

# 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](mailto: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	Chang Sun
Student number	5573491

Studio		
Name / Theme	Urban Ecology	
Main mentor	Nico Tillie	Urban ecology, Urban landscape, Integrated planning
Second mentor	Kristel Aalbers	Water management, Water resilience, Environmental Technology and Design
Argumentation of choice of the studio	<p>The uncertain situation of recent years, with intensifying climate change and rampant epidemics, have not stopped the process of continued urbanization. Urban areas are not only spaces inhabited by an increasing number of people, but they are also a central point of conflict for environmental pollution and ecological problems. Sustainable solutions are gradually taking center stage in regional development strategies. To understand the role of urban landscapes in this context, one must first understand the role of humans in urban ecosystems.</p> <p>During the past five years of my study experience, I have been exposed to regional ecological theories such as the patch-corridor-matrix model many times in different theoretical courses and design exercises. What fascinates and confuses me most was how these ecological models should function in more complex urban contexts. I find that there is a greater need to sort out the interrelationships of the components in an integrated urban ecosystem. Therefore, I would like to take urban ecology as a broad theme to lead my graduation thesis, learn about the collaboration of researchers, practitioners, decision makers and participants in this complex system, and explore the value of landscape designers.</p>	

Graduation project	
Title of the graduation project	EMBRACE THE FLOOD: Designing A Nature-based Flood Resilient Solution for the City of Winnipeg
<b>Goal</b>	
Location:	Winnipeg, Canada
The posed problem,	The city Winnipeg on the wet prairie has been threatened by severe flooding for decades. The initial decision to build the city at the confluence of the Red and Assiniboine rivers led to the inevitable consequence of recurrent natural flooding. The floods prompted the

	<p>provincial government to take a series of measures to protect the city. However, the crisis has not subsided.</p> <p>During the significant technical and territorial transformations in the last two centuries, the rivers and creeks have been heavily dammed and channelized. The hasty attempt at city development resulted in immediate economic benefits, but at the expense of eliminating the land's ability to drain water through naturally occurring streams and coulees. Due to environmental impacts on a wider geographical scale, most notably climate change, both floods and droughts are hitting the extremes, which is escalating the challenge on flood management.</p> <p>One of the main obstacles in this project is to solve the problem of threatening floodwaters and turn the negative impacts into the extra values on Winnipeg's urban expansion. Tracing back to last century, the indigenous peoples of the plains used to share a mutually beneficial living pattern with beavers and other species on the prairies. This coexistence approach towards humans, wildlife and nature deserves an opportunity to be brought back to Winnipeg. Through flood-mitigation measures based on natural processes, the urban hydrologic system is anticipated to move toward sustainable development and provide fairness and reliability to the living environment and urban ecosystems in response to challenges posed by habitat loss, climate change, and emerging conservation issues.</p>
<p>research questions and</p>	<p>How can a nature-based flood solution be integrated into Winnipeg's massive urban development on the wet prairie while offering a flood resilient design for long-term coexistence between people and wildlife?</p> <p>The following sub-questions are:</p> <ol style="list-style-type: none"> <li>1. How can we increase stormwater storage through ecological rehabilitation based on the current fragmented open space structure?</li> <li>2. How to incorporate Winnipeg's urban hydrologic system and sewer system into the solution response to threatening floods?</li> <li>3. Can the indigenous human-beaver relationship be revitalized in the urban context as a cost-effective strategy to secure and stabilize surface water?</li> <li>4. How can the growing population benefit from a resilient hydrologic system in terms of housing, greening, and recreation?</li> </ol>
<p>design assignment in which these result.</p>	<p>Three levels of design objective are expected to be reached in this project:</p> <p><b>System Level</b> - implement specific restoration strategies on various components of the urban hydrologic system (major waterways, tributaries and water surfaces)</p> <p><b>Habitat Level</b> - enhance the volume of water storage through ecological rehabilitation, and create a reciprocal co-living community model for the rising population</p> <p><b>Species Level</b> - introduce beaver with good consequences for humans and other organisms within the urban ecosystem</p>

## Research Question

How can a **nature-based flood solution** be integrated into Winnipeg's massive urban development on the wet prairie while offering a **flood resilient design for long-term coexistence between people and wildlife?**

- 1. How to increase **stormwater storage** through ecological rehabilitation based on the spatial segmentation of the buried creeks and lost water surface?
- 2. How to incorporate Winnipeg's **urban hydrologic system** (combined sewer overflow) into the solution response to threatening floods?
- 3. Can the **human-beaver relationship** be revitalized in the urban context as a cost-effective strategy to secure and stabilize surface water?
- 4. How can the **growing population** benefit from a resilient hydrologic system in terms of housing, greening, and recreation?

## Design Objective

### Challenges & Potentials

**Analyzing the urban hydrologic system/ecosystem**

- fragmented surface water mosaic
- overland flood risk
- urban voids potential
- possible beaver habitats
- natural flow - vegetation, hydrology and topography
- urban flow - urban densities, available drainage infrastructure and flooding patterns

### Development

**Nature-based solutions for water**

- enhance water availability (soil moisture retention, groundwater recharge, beaver revitalization...)
- improve water quality (natural and constructed wetlands, riparian buffer strips...)
- reduce risks (stream restoration, permeable paving, green roof...)

### Guiding models

**For Flows:** ●●●  
water flow - resilient floodscape scenario  
beaver flow - habitat management scheme  
urban flow - green infrastructure and mobility network

**For Areas:** ●●●  
mature community redevelopment sites  
urban fringe (to be developed)

**For Organizations:** ●●●  
pilot project  
public involvement actions

### Strategic plan

**Strategic plan** ●●●●

- sustainable hydrological cycle
- flood adaptive developments
- beaver-human symbiosis scenario

**Spatial proposal** ●●●●

- urban water resilient network
- multifunctional open space system
- sustainable urban drainage

### Design projects

**Building Typologies** ●●●

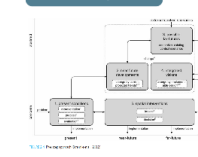
**Public Green Space** ●●●

**Stormwater Basin** ●●●

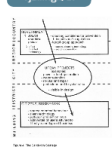
**Symbiotic Riparian Neighborhood Model** ●●●●

## Theory Alignment

### FIVE-STEP APPROACH



### ECOPOLIS



### SWARM PLANNING



### LAND MOSAICS



# Process

## Method description

### Fascination



### Problem Statement

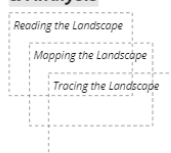
### Research Question

How can a **nature-based flood solution** be integrated into Winnipeg's massive urban development on the wet prairie while offering a **flood resilient design for long-term coexistence between people and wildlife?**

### Design Objective

**System Level** - implement specific restoration strategies on various components of the urban hydrologic system (major waterways, tributaries and water surfaces)  
**Habitat Level** - enhance the volume of water storage through ecological rehabilitation, and create a reciprocal co-living community model for the rising population  
**Species Level** - introduce beaver with good consequences for humans and other organisms within the urban ecosystem

### Data Collection & Analysis



### Sub Research Question

1. How to increase **stormwater storage** through ecological rehabilitation based on the spatial segmentation of the buried creeks and lost water surface?
2. How to incorporate Winnipeg's **urban hydrologic system** (combined sewer overflow) into the solution response to threatening floods?
3. Can the **human-beaver relationship** be revitalized in the urban context as a cost-effective strategy to secure and stabilize surface water?
4. How can the **growing population** benefit from a resilient hydrologic system in terms of housing, greening, and recreation?

### Method

- Desktop study
- Literature review
- GIS mapping
- Research by design
- Case study
- Stakeholder interviews
- Policy study

### Design Process

**Scale:** Macro / Meso / Micro  
**Participant:** Ecosystems / Organisms / Human activity  
**Phase:** Present condition / Near-future development / Far-future scenarios / Integrated visions / Spatial interventions

**Principle:** Vision  
**Intervention:** Detail design

### Theoretical Framework

Five-step approach  
Swarm planning  
Land Mosaics  
Ecopolis

### Conclusion

### Reflection

## Literature and general practical reference

### Field Research:

1. Brokke, K. R. G. (2016). Transformations of the Red River Valley of the North: An Environmental History.
2. Brooks, G. (2017). Red River Valley, Manitoba: The Geomorphology of a Low-Relief, Flood-Prone Prairie Landscape (pp. 143–155).
3. Flood frequency analysis for the Red River at Winnipeg. (n.d.). Retrieved 1 December 2022
4. Graham, R. M. W. (2012). The surface waters of Winnipeg: Rivers, streams, ponds and wetlands 1874-1984: the cyclical history of urban land drainage.
5. Manitoba History: “Duff’s Ditch”: The Origins, Construction, and Impact of the Red River Floodway. (n.d.). Retrieved 19 December 2022, from [http://www.mhs.mb.ca/docs/mb\\_history/42/duffsditch.shtml](http://www.mhs.mb.ca/docs/mb_history/42/duffsditch.shtml)
6. Morgan, R. G. (1991). Beaver ecology/beaver mythology. ERA.
7. Red River Floodway | Infrastructure | Province of Manitoba. (n.d.). Retrieved 19 December 2022, from <https://www.gov.mb.ca/mit/wms/rrf/index.html>

### Case Study:

1. Between Floods: Resiliency & Urban Regeneration. (n.d.). Sasaki. Retrieved 19 December 2022, from <https://www.sasaki.com/voices/between-floods-resiliency-urban-regeneration/>
2. ENGHAVEPARKEN - CLIMATE PARK - TREDJE NATUR. (n.d.). Retrieved 19 December 2022, from <https://www.tredjenatur.dk/en/portfolio/enghaveparken-climate-park/>
3. Krueger, K. Beaver, A Natural Solution to Urban Stream Restoration.
4. Lourenço, I. B., Beleño de Oliveira, A. K., Marques, L. S., Quintanilha Barbosa, A. A., Veról, A. P., Magalhães, P. C., & Miguez, M. G. (2020). A framework to support flood prevention and mitigation in the landscape and urban planning process regarding water dynamics. *Journal of Cleaner Production*, 277, 122983.
5. MALMØ 2030. (n.d.). TREDJE NATUR. Retrieved 19 December 2022, from <https://www.tredjenatur.dk/en/portfolio/2030-norra-bunkeflo-strand/>
6. OPINION: When it Comes to Resiliency, Boston Can Think Bigger. (n.d.). Metropolis. Retrieved 19 December 2022, from <https://metropolismag.com/viewpoints/michael-liu-boston-waterfront-resiliency/>
7. Palazzo, E., & Wang, S. (2022). Landscape Design for Flood Adaptation from 20 Years of Constructed Ecologies in China. *Sustainability*, 14(8), Article 8.

### Theoretical Approach:

1. Forman, R.T. (1995). *Land Mosaics: The Ecology of Landscape and Regions*. Cambridge University Press, New York.
2. Research by Design - International Conference (2000). - Delft University of Technology - Faculty of Architecture, in cooperation with the EAAE/AEEA, November 1-3.
3. Roggema, R. (2012). Swarm Planning Theory. In *Advances in Global Change Research* (Vol. 48, pp. 117–139).
4. Stremke, Sven. (2010). *Integrated Visions at the Regional Scale: Five-step Approach*.
5. Sun, N., Limburg, K., & Hong, B. (2019). *The Urban Hydrological System* (pp. 119–136).
6. Tjallingii, Sybrand. (1995). *Ecopolis: Strategies for Ecologically Sound Urban Development*.

## Reflection

### **1. What is the relation between your graduation (project) topic, the studio topic (if applicable), your master track (A,U,BT,LA,MBE), and your master programme (MSc AUBS)?**

McHarg’s view of the ecological design approach is particularly enlightening: “The ecological method is the perception of form, an insight to the given form, implication for the made form which

is to say design". Based on the palimpsest of form, this thesis aims at providing a comprehensive symbiotic solution by seeing form as a signal of a readable landscape. The pattern of meandering rivers and streams that is still visible today brings back a vivid picture of ancient people living on the plains would draw support from beavers and other organisms to live in harmony with natural forces. This symbiotic triangle of humans, wildlife and nature could bring inspiration to a new picture of modern lifestyle in Winnipeg.

I think another valuable aspect of this project is integrating people's daily life into designing the consequences of landscape intervention, as a reflection of the idea 'design in process'. In order to achieve the goal of sustainability in water issue, social scenarios are brought into the temporal dimension to enhance the identity of urban landscape. By examining time phases in landscape designs, this project demonstrates some practical solutions that integrate various flows and mitigate the detrimental consequences of blind urbanization through ecological approaches.

## **2. What is the relevance of your graduation work in the larger social, professional and scientific framework.**

Social relevance:

The project follows the trace of the sensitive hydrology phenomenon and calls for the necessity and urgency of natural watercourses preservation in cities, which contributes to a more sustainable city life. From the cultural perspective, the benefits of coexisting with wildlife can be a response to the indigenous views of the plains and beavers. Instead of replicating the way of life of the ancestors of the prairie, the project rethinks of a new vision that contemporary lifestyles, along with other natural organisms, can be integrated into urban ecosystems.

The project opens up a view on the beneficial interaction between ecosystems, animals, and human activity, improving sustainability in terms of maximizing cost effectiveness, promoting biophilia behavior of urban residents, and avoiding risks to city infrastructures from beavers and other animals while sharing. Moreover, it arouses the awareness of citizens to better live with the flood and rethink differently about land use in urban planning.

Bringing Winnipeg's urban hydrology system into the response to threatening floods also provide additional advantages for the city: reduced construction costs, increased property values, basement flooding elimination, recreational amenity, increased aesthetic values, potential for notable species habitat, and pollution load prevention for the receiving stream by the natural-based flood solution.

By structuring a more resilient hydrologic system with different stakeholders, they learn to collaborate to satisfy the requirements for housing, greening and recreation with a more sustainable approach.

Professional and scientific relevance:

Through research by design approach, the project would provide a comprehensive model for regenerating the potential for more adaptable hydrologic cycle. The strategic plan in response to two main flooding types in Winnipeg, overland flooding and river flooding, pursues a sustainable development approach on water availability, quality and safety for a better quality of life in urban environments.

In a larger scale, the disappearing water surface (creeks and marshes) under the influence of urban expansion has aroused hydrologic crisis that spreads across the metropolitan areas in North America. This graduation work aims at providing a solution to cure the losing water surface under the pressure of the rapid urban expansion.

Landscape planning and design is a vehicle for human understanding of ecosystems, a catalyst for the mutually beneficial development of humans and nature. It is also fundamental in this project to look for a different identity and provide a more livable social structure through landscape design, which counts on a combination of spatial strategies and social studies. The symbiotic urban development plan in Winnipeg's Northwest region may willingly show an aspect on working with different disciplines (architecture, engineering, ecology...) to achieve the public welfare.

