on Wageningen Campus[1]

The land under Wageningen Campus has been at its current location for about 2 million years. In the penultimate ice age, it was covered by the trailing edges of a glacier. Approximately 150,000 years ago it started to melt, leaving behind a glacial basin: the Gelderland Valley. The location of the campus, on the crossing between the higher situated sandy soils of the Veluwe and the (former) peat marsh along the Grift, was decisive for the grounds' use and the development of the green spaces within them.

3.1. Green spaces up to the middle of last century

The retreating glacier left a loamy, sandy soil with gravel and layers of clay, where in some places groundwater from higher elevations is pushed up (seepage currents). The flora largely consists of wet grasslands and shrub forests of birch, willow and alder. The first inhabitants (approx. 5000 BC) settle in a ribbon on the higher, drier parts. There they developed the fertile lands for agriculture. Their cattle grazed on the edges of the campus. In the woods, they collected wood and berries.

In the early Middle Ages, the residents joined forces in village communities and set up local authorities to jointly manage the land. They built ramparts along the edges of the Veluwe to protect the fields. Wooded banks, hedges and hedgerows served as fences and for the supply of firewood and food. Around the 12th century, landlords seized the initiative for a systematic and extensive exploitation of the lower-lying land. They made the area around the campus more accessible and tillable by straightening and connecting existing streams and roads (Dijkgraafse and Bennekomse polders). Wooded banks, alders, pollard willows, coppice forests and (wet) hay fields and meadows were planted or laid, as well as stately oak lanes from the Nergena estate to the city of Wageningen (figure 1).

Figure 1: This map from 1752 of the Bovendijkgraafse polders shows who had a lease on what land and for what purpose. From bottom to top: Dijkgraaf, fifth polder, Bornsesteeg, sixth polder, de Lange Steeg, seventh polder, Brink. Light yellow parts are fields. Tobacco was the primary crop on the drier parts at the peripheries. Plots on the south side (right-hand side of the map) with larger green dots are orchards. The site of the current Dassenbos (in frame) was used as '*Weij en Bouw Land*'' (pasture and agricultural land) (16, northern part) and '*Akkermaal*' (15, southern part). The 'Sterrebos' of Landgoed Nergena is seen on the left of the map.

[1] Images and texts are taken from a background memorandum on the development of the area and the characteristic green elements: 20190516_Het groen op Wageningen Campus in historisch perspectief.

3.2 Green spaces from 1950 until the construction of Wageningen Campus

In the 1950s, the government established the first research institutes here (predecessors of Wageningen Research WR). The soil was cultivated and enriched for testing, and the sites had ornamental shrubs and trees added. A number of these are still present, such as the large poplars near Orion and the small forest east of Forum.

In 1998, the nature research moved from WR to Lumen, an environmentally and people-friendly building with two large courtyards. The architect designed a garden near Lumen with a large pond to irrigate the plants in the atria. Within this design, WR's ecologists created a garden with rough, species-rich grasslands. It is an example of how, with the right measures, former agricultural land and industrial sites can be returned to nature. A garden around the Leeuwenborch had already been laid out in 1973 according to the same principles. However, due to inadequate management, the variation originally introduced did not propagate.

Around 2000, WR and Wageningen University (WU) merged. Soon after, the new Executive Board decided to concentrate education on the WR grounds north of Wageningen. It commissioned a landscape and urban design for the development of the site, in which the linear structures of the surrounding cultural-historical landscape form the basis (De Born Master Plan, 2009). Old, existing wooded banks and groups of trees were supplemented with flowering hay meadows, wild forests and oak lanes, among other things, to create an open park landscape with long sight lines and connection with the surroundings. Field maple hedges surround the car parks. A number of large ponds and watercourses with locks ensure better water management and connection to the ecological water system of the Municipality of Wageningen. The works coming from the gardens of abandoned WR and WU buildings were placed along an art route.

3.3 Green spaces from the construction of Wageningen Campus to date

The completion of the second educational building 'Orion' marked the start of the next step in the development of Wageningen Campus: attracting companies and stimulating vibrancy (Wageningen Campus Strategy, 2013). When asked how the attractiveness and suitability of the outdoor space for meeting and interaction could be increased, users regularly refer to the 'green' image. They want to see WUR's knowledge and mission reflected in the plants: more colour, sheltered seating areas, nature and trees, an orchard and fruit for picking (Vibrancy Master Plan, 2014).

These wishes have been elaborated in an integrated green plan (2016). In consultation with WUR experts and students, approximately 300 trees were subsequently planted, including the 'Timeline of apple production'. A wetland version of Lumen's nature garden has been laid out at Atlas. 'The Field', an experimental garden behind Vitae has been set up, where students and staff can carry out small-scale, soil-related projects. Various new user spaces, such as the amphitheatre near Impulse and the square in front of Forum, have been beautified with trees and flowering groups of shrubs (see figure 2 as well). Alternating with the grassy lawns for sunbathing and recreation, 10,000 m2 of flowering hay meadow has been sown.

The Field, May 2019, implementation of student project Eetbare Academische Tuin (Edible Academic Garden) (EAT, 2013)

Terrace platform on the pond at the Forum square

4. Green concepts and the campus

Green can have many meanings. For many people, green is nothing more than the 'wallpaper' of a space to be used. Functionality comes first: being able to move quickly and safely from A to B and having space to relax and organise activities. This group values greenery that supports these functions and looks attractive: lots of colour, variation in height and shape and well cared for throughout the year so that it does not become a breeding ground for pests and diseases.

The other group sees green as the cornerstone of life. They are worried about the precipitous decline in plant and animal species and the deterioration of nature in general. This group looks 'through the wallpaper' and appreciates the green that they experience as a 'treasure trove of native flora and fauna': countless wild flowers and rugged terrain to provide food and living space for a host of animals. In discussions about what this means for the campus, terms such as nature, biodiversity, ecosystems, indigenous and exotic are bandied about and jumbled. This section aims to provide a modicum of clarity in the terminology in order to arrive at shared concepts so we can work together on the further development of the green spaces on Wageningen Campus.

4.1 Ecosystems

Minerals, moisture, light and temperature or the physical factors of an area determine which plants (can) thrive and which animals (can) can survive there. Over the course of time, a balance develops between 'dead and living nature' and one area begins to distinguish itself from another area as a relatively stable biotic community. This can be done at different levels of scale, depending on what is considered typical soil structures, vegetation or animal species of the biotic community. At the highest level of scale, one speaks of ecosystems.

The self-ordering of ecosystems is often taken as a criterion for what constitutes nature. Nature that can only survive with human management, such as heathland, is called semi-natural. If there is only an ancillary function to green spaces, such as agricultural production or urban green spaces, this is referred to as functional nature.

The original ecosystem of the campus is an alder shrub forest on slightly alkaline seepage grounds. Groups of shrubs, a brook or an open space are examples of smaller, typical biotopes. An even smaller unit (habitat) is, for instance, a fallen tree on which all manner of moss, fungi and insects settle.

Physical conditions have changed at a number of locations on campus. For example, the soil has been intentionally depleted to create the nature gardens at Lumen and Atlas. A specific management plan ensures that the desired variety of species develops here. The ponds, dug at the beginning of 2000, have also developed into balanced biotopes. Pike were observed last year. However, without targeted management and maintenance, the ponds would not be able to regulate themselves and the campus would soon be overrun with willow, poplar, black alder and common herbs and shrubs such as blackberry, nettle, mugwort and pitrus. These rugged flora species are partly the result of (former) fertilisation and cultivation of the soil, but are also characteristic of the physical condition of the area since the retreat of the glacier.

4.2 Natura 2000 and National Nature Network (NNN) areas

Due to human influence, variation in (abiotic) environmental factors has become increasingly monotone. In recent centuries, many soils have been polluted or enriched with fertilisers from agriculture, industry and traffic, or dehydrated by land reclamation and water extraction. In order to prevent the disappearance of ecosystems, it has been researched which ecosystems are valuable and what measures are needed to preserve them. Alterra has brought these studies together in the 'Syntaxonomic Biological System'. SynBioSys is the basis for the allocation of the Natura 2000 areas and the National Nature Network (NNN), formerly the National Ecological Network (EHS).

The Province of Gelderland has arranged this in the form of the Gelderland Nature Network (GNN). To the northwest of Wageningen Campus is the Binnenveld, a meadow bird area and quiet zone, part of which has been designated as a Natura 2000 area. The Rhine tributaries and the Veluwe are also Natura 2000 areas. The Municipality of Wageningen is working on the 'Northern ecological connecting zone', which runs from the Utrechtse Heuvelrug to the Grift and to the Veluwe via the Binnenveld. Animals that live in these areas forage on campus or use them as (temporary) shelter. Wageningen Campus' landscape design anticipates this with (small-scale) connecting zones and stepping stones (Appendix 1).

4.3 Nature types

Human influence has also increased the variation in living environments. Humans introduce elements that are not indigenous to the area (hedges, ditches) and stagnates or accelerates the natural development process of an area. As a result, many historical landscape elements house biotopes and habitats that would not exist nor could survive without human intervention. The question is where, when and how people should intervene to conserve, develop and manage nature.

In order to streamline discussions on the conservation and management of nature in the Netherlands, the provinces had the Nature and Landscape Index developed based on SynBioSys. A distinction is made between *nature types, landscape element types* and *agricultural nature types*. For each type, the characteristic nature values, most important physical and spatial conditions and the management requirements are described. Managers who design and manage their area according to these criteria can receive a subsidy from the province.

The municipalities of Wageningen and Ede have published historical value maps. These show that Wageningen Campus consists mainly of wet, locally loamy, sandy soil, traditionally used as grassland. This landscape was more or less regularly divided into ditches, (alder) canals and tree-lined roads. Most of the land had already been drained by the 19th century to be used for fields and buildings.

Figure 2: Layout of Wageningen Campus in March 2015 with new design elements and green spaces (Source: Vibrancy working group for the project 'Further Development of Wageningen Campus').

The historical layout has been maintained and reinforced in the landscape design of Wageningen Campus. A number of characteristic *landscape element types* have also been integrated into the design, such as the wooded embankment along Bornsesteeg, the coppice forest (Dassenbos) in the west of the campus and an old ditch with pollard willows on The Field. The current planting of these green elements probably dates from just before the Second World War. Photographs by the RAF from 1945 show the almost bare banks of the Dassenbos and the Bornsesteeg as a white strip of land.

The flower meadows, nature gardens, The Field (formerly EAT) and stepping stones are elements with characteristics of *(agricultural) nature types*. These biotopes on Wageningen Campus are relatively small (1 to 2 hectares). Although interesting in themselves, their role as a buffer/connection to the environment is of greater importance (see Appendix 1 and figure 2).

4.4 Nature values

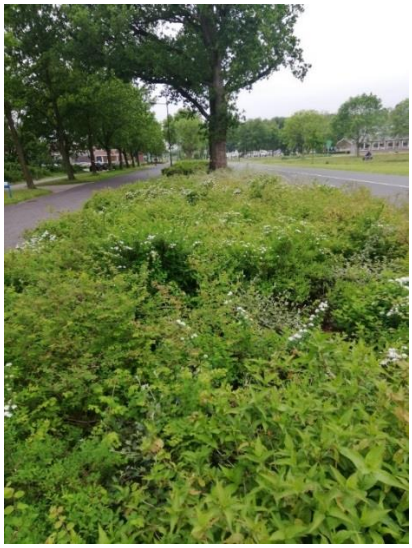
According to the Nature Protection Act, all spatial interventions with possible damage to nature require a permit or exemption. The law defines what is covered by the protection and applies different levels of protection. Major spatial interventions, such as new construction, demolition and infrastructural work, are accompanied by a nature value study. This research takes stock of the flora and fauna present, identifies the protected species and examines how animals use the area under investigation for one year.

In 2009, an extensive nature value study was carried out for the Wageningen Campus zoning plan, based on year-round field measurements and data from the National Database Flora and Fauna (NDFF). This was then repeated twice. The latest version dates from November 2017. In the case of minor renovations, applications for cutting permits or prior to maintenance work, WUR has ecological tests carried out to determine whether and which compensatory or mitigating measures are required to protect the flora and fauna present.

The measurements show that various special plant species occur on the campus grounds, none of which is currently protected under the nature conservation act. The species in question can mainly be found in the nature gardens at Lumen and Atlas. They originate from seed mixtures used in the landscaping of these areas. Protected animal species living in the area use the WUR grounds to migrate and forage, in particular, various species of bats. The protected brown hairstreak (butterfly) has been observed in the thickets around the Lumen garden and along the bus lane.

4.5 Indigenous and exotic species (exotics)

The Register of Dutch Species provides an up-to-date and comprehensive overview of plant and animal species naturally occurring in the Netherlands. Dutch specialists bring together the information from other sources and determine the status of a species according to established criteria. For example, whether a species has reached the Netherlands on its own or has been introduced by humans and how it has managed to maintain (and reproduce) itself. This creates a theoretical divide between native and exotic species, whereby the status of a species may change over time. For example, because the ranges of animal and plant species in our part of the world are shifting northwards as a result of changes in temperature. In addition, horticulture in the Netherlands has led to the introduction of species that are slowly but surely seen as an accepted part of our landscape.



Line of five low-growing ornamental shrubs have something to offer year round and can withstand shade, bright sun, aridity and wet conditions.

Flower meadow with perennials opposite Orion's terrace. Wild plants mix with exotic grasslands such as pimpernel (Sanguisorbia menziesii) and Iris sibirica (left), European bluestart (Amsonia orientalis) and lady's-mantle (Alchemilla mollis).

In other words, Dutch nature is more than biotic communities of indigenous species. The common corn-cockle and poppy, for example, are native according to the Dutch Species Register, while the cornflower is an established exotic species. All three are characteristic of the 'grain field' *agricultural nature type*. The American currant tree is also an exotic species, but is now listed in the Veldgids

Plantengemeenschappen van Nederland (field guide of plant communities in the Netherlands (J. Schaminée et al., 2010) as a species of the pendunculate oak and beech-oak forest.

Exotic plant species can also act as alternative host plants for (protected) native animals. The berries of the American currant tree, for example, are very popular with our birds. The discovery of the brown hairstreak in the shrubbery along the bus lane is also striking. Only ornamental shrubs are found there, while it is generally assumed that the indigenous blackthorn (Prunus spinosa) is the (only) host plant of this butterfly.

4.6 Ecosystem services

Nature provides all kinds of products important to people, such as wood, drinking water and clean air. Nature in the city can serve as a space for water storage and city cooling and offers people peace and relaxation. In fields, the natural fertility of the soil ensures that crops can grow. These contributions by nature to human survival and functioning are called ecosystem services (see figure 3).

A survey among students asked which campus ecosystem services they consider to be the most important and in which landscape elements they mainly see them. This survey showed that they attach particular importance to cultural services. Elements that support recreation and relaxation, such as lawns, groups of trees and water features, score the highest. The regulatory services of green space are recognised, but above all, they are seen as a value in the general public interest.

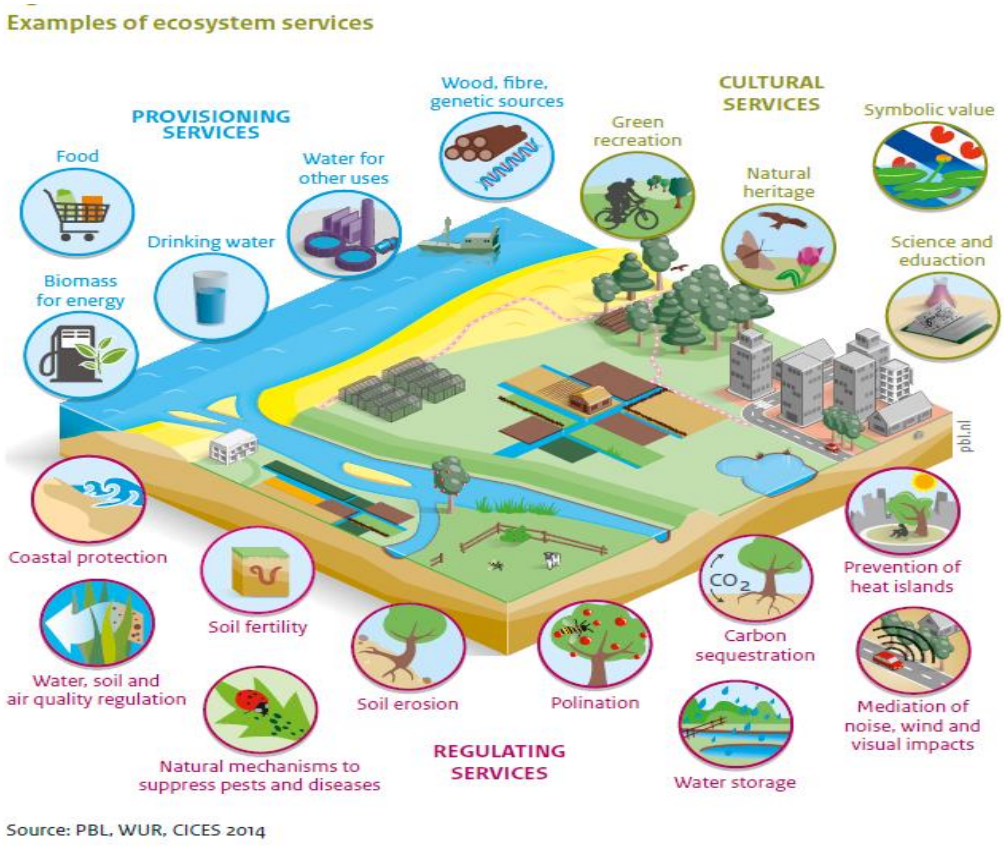


Figure 3: Overview of ecosystem services (Source: 'What nature offers mankind', Netherlands Environmental Assessment Agency, 2010)

4.7 Biodiversity

Biodiversity is the living part of nature and encompasses the variation in life on earth, at the genetic, species and ecosystem levels. In this concept, man is an external factor (see figure 4). Human activities influence the (physical) living conditions of species or interfere with evolutionary processes by breeding and exchanging genetic material.

Biodiversity is used as an indicator of the vitality of nature as a provider of ecosystem services. Research shows that biodiversity is declining all over the world. In the Netherlands, this has led to a call to use our knowledge, prosperity and energy to restore the variety of species, ecosystems and landscapes. (Delta Plan for Biodiversity Recovery, December 2010). The aim is to jointly tackle pressure factors and threats such as eutrophication, dehydration, acidification, pollution and fragmentation, and to stimulate favourable habitats for wild animals and plants.

For example, more than 75% of hedges have disappeared from the Dutch landscape since the introduction of barbed wire. As a result, the flora and fauna that had their habitat there have also been lost. Because hedges, bushes and wooded banks are typical of the campus landscape, they offer opportunities to increase biodiversity on Wageningen Campus and strengthen the connection and buffer zones with the surrounding nature areas. Especially in combination with flowering areas that provide food for insects, birds and other animals from early in the year until late in the autumn.

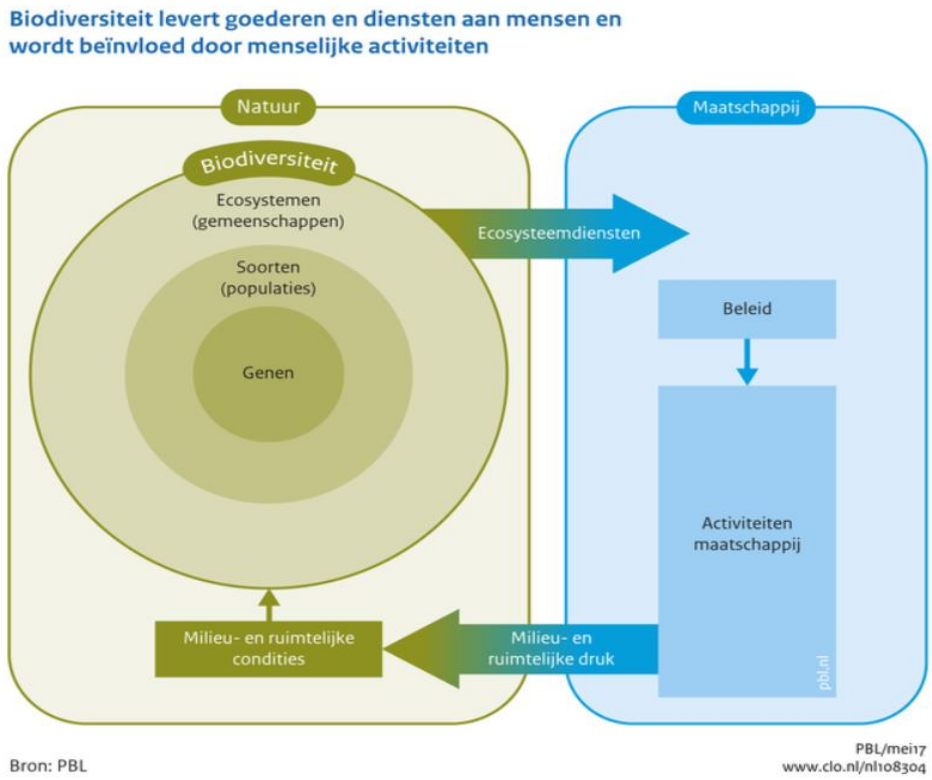


Figure 4: Ecosystem services in relation to nature and society. Nature includes biodiversity (from the genetic and species level, to entire ecosystems) and environmental and spatial conditions. Nature provides ecosystem services and is under pressure from society (policy and social activities). Netherlands Environmental Assessment Agency (PBL), May 2017

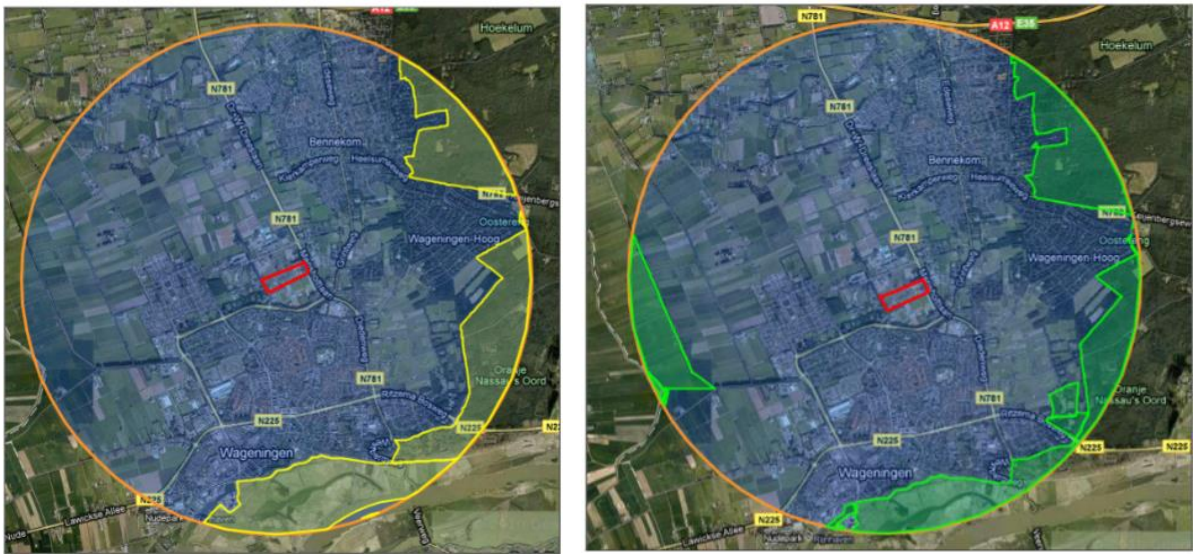
The plan for biodiversity recovery focuses on wild (i.e. indigenous) plants and animals, especially the vulnerable species that are in danger of disappearing. However, exotic and cultivated native species (i.e. cultivated plants) can also be an enrichment for (local) biodiversity because they offer an expansion of the range that meets the desired functionalities and existing growth conditions. Moreover, places with a colourful mix of exotic plant species, such as arboreta and large flower borders, are often hotspots for insects, birds and other animals. On the more intensively used parts of the campus, experiments are therefore being carried out with (mixes of) wild and cultivated plants. Such as the flower borders on The Field, the planting of the parking deck at Radix, the shrubbery ribbon along the bus lane and the flower meadow with perennials opposite Orion's terrace (see also photos in section 4.5).

5. Selection of consulted websites and (online) publications

Biodiversity WUR
Central Dutch website on biological diversity
Nature and Landscape Index. BIJ12
Netherlands Ecological Research Network (NERN)
Nederlandse Soortenregister
Synbiosis Alterra

Dijkveld Stol, J.J., 1965 (?): De duizendjarige geschiedenis van het landgoed 'De Nergena' temidden van de polders van Wageningen en Bennekom.
Hoffman, Marco, 2011. Inheemse en uitheemse soorten in stad en landschap. Plant Publicity Holland, Boskoop.
Kwartiermakers 'Samen voor biodiversiteit', December 2018. Delta Plan for Biodiversity Recovery.
Lueschen, Tim (Rudolf de Groot and Lars Hein), 2016. Identifying and valuing ecosystem services on the campus of Wageningen University. BSc thesis.
Opdam, Paul, 2009. Groen-blauwe netwerken in duurzame gebiedsontwikkeling, Habiform/ Wageningen UR.
Wit, H.C.T. de, 1959. Inaugural address Agricultural College Wageningen. Plantensystematiek. Veenman & Zonen, Wageningen.

Appendix 1: Location of Wageningen Campus in relation to nature areas



Natura 2000 (left, yellow shaded) and National Ecological Network areas (right, green shaded) within a radius of 3 km (orange circle) to the planning area (red outlined). This planning area is the Schiphorst nursery, where the business strip of Wageningen Campus is now located.
(Source: *Natuurtoets Schiphorst Wageningen def, Grontmij Nederland B.V. Arnhem 29 October 2010*)

Above: Ecological connecting zone Wageningen North (*Source: Kader ecologische verbindingszone Wageningen, 2016)*; below: Ecological connection zones Wageningen Campus (*Source: Sketch for integrated green plan 2016)*