MASTER'S THESIS TOPIC PROPOSALS

2025-2026

Master Bioscience Engineering:
Sustainable Urban Bioscience Engineering

Overview

Title of the thesis topic	Application of a photocatalyst coating on urban structures: a comprehensive modeling, experimental, and theoretical approach
Keywords	photocatalyst, coating, modeling
Description The topic focuses on identifying the optimal area, such as concrete structures, for the application of a photocatalyst coating in an urban environment to degrade air pollutants. The study aims to use modeling software (such as ENVI met, OpenFOAM, COMSOL) to simulate urban microclimates and predict the effectiveness of photocatalyst coatings in reducing pollutants and enhancing air quality. This will be complemented by experimental and theoretical investigations to validate and refine the model.	
Related to CityLab	CityLab 1: The Urban Ecosystem
Relevance to urban challenges and/or applications This research aims to develop a predictive model that can guide urban planners and engineers in applying photocatalyst coatings effectively to maximize environmental benefits in urban settings. The study not only seeks to advance understanding of photocatalysis in urban contexts but also to contribute to practical solutions for improving air quality in densely populated areas.	
Max. number of students	1
Promoter	Siegfried Denys (Siegfried.denys@uantwerpen.be)
Supervisor	Marjan Demuynck (marjan.demuynck@uantwerpen.be), Megha Ramteke (Megha.Ramteke@uantwerpen.be)
Research project abroad?	No
Compatibility with internship	No issues specified

Title of the thesis topic	Assessing indoor thermal comfort in university lecture rooms: a campus study
Keywords	thermal comfort, lecture rooms, modelling
Description This thesis investigates thermal comfort conditions in university lecture rooms, focusing on their impact on student experience and energy efficiency. The study combines on-site measurements, occupant surveys, and thermal modeling to evaluate indoor climate conditions and identify potential improvements in ventilation, heating, and cooling systems to optimize learning environments.	
Related to CityLab	CityLab 1: The Urban Ecosystem
Relevance to urban challenges and/or applications Thermal comfort in educational spaces is a critical component of sustainable urban development, as universities are integral parts of urban life. Optimizing thermal comfort in lecture rooms through energy-efficient systems can reduce the overall energy footprint of campus buildings, aligning with urban sustainability goals. Thermal discomfort in learning spaces directly impacts students' focus, health, and academic performance.	
Max. number of students	1
Promoter	Siegfried Denys (Siegfried.denys@uantwerpen.be)
Co-promoter	Tom Tytgat (tom.tytgat@uantwerpen.be)
Supervisor	Marjan Demuynck (marjan.demuynck@uantwerpen.be)
Research project abroad?	No
Compatibility with internship	No issues specified

Title of the thesis topic	Designing Healthy Public Spaces: Promoting Well-Being and Reducing Health Inequalities
Keywords	Inclusive urban design /// Urban well-being

Description

According to the World Health Organization (WHO), an unhealthy environment accounts for approximately 24% of the global disease burden. Research has shown that the physical and social characteristics of public spaces have a direct or indirect impact on the health of residents. By designing healthier public spaces, we can improve mental health and significantly reduce the risk of chronic illnesses such as obesity, type 2 diabetes, and cardiovascular diseases.

Vulnerable populations—including those with a lower socio-economic status, migration background, or lower income, as well as children, youth, and the elderly—are disproportionately affected by environmental impacts. Creating healthy, inclusive public spaces can help narrow the health gap and improve equity.

This master's thesis will focus on health-promoting factors in public spaces. Public spaces can encourage play and physical activity and foster social interaction, all of which contribute to better physical and mental health. The research will address the following questions:

- Which design principles (e.g., sidewalk and road width, green management, lighting, visibility, etc.) promote increased and/or intensive use of healthy public spaces?
- What motivates diverse groups to use healthy public spaces?
- What barriers do these groups face?

The research will involve a comparative or experimental intervention study, combining observations with questionnaires completed by users and non-users, to answer questions about one or more design principles. Additionally, a literature review or interviews with relevant stakeholders will explore whether similar interventions have been studied previously.

The goal is to provide actionable recommendations for policymakers and spatial planners to transform public spaces into "healthy public spaces" that promote both social interaction and play/physical activity.

This thesis topic has been suggested and will be supervised by the NGO Vlaams Instituut Gezond Leven. The Vlaams Instituut Gezond Leven is a Flemish organization dedicated to promoting healthy lifestyles and environments through evidence-based guidance, tools, and initiatives.

Related to CityLab	CityLab 3: Human Health & Urban Liveability

Relevance to urban challenges and/or applications

The topic "Designing Healthy Public Spaces" is highly relevant to urban challenges and holds significant potential for practical applications in urban settings.

Urban areas are facing increasing health disparities, exacerbated by dense infrastructure, limited access to green spaces, and social inequities. Public spaces, as key components of urban environments, often fail to support residents' health needs, particularly for vulnerable groups such as those with lower socio-economic status, migration backgrounds, children, and the elderly. By reimagining and redesigning these spaces to prioritize health-promoting factors, we can directly address issues such as sedentary lifestyles, social isolation, and chronic health conditions like obesity, diabetes, and cardiovascular disease.

The findings of this research can inform urban planning and policy-making by identifying evidence-based design principles—such as optimal sidewalk widths, green space management, visibility, and lighting—that encourage physical activity, play, and social interaction. This contributes to creating inclusive, accessible public spaces that enhance both physical and mental well-being for all residents.

Moreover, applying these insights in urban settings can help bridge health gaps by fostering environments that are not only functional but also equitable and supportive of diverse populations. This approach aligns with global efforts to make cities more sustainable and livable, addressing public health issues through strategic urban design and planning.

Max. number of students	1
Promoter	Ben Somers (ben.somers@kuleuven.be)
Co-promoter	Eline De Decker (eline.dedecker@gezondleven.be)
Supervisor	Eline Rega (eline.rega@kuleuven.be)
Research project abroad?	No
Compatibility with internship	No issues specified
Any other relevant information	The thesis will be executed in collaboration with Vlaams Instituut Gezond Leven (Brussels).

Title of the thesis topic	Ecophysiological stress detection in urban trees
Keywords	drought, heat, pests and diseases, urban tree management, urban heat island
Description This thesis aims to contribute to an online and continuous monitoring of the ecophysiological health status of trees. Therefore, representative trees will be selected in contrasting urban environments, and equipped with sensors to monitor some key ecophysiological processes, e.g. sap flow and diameter fluctuations. Trees' responses to stress will be assessed in relation to environmental (e.g. heat and drought stress) and site (soil physical characteristics) parameters, and practical tree health indicators and thresholds will be derived to improve urban tree management.	
Related to CityLab	CityLab 1: The Urban Ecosystem CityLab 3: Human Health & Urban Liveability
Relevance to urban challenges and/or applications Urban trees, and certainly streetscape trees are often growing in high stress conditions due to low quality growing sites. Climate change related effects like heat and drought stress are topping up to this stress, further decreasing tree vitality posing a serious threat for tree survival. All over Europe this results in weakened trees of which many eventually die off. The replacement of trees and the damage that weakened trees can cause (e.g. due to falling branches) can be considerable. Low tree vitality further results in a decreasing delivery of ecosystem services which has a negative impact on the livability of cities. Monitoring tree vitality is thus key to maintain and enhance urban livability, as it allows that proper management decisions can be taken in time. We therefore need ecophysiological tree stress indicators that can be monitored in a smart and continuous way.	
Max. number of students	1
Promoter	Roeland Samson (roeland.samson@uantwerpen.be)
Research project abroad?	If the student is interested and motivated, it can be discussed whether (part of) the research project can take place abroad. In this case, please let the promoter know as soon as possible to initiate the necessary procedures on time.
Compatibility with internship	No issues specified

Title of the thesis topic	Enhancing the biofiltration of indoor air pollutants using a mixture of plants to reduce CO2 emissions in low-light indoor environments
Keywords	Active flow, Bioremediation, Botanical biofiltration, CAM metabolism, C3 metabolism, CO2 production, Plant metabolism, Respiration, Suitable Light, VOCs

Description

Botanical biofiltration is a relatively less studied technique that can treat indoor air pollutants, particularly gaseous pollutants like volatile organic compounds, by combining plants, substrates, and microorganisms in a more robust and versatile system. When an active flow is directed through it, it is called active botanical biofiltration. Bacterial communities are present in the leaves, i.e., phyllosphere and substrate compartments that can metabolize the VOC into CO2 and by-products. Most research has acknowledged that the removal of VOCs mostly occurs in the substrate compartment, given that under an active flow regime, the retention or contact time between plant leaves and VOC is minimal. More concerning is that botanical biofilters can also generate a high concentration of CO2 during plant respiration, particularly C3 plants, under low light conditions, which is often the case in indoor settings. Additionally, CO2 can also be emitted by the bacteria present in the substrate that can also metabolize VOCs. The latter concerns indoor spaces since high CO2 concentrations harm human health. On one hand, VOCs are removed; on the other hand, CO2 is obtained as a by-product.

It has been proposed that CO2 emissions from a botanical biofilter can be reduced by combining C3 and CAM plants, as CAM plants open their stomata at night and absorb the CO2 produced by C3 plants. This can be further enhanced by providing suitable light > 10,000 lux, which might also increase the VOC removal. The addition of light directly impacts the system's sustainability by using more energy. This thesis aims to evaluate the VOC removal of a botanical biofilter under a combination of different plant metabolism (C3 and CAM) types and their impact on the generation of CO2 in indoor environments to obtain the largest VOC reduction with the least CO2 generation. The VOC removal and CO2 production will be quantified under day and dark conditions in a climate chamber using innovative SIFT-MS that allows the VOC quantification in real time. The botanical biofilters will be operated in an active flow regime, and environmental variables will be measured. Suitable light intensities measured will be provided to the botanical biofilter during light conditions to evaluate the removal effect. A trade-off between plant metabolism, VOC removal, CO2 production, and light will be derived to optimize botanical biofilters.

Related to CityLab	CityLab 1: The Urban Ecosystem CityLab 3: Human Health & Urban Liveability

Relevance to urban challenges and/or applications

With the world population shifting increasingly to cities and spending more than 90% of their time indoors, it is imperative to guarantee adequate indoor air quality. The indoor

environment is believed to be often more polluted than outdoors, particularly by volatile organic compounds (VOCs). These substances are highly detrimental to human and environmental health. Many physical and mental health complaints and work productivity are directly linked to indoor air pollution, affecting the economy. For instance, it is sustained that work productivity is reduced by 15%. Furthermore, regulations concerning indoor air pollutants have become stricter to guarantee human health. Botanical biofiltration is a promising yet less studied technology that can aid in achieving these regulations while providing additional benefits to society. Moreover, it promotes a paradigm shift from traditional air treatment to biological with an efficient use of resources and less energy consumption.	
Max. number of students	1
Promoter	Siegfried Denys (siegfried.denys@uantwerpen.be)
Co-promoter	Wenke Smets (wenke.smets@uantwerpen.be)
Supervisor	Allan Augusto Alvardo-Alvardo (allan.alvardoalvardo@uantwerpen.be)
Research project abroad?	No
Compatibility with internship	No issues specified
Any other relevant information	• Interest or experience in air quality and the indoor environment will be appreciated • Interest or experience in biological systems, nature-based solutions, bioremediation • Proactive and independent attitude toward laboratory work • Use of R as a statistical software package

Title of the thesis topic	Exploring abiotic and environmental characteristics relevant for the microbiomes of Urban Green Spaces (UGAs)
Keywords	Urban green, park characteristics, microbiome

Description

Urban green spaces (UGAs), such as parks, could act as reservoirs of beneficial microbes in cities that promote both biodiversity and human health. However, we still do not know how to design UGAs that contain beneficial microorganisms, because it is not yet clear how the UGA microbiome is influenced by its abiotic and environmental characteristics.

This Master's thesis will focus on selecting key abiotic and environmental factors that can shape the microbiome of UGAs. The initial list of factors to explore can include park area, connectivity, land cover, surface temperature, and air pollution. Subsequently, these factors will be analysed in UGAs in the Antwerp region. Examples of techniques include GIS analysis, air pollution analysis using public data and sensors measurements, and statistical analysis using the R software and/or GraphPad Prism. The obtained results will guide the selection of UGA candidates for microbial characterization in future studies.

Furthermore, the student will have the opportunity to contribute to current citizen science projects focusing on the microbiome of UGAs, for example through helping with communication (in Dutch/English). An example of a currently running project is BUGS (Benefits of Urban Green Spaces; uantwerpen.be/bugs).

This Master's thesis offers a unique opportunity to contribute to sustainable urban green design. In the future, its findings could shape healthier, more resilient cities by integrating microbial diversity into urban planning frameworks.

Related to CityLab	CityLab 1: The Urban Ecosystem CityLab 3: Human Health & Urban Liveability

Relevance to urban challenges and/or applications

This project tackles urban challenges by taking the first steps in exploring how urban green spaces can be designed to promote the presence of beneficial microorganisms. It focuses on identifying environmental factors shaping these microbial communities and their integration into urban planning, offering important insights for policymakers and planners.

Max. number of students	1
Promoter	Roeland Samson (roeland.samson@uantwerpen.be)
Co-promoter	Irina Spacova (Irina.spacova@uantwerpen.be)
Supervisor	Augustina Santullo Latorre (agustina.santullo@uantwerpen.be)
Research project abroad?	No

Compatibility with internship	The expected starting date is in September 2025, or earlier (if this is possible for the student and mentor). Fieldwork in Antwerp parks will be planned throughout the thesis, however adjustments are possible depending on the student's availability.
Any other relevant information	The student is required to have a good understanding and use of GIS (as taught in the Master SUBE course). Speaking Dutch may facilitate more active participation in the communication within one of the currently ongoing citizen science projects but is not a deciding factor for this Master's thesis as a whole.

Title of the thesis topic	Green Hydrogen Production
Keywords	Hydrogen, (photo)electrolysis, catalysis

Description

Sustainable cities run on sustainable fuels. In that context, the EU has recognized the value of hydrogen gas as an important energy carrier in an urban context. It can be used as a clean fuel (e.g. hydrogen cars, busses and trucks), but could also be used as an energy storage medium to store excess wind or solar energy.

In this thesis you will contribute to new disruptive hydrogen production technologies. Depending on the interests of the student, the work will focus on either catalyst synthesis, reactor development and/or modeling. The research will be conducted at the Verbruggen-lab within the A-PECS research group at the Department of Bioscience Engineering (UAntwerp), under the guidance of an interdisciplinary team of engineers and photo/electro-chemists. At the level of catalyst research, you will actively study new, earth-abundant materials for water splitting, as opposed to the current generation of platinum group metals. You will develop new synthetic methods and test your materials in a lab setting.

In addition, or alternatively, you will focus on new reactor configurations. These can be based on unique compartmentalized photo-electrolyzers developed in our group, that couple oxidative treatment of waste sources, to hydrogen production. These can also be based on a novel type of membraneless electrolyzer that we have recently patented, and that we aim to bring to scale. Flexible engineering using 3D printing techniques will be a key facility.

Related to CityLab	CityLab 2: Urban Resources

Relevance to urban challenges and/or applications

The quest for alternative energy carriers in an urban context is a key challenge. These carriers also need to be produced in a sustainable way. Hydrogen has been identified by the EU as an important candidate in this regard, and explorative city-related projects have already been performed (e.g. H2-busses of De Lijn).

Max. number of students	2
Promoter	Sammy Verbruggen (sammy.verbruggen@uantwerpen.be)
Co-promoter	Rituraj Borah (depending on the exact final topic) (Rituraj.borah@uantwerpen.be)
Research project abroad?	No
Compatibility with internship	Ideally, the thesis starts between 15/08 and 01/09, but depending on the situation this can be discussed. Proactive communication is the only request.

Title of the thesis topic	Leaves as bio-indicator of urban microplastic pollution
Keywords	biomonitoring, mapping, deposition, environmental pollution, urban health

Description

It is important to obtain a good insight into the spatial distribution of this pollutant in urban environments to be able to take adequate measures to diminish citizens' exposure to microplastics.

Leaves proved to be a good indicator to assess the spatial distribution of particulate matter in urban environments. In this thesis project we will assess the usability of plant leaves for microplastic detection in urban environments. Therefore, a leaf sampling strategy will be developed to sample the urban environment. Subsequently, the presence, size and composition of microplastics on leaves will be assessed by a multitude of approaches, e.g. Scanning Electron Microscopy and Raman Spectroscopy.

Related to CityLab	CityLab 1: The Urban Ecosystem CityLab 3: Human Health & Urban Liveability

Relevance to urban challenges and/or applications

Microplastic pollution is one of the major emerging environmental challenges humans are facing. The focus was long on (micro)plastic pollution in aquatic environments, but it becomes more and more clear that microplastic pollution can be found everywhere on the globe up to the highest mountains.

Urban environments are majorly contributing to this pollution, with the abrasion of tyres as one of the major sources. Part of this pollution will indeed find its way to the aquatic environment but part will via the atmosphere be diffused into the urban environment with the risk of soil accumulation and direct and indirect uptake by humans and other animals. As such they create a health risk for citizens.

Max. number of students	1
Promoter	Roeland Samson (roeland.samson@uantwerpen.be)
Co-promoter	Karolien De Wael (Karolien.dewael@uantwerpen.be)
Supervisor	Gert Nuyts (gert.nuyts@uantwerpen.be)
Research project abroad?	No
Compatibility with internship	No issues specified

Title of the thesis topic	Light-driven CO2 conversion
Keywords	CO2, (photo)catalysis, photo thermal, materials

Description

Densely populated and industrialized urban areas suffer from excessive CO2 levels. To that end different CO2 capture technologies have been proposed that extract CO2 from the city air and concentrate it in a small volume that can be processed further, e.g. by converting it into new and useful feedstocks.

In this thesis you will contribute to new methods for CO2 conversion, through which large CO2 quantities (such as those from point sources or the product of direct air capture technologies) are converted into useful molecules such as CO or methanol.

Depending on the interests of the student, the work will focus on either catalyst development, or catalytic process optimization. The research will be conducted at the Verbruggen-lab within the A-PECS research group at the Department of Bioscience Engineering (UAntwerp), under the guidance of an interdisciplinary team of (environmental) engineers and chemists.

At the level of catalyst research, you will actively study new, earth-abundant photoactive materials for CO2 conversion, as opposed to the current generation of platinum group metals, or noble metals like gold. You will develop new synthetic methods and test your materials in a lab setting.

In addition, or alternatively, you will focus on catalytic process optimization, by testing novel materials in the photocatalytic (i.e. purely light-driven) or photo-thermo-catalytic (i.e. light + heat) conversion of CO2. This part of the work will involve studying the relation between process parameters, and the activity/selectivity/stability of the catalyst, to enable further optimization of the overall technology. It can also involve studying the reaction pathway in more detail by making use of a newly acquired photo-thermal in-situ reaction cell. In this way, both fundamental as well as applied insights can be gathered, depending on the student's main interest.

Related to CityLab	CityLab 2: Urban Resources

Relevance to urban challenges and/or applications

The relevance of air quality in a city context is clear. Especially in highly populated areas with a lot of traffic and little green infrastructure, CO2 levels can be high. Application of direct air capture technologies is one thing to reduce these levels, but we want to go beyond that point by also converting CO2 in useful feedstock chemicals.

Max. number of students	2
Promoter	Sammy Verbruggen (Sammy.verbruggen@uantwerpen.be)
Research project abroad?	No

Compatibility with internship	Ideally, the thesis starts between 15/08 and 01/09. Depending on the situation, this can be discussed. Proactive communication is the only request.

Title of the thesis topic	Multi-criteria decision analysis framework to assess risks and benefits related to microbiological food safety of alternative food systems
Keywords	microbiological food safety, aquaponics, urban food system, multi-criteria decision analysis

Description

Current food systems are present in a fast-changing environment driven by various co-occurring stressors such as climate change, the need for a circular economy and a more sustainable food system. This drives innovation in the food industry, resulting in alternative food production and/or delivery systems, e.g. aquaponics and last-mile delivery. Changes in the food system could impose both risks as benefits regarding microbiological food safety.

This master dissertation will design a holistic multi-criteria decision analysis (MCDA) framework, focusing on microbiological food safety, to assess risk and benefits related to changes in the food system. The proposed framework will be applied on a circular urban farming system (aquaponics). The MCDA framework has the objective of enabling a proactive, integrated and transparent analysis of food systems, giving support to regulatory bodies. This research is carried out in the frame of an European Horizon Europe project, FoodSafeR. Applied research methodologies are literature study, expert elicitation (from different domains) and citizens consultation.

Related to CityLab	CityLab 2: Urban Resources

Relevance to urban challenges and/or applications

Aquaponics is an emerging method to cultivate fresh food in an urban setting (combinations of herbs, vegetables and fish production).

Max. number of students	1
Promoter	Liesbeth Jacxsens (liesbeth.jacxsens@ugent.be)
Co-promoter	Mieke Uyttendaele (mieke.uyttendaele@ugent.be)
Supervisor	Mathis Vermeersch (mathis.vermeersch@ugent.be)
Research project abroad?	If the student is interested and motivated, it can be discussed whether (part of) the research project can take place abroad (University of Athens). In this case, please let the promoter know as soon as possible to initiate the necessary procedures on time. The research can NOT start in second semester.

Compatibility with internship	Starting date is end of August till mid September. As this research needs to follow the flow of the FoodSafer project. https://foodsafer.com/

Any other relevant information	Specific interest in multidisciplinar research.

Title of the thesis topic	Novel diagnostic test for emerging infectious diseases
Keywords	infectious diseases; diagnostics; biotechnological amplification

Description

Mosquito-borne infections, such as dengue, chikungunya and Zika, cause millions of infections each year and pose a significant public health burden. While these diseases mainly occur in (sub)tropical areas, they are a growing threat to European citizens as the mosquitos carrying these diseases are spreading due to extensive trade and travel with (sub)tropical regions and climate change. Moreover, urbanization plays a crucial role in the spread of mosquito-borne diseases, as it accelerates the transmission cycle and leads to large outbreaks. Hence, obtaining fast and accurate data on circulating infections in a population is important to effectively implement disease control measures. However, current tests are either expensive and only applicable in lab settings, or lack sensitivity and specificity. Therefore, this project will contribute to developing an accurate and affordable diagnostic test for infectious diseases that is applicable at the point of care.

To pursue this goal, this project aims to combine biotechnological amplification strategies (e.g. rolling circle amplification) with electrochemical readout (similar as glucose meter) to detect viral RNA. Efforts will be made to develop and optimize sample preparation and amplification protocols. Thanks to this novel technology, it will be possible to detect different infectious diseases in a fast (less than one hour), specific (discrimination between related viruses) and sensitive (fM range) way.

Related to CityLab	CityLab 3: Human Health & Urban Liveability

Relevance to urban challenges and/or applications

Many infectious diseases cycle between humans and mosquitos. These mosquitos thrive in urban environments and are spreading towards Europe due to increased urbanization, travel, trade and climate change. Dengue and chikungunya viruses have repeatedly initiated urban transmission cycles involving human amplification which causes large outbreaks in urban areas.

Max. number of students	2
Promoter	Karolien De Wael (karolien.dewael@uantwerpen.be)
Co-promoter	Elise Daems (elise.daems@uantwerpen.be)
Research project abroad?	No
Compatibility with internship	No issues specified

Title of the thesis topic	Quantifying the Impact of Nature Exposure on Physiological Responses in Urban Settings
Keywords	Urban green /// nature exposure /// well-being

Description

Urban environments often limit exposure to nature, despite its known health benefits. Research increasingly highlights how nature influences well-being, yet most studies focus on static environments. This thesis explores how dynamic, real-world nature exposure affects physiological responses, particularly electrodermal activity (EDA), a marker of emotional arousal.

A cross-sectional study will assess real-time physiological responses to dynamic exposure levels, involving on-site experiments with participants navigating urban green spaces. Finally, we will create a dose-response curve to show how varying levels of urban nature exposure impact EDA measurements.

This research aims to provide quantitative evidence of the well-being benefits of urban nature, with applications in city planning. By understanding the relationship between nature exposure and physiological responses, we can inform guidelines for optimizing urban green spaces to enhance health outcomes.

Related to CityLab	CityLab 3: Human Health & Urban Liveability

Relevance to urban challenges and/or applications

This topic directly addresses key urban challenges and offers valuable applications for improving urban environments.

One of the primary challenges in urban areas is limited access to natural environments due to dense infrastructure, urban sprawl, and insufficient green space planning. This lack of exposure to nature has been linked to increased stress, reduced well-being, and other health disparities among urban populations. By focusing on the real-time physiological responses to varying levels of nature exposure, this research provides critical insights into how urban green spaces can positively influence health and well-being.

The findings have direct applications in urban settings. The dose-response curves generated in this study can inform urban planners and policymakers about the optimal quantity, quality, and distribution of green spaces required to maximize health benefits. This evidence can support the development of urban design guidelines that prioritize accessible and impactful natural environments, particularly in high-density areas where such interventions are most needed.

Additionally, this research can guide future strategies for integrating green spaces into urban renewal projects and community health initiatives. It also highlights the importance of dynamic and real-world exposure scenarios, ensuring that the planning and design of urban nature are aligned with how people interact with their environments daily. By linking nature exposure to measurable health benefits, this study contributes to creating healthier, more sustainable cities.

Max. number of students	1
Promoter	Ben Somers (ben.somers@kuleuven.be)
Co-promoter	Filip Raes (filip.raes@kuleuven.be)
Supervisor	Yangyang Shi (yangyang.shi@kuleuven.be)
Research project abroad?	No
Compatibility with internship	No issues specified
Other relevant information	Ideal participants are passionate about urban sustainability, enjoy working with wearable sensors, and are eager to engage in interdisciplinary collaboration.

Title of the thesis topic	Scenario-Based Life Cycle Assessment of Circular Food Systems in Flanders Using Mass Balance Approaches
Keywords	Material flow analyses, Life cycle analyses

Description

The project aims to evaluate the environmental performance of agricultural systems under different scenarios, such as:

- Conventional practices (baseline comparison).
- Circular systems with waste valorization (e.g., anaerobic digestion and nutrient reuse through digestate application).
- Optimized resource efficiency (e.g., alternative protein sources or feed strategies).

Mass balance modeling will be integrated with LCA to quantify resource flows, emissions, and sustainability benefits. While the project could focus on general food systems, it could also delve into protein production and valorization pathways for added relevance.

The main theme of this thesis is food systems, with a specific focus on sustainable protein production and nutrient recycling. It will be ideal for the student to explore how new methods of closing the nutrient loop to meet protein demand can be achieved in a more sustainable manner. This could involve alternatives to the business-as-usual model, such as utilizing urban resources—food waste, wastewater, and by-products—to close nutrient cycles within cities.

Related to CityLab	CityLab 2: Urban Resources

Relevance to urban challenges and/or applications

This aligns closely with the themes of circularity and resource efficiency. It could make a meaningful contribution to sustainable agricultural research in Flanders. By focusing on urban challenges like spatial constraints, resource limitations, and the need for resilient food systems, this thesis directly aligns with the objectives of the Master SUBE programme CityLab.

Max. number of students	1
Promoter	Marc Spiller (marc.spiller@uantwerpen.be)
Supervisor	Enrico Roets (enrico.roets@uantwerpen.be)
Research project abroad?	No.
Compatibility with internship	No issued specified.
Other relevant information	This is all dry work and no field work or lab work will be conducted.

	This topic is ideal if you have an interest in building a model scenario that's different to the current system and measuring the changes and hidden costs environmentally with means of LCA.

Title of the thesis topic	Sewer solutions: In-sewer urine dosing to maximise resource-efficiency and sustainability across the urban wastewater system
Keywords	Urban sanitation, emission control, odour control, denitrification

Description

Did you know that urine is liquid gold? With this thesis, you and your urine could contribute to making Flanders' urban sanitation cycle more sustainable!

Flanders is an urbanised region with an expansive sewer network dominated by centralised sewage treatment. This current sanitation system is outdated, as it suffers from dilution of valuable resources, expired/expiring sewer pipes and gaseous emissions in the form of odorous compounds or greenhouse gases. Furthermore, the existing wastewater treatment plants face increasing pressure on the plants' high aeration costs and limiting treatment capacity, largely caused by the high nitrogen load of municipal wastewater.

Urine is highly concentrated in N, P and micropollutants. Hence, its decentralized treatment would decrease the high nutrient loads reaching the central plants. Though decentralized treatment has promising benefits in terms of resource recovery, its implementation may be infeasible in a fast enough timeframe.

A possible solution is a hybrid approach: Diverted urine could provide an overall bigger benefit when seen as a multi-resource product used within system boundaries of urban sanitation, rather than exported outside as a fertilizer or as N2. Urine could be fully nitrified to nitrate in a decentral plant and subsequently dosed in sewers. Dosing nitrified urine in sewers gives several benefits: 1) it facilitates in-sewer denitrification, thus reducing the C and N load of the wastewater and saving money and energy; 2) valorising the sewer as a pre-anoxic reactor virtually increases the treatment capacity of the urban sanitation cycle; 3) anoxic conditions in the sewer will reduce greenhouse gas emissions such as methane (inhibition of methanogenesis) and odorous compounds such as hydrogen sulphide (autotrophic denitrification and inhibition of sulphate reduction).

In this thesis, a lab-scale sewer reactor with sewage, dosed with nitrified urine, will be operated and optimized. To prove the sewer as reactor concept, we need a good understanding of the kinetic and stoichiometric reactions taking place in the sewer. Micro-organisms, often growing in biofilms on the sewers, are responsible for biological processes such as denitrification, sulphate reduction and methanogenesis. Hence, technologies and control strategies will be investigated and integrated in terms of kinetics, microbiomes, emissions and overall performance.

The main goal is to investigate the effect of nitrified urine dosage on denitrification and gaseous emissions under various relevant urban sewer conditions and to integrate a smart nitrate dosing strategy to minimize these emissions. Although there is a lot of existing research on separate subjects such as nitrate dosing in sewers, methanogenesis, sulphate reduction, etc., the current literature lacks a more integrated approach. Hence, during the literature review, the urban sanitation system will be viewed in an interdisciplinary way, not only looking at the specific in-sewer nitrogen conversions, but also at the environmental

(greenhouse gases & energy cost), the social aspects (odor in cities) and economic costs (energy cost & chemicals cost).	
Related to CityLab	CityLab 2: Urban Resources
Relevance to urban challenges and/or applications As Flanders suffers from an increasing urban population in an already extremely dense region, sustainable nutrient management is crucial. This thesis focuses on the nutrient flows in an already existing, but outdated urban sanitation system, and aims to improve it by a more resource-efficient wastewater and nutrient management. The urban sanitation system will be viewed in an interdisciplinary way, not only looking at the specific in-sewer nitrogen conversions, but also at the environmental (greenhouse gases & energy cost), the social aspects (odor in cities) and economic costs (energy cost & chemicals cost).	
Max. number of students	1
Promoter	Siegfried Vlaeminck (siegfried.vlaeminck@uantwerpen.be)
Co-promoter	Tim Van Winckel (tim.vanwinckel@uantwerpen.be)
Supervisor	Iris De Corte (iris.decorte@uantwerpen.be)
Research project abroad?	If the student is interested and motivated, it can be discussed whether (part of) the research project can take place abroad (Switzerland). In this case, please let the promoter know as soon as possible to initiate the necessary procedures on time.
Compatibility with internship	The thesis will be done at campus Groenenborger, University of Antwerp. Working hours are from 9 to 5. Start and end date are flexible.
Other relevant information	Basic lab skills are desirable

Title of the thesis topic	Sufficiency in food systems: exploring urban practices
Keywords	sufficiency, food consumption, material flow analysis, energy flows, interdisciplinary

Description

This thesis aims to define what sufficiency means for the Belgian food system and examine how urban food-related practices—such as shopping, cooking, and waste management—can either accelerate or hinder the transition towards sufficiency. The student will begin with a comprehensive literature review to understand existing concepts and definitions of food system sufficiency. Building on this foundation and considering the current Belgian diet, the student will model an urban household (or different household typologies) that operates within the bounds of food sufficiency. This will involve (i) quantifying direct (and eventually embodied) material and energy flows related to food consumption, and (ii) linking these flows to food consumption patterns and food-related practices. The study's findings will provide contextualized insights into the quantities of food necessary for a sufficient diet and the everyday practices that influence the transition towards sufficiency. Ultimately, this research will contribute to ongoing efforts to promote sufficiency and demand-side measures as effective strategies for reducing resource use and the environmental impacts of consumption and production.

Related to CityLab	CityLab 2: Urban Resources

Relevance to urban challenges and/or applications

Reducing the environmental impact of the current food system requires a combination of a shift in agricultural production (e.g. promoting agro-ecology, developing alternative protein sources), rethinking supply chains (decentralizing power, fostering local food networks), and demand-side measures (reducing food waste, shifts to plant-based diets, and addressing overconsumption). The latter are the most relevant for urban settings, because cities concentrate population, and thus demand for food and other resources, and because urban environments shape people's eating habits. The focus of this master thesis will particularly be on how urban environments influence what people eat and how food sufficiency would translate into urban settings.

Max. number of students	1
Promoter	Anastasia Papangelou (anastasia.papangelou@uantwerpen.be)
Co-promoter	Gwenny Thomassen (gwenny.thomassen@uantwerpen.be)
Research project abroad?	No
Compatibility with internship	No issued specified

Other relevant information	There is a strong interdisciplinary element in this thesis, as it combines conventional material and energy flow analysis with social practices theory. We expect the student to be interested in this type of work and willing to potentially complement their modeling work with qualitative research methods (e.g. interviews and observations).

Title of the thesis topic	Towards Net-Zero Cities: CO_2-Integrated Desalination and Sustainable Brine Management
Keywords	Climate change, CO2 capture, carbonization, water treatment, water recovery

Description

Desalination is becoming increasingly critical for water-stressed regions, particularly urban areas where growing populations and industrial demands intensify freshwater scarcity. However, the process produces vast amounts of saline brine—about 141.5 million cubic meters daily as of 2019—posing significant environmental challenges, especially in inland cities where brine disposal is a big challenge. At the same time, CO_2 emissions, a key driver of global warming, continue to rise, reaching record highs, further intensifying the climate challenges faced by urban centers.

While CO_2 is a major contributor to climate change, its chemistry offers a promising solution to the persistent problem of brine disposal. The hardness minerals (e.g., Ca and Mg) in these concentrated salt solutions can react with dissolved CO_2 to form stable precipitates ($CaCO_3$ and $MgCO_3$), enabling long-term CO_2 storage while recovering valuable materials for urban applications, such as sustainable construction. Moreover, treating brine in this way could facilitate further water recovery, as Ca and Mg are major scaling agents that currently limit desalination efficiency—helping urban areas enhance their water supply resilience.

In this MSc thesis, you will explore the possibility of a novel approach to reverse osmosis brine treatment and CO_2 capturing, with a focus on how this method can contribute to urban sustainability. The approach could help transform two environmental challenges into a single solution for cities, addressing water scarcity and emissions while supporting resource recovery and circular economies.

Research questions include: understanding the reaction kinetics and chemistry of carbonization, determining optimal calcium and magnesium concentrations, examining how process parameters influence carbonization efficiency—including pH control, CO_2 injection rates, temperature, and mixing conditions—analyzing the characteristics of the precipitates for potential urban uses, and establishing operating conditions for maximum CO_2 sequestration and brine treatment. Additionally, opportunities to assess how CO_2 brine treatment can enable further water recovery by addressing scaling agents like Ca and Mg will be explored, with a focus on improving urban water systems.

Following methods will be applied during MSc thesis:

-Literature review

-Calculations

-Lab experiments

Related to CityLab	CityLab 1: The Urban Ecosystem CityLab 2: Urban Resources

Relevance to urban challenges and/or applications

This topic addresses two critical urban challenges: water scarcity and CO_2 emissions. As urban populations grow, the demand for freshwater intensifies, making desalination an increasingly important solution. However, the associated production of saline brine poses significant disposal and environmental challenges, often in or near urban coastal areas.

By integrating CO_2 capture with brine treatment, this approach mitigates emissions, enhances desalination efficiency, and recovers valuable resources like $CaCO_3$ and $MgCO_3$ for construction. These benefits directly support urban sustainability, improving water management, resource recovery, and climate resilience in cities.

Max. number of students	1
Promoter	Marjolein Vanoppen (marjolein.vanoppen@ugent.be)
Co-promoter	Ivaylo Plamenov Hitsov (ivaylo.hitsov@ugent.be)
Supervisor	Evgeniy Matveev (evgeniy.matveev@ugent.be)
Research project abroad?	No
Compatibility with internship	No issues specified
Other relevant information	During the thesis, you will conduct lab experiments at CAPTURE (Centre for Advanced Process Technology for Urban Resource Recovery) in Ghent, Belgium. A free shuttle bus is available, operating between Ghent-Sint-Pieters station and CAPTURE (and back). https://capture-resources.be/

Title of the thesis topic	Virtual nature for a healthy future: Comparing the emotional impact of different types of exposure to natural environments
Keywords	Green Spaces /// Virtual Reality (VR) /// Environmental Psychology

Description

Connecting with nature enhances both physical and mental well-being, but in urban areas, many people face barriers to accessing natural environments due to mobility issues, urban design constraints, or a lack of nearby green spaces. Virtual reality (VR) may offer a solution by providing immersive, nature-based experiences that replicate outdoor environments. This raises a central question: Can exposure to virtual nature effectively replace real-world nature experiences?

In this study, we will first examine the use of VR technology within environmental psychology. Next, we will employ tools like panoramic cameras and Unity software to capture and construct realistic, immersive virtual natural settings. Finally, we will conduct a randomized cohort study using a mixed lab and field experiment to compare participants' physiological and psychological responses across different types of exposure.

This research aims to evaluate the effectiveness of virtual nature as a substitute for real nature. Our findings might contribute to the understanding of VR's role in health-related applications of nature exposure and its potential use in therapeutic contexts.

Related to CityLab	CityLab 3: Human Health & Urban Liveability

Relevance to urban challenges and/or applications

The topic "Virtual Nature for a Healthy Urban Future" addresses critical urban challenges by offering innovative solutions to improve health and well-being in cities. Many urban areas lack accessible green spaces due to dense infrastructure and land-use constraints, which impacts residents' mental and physical health. VR can bridge this gap by providing immersive nature experiences, particularly benefiting individuals with limited mobility or those in underserved communities.

This research has practical applications in urban settings. VR nature can be used as a therapeutic tool in hospitals, workplaces, and care facilities, providing stress relief and mental health support. It can also inform urban planning by demonstrating the health benefits of different types of green spaces, guiding more inclusive and effective green infrastructure design. Additionally, VR simulations can engage communities in urban planning, fostering collaboration and advocacy for sustainable urban environments.

By combining technology with sustainability, this project offers a unique approach to addressing urban health disparities and enhancing quality of life in cities.

Max. number of students	1
Promoter	Ben Somers (ben.somers@kuleuven.be)

Co-promoter	Filip Raes (filip.raes@kuleuven.be)
Supervisor	Yangyang Shi (yangyang.shi@kuleuven.be)
Research project abroad?	No
Compatibility with internship	No issues specified
Other relevant information	We expect participants in this study to have a strong interest in the topic, enthusiasm for working with wearable sensors, and a commitment to interdisciplinary collaboration. Proficiency in Dutch would be preferred.

Title of the thesis topic	War on drugs: soil (im)purity
Keywords	drugs; disposal; soil; electrochemistry

Description

The disposal of drug production waste, particularly from MDMA, methamphetamine, and amphetamine synthesis, poses an environmental hazard in forests across Belgium and the Netherlands. Contaminated soil can leach harmful compounds into surrounding ecosystems, impacting soil quality, water sources, and potentially human health. This project aims to develop a robust detection procedure to assess soil contamination levels at these sites, supporting effective cleanup efforts. Electrochemical methods will be implemented to achieve sensitive and reliable measurements of target drugs. Initially, the procedure will be optimized in controlled buffer solutions to establish appropriate detection parameters. Subsequently, soil samples will be spiked with the target drugs to evaluate the effects of soil composition on measurement accuracy. This study will provide insights into how soil matrices influence the detection of these contaminants and will support field applications for determining soil purity, ensuring that remediated areas are safe and free from residual drug compounds.

Related to CityLab	CityLab 1: The Urban Ecosystem

Relevance to urban challenges and/or applications

The illegal disposal of drug production waste poses a significant environmental and public health risk not only in rural forests but also in urban-adjacent natural areas and green spaces. As urban expansion brings residential zones closer to forests and protected areas, contamination risks extend to urban populations through soil and water pollution. Additionally, after law enforcement raids on clandestine labs, the immediate environment—including parks, rivers, and other recreational areas—can become contaminated. Developing a reliable detection procedure for soil and water contamination, using electrochemical methods such as cyclic voltammetry and square wave voltammetry, will provide essential tools for assessing and mitigating pollution in these urban-adjacent ecosystems. This protocol will support urban cleanup efforts, inform public health responses, and help ensure that affected sites, whether near residential zones or within urban green spaces, are fully remediated.

Max. number of students	2
Promoter	Karolien De Wael (karolien.dewael@uantwerpen.be)
Co-promoter	dr. Julia Mazurkow (Julia.mazurkow@uantwerpen.be)
Research project abroad?	No
Compatibility with internship	No issues specified