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CA2RE+DELFT

Book of Proceedings

Recommendation

Conference for Artistic and Architectural Research & Collective Evaluation of Design-driven Doctoral Training Programme

Faculty of Architecture and the Built Environment,
Delft University of Technology

The Netherlands, Delft, March 28 – April 1 2022

Recommendation Book of Proceedings
Colophon

CA²RE+ Delft RECOMMENDATION: Conference for Artistic and Architectural Research & Collective Evaluation of Design-driven Doctoral Training Programme

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Keywords
Design-driven doctoral research, design-driven research recommendation, architectural research, artistic research

Published by
TU Delft OPEN Publishing, Delft University of Technology, The Netherlands

ISBN 978-94-6366-660-2
DOI: https://doi.org/10.59490/mg.61

Design concept, layout, and typesetting
Marko Damiš

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Scientific Committee
As mentioned in Section 05, p. 476

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Special thanks to
Michele Puddu, text editing
Mimi Cepic, text editing
Luísa Ferreira Martins, text editing
Szymon Kaniewski, text editing
Lilani Oei, text editing
Nicolette van Dongen, event organization
Nathalie Kooijmans, event organization

TU Delft BK Bouwkunde — Delft University of Technology, Faculty of Architecture and the Built Environment

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Co-funded by the Erasmus+ Programme of the European Union

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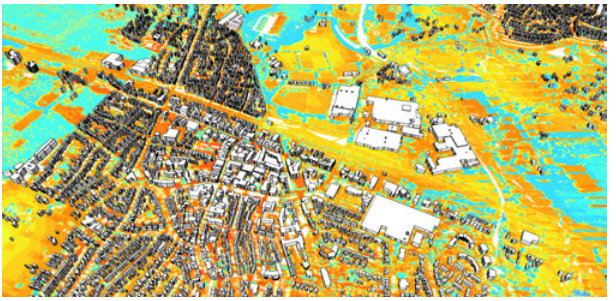
The Evaporative City Bioclimatic Adaptation and Regeneration Using Water

Mariana Pereira Guimaraes, Politecnico di Milano



Intermediate doctoral stage

Supervisor: Valentina Dessì, Politecnico di Milano

Water-cooling, Neighborhood, Microclimate

Abstract

The proposed paper highlights preliminary steps of an ongoing doctoral thesis, developed in the context of a European Commission's Horizon 2020 innovation programme conducted in partnership with the industry, which aims to define strategic urban water use guidelines that can help alleviate the heat stress in neighborhoods located in different European climate regions. To achieve it, it also evaluates the effects of urban morphology (density, geometry, surface cover) on microclimate (air temperature, solar radiation, relative humidity, wind direction, and speed). The focus is to understand water cooling solutions synergies for master planning solutions. Although the block and neighborhoods are understood as part of a city system and cannot be dissociated from its context, a closer look is necessary when undertaking microclimate studies. The different allocation of such systems in the city allows us to investigate the contribution and combined local effect in reducing outdoor temperatures in response to the UHI effect.

DDR statement

The global and local nature of climate change forces us to think on scales. On the macro scale of cities, several studies, and theories such as urban metabolism helps advance systemic notions such as sustainable cities and development. On the other extreme, in buildings design and performance, a lot of effort has been put to make buildings smarter, biophilic, and healthier. The scale in between, the neighborhood, remains a mostly unexplored topic. Nevertheless, it is fertile ground to test innovative solutions and synergies in a design-driven approach. It is small enough to investigate urban design solutions, envision hypotheses, propose, test, and evaluate. It is also within the limit to perform not-so-complex environmental analysis and simulations using thermal and hydrodynamic software. Regarding stakeholder involvement, it has the potential to mobilize a local community in participatory dynamics. It is also easy to involve outsiders and specialists alike in issues they relate to. Given all these interesting aspects, the third part of the thesis "The Evaporative City: Bioclimatic Urban Regeneration Through Water" uses three neighborhoods located in different European climates and countries to test and re-test potentialities and synergies of water-cooling designs based on fountains, mists, and ponds. Evaluation is carried out with experts' inputs and thermal simulation software (ENVI-met 5). The design and combination of these solutions are assessed with the goal to equip design professionals and related professions, in different European climate zones with guidelines on how and where to best place these solutions in public spaces, thus providing RECOMMENDATIONS to create positive design knowledge,[1] foster livable places and promote both climate adaptation and mitigation.

1 Lenzholzer, Sanda (2010): Designing atmospheres: research and design for thermal comfort in Dutch urban squares. PhD Thesis.

The present extended abstract highlights preliminary steps of an ongoing industrial doctoral thesis, developed in the context of the European Commission's Horizon 2020 innovation programme (SOLOCLIM-EU) conducted in partnership with the industry, which aims to educate, supervise, and train six Early-Stage Researchers (ESRs) on generating microclimate solutions that can respond to urban overheating[1] in outdoor environments throughout a Ph.D. Program developed inside the practice. The programme is divided into three work packages (WP): Vegetation (WP-1), Water (WP-2), and Responsive Systems (WP-3). The solutions within each cluster are examined at two scales: the streetscape, i.e., the interface of buildings and their outdoor environment, and the larger scale of the urban block, neighborhood, and city-scale. The principal methodology of all three WPs is "Research Through Design" (RTD) supported by rigorous analysis as appropriate for the different scales (such as microclimate simulation software, geoprocessing using satellite images, and spatial analysis using GIS software). The Thesis titled "The Evaporative City: Bioclimatic Urban Regeneration Through Water" is part of the WP-2 at the neighbourhood scale and seeks to redefine the use of water systems such as fountains, water mists and small ponds, in neighborhoods located in different European climate regions.

Designs and plans delivered now by design, planning, and engineering need to incorporate a microclimate-sensitive approach that can respond to shifting extremes (too hot, too cold, too dry, and too wet). However, apart from the need for new solutions, the industry currently lacks expertise. On the academic side, some of this body of knowledge is also lacking research. The use of vegetation in cities, for example, is well known to reduce the Urban Heat Island (UHI) effect. Still, there are remaining questions about the proper allocation of green in cities to have an optimal effect. Little is also known about the efficacy of water-based interventions to the urban microclimate such as misting systems, evaporative cooling of facades, sprays, fountains, water walls, etc., in relation to the surrounding urban fabric and when applied broadly in the city.[2] [3] [4] These interventions also have social and urban ecological co-benefits such as stormwater infiltration and storage and provide a respite to citizens during heatwave events – instantly generating space liveability.

Besides being a powerful tool for transforming urban spaces into new commons and its role in promoting the "Right to the city," as proposed by David Harvey (2008), water has several advantages as a natural cooling technique. The two main effects are the high thermal mass of water and evaporative cooling, due to the evaporation process. A lot of energy is needed to convert liquid water to vapor, and this energy comes from the water and surrounding air, resulting in cooler air and water. Regarding cooling principles and physics, urban water cooling can be divided into three main groups: ponds or water bodies Ⓟ, fountains, sprays, jets (F), and misting or fog systems (M). The way citizens interact with urban waters and thus experience such principles can be divided into nine verbs: to swim (on), to perform (on), to transit (through), to shelter (in), to sightsee (to go see and be seen), to manage (store, infiltrate, conduct), to play (with), to listen and to contemplate. In Figure 1, nine contemporary design projects were linked to "water interactions" and to "water cooling

Figure 1: [SWIM] (P) Biotop Pool – Ooze, Source: https://nl.bio.top/references/public-natural-pool-uk-art-project Accessed 07/03/2022, Biotop company / Commercial; [PERFORM] (F) Desio – Openfabric, Source: http://www.openfabric.eu/projects/desio-centro-desio-italy/ Accessed 07/03/2022, Photo credits: Daniele Pavesi; [TRANSIT] (F) Grotestraat – OKRA, Source: https://www.okra.nl/projecten/grotestraat-nijverdal/ Accessed 07/03/2022, Photo credits: Thomas Klomp; [SHELTER] (M) - Air Tree Ecoboulevard - ECOSISTEMA URBANO, Source: https://ecosistemaurbano.com/eco-boulevard/ Accessed 07/03/2022, Photo credits: Emilio P. Doiztua and Roland Halbe, https://5osa.com/218; [SIGHTSEE] (M) Miroir d'Eau - Michel CORAJOUD, License: Creative Commons Attribution-Share Alike 3.0 Unparted license., Author: Blaue Max, Source: https://commons.wikimedia.org/wiki/File:Bordeaux_-_Juillet_2012_(85).JPG Accessed 07/03/2022; [MANAGE] (P) Tåsinge Square – GHB, Source: https://www.publicspace.org/works/-/project/j075-refurbishment-of-tasinge-square Accessed 07/03/2022; [PLAY] (F) Bellamyplein - Jakoba MULDER, Source: https://bellamystraat49.nl/ Accessed 07/03/2022; [LISTEN] (P) Morske orgulje - Nikola BAŠIĆ, License: Creative Commons Attribution-Share Alike 2.0 Generic license., Autor: Ben Snooks; Source: https://bluehealth.tools/51-2-copy-copy-copy-2-copy-14/ Accessed 07/03/2022; [CONTEMPLATE] (F) Water traces - Atelier DREISEITL, Source: https://www.dreiseitlconsultin...,

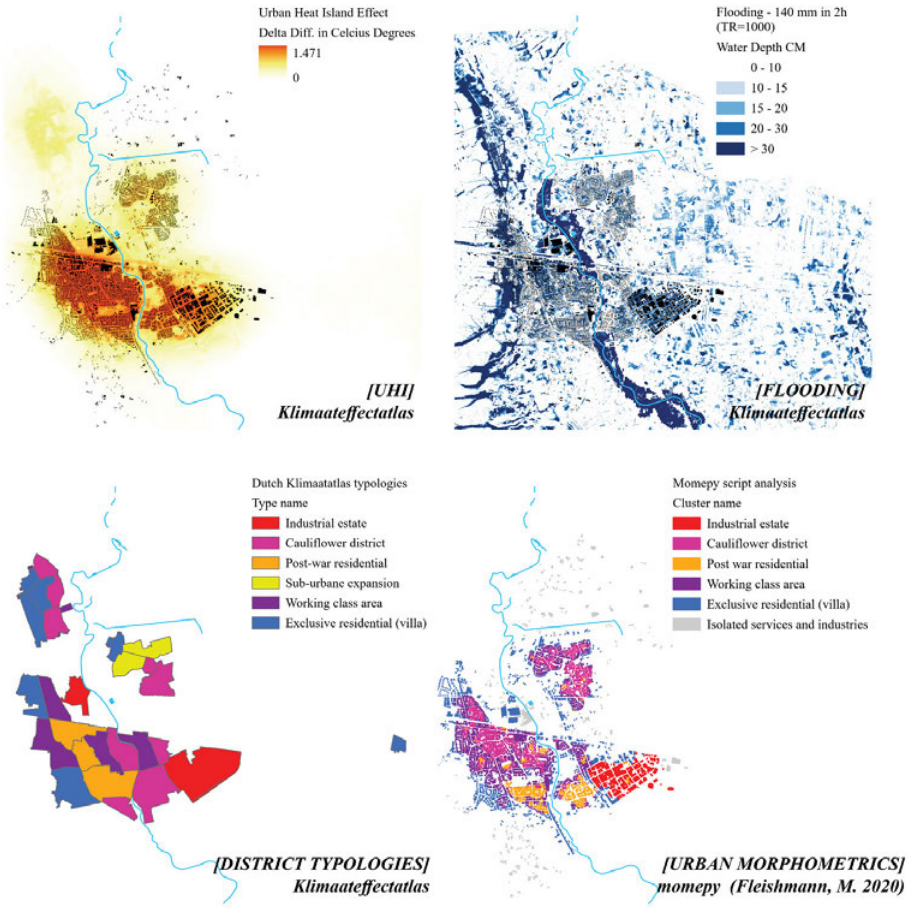
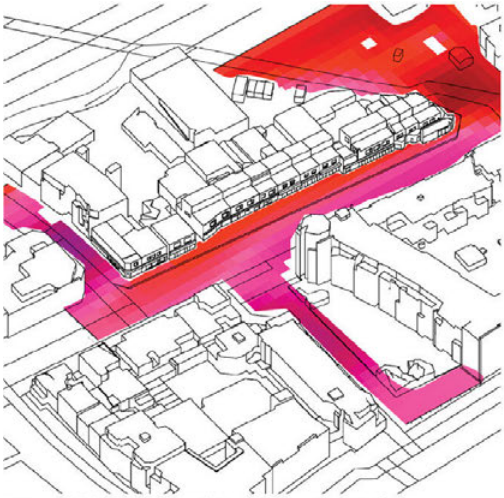


Figure 2: Sources: https://www.klimaateffectatlas.nl/nl/gebruik-van-de-atlas. Organization and design: Mariana P. Guimarães

principles." These projects constitute the preliminary steps in the research and one of its products: a catalogue of references containing a description of the project and the microclimate benefits provided by the water cooling features. The situation before and after the introduction of water is simulated using ENVI-met software to estimate gains in thermal comfort such as air temperature decrease, mean radiant temperature, and wind speed. An example is the Grotestraat in Nijverdal, The Netherlands – an intervention project from the Dutch Landscape office OKRA Architects, highlighted in Figure 3. This project puts together rain gardens, bioswales, fountains, and splashes. Fountains are remarkable elements in several cultures and carry enormous symbology. Nowadays they became key elements to urban revitalization because can at the same time engage citizens and provide respite during heatwaves. The way they are now conceptualized is key to achieving a more sustainable urban water management. The new Grotestraat addresses both heat and flooding through a water and climate-sensitive design.

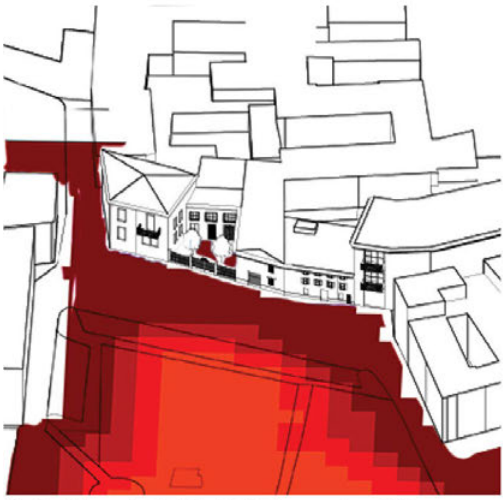
The Grotestraat is almost unique because there's a gap of cases that purposefully addresses multiple instances. The announced climate crisis upon us is widely advertised but it is surprising how little the design discipline, and especially the design of cities, devotes to thinking about the way architecture interacts and influences climatic processes.[5] The issue seems to be two-fold: technical and scalar. First, thermal and microclimate analysis demand specific knowledge and software that is out of reach to most architects. Second, it requires to be seen in multiple scales. The Urban Heat Island (UHI), for example, is expressive on the city scale, but to address it, solutions happen in the very small scale of buildings and squares and need to resolve not only environmental concerns but also livability, disuse, and equality. A view from the city allows to identify local hot spots (literally as hotter areas in city and also as problematic spaces), as Sofia Dona poses in the text "Moving from the Macro to the Microscale in the Anthropocene,"[6] the UHI problem is not enough faced from the small scale, spaces must be also integrated into a network of medium and large-scale green corridors to generate continuous masses of plants, pedestrians, and breezes, to be more effective physically and collectively.

With the goal to generate a design decision support system (DDSS) regarding urban planning, design, and policy guidelines for implementation of the water systems in the masterplan scale, or the neighborhood, the thesis was divided into four main parts: the Block, the City, the Neighborhood and Guidelines. In the Block scale, several ENVI-met simulations are performed in 'test-bed' blocks selected from urban morphometric analysis for European cities in three different climate zones (Milan, which has hot Mediterranean summers, Rotterdam, with cold oceanic summer and Madrid, located in arid hot summer climate). Data such as temperature, humidity, and wind speed are also collected on the field with a mini mobile station to gain insights into the human scale of the "testbed" blocks. In the City scale, morphometric analysis using momepy Python script[7] is combined with GIS spatial analysis and heat and flooding vulnerabilities to gather insights into water-cooling aptness in these cities (see Figure 2 maps for Nijverdal as reference for studies in the City scale). Results from Block and City together inform the Neighbourhood

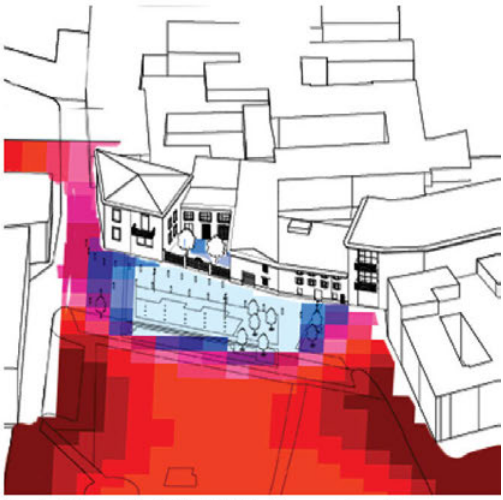


Nijverdal / Grotestraat / Air Temperature Before

Nijverdal / Grotestraat / Air Temperature After



Desio / Parco degli Alpini / Air Temperature Before



Desio / Parco degli Alpini / Air Temperature After

25 °C 30 °C

Simulations of Potential Air Temperature for Baseline 0 and Scenario 1 (case studies)
ENVI-met 5.0 / 14.00 / 23/6/2018 / k = 1.2m

Figure 3: © ENVI-met 5.0. Organization and design: Mariana P. Guimarães

study: quantitative results are used to test and simulate toolkits of solutions in this scale, that are re-assessed together with a group of experts in an iterative design process (RTD). Lastly, Figure 3 also brings the question of different cultural relationships communities might have with water by placing side by side a small-town project in the Netherlands and one in northern Italy.

1 Santamouris, Mattheos (2020): »Recent progress on urban overheating and heat island research. Integrated assessment of the energy, environmental, vulnerability, and health impact«, in: Synergies with the global climate change, Energy and Buildings issue 207, pp. 1–28.

2 Steeneveld, G.J./Koopmans, S./Heusinkveld, B.G./Theeuwes, N.E. (2014): »Refreshing the role of open water surfaces on mitigating the maximum urban heat island effect«, in: Landscape and Urban Planning issue 121, pp. 92–96.

3 Cortesão, João/Lenzholzer, Sanda/Klok, Lisette/Jacobs, Cor/Kluck, Jeroen (2017): »Creating prototypes for cooling urban water bodies«, in: ECLAS Conference 2017 Proceedings single issue, pp. 349–364.

4 Sun, Ranhao/Chen, Liding (2012): »How can urban water bodies be designed for climate adaptation?«, in: Landscape and Urban Planning issue 105 (1–2), pp. 27–33.

5 Chiri, Gianmarco (2018): Climatica: Forma Urbis (Back to Basics). Milano: LISTLab.

6 Dona, Sofia (2018): »Moving from the Macro-to the Microscale in the Anthropocene«, in: Wolfrum Sophie (Ed.), Porous City: From Metaphor to Urban Agenda, Boston: Birkhäuser, pp. 198–199.

7 Fleischmann, Martin (2019): »momepy: Urban Morphology Measuring Toolkit«, in: Journal of Open-Source Software issue 4 (43), pp. 1–4. https://doi.org/10.21105/joss....

CA²RE / CA²RE+, the Conference for Artistic and Architectural Research, is dedicated to promoting Design-Driven Doctoral Research (DDDr) through its conference series. This initiative aims to strengthen and expand the community of researchers interested in this subject. The Faculty of Architecture and the Built Environment at Delft University of Technology has gladly provided the platform for this noteworthy conference.

The central theme of this event revolves around the "RECOMMENDATION" for Design-Driven Doctoral Research. This theme is a natural progression from the main topics explored in the previous CA²RE+ conferences, which included OBSERVATION, SHARING, COMPARISON, REFLECTION, and FRAMEWORK. The CA²RE+ Delft conference seeks to scrutinize the progress made thus far and endeavors to formulate guidelines and recommendations for the establishment, introduction, development, and evaluation of DDDr.

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ISBN 978-94-6366-660-2