Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Zhuo Yu
Student number	5585252

Studio		
Name / Theme	Metropolitan ecology of place	
Main mentor	Ulf Hackauf	Environmental technology and design
Second mentor	Edo Abraham	Water & Control at TU Delft's Faculty of Civil Engineering and Geosciences
Argumentation of choice of the studio	I am interested in the topics of environmental issues, climate-resilient urban design and sustainable urban development, especially in solving water shortage and applying technology in urban environment, this studio is most related to those topics, and the teachers are experienced in this field.	

Graduation project	
Title of the graduation project	A future-proof water system for Campbelltown and the Greater Sydney area: Implementing decentralised wastewater treatment system to facilitate water re-use and evaluating its performance with densification
Goal	
Location:	Sydney
The posed problem,	At present, more than 75% of the water supply for Greater Sydney comes from stormwater, but the precipitations are more and more unpredictable in recent years and in the future. Meanwhile, the demand for potable and non-potable water is still increasing because of population growth and planning for extra greenery. Therefore, the current stormwater-dependent system is insecure to supply the future population and household consumption, other solutions should be prepared as supplements whenever needed.

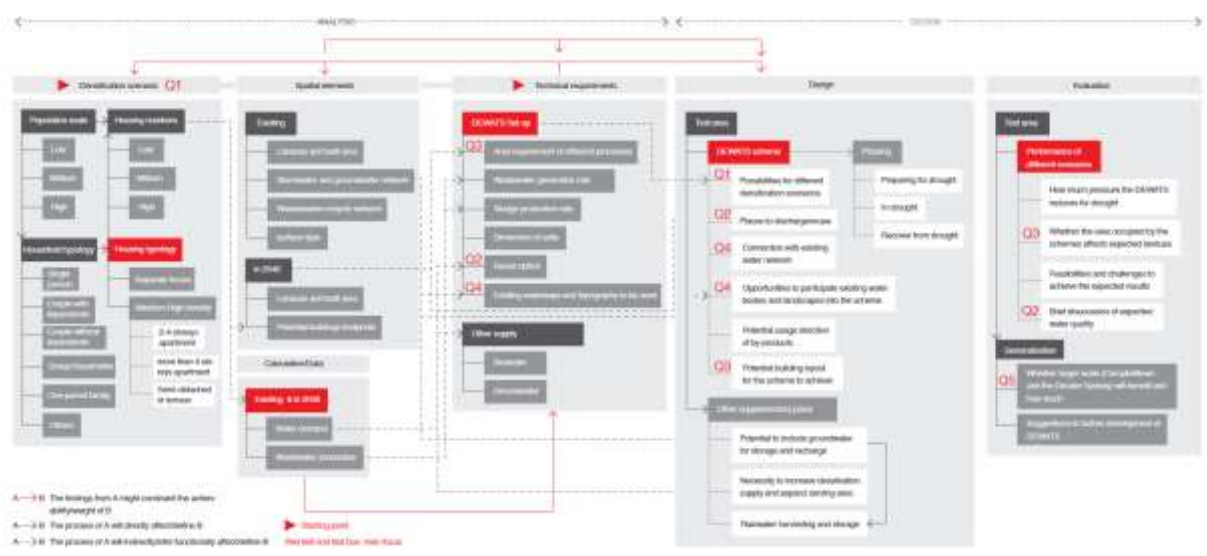
	From year 2000 to 2020, Sydney has experienced 2 times of drought (fig.), the most recent one happened from 2017 to 2020, accompanied with intolerable heat flow in summer (from December to February) and severe wildfire. It is clear that insufficient precipitation not only limits water use, but also generates negative side-effects to social and natural order. A set of flexible and farsighted plans is required that reduce the dependence on stormwater by promoting water re-use and exploring other available sources. Bringing up water re-use, centralised wastewater treatment is always the most popular way of water sanitation recycling for re-use and discharge. As urbanisation continues, more treatment plants are required and the limitations of that are exposed, such as the large occupation of on-ground area, high energy consumption in operation and long-term constructive process, etc. Therefore, the demand for smaller scale, more flexible and natural based way of water treatment comes out, which stimulates the idea of decentralised wastewater treatment system (DEWATS). With the characters of subtropical climates, Sydney provides an ideal environment for various plants to grow, which is an advantaged condition for the constructed wetlands (a main component in DEWATS) to operate with high efficiency. Additionally, large open space availability for both individual household and public also support interventions with different scales to happen on site. Therefore, it is certain that DEWATS is highly possible to be well-developed in Sydney.
research questions and	How to implement Decentralised Wastewater System (DEWATS) as a means to alleviate water shortage that

	affects household consumption in Campbelltown? - Q1: How to apply (design) the system to fit different densities? - Q2: How can we ensure the treated water quality for different purpose of reuse? - Q3: What are the spatial effects of DEWATS? - Q4: How can the existing infrastructure and landscape participate? - Q5: How can the interventions contribute to bigger scale?
design assignment in which these result.	Explore and experiment how the implement of decentralised wastewater treatment system (DEWATS) for different population density contributes to water re-use in Campbelltown. Meanwhile, understanding the upper limit for uban sprawl based on the gap between water supply and consumption.

Process

Method description

The research is divided into three parts: densification scenarios, technical requirements, and spatial elements. Densification scenarios and technical requirements are start points to get an overview of what spatial elements are needed to analyse. The process of design is interwoven with research, and as iterative tests of research that translates the theories into tangible scenarios. For example, in order to serve different densification scenarios and housing typologies, different total area and modular scales of DEWATS is required, researching of that helps to set a target for the design in amount and guidance to find the ideal place spatially. The evaluation of this process informs the possibility to realise the system for different scenarios, and how supplementary methods can work with that, which initiates a new round of research, and the design process itself is a part of the research as well. Therefore, in my thesis, research and design are simultaneously processed and they inform and are included in each other.



Literature and general practical preference

Literature:

Dolnicar, S., & Schäfer, A. I. (2009). Desalinated versus recycled water: Public perceptions and profiles of the accepters. Journal of Environmental Management, 90(2), 888–900. https://doi.org/10.1016/j.jenvman.2008.02.003

Harvey, E., Oko-Williams, A., Kaupp, R., Naafs, A., Fabian, M., & Al-Muyeed, A. (2017). Technical guidelines for designing a decentralised waste water treatment system. https://www.pseau.org/outils/ouvrages/wateraid_technical_guidelines_for_designing_a_decentralised_waste_water_treatment_system_2017.pdf

Saeid Eslamian. (2016). Urban water reuse handbook (pp. 1107–1114). Crc Press, Taylor & Francis Group. https://www.researchgate.net/publication/364756666_Urban_Water_Reuse_Future_Policies_and_Outlooks

Troy, P., Holloway, D., & Randolph, B. (2005). Water Use and the Built Environment: Patterns of Water Consumption in Sydney. City Futures Research Centre, University of New South Wales. https://cityfutures.ada.unsw.edu.au/documents/34/waterconsumption.pdf

General practical experience/precedent:

City of Sydney. (2012). Decentralised water master plan 2012-2030/ prepared by the City of Sydney. City of Sydney Archives. https://archives.cityofsydney.nsw.gov.au/nodes/view/1753539

ARUP. (2015). The Future of Urban Water: Scenarios for Urban Water Utilities in 2040. Arup.com. https://www.arup.com/perspectives/publications/research/section/the-future-of-urban-water

CRC for Water Sensitive Cities. (2018). Central Park Recycled Water Scheme. https://watersensitivecities.org.au/wp-content/uploads/2018/10/2-Central-Park-Wastewater-Treatment-FINAL.pdf

Reflection

Relation between the topic and the studio (programme)

This project is dedicated to promote DEWATS and other supplementary solutions that can serve a future densified area (Campbelltown) sustainably during stormwater shortage period. The core of it is water re-use and circulation, which is related to the studio's (MEP) topic that seeks for environmental and climate resilient approaches in urban context. The thesis is related to the master track and master programme in that it responds to the design for social concern in urbanisation and can be achieved in built environment.

Social relevance

Social relevance in this thesis is mainly reflected in the growing population (density), the contradiction between the growing demand and stormwater shortage, and social concerns about the quality and re-usability of treated water. Through the research, design, and evaluation, this project simulates the densification scenarios and possibilities to reduce the dependence on stormwater shortage by water-reuse, and explores the ways to meet the qualities for different re-use purpose. The final result might support or discourage the densification scenarios, while it creates an overview for the society of how the urban environment will be like if we base the urbanisation on water saving and water re-use with DEWATS and how to achieve the balance between social development and sustainable water supply.

Professional relevance

The thesis addresses possibilities and challenges in professional goals of urbanists. In most cases, designing urban environment can be easily based on

and target at achieving well outward functions and appearance of the space, but it is difficult for urbanists to tailor a certain technical intervention in place that is required to achieve those targets, thus resulting in obstacles to developing more advanced urban functions. The thesis might point out the way to understand the relations between the technical requirement of DEWATS and the layout of built environment, which can be inferred to other technical-centred innovations to be built in urbanisation, and helps the urbanists have easier communication with technical engineers.

Scientific relevance

The thesis focuses on the development of DEWATS, which is a new way of wastewater treatment compared to traditional centralised treatment plants. This technology is still imperfect and there is a lot to be improved. The thesis will reveal and summarise the problems, providing suggestions for the future development of this technology from the perspective of applying it in an growing district, which might be valuable for other experts in scientific field to develop DEWATS with better performance.

Limitation

Because of the lack of data availability, some of the information (especially the demographic related) comes from assumption based on partly related or out-dated materials, and some sources give different estimation or counting outcomes, which reduces the accuracy of the calculation results.

The topic is seldom discussed together with densification and large-scale distribution, therefore precedents can hardly be found. Multiple practices are available with different scales without design processes, which can only consulted for their layout and technical set-up.

I do not have any background or experience related to water management while finishing the thesis, the understanding and expression of the technical parts might be incomplete and abridged because of insufficient knowledge and the intention to make it more understandable for the public.