LIÈGE université

URBAN & ENVIRONMENTAL ENGINEERING

ANNUAL ACTIVITY REPORT
04/2018

UEE
Urban & Environmental Engineering

Dear Colleagues,
Dear Partners,
Dear Students,

It is my pleasure to present the first Activity Report of the Research Unit **Urban & Environmental Engineering (UEE)**, formerly known as the Department of Architecture, Geology, Environment and Construction (ArGEnCo). Following the former ArGEnCo Research Self-Evaluation Report in 2015, we decided to deliver a yearly outline report to maintain a regular and dynamic flow of information regarding our research activities towards our academic colleagues, students and industrial partners.

This report contains basic facts & figures on the Research Unit and a selection of research activities developed by our staff.

Four major projects representing the main Research themes of **UEE** are highlighted: Buildings & Structures, Materials, Environment and Human activities. The report further provides information about Grants obtained from the highly competitive Horizon 2020 EU Research and Innovation programme during the period 2014-2017. Altogether, the diversity in terms of scope, from Industrial Leadership to Excellent Science, and quality of these featured projects demonstrate the innovation and dynamism of our staff as well as their integration in renowned networks from regional to international levels.

The present report provides up to date figures concerning our scientific publications. It highlights the continued efforts of our Research teams in terms of impact and outreach.

Finally, we decided to put in the spotlight our core Researchers: our PhD students, with a special emphasis on recent or on-going PhD theses. Young researchers are of vital importance to any academic Research Unit as their work paves the way for future collaborations at the academic and industrial level. Four PhD theses are here summarized to illustrate the diversity of the Research themes addressed in our Unit.

I hope that you will enjoy reading this report and that it will inspire you to collaborate with us. You will find more information on our research and education activities at **www.uee.ulg.ac.be** or by following our LinkedIn account.

Sincerely Yours,

Jacques Teller
DIRECTOR OF THE **URBAN AND ENVIRONMENTAL ENGINEERING** RESEARCH UNIT

URBAN & ENVIRONMENTAL ENGINEERING

OUTLINE OF ACTIVITIES • 2018

Urban and Environmental Engineering (UEE) addresses the construction of structures and networks of modern cities, the assessment, characterization and modeling of the built and natural environment, and the sustainable design, management and recycling of materials and resources to develop these infrastructures. This requires a close integration between advanced technical skills and human factors shaping the city and its environment at different scales, from building components to metropolitan areas, from physical networks to natural resources.

Tomorrow will turn to Engineers to solve the most difficult challenges regarding resilient cities and resource- and energy-efficient buildings, providing adequate conditions for human activities and mitigating natural and technological hazards. Here, at UEE, we connect core engineering technologies integrating a multitude of disciplines to address these future challenges, achieve higher levels of efficiency and life safety, and reduce construction & operating costs and resources consumption.

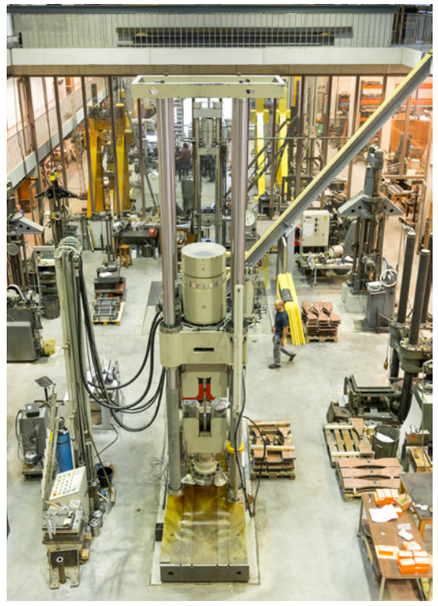
Our Research Unit is composed of 191 members, including 25 academic staff members, 112 scientific members and 54 administrative and technical staff members. Among the 112 scientific members, 94 are PhD researchers.

UEE provides key modeling tools and unique laboratory facilities that attract regional, national, and international collaborations for the academic, public and industrial sectors resulting annually in more than 10 million Euros of investments in R&D, 80 journal papers and 10 PhDs.

FOUR MAJOR RESEARCH PROJECTS
developed by UEE

OPTIBRI

▶ BUILDINGS & STRUCTURES, RFCS, DR. ANNE-MARIE HABRAKEN



The OPTIBRI project gathers the University of Liège, University of Stuttgart, University of Coimbra, the Belgian Welding Institute, the GRID (Lisbon, Portugal) and Industeel Belgium. The project aims to develop welded bridges using High Strength Steel (HSS). It studies the optimal welding and post welding treatment in order to have a high fatigue resistance as well as the buckling behaviour of multiaxially stressed plate. The quantification of the performance of HSS welded bridge is performed on a 20 m wide highway bridge considering both cost and environmental issues. The bridge, which spans 80 meters, presents clear fatigue and stability challenges, requiring enhanced rules for buckling of multiaxially stressed plates. Three designs of the bridge are compared through Life Cycle Environmental Assessment, Life Cycle Cost analysis and Life Cycle Performance. The first bridge design uses only standard S355 steel grade whereas the second design uses also HSS S690 QL steel. The third design relies on real HSS behaviour and HFMI post treated weld attachments. This third design highlights the need of updating Eurocodes. The project shows that the use of S690 QL enables a reduction of 25% to 32% of steel weight and about 50% on full penetration welding volume when compared to a design with standard steel S355 NL. It will also provide guidelines to the Civil Engineering community about how to integrate HSS within bridges.

REVERSE METALLURGY

▶ MATERIALS & RESOURCE EFFICIENCY,
WALLOON REGION NEXT PROGRAM, PROF. ERIC PIRARD

The Reverse Metallurgy Project is a five-year Technological Innovation Partnership gathering industrial partners (Hydrométal, Comet, Carmeuse, Marichal Ketin, Magotteaux, Silox), Research Centers (Centre de Recherches Métallurgiques, Centre Terre et Pierre) and the University of Liège. This project is structured along three axes: (i) Smart Sorting for Recycling, (ii) Hydrometallurgy and (iii) Plasma Technology for Pyrometallurgy. **Urban and Environmental Engineering** leads a multi-disciplinary team of Geological and Mining Engineers, Metallurgists, Chemists, Physicists, Mechanical Technicians and Computer Scientists in Smart Sorting and Hydrometallurgy.
It aims to develop tomorrow technologies for an improved recycling of metals: recycling copper from End Of Life cars and electric and electronic equipments, innovative processes for the recycling of Rare Earth Elements from permanent magnets, sensor-based robotic sorting prototype for the recycling of metallic scraps and alloys. **Urban and Environmental Engineering** paves the way of tomorrow's recycling industry in Europe and around the World.

MODELLING THE BEHAVIOUR OF HOST ROCK FOR NUCLEAR WASTE

▶ RISKS & ENVIRONMENT, PROF. ROBERT CHARLIER, PROF. FRÉDÉRIC COLLIN

The fate of radioactive waste poses a tremendous threat for future generations. Underground laboratories are one of the only way to test hypotheses on a large scale together with numerical modelling. **Urban and Environmental Engineering** leads the research in Europe with the development of the finite element code LAGAMINE capable of simulating the behaviour of the rock that will host the nuclear waste over several tens of thousands of years.

The research addresses more specifically the problematics of the modelling of fracture zones that initiate during excavation, the behaviour of rock under the effect of ventilation and the behaviour of concrete supports and the plugs designed to seal off the galleries. The research results are designed to help decision makers around the world and in Europe for the storage of nuclear waste.

WAL-E-CITIES

▶ HUMAN ACTIVITIES & LIVING ENVIRONMENT, ERDF-FEDER, PROF. CATHERINE ELSEN

Facing socio-environmental and demographical issues, many cities opted for a "Smart City" strategy. In practice, many of the first "smart" initiatives remain essentially focused on the introduction of new technologies, without considering their huge impact on the lives of the citizens. Disregarding citizens' needs and perceptions can yet potentially endanger the robustness of the Smart City model, since people can decide to accept or reject some key 'smart' concepts or devices and have behavioral influence on their failure/success rate. In this research project, the Urban & Environmental Engineering unit assumes that the sustainability of our future cities is strongly related to end-users' acceptability towards the introduction of new technologies into their daily-life urban environments.
The research project aims at developing methodologies and tools for sampling, data collection and processing that will help better frame the needs of citizens in terms of well-being in urban environments and enable citizen empowerment through revisited participatory and co-creative frameworks.
The « user data » collected will complement environmental data additionally acquired through physical sensors in pilot sites (such as multi-energy sensors, pollution sensors or intelligent sensors for water management) as well as individual "Internet of Things" (IoT) physical sensors. The user data and environmental data will be associated and contextualized so as to generate enriched data and operational indicators offering high added-value for both the Smart City itself (in view of its strategic development) and for the Walloon SMEs (in view of technological and economic development).

EUROPEAN PROJECTS DEVELOPED BY UEE

over the period 2014-2017

H2020 Pilar Excellent Science

ADVOCATE:
ADVANCING SUSTAINABLE IN SITU REMEDIATION FOR CONTAMINATED LAND AND GROUNDWATER

▶ DR. SERGE BROUYÈRE

This project develops innovative in situ remediation concepts for the sustainable management of contaminated land and groundwater, as required by the Water Framework Directive. The proposal has 18 academic and industry partners, with expertise in groundwater remediation issues, ranging from pore-scale processes to field-scale application, as well as technology development, water management/treatment, regulation and policy. The research links lab-scale studies of processes with field-scale evaluation and demonstration of novel technology applications, using state-of-the-art methods. It develops new scientific understanding, performance assessment tools and decision-making frameworks which advance the use of sustainable in situ remediation for contaminated land and groundwater. **Urban and Environmental Engineering** contribution in this project consists in the field scale quantification of water recharge and pollutant leaching processes across the unsaturated zone using advanced monitoring based on coupled vadose zone monitoring system (VMS), downhole geophysics and applied tracer experiments.

H2020 Pilar Excellent Science

ENIGMA:
EUROPEAN TRAINING NETWORK FOR IN SITU IMAGING OF DYNAMIC PROCESSES IN HETEROGENEOUS SUBSURFACE ENVIRONMENTS

▶ PROFS. FRÉDÉRIC NGUYEN & ALAIN DASSARGUES

ENIGMA is an Innovative Training Network regrouping academic and industrial partners focused in the development of innovative sensors, field survey techniques and inverse modelling approaches. The project aims at improving our ability to understand and monitor dynamic subsurface processes that are key to the protection and sustainable use of water resources. ENIGMA focuses mainly on critical zone observation, but the anticipated technological developments and scientific findings will also contribute to monitor and model the environmental footprint of an increasing range of subsurface activities, including large-scale water abstraction and storage, enhanced geothermal systems and subsurface waste and carbon storage. **Urban and Environmental Engineering** contribution in this project consists in developing data assimilation techniques together with multi-physics tracers and geophysical imaging to understand flow and transport in the subsurface.

H2020 Pilar Excellent Science

INSPIRATION:
MANAGING SOIL AND GROUNDWATER IMPACTS FROM AGRICULTURE FOR SUSTAINABLE INTENSIFICATION

▶ DR. SERGE BROUYÈRE

Agricultural production in Europe has significantly damaged soil and water resources, ecosystem biodiversity, socio-economic well-being and contributed to climate change. Expected further intensification of production to ensure food safety for population growth must be sustainable to minimise future impacts and negative externalities.

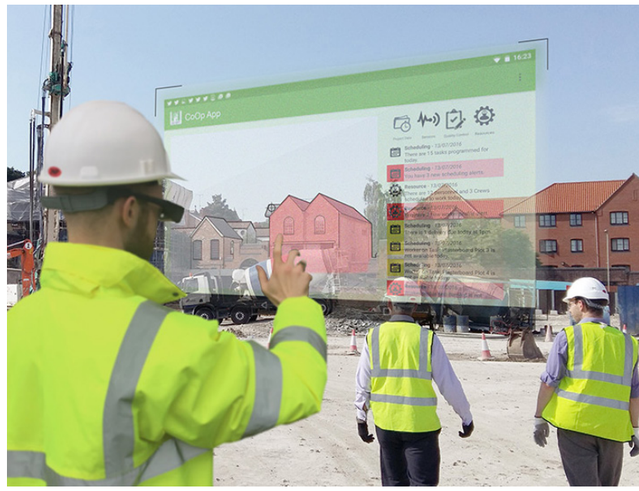
The scientific objectives focus on developing management techniques which mitigate environmental impacts of agricultural practices on soil, water and climate systems, and support sustainable intensification using new production methods; «smart» environmental monitoring, biotechnology and modelling tools to predict the outcome of measures and practices ; decision-making tools with sustainability indicators to implement sustainable agricultural production methods. **Urban and Environmental Engineering** contribution in this project consists in the quantification at groundwater catchement scale and groundwater - river interface of greenhouse gases (N2O, CO2 and CH4) production and transport mechanisms in groundwater, based on advance hydrochemistry, stable isotopes and applied tracer experiments.

H2020 Pilar Industrial leadership

ACCEPT:
ASSISTANT FOR QUALITY CHECK DURING CONSTRUCTION EXECUTION PROCESSES FOR ENERGY-EFFICIENT BUILDINGS

▶ PROF. PIERRE LECLERCQ

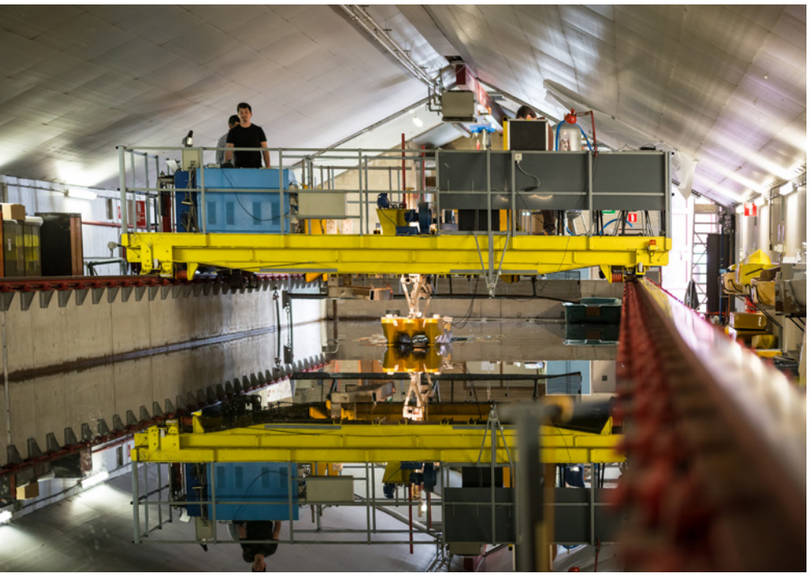
The potential loss of benefits of energy-efficient building components because of the lack of knowledge or bad implementation during the construction processes is a major problem. The ACCEPT project is developing an assistant for quality check during construction execution processes dedicated to energy-efficienT buildings. The assistant will run on Smart Glasses and unobtrusively guide workers during the construction on site. This provides a standardized and coordinated process for all workers, ensuring that all benefits of energy-efficient building components are maintained. From a user perspective ACCEPT is focused on the following products: the Construction Operator Assistant App (CoOpApp), a Site Manager App (SiMaApp) running on a mobile device and an interactive web-based Dashboard designed as a monitoring and quality assurance solution.



H2020 Pilar Societal Challenges

HOLISHIP:
HOLISTIC OPTIMISATION OF SHIP DESIGN AND OPERATION FOR LIFE CYCLE

▶ PROF. PHILIPPE RIGO



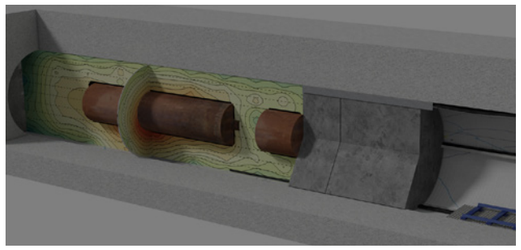
One of the most important design objectives of ship building is to minimize total cost over the economic life cycle of product, taking into account maintenance, refitting, renewal, manning, recycling, environmental footprint, etc. The trade-off among all these requirements must be assessed and evaluated in the first steps of the design process on the basis of customer / owner specifications. Advanced product design needs to adapt to profound, sometimes contradicting requirements and assure a flexible and optimised performance over the entire life-cycle for varying operational conditions. This calls for greatly improved design tools including multi-objective optimisation and finally virtual testing of the overall design and its components.

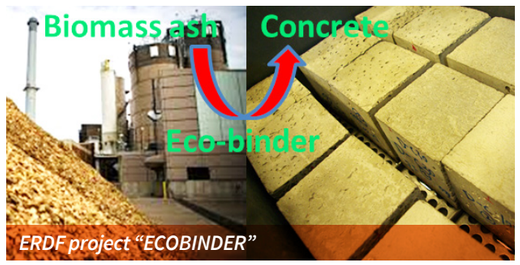
Horizon H2020 Pilar Euratom

BEACON:
BENTONITE MECHANICAL EVOLUTION

▶ PROF. ROBERT CHARLIER

This project is dedicated to the management of ultimate nuclear waste. The overall objective of the project is to develop and test the tools necessary for the assessment of the hydro-mechanical evolution of an installed bentonite barrier and its resulting performance. This will be achieved by cooperation between design and engineering, science and performance assessment. The evolution from an installed engineered system to a fully functioning barrier will be assessed. One of the challenges is to take into account initial heterogeneities introduced in the system by conception with a combination of block and pellets or due to the size of the bentonite component.





ERDF project "ECOBINDER"

Over the period 2014-2017, Urban and Environmental Engineering further secured 5 ERDF-FEDER projects, 7 INTERREG projects, 22 EIT – KIC Raw Materials and 17 RFCS projects.

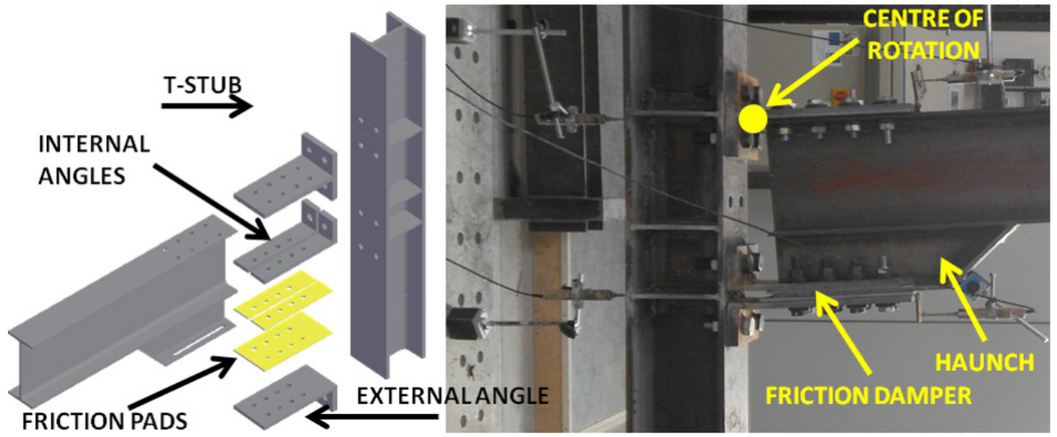
A FOCUS ON FOUR PHD THESES

developed in our Research Unit

Marina D'Antimo (on-going)

" STRUCTURES BEHAVIOUR UNDER EXCEPTIONAL EVENTS "

▶ SUPERVISORS: DR. JEAN-FRANÇOIS DEMONCEAU, PROF. JEAN-PIERRE JASPART



Beam-to-column joints are playing a key role as they are located at the extremities of the beams, where they are intended to dissipate the earthquake energy according to the so-called " capacity design ". If reference is made to the Eurocodes, it is strongly recommended to design full-strength joints, taking into account possible overstrength effects. Such design leads generally to expensive construction solutions. This thesis provides an innovative beam-to-column joint solution able to withstand not only frequent and occasional seismic events, but also destructive earthquakes, without suffering significant damages. The proposed joint solution is equipped with friction pads with a specific coating. This solution allows the dissipation of the earthquake energy at the level of an haunch connected to the bottom flange of the beam without any degradation of its dissipating capacity during the whole duration of the earthquake.

In addition, it is intended to optimize the structural properties of the proposed innovative joint solution in order to ensure an appropriate behaviour of the structure in case of exceptional events such as impact, explosion, etc. leading to the loss of a supporting column. In the modern codes for design, and in particular, in the Eurocodes, it is required to ensure an appropriate robustness to a structure in case of such exceptional events. From that point of view, the proposed joint solution presents interesting structural properties, in particular in terms of deformation capacity and ductility.

Marina D'Antimo is in charge of investigating the behaviour of the proposed joint typology under static and dynamic loading conditions with the final objective of deriving a design procedure for these joints. To achieve this objective, she conductes analytical, numerical and experimental investigations.

Simon Delvoie (2017)

“ MULTISCALE CHARACTERIZATION OF LOESS IN HESBAYE REGION (BELGIUM) WITH A COUPLED GEOLOGICAL AND GEOTECHNICAL APPROACH ”

▶ SUPERVISORS: PROF. F. COLLIN, PROF. R. CHARLIER

Loess is a natural deposit mainly composed of silty particles (mean grain size around 30 µm) blown by the wind during last glacial periods. Some of these layers were deposited several hundred thousand years ago. It is estimated loess deposits cover as much as 10 % of the Earth’s surface. Loess study is at a crossroads between various scientific disciplines that are geotechnics, environmental geology, archaeology and agronomy.

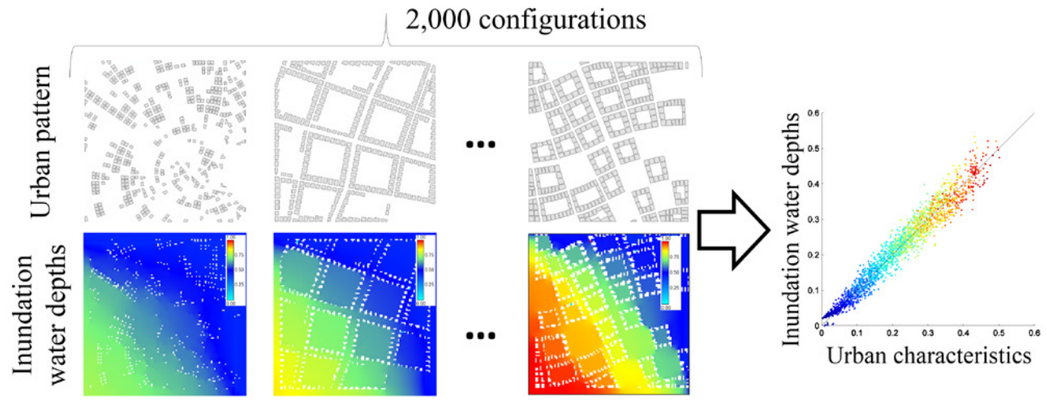
From a comprehensive multiscale experimental investigation performed both on the field and in the laboratory, the material has been physically and mechanically characterized. Results bring out a relative heterogeneity of some mechanical properties. The PhD thesis provides to industry and practitioners mean values of many properties of the silty material. Some of them are useful to evaluate as a first step the design of foundations even if these results cannot prevent to carry out complementary on-site investigations.

In collaboration with the Department of Archaeology (“ Direction de l’archéologie ”) of the Walloon Public Services, the PhD thesis couples measurements of mechanical properties of the loess material with a geological interpretation. This analysis results in the identification, at regional scale, of a series of stratigraphic markers defined by a modification of the mechanical properties between two successive loess layers. The most significant stratigraphic marker corresponds to a layer, called by geologists the “ Whitish Horizon of Momalle ”. This layer and the surrounding ones are well known by archaeologists because they include archaeological materials (artefacts) related to Middle Palaeolithic (period from 300 000 to 45 000 years before present). As a result, Simon showed that cone penetration tests can be used in loess layers to assess the Middle Palaeolithic archaeological potential for forensic applications. Simon is currently pursuing his academic career at **UEE** by working as a Researcher for the SeRaMCo project looking to replace primary raw materials with high-quality materials recycled from construction and demolition wastes.

Martin Bruwier (2017)

“ ADVANCED POROSITY-BASED MODELS TO ASSESS THE INFLUENCE OF URBAN LAYOUTS ON INUNDATION FLOWS AND IMPACT OF URBAN EVOLUTION ON FLOOD DAMAGE ”

▶ SUPERVISOR: PROF. B. DEWALS



Worldwide, flood risk is expected to increase over the 21st century due to the combined effect of climate and land use changes. However, while the impact of climate change on future flood risk was extensively studied, the effects of urbanization remain unclear. The goal of this PhD thesis is to contribute to a better understanding of the influence of future urban development on changes in inundation flows as well as on the related damage.

First, an original porosity-based model was developed, which enables efficient computation of urban flooding. It uses anisotropic porosity parameters to reproduce the influence of subgrid-scale obstacles on the flow. An original merging technique was implemented to optimize the computational efficiency in the presence of low values of the storage porosity parameter. Compared to a standard inundation model, the developed model enables speedup factors of the order of 100, while keeping the error on the flow variables at a few percent.

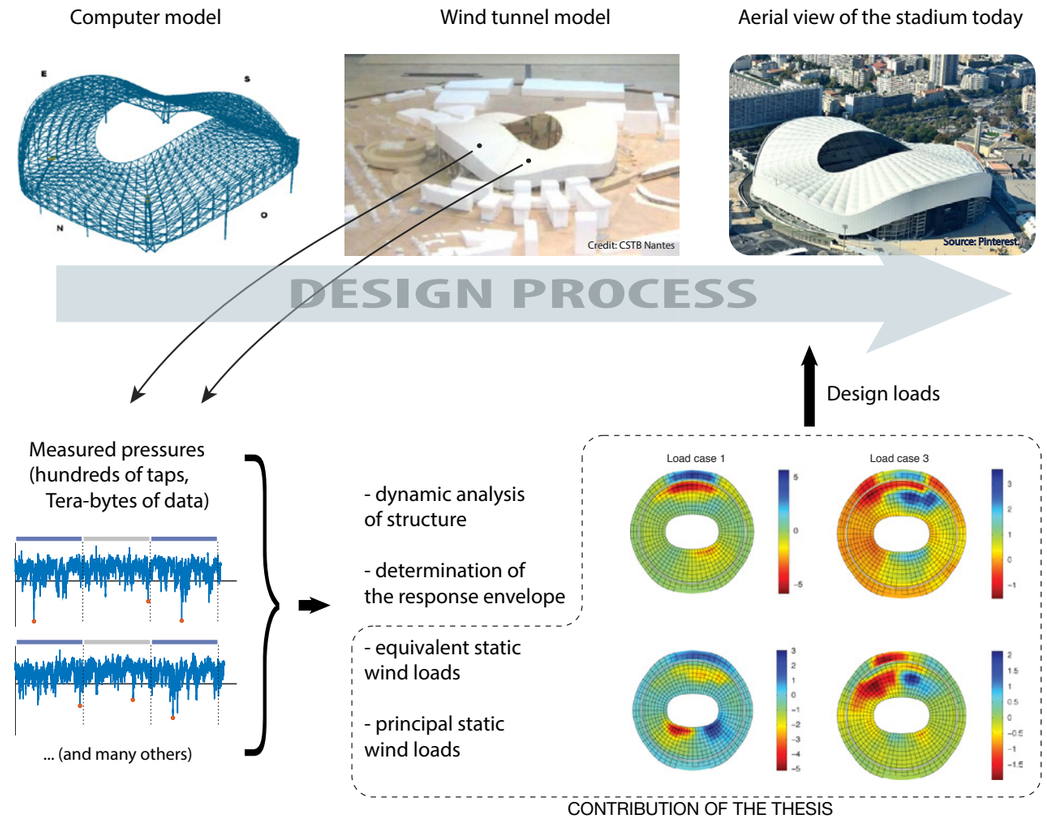
Second, we systematically investigated how the layout of buildings located in floodplains influences the inundation characteristics for a long-duration flood scenario. The anisotropic porosity-based model was used to compute the flow variables for 2,000 alternative urban patterns. Correlations between the computed water depths and the urban characteristics reveal which features of the layout of buildings influences most the severity of urban flooding. In particular, the results suggest how the hydraulic effect of new urban development can be effectively mitigated by a suitable location of the buildings preserving a higher flow conveyance at the district-scale. This result provides guidance for more flood-proof urban developments.

Finally, we evaluated the evolution of future flood damage as a result of urbanization along all the main rivers in the Walloon region, Belgium. The study was conducted at the regional level using detailed hydraulic results (resolution of 2 to 5 m). Despite high uncertainties in the considered urbanization scenarios, involving both urban expansion and densification, robust conclusions could be drawn, such as the overwhelming influence of banning new developments in flood-prone areas compared to the other tested facets of urban planning policy.

Nicolas Blaise (2016)

“ PRINCIPAL STATIC WIND LOADS WITH A RIGOROUS METHODOLOGY TO THE ENVELOPE RECONSTRUCTION PROBLEM ”

▶ SUPERVISOR: PROF. V. DENOËL



Large civil structures such as high-rise buildings, large roofs and long-span bridges need to be designed for wind loads. Small-scale models, covered with hundreds of sensors are used in wind tunnel experiments to determine the wind pressures on the structures under various environmental conditions. The large amount of data generated in the process needs to be engineered in order to determine the relevant information for the designer. In particular, the design office usually requests equivalent static wind loads, which provide the same structural responses (stresses, internal forces, displacements) as what the dynamic response under the most severe wind load pressure would have provided. This data compression problem has been analyzed by Nicolas Blaise in his PhD thesis. The most important outcome of his work consists in the concept of Principal Static Wind Load, which results from the principal value decomposition of a large set of wind load distributions, in order to optimally solve this envelope reconstruction problem. Nicolas Blaise currently works for CPP, which is a world-wide leader in the wind engineering consultancy established in Fort Collins, Colorado. At CPP, Nicolas Blaise has implemented the concepts developed during his PhD, in particular for the design of the future Lusail stadium in Doha (Qatar), where the opening game of the world cup 2022 will take place. He has also exploited his methods for the future American football stadium in Las Vegas, in partnership with the prestigious design office ARUP.

PUBLICATIONS

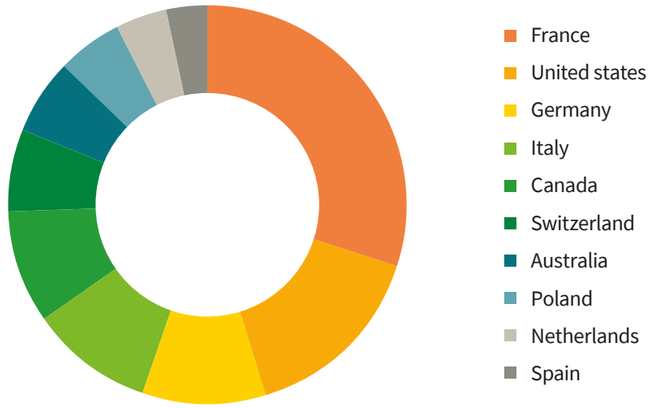
UEE mainly publishes in the following domains: Engineering (235 documents), Earth and Planetary Sciences (94 documents), Environmental Science (92 documents), Materials Science (64 documents), Computer science (47 documents) and Energy (45 documents). This diversity of domains reflects the variety of challenges associated with tomorrow’s engineering that **UEE** addresses.

	h index	Cites (total)	J. Papers (annual)	J. Papers (total)	Conf. Papers (total)	Books (total)
2015	36	6748	74	1106	2214	148
2018	44	11378	79	1361	2485	169

Total number of types of publications and h-index (Source: ORBi)

A comparison of figures over this period highlights the progression and dynamism of our Research Unit. This is especially true for the cumulative h index that passed from 36 (2015) to 44 (2018). In 2017, more than 50% of **UEE** scientific contributions were published in top-ranked (first quartile) international peer-reviewed journals[1].

Our research staff is involved in a number of international collaborations, which reflects through the authorship of collective papers issued by the Unit.

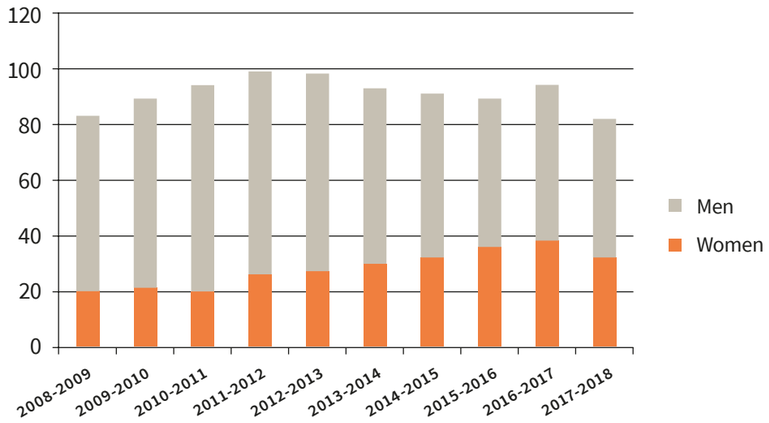


Top 10 international origins of Urban and Environmental Engineering coauthors

[1] *According to the 2016 SJR index of all the journals where **UEE** published in 2017 using the Scimago Journal & Country Rank web site (www.scimagojr.com).*

PHD THESES

The average time of completion of a PhD research is 4.35 years. By comparison, the average time of completion of a PhD at the University of Liège is 4.9 years. The number of completed PhD theses is about 10 per year.

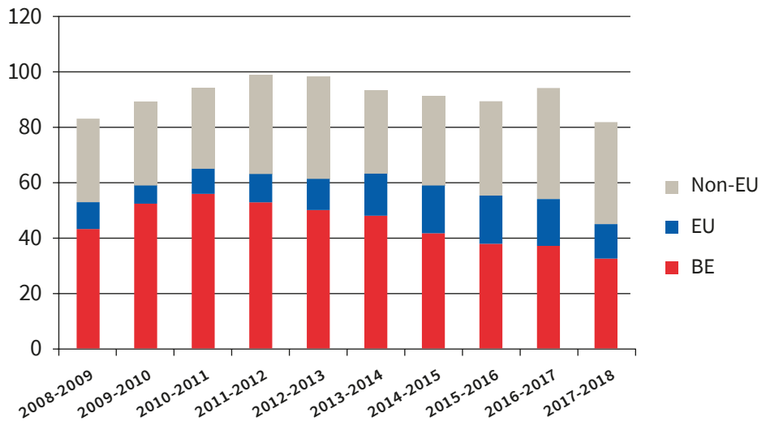


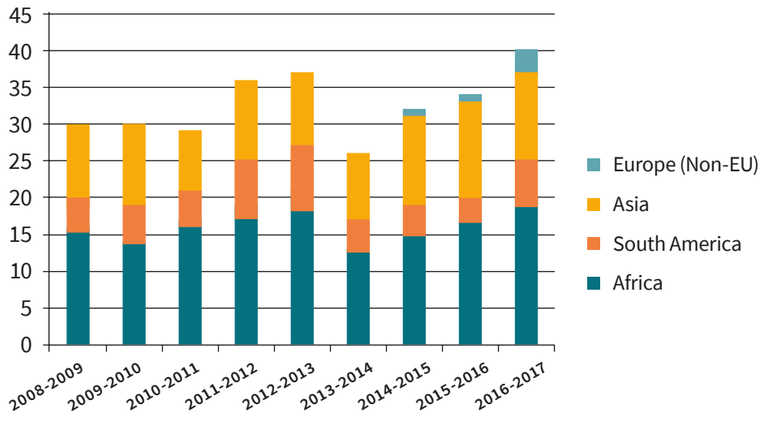
Gender repartition among the Urban and Environmental Engineering PhD students

There is an increase of the presence of women in our PhD students. Among the enrolled PhD students, 39% are now women. By comparison they were only 27% over the period 2010-2013.

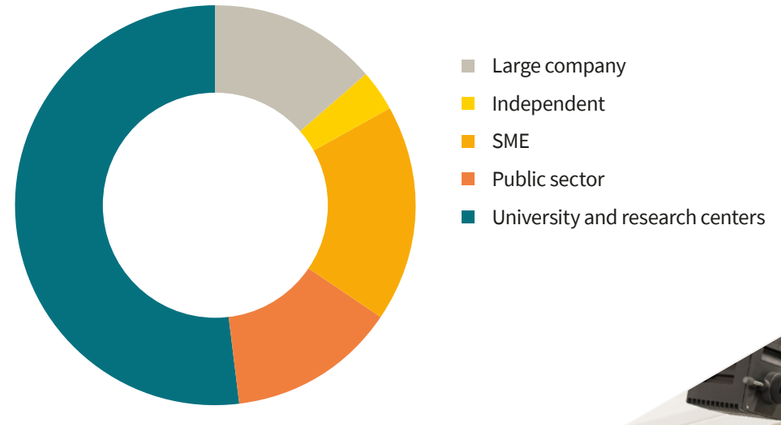
GEOGRAPHIC ORIGIN OF OUR PHD STUDENTS (TOTAL AND NON EU)

45% of our enrolled PhD students are of Belgian nationality, while 18% are coming from the EU and 37 % from non-EU countries. The share of EU PhD students increased since the latest report (10% in average for the 2010-2013 period). If we consider the origin of the non-EU PhD students, African PhD students represent the major population with 50% in average for the 2014-2017 period, which reflects our strong activities in North-South Cooperation.





A recent survey conducted by the Faculty highlights that a number of our former PhD researchers tend to develop their career in the private sector. One third of PhD researchers graduated from **Urban and Environmental Engineering** were hired in large or small-companies within a three-years period after the completion of their PhD.



Current employers of UEE former PhD researcher

FUNDING

The ***Urban and Environmental Engineering***'s different sources of incomes were gathered into 3 main categories: (i) direct funding (funding directly received from University and donations), (ii) Industry contracts and (iii) Research grants.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Direct funding (k€)	4.668	4.546	4.739	4.627	4.645	4.739	4.849	4.897	4.607	4.891
(%)	36	33	32	34	36	36	36	31	34	33
Industry contracts (k€)	3.463	3.307	4.715	3.768	3.654	3.348	3.995	4.634	2.724	2.385
(%)	27	24	32	28	28	26	30	30	20	16
Research grants (k€)	4.736	6.079	5.272	5.159	4.581	4.913	4.444	6.122	6.277	7.364
(%)	37	44	36	38	36	38	33	39	46	50
Total (k€)	12.866	13.932	14.726	13.554	12.881	13.001	13.288	15.654	13.607	14.640

***Urban and Environmental Engineering** sources of incomes (2008-2017)*

The total funding of our Research Unit fluctuates between 13 M€ and 15M€ over time. Our funding through research grant strongly increased in 2015 (6.122 k€), 2016 (6.276 k€), 2017 (7.363k€). This is partly related to the impact of one important project that is the Reverse Metallurgy project. At the opposite, our funding from industry contracts decreased in 2016 (2.723 k€) and 2017 (2.384k€) when compared to previous years (2008-2014). Research grants are the most important funding resource of the Research Unit, as they represent in average 40% of the Research Unit total incomes.

When we compare these figures to the staff, it yields a ratio of 415k€ per year and per academic staff member provided through industry contracts and/or competitive research grants (425k€ in 2010-2013). This represents a remarkable achievement of the ***Urban and Environmental Engineering***, given the high competition observed in calls for projects, either at the European, national or regional level.

The success of the **Urban and Environmental Engineering** and facilities in securing external funding, which accounts for more than two thirds of the **Urban and Environmental Engineering** funding, shows the scientific excellence and competitiveness of the research performed at **UEE**. It also illustrates the strength of the groups in terms of international reputation, and collaboration with industry. This is particularly illustrated with the number of H2020 projects (= 6) secured by ***Urban and Environmental Engineering***.

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