Urban forestry programme outline

van der Velde, Rene; Dijkstra, Lotte

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TU Delft

urban forestry research fellowship

Programme Outline

vhg brancheverenigingen

LANDSCAPE ARCHITECTURE

TU Delft BK Bouwkunde Department of Architecture

Research Fellow Urban Forestry
Programme Outline

Author(s): Dr. René van der Velde
Associate Professor
Section Landscape Architecture
Department of Urbanism
Faculty of Architecture
Julianalaan 134 | 2628 BL Delft | Postbus 5043 | 2600 GA Delft
j.r.t.vandervelde@tudelft.nl | +31 (0)6 39 25 1090

Partners: VHG (Association for Greenspace Professionals, Netherlands)

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Duration: 3 years

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1. Domain & Initiative

Greenspace forms an integral part of the urban fabric and its planning, design and management a critical focus for urban administrations, professionals and academia. This importance only increases with cities and urban societies facing challenges such as climate adaptation, biodiversity loss and the health & well-being of urban communities. In recent decades new paradigms and discourses have emerged to understand, order and act in cities in response to these developments, including Blue-Green Infrastructures, Ecosystem Services, Urban Ecology and Urban Forestry. Approaches such as these can not only help shape sustainable green spaces, but also the resilient composition of neighbourhoods, districts and entire cities.

Urban forestry approaches urban greenspace from the perspective (one of) the city's core 'hardwares': its tree-based resources. The broadly accepted definition of urban forestry, described firstly by Jorgenson[1] is 'the art, science and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economic and aesthetic benefits trees provide society'[2]. As such, the breadth of impact of the urban forest necessarily positions it within multiple knowledge realms: the earth and life sciences, the humanities, social sciences, design and engineering.

The national association for greenspace professionals in the Netherlands (VHG) advocates for urban forestry in realms of governance, praxis and research in the Netherlands, as part of a broader strategy to support and develop the 'engine room' of greenspace planning, design, construction and management. Their advocacy for urban forestry is in particular driven by the decline in research and development on and around wood-based resources in recent decades, and the lack of attention for urban forestry at a university level in the humanities, social sciences, design and engineering. The VHG has chosen to focus attention on design and engineering and has set up a collaboration with TU Delft to initiate a more fundamental embedding of urban forestry in the built environment disciplines. This initiative dovetails with the focus of research and education at the Faculty of Architecture & the Built Environment (A+BE): understanding, ordering and acting in cities and territories.

2. Embedding

The embedding of this position within A+BE frames the initiative within the spatial and building design disciplines, focussing on planning aspects at various scales, as well as on the level of design and realization of urban landscapes themselves. To this end the initiative has been nested within the disciplinary lens of (urban) landscape architecture in the section landscape architecture, which currently forms one of four sections in the department of urbanism at the faculty. The collaboration initiates an expansion of

[1] Dean, 2009.

[2] Helms, 1998.

attention for Urban Forestry through the establishment of a research fellow(ship). The goal is to deepen and broaden knowledge, awareness and activity is this field at a (technical) University level.

The Research Fellow Urban Forestry cultivates relations with other sections in the department through joint research projects and education. The fellow also explores interfaces at the building and construction level with the departments of Architecture and AE+T. Collaboration is sought with researchers from the botanic garden and the section environmental modelling.

3. Scope & Focus

The fellowship interprets Urban Forestry from the perspective of built environment studies, whereby 'the urban forest' is nested within the concept of greenspace planning, design and management at various spatial scales. As such the urban forest is seen to encompass a range of features, typologies and systems, from individual trees on public and private lands, through to wooded streets, squares, parks and woodlands, neighbourhood green networks, and green-blue systems at the scale of city and urban region.(Fig. 1) Given the disciplinary angle of the fellowship and the current limitations of resources, the focus will be on the investigation and elaboration of these various scales through the (lens of) of Dutch (lowland) cities.

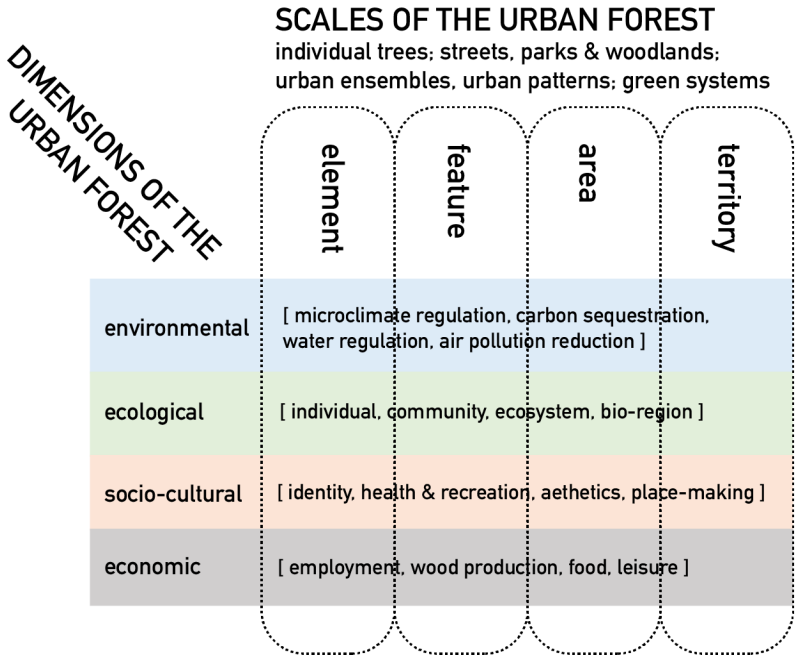

Figure 2. Urban Forestry Matrix

The various scales of urban forestry also reveal the multi-dimensionality of the urban forest, impacting as it does on environmental, ecological, socio-spatial and economic health of cities and urban communities. As such, urban forestry encompasses all these dimensions, and assumes their synergy to be fundamental to any sustainable urban environment. This multi-dimensionality resonates with the discipline of landscape architecture and informs the further elaboration of the focus of the fellow(ship). The fellowship strives to address each of these dimensions in research, education, valorisation and advocacy but within

the limits of the appointment, focusses specifically on environmental aspects such as climate adaptation and microclimate (see research projects).

4. Research Projects & Initiatives

The scales of the urban forest and the thematic dimensions addressed by it form an overarching framework for research. Elaborating this matrix forms a central research focus of the fellowship, an objective nested in an overarching research project: **Delta City Tree Syntax**. A second research project – **Tree Architecture and Urban Microclimate** – focusses specifically on the scale of the tree and environmental aspects associated with it. A third initiative to be undertaken is the development of a **Research Agenda Urban Forestry 2020-2030**, in collaboration with other knowledge institutions, government agencies and professionals bodies.
Rollout of further projects is possible if additional resources (funding and staff) become available.

Delta City Tree Syntax

This project elaborates the concept of the urban forest by drawing on the particular dendrological heritage of trees and woodlands in Dutch lowland cities, from the early modern period to the present day. It looks into the various dimensions of this heritage, how this plays out at different scales and in different contexts, and what this heritage can mean for emerging challenges and urban transformations.

The project is structured in four stages:

- *kennismontage* (collating and reviewing the existing body of knowledge);
- data collection, documentation & visualisation;
- calculations & simulations;
- dissemination;

Objectives

- elaboration of the dendrological 'languages' of Dutch lowland cities: historical developments ('first words'): species, practises and details ('vocabulary'); structures and patterns of tree plantings('grammar'); wooded features such as forests, parks and gardens ('sentences' & 'stories'); using historical, typological and case study research;
- development of planning and design principals and (generic) models from this heritage;
- investigation of what the planning and design dimensions of this legacy mean/can contribute to contemporary urban challenges;
- development of new models from this legacy to respond to specific challenges such as urban climate (adaptation & mitigation);
- development of models for expanding urban forestry into new urban and peri-urban contexts such as residential expansions, brownfields, industrial & recreational areas;
- attention for this dendrological heritage and its protection and management by municipal, provincial and federal government bodies;

Research questions:

- how have trees and woodland been incorporated into urban plans and landscapes at different scales from the early modern period to the present day?
- what role did they play in the environmental, ecological, socio-cultural and economic life of neighbourhoods, districts and cities?
- What differences and similarities exist between cities?
- what does this language offer in terms of contemporary sustainability challenges?
- how does this inform the dimensions of urban forestry as an academic and professional discipline?

Outcomes

- dissemination via an 'Atlas of Urban Forestry in the Netherlands' documenting the planning and design dimensions of the urban forest in Dutch (lowland) cities;
- a scan of opportunities for - and threats to - this heritage;
- an agenda for further research;

Figure *3*. Concept illustrations of the proposed Atlas of Urban Forestry

Urban Climate Arboreta

Individual trees are the elemental building blocks of the urban forest. They aid in the mitigation of negative thermal conditions (both absolute air temperatures and in terms of thermal comfort) in urban environs, through mechanisms such as reflection & absorption of irradiation, transpiration cooling and shading. Despite increasing attention for the cooling benefits of the urban forest, insights into the norms for thermal cooling properties of individual tree species are still relatively broad. Current assumptions note a reduction of surface temperatures of between 10-25° Celsius, and air temperature by 1-5° Celsius.[3] Further work on sharpening these estimates by studying at the cooling performances of different tree species is needed.

A review of 89 studies on the impact of trees on urban heat mitigation and thermal comfort in Sweden, the Netherlands, Portugal and Israel (representing four distinct climate regions) found that only about 10% of the studies actually referred to specific tree species.[4] Some important studies have however since started to emerge; an overview of microclimate regulation of more than 100

[3] Döpp, et al., 2011.
[4] Saaroni, Amorim, Hiemstra & Pearlmutter, 2018.

important urban tree species grouped them into cooling categories 'high', 'medium', or 'low'.[5] These estimates were based on expert judgement and growth characteristics derived from a recognized dendrological catalogue.[6] More accurate values for the cooling capacities of different species to cool urban areas is a critical step in addressing urban heat cycles. As such the broader research objective for this project is to ascertain which trees cool the best, and more particularly how they do this.
An approach that potentially offers new insights in microclimatic benefits of different tree species is to focus on their physiognomic characteristics or 'tree architecture'. Studies into the developmental morphology of trees in tropical forests identify architectural traits that taxonomically dissimilar trees share.[7] Architectural classifications of trees have also emerged in professional landscape and urban design praxis (e.g. Rose, 1958).

Physiognomic determinants relevant to urban microclimate regulation in the literature include such factors as: tree dimensions, canopy proportions and canopy shape; foliage transparency and foliage clumping; stem and branching structure; leaf size, leaf form, leafing period and leaf colour; leaf area index, plant area index and sky-view factor. Similarly, the physiology of a tree that determines its evapo-transpirational characteristics can be measured. Insights into these variables in relation to the cooling performance of various tree species is the primary objective of this project. Insights into which aspects of a tree's 'architecture' and physiology that impact on these differences is an extended objective. As such, three central research questions arise:

1. **What are the physiognomic characteristics of trees (relevant to their cooling performances)?**
2. **Which tree architecture models can be developed/identified based on these characteristics?**
3. **What are the cooling performances of these models (including physiological aspects)?**

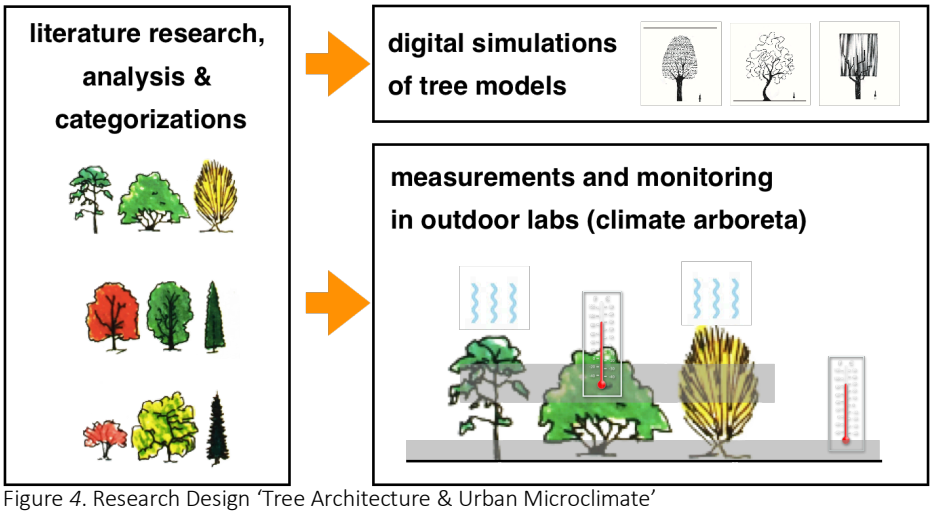

Figure 4. Research Design 'Tree Architecture & Urban Microclimate'

A related area of investigation is the cooling performance of trees in various configurations. Urban trees are planted in different arrangements, from solitaries to group plantings such as tree lines, avenues, bosques and groves etc. (Figure 5) These configurations have potentially significant effects on the level of heat island mitigation in both absolute terms and in relation to

[5] e.g. Samson et al. 2017.
[6] by Roloff & Bärtels 2014.
[7] Hallé & Oldeman, 1970.

auxiliary factors such as urban typo-morphology, prevailing wind directions & surface characteristics. A secondary focus for the project is to develop insights into the performance of different configurations in various urban typo-morphological situations.

Research Agenda Urban Forestry NL 2020-2030

The urban forest in Dutch cities faces multiple challenges in the coming years. Beyond the continuing problems of maintaining tree-based resources in cities in the face of competing spatial and infrastructural demands, problematic growing conditions, concerns about buildings, property values and safety, and limited planting and maintenance budgets, emerging challenges in areas of densification, climate adaptation, (urban) ecology and biodiversity, health & well-being and energy transition are expected to significantly impact on the urban forest in the Netherlands in the future. A preliminary assessment of the current body of knowledge on urban forestry in the Netherlands indicates that it is insufficiently elaborated to deal with these developments in a proactive way, such that it is unlikely that the full potential of trees and woodlands will be realized. Indeed, serious concerns can be raised about the endurance of the urban forest in the medium to long term.

The third focus of the fellowship is thus the preparation of a comprehensive and structured assessment of challenges, the current body of knowledge, skills and technologies at hand, and the gaps in the knowledge base to be filled in coming years. This agenda is intended to cover the full breadth of the field of urban forestry, from arboriculture & silviculture to planning & policy, design, construction, and management & maintenance (Fig. 5). To this end collaboration is sought with other knowledge institutions, government agencies and professionals bodies.

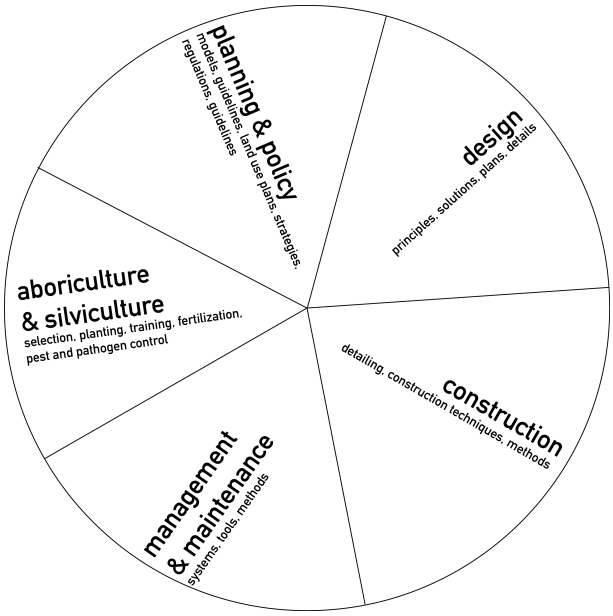

Figure 5. Urban Forestry *Realms*

5. Education

The fellow(ship) elaborates urban forestry within education programmes in the master track landscape architecture, the department of urbanism and the faculty as a whole. These initiatives are nested within:

- Graduation lab urban forestry offered in the academic year 2019-20, 2020-21 (see appendix 2)
- Knowledge components in the MSc 1 Landscape Architecture
- Design components in the MSc 1 Landscape Architecture
- master thesis project mentoring in Landscape Architecture, Urbanism and Architecture
- Individual exercises in the honours programme
- Workshops and masterclasses offered to the entire student body

6. Valorization

Dissemination and transferral of knowledge is a central mandate of fellowship. Where relevant, the fellow will contribute to working committees on relevant topics, such as I-tree, TEEB etc. The relationship with the VHG is of relevance here, as through this cooperation the fellow's work is brought to the attention of a network of national and international scientists as well as the members of the association. The fellow will also publish in peer-reviewed international journals and books as well as media for professionals and the general public. Other possibilities for knowledge valorisation include external presentations, and cooperative arrangements with governments. The Department of Urbanism has good connections with various ministries, and provincial and municipal authorities. The fellow is expected to contribute to these connections as well as extend the national and international network with practice, related chairs, scientific institutes, and professional organization.

7. Outcomes & Deliverables

Specific deliverables in the fellowship period include:

1. A minimum of three scientific publications in (peer-reviewed) journal articles/refereed chapters.
2. Regular (yearly) publication in professional publications.
3. Regular participation in – and/or organisation of - conferences to disseminate and facilitate interchange of knowledge.
4. Development of teaching resources in urban forestry (e.g. Readers).
5. Regular participation in relevant working groups and initiatives related to urban forestry.

A number of general outcomes are envisaged in the fellowship period:

- Advocacy for trees in Dutch cities;
- Community-building;
- Covenants & Manifestations;
- Agenda for further research (TU & beyond);
- Concept publication (Atlas of Urban Forestry in the Netherlands);
- Living labs (e.g. *climate arboretum*);

8. Advisory Board

The fellowship is supported by an advisory board from governmental, professional and academic backgrounds. Its members are:

Marc Custers	Senior Policy Officer, VHG
Dr. Bob Ursem	Scientific Director, Botanic Gardens TU Delft
Hans Kaljee	Senior Tree officer, City of Amsterdam
Hanna Hirsch	Director Bomenstichting Nederland
Leendert Koudstaal	Senior Tree Officer, City of the Hague
Prof. dr. ir. Erik de Jong	Professor of Culture, Landscape & Nature (Artis-leerstoel) UVA
Olivier Copijn	Director Realisation Van der Tol bv
Prof. ir. Dirk Sijmons	Emeritus Professor Landscape Architecture, TU Delft
Harold Schoenmakers	Founder/Director Boomtechnisch Advies
Djorn Noordman	Strategic Asset manager Public Space, City of Haarlem
Maarten Loeffen	Director Vereniging Stadswerk Nederland

9. Details

Fellow:

Dr. René van der Velde
Associate Professor
Section Landscape Architecture
Department of Urbanism
Faculty of Architecture
Julianalaan 134 | 2628 BL Delft
j.r.t.vandervelde@tudelft.nl |
+31 (0)6 39 25 1090

Research Assistant:

Ir. Lotte Dijkstra
Section Landscape Architecture
Department of Urbanism
Faculty of Architecture
Julianalaan 134 | 2628 BL Delft

10. Annex

Areas for further research

Territorial scale

- contribute to understanding of urban region as mosaic of urban and 'rural' features, and the urban forest in inter-urban zones;
- role of UF in linking to emerging field of urban ecology with its focus the hybrid nature of towns and cities, in which organisms and ecosystems co-exist with humans in a diversity of built environments.
- role of UF in exploring the complex relationship between nature and cities, and the challenges facing these two realms, posits urban ecology not only in the domain of the life sciences but also in the built environment domains of physical planning and spatial design.
- understanding the city as a separate and distinct ecosystem, with its own unique parameters, complexities, problems and opportunities, a perspective which places systems ecology (ecology "of" the city/landscape ecology).
- develop management tools for urban administrations.
- How trees and woodlands also function ecologically at a urban-regional scale, forming part of habitat, forage and movement systems (e.g. the patch-corridor-matrix theory).
- Empirical research to contribute to the theoretical development of ecology at the urban-regional scale, as well as inputting into greenspace planning.
- elaboration of socio-ecological principles for forestry praxis drawing on the hybrid characteristics of Dutch urban woodlands, which by default integrate human-social and earth-life aspects;
- contribution to the theoretical and philosophical discourse on the re-linking of natural sciences and social sciences/humanities, in the frame of the Anthropocene and an 'after-modern' paradigm;

Area & Feature scale

- attention to the historical and contemporary importance of trees planted along infrastructure such as highways, streets and avenues, canals and waterways, dikes and levees;
- development of spatial/technical models for extending and expanding tree planting into different urban infrastructures (grey, green, blue), in combination with other above and below-ground claims;
- integration of trees and other aspects into new infrastructural projects (which is gathering pace in the Netherlands and internationally, as awareness of the criticality and instrumentality of integrated infrastructure rises).
- models to combine underground services (electricity, gas and water) with tree planting, incorporating safety and circulation considerations and tree planting;
- models to optimize growing conditions for trees in extreme environmental conditions;
- technical innovations in relation to soil compaction/nutrition (suspended pavements), irrigation, anchoring, and biomechanics;
- understanding of succession, species occurrence and species diversity in urban woodland areas;
- contribution to socio-ecological theory and methodology through case study research into particular urban woodlands;

Element scale

- assessment of suitable tree species for C02 uptake and particulate matter, resistance to compaction and poor growing conditions, shade and evapo-transpiration, drought and flood tolerance.
- development of (design) models for tree plantings in various urban situations – at different scales - and their effect on air quality, temperature, micro-climate and water management;
- Attention to the development of technical innovations in relation to soil compaction/nutrition, irrigation, anchoring and biomechanics;
- Research into the relationship between architecture and trees (use of certain species for particular styles and periods, technical innovations for courtyard trees, trees on decks and rooftops etc);
- technical innovations in relation to soil compaction/nutrition (suspended pavements), irrigation, anchoring, and biomechanics;
- the valuing of trees and woodlands (socio-cultural, economic, ecological) in the urban realm, building on models such as TEEB, I-Tree, Groene Kaart, ROIC, UFORE, STRATUM etc;
- investigation of changes in physiological processes and structure of trees (necrosis etc) in reaction to urban environmental factors such as pollution (soil, water and air);
- development of methods to establish trees in problematic conditions;

Graduation Lab Urban Forestry

Increasing attention is being given to the benefits of urban woodlands, parks and green infrastructure in cities for (good) environmental reasons, but how these features shape the urban realm spatially and socially and develop the intrinsic identity of site and place, is as critical a question for landscape architects. This lab brings together two topics that are critical in shaping the city in an Anthropocene 2.0: developing urban landscapes that address biophysical challenges of climate change, biodiversity loss and food security, and giving form to urban landscapes as experiential, social places.

The approach in the lab builds on the work being carried out in the urban forestry fellowship in the section landscape architecture. This research attempts to understand cities as urban forests by studying their dendrological syntaxes: the ‘words’, ‘grammar’, ‘sentences’ and ‘stories’ of trees and green spaces in various quarters, at various scales and through various time periods, with the intention to use this language to help shape their human-social and ecological futures. Various forms of experimental analysis will also be used, such as deep mapping and time analysis, as well as explorations of the practices, stories and discourses that backdrop this green language. Sensorial aspects also form part of the experimental analysis. Parallel activities include speculative design interventions and creative process(ing).

In this studio the analysis informs the design question; that is to say you will not start with a programme or brief, but shape the analysis in such a way that the design assignment emerges from it.

Theoretical/methodological themes: Urban Forestry; Socio-Ecology; Place Experience; Site-specific Design; Aesthetics & Synesthetics; Narrative Design; Time.

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