

# Winter School

## Principles and application of catchment-scale flow and transport modelling in groundwater

29 January - 01 February 2019, Liège, Belgium

The aim of this 4 day winter school is to demonstrate the practical application of commonly-used advanced numerical modelling tools for the investigation of flow and reactive solute transport in groundwater at the catchment-scale, with special focus on nutrients and other types of agrichemicals. The course will cover theoretical aspects of flow and transport modelling, and the use of appropriate modelling tools in specific contexts. Participants will be introduced to modelling applications using lectures, practical exercises, computer-based simulations and keynote talks on research case studies focused on catchment-scale reactive transport modelling of pollutants in groundwater and connected aquatic systems. An introduction to modelling the fate of stable isotopes in groundwater will also be provided.

The course will provide participants with a wider understanding of modelling issues related to impacts of nutrients and agricultural activities on soils, groundwater and drinking water, and within European countries from different perspectives. Participants will gain insight into state-of-the-art modelling techniques necessary to interpret pollutant and nutrient cycles and agrichemical impacts in environmental systems.

The winter school is presented by the INSPIRATION Marie Skłodowska-Curie Innovative Training Network ([www.inspirationitn.eu](http://www.inspirationitn.eu)). After attending this winter school, participants will be able to:

1. Understand the principles and limitations of subsurface flow and transport modelling in general and applied specifically to the case of nutrients and other agrichemicals
2. Develop an adequate conceptual site model related to real cases of soil and groundwater contamination for the purpose of using a numerical model
3. Understand key components used for model development and the analysis of results, such as inverse modelling and automatic calibration or model sensitivity analysis
4. Apply the specific modelling tools to investigate and interpret the subsurface fate and transport of contaminants in relevant and realistic scenarios

The sessions will be presented by experienced training facilitators, experts and invited speakers from the INSPIRATION Innovative Training Network and the University of Liège, VITO and SPAQuE in Belgium, IWW and UFZ Leipzig in Germany, EAWAG and University of Neuchâtel in Switzerland and the University of Laval in Québec in Canada.

The event is open to external participants including, but not limited to, stakeholders, practitioners, managers, researchers and students with interests in the assessment, management and remediation of nutrient and hydrochemical impacts from different sources. Participants with backgrounds in agricultural/environmental engineering, geoscience and environmental sciences are encouraged to attend. The course will be attended by scientists and researchers from the INSPIRATION Innovative Training Network, providing a unique opportunity for networking with leading experts in the field.

Further information on the technical programme, joining instructions and venue for the winter school is provided overleaf.



# Organisation & Programme

## Organisation

The winter school is organised into 3 modules which run in parallel, linked by common elements. The three modules are designed to provide training on specific modelling tools. Participants must choose **ONE** of the three following modules when registering for the winter school, which they will work with for the duration of the school:

**Module 1** focuses on modelling applications using PHREEQc, in particular with the HP-1 model (a coupled PHREEQc-Hydrus1D model)

Instructors: Dr. Christine Kübeck (IWW Water Center, Germany), Dr Diederik Jacques (SKEN, Mol, Belgium) and Dr. Ingeborg Joris (VITO, Mol, Belgium)

**Module 2** focuses on groundwater flow and reactive transport modelling using the finite element code FEFLOW®

Instructor: G. Preisig, Centre d'Hydrogéologie et Géothermie (CHYN), University of Neuchâtel (Switzerland)

**Module 3** focuses on the control volume finite element code HydroGeoSphere (HGS) which allows modelling of flow and transport in a coupled surface water – groundwater flow system.

Instructor: Professor René Therrien (Université Laval, Québec, Canada)

## Programme

The winter school will start at 09.00 on Tuesday 29 January 2019 and end at 12.00 on Friday 01 February 2019 (except for the special session on stable isotope modelling, which ends at 17:30). Venue details and joining instructions are provided overleaf.

### Day 1: Tuesday 29 January 2019

08:30	Registration of participants
09:00	Welcome and roundtable
09:15	<b>Introductory lecture:</b> Catchment scale groundwater flow and transport modelling (A.Dassargues, U.Liège)
10:00	Refreshment break
10:30	<b>Lecture:</b> Catchment scale flow and transport modelling: mathematical and numerical aspects (A.Dassargues, U.Liège)
12:30	Lunch break
13:30	<b>Lecture:</b> Catchment scale flow and transport modelling: the conceptual model and its specific aspects related to catchment scale (P.Orban, U.Liège)
15:30	Refreshment break
16:00	<b>Keynote:</b> Modelling groundwater quality trends at the catchment scale (S.Brouyère, U.Liège)
16:45	<b>Keynote:</b> Modelling surface water quality at catchment scale using PEGASE (J-F.Deliège, Aquapôle U.Liège)
17:30	Ice-breaking event



# Programme

## Programme

### Day 2: Wednesday 30 January 2019

09:00	<b>Lecture:</b> Description of the modelling suites used during the course (PHREEQc : C.Kübeck, FEFlow : G.Preisig, HGS : R.Therrien)		
10:30	Refreshment break		
11:00	<b>Module 1</b> PHREEQc (C.Kübeck)	<b>Module 2</b> FEFlow (G.Preisig)	<b>Module 3</b> HGS (R.Therrien)
12:30	Lunch break		
13:30	<b>Lecture:</b> Model calibration and sensitivity analysis (M.Ramgraber, EAWAG)		
15:00	Refreshment break		
15:30	<b>Module 1</b> PHREEQc (C.Kübeck)	<b>Module 2</b> FEFlow (G.Preisig)	<b>Module 3</b> HGS (R.Therrien)
17:30	<b>Keynote:</b> Using Kalman and particle filters for data assimilation and model uncertainty assessment (M.Ramgraber, EAWAG)		
18:00	End of Day 2		
19:30	Common dinner		

### Day 3: Thursday 31 January 2019

09:00	<b>Lecture:</b> Effect of spatial discretization on model performance and prediction uncertainty (S.Wildemeersch, SPAQuE)		
10:00	Refreshment break		
10:30	<b>Module 1</b> HP1 (D.Jacques & I.Joris)	<b>Module 2</b> FEFlow (G.Preisig)	<b>Module 3</b> HGS (R.Therrien)
12:30	Lunch break		
13:30	<b>Module 1</b> HP1 (D.Jacques & I.Joris)	<b>Module 2</b> FEFlow (G.Preisig)	<b>Module 3</b> HGS (R.Therrien)
15:30	Refreshment break		
16:00	<b>Module 1</b> HP1 (D.Jacques & I.Joris)	<b>Module 2</b> FEFlow (G.Preisig)	<b>Module 3</b> HGS (R.Therrien)
18:00	End of Day 3		



# Programme & Further Information

## Programme

### Day 4: Friday 1 February 2019

- 09:00 **Keynote:** Modelling agrichemical fluxes at regional and catchment scales using the EPIC-GRID model (A.Degré, U.Liège)
- 10:00 Poster session and refreshments: Participants will prepare a basic poster on their modelling results or the case study for which they expect to apply numerical models. This will be discussed by the group, with feedback and advice provided to each participant
- 12:00 Lunch break
- 13:00 Special session on modelling stable isotopes in aquatic systems: theory (S.Lutz, UFZ Leipzig)
- 15:00 Refreshment break
- 15:30 Special session on modelling stable isotopes in aquatic systems: exercises (S.Lutz, UFZ Leipzig)
- 17:30 Conclusions and departure of participants

## Further Information

### Computer exercises and expected level of understanding of participants

The winter school will include computer-based exercises using the modelling codes indicated. **Participants must provide their own laptop.** The software used will be installed on these computers and be available for the participants during the winter school. Participants will receive a temporary user ID and password to have access to the internet and, where required, temporary licenses for the modelling software.

### What is provided

A hardcopy copy of the lecture and tutorial notes for each session will be provided to participants. Refreshments will be provided on each day, but participants are expected to pay for their own meals and accommodation during the winter school.

### Registration

Registration for this winter school is essential as places are limited. Please send your application by e-mail to Gabriella Kakonyi ([g.kakonyi@sheffield.ac.uk](mailto:g.kakonyi@sheffield.ac.uk)) with a copy to the local organiser, Serge Brouyère ([Serge.Brouyere@uliege.be](mailto:Serge.Brouyere@uliege.be)). The last day for acceptance of applications is **11 January 2019**.

### Cost

The fee for the winter school is 350 EUROS, payable electronically upon receipt of registration. This covers course notes (on USB stick), refreshments and certificate of attendance. A receipt will be provided for all payments.

### Venue Information

The winter school will be organised in the *Institut de Mécanique et Génie Civil* (Building 52 in Figures 1 and 2) on the campus of the University of Liège. The meeting room (-1/631) is located in level-1 in front of the entrance located at the back of the building. You can use the entrance at level -1 located on the south side of the building.



# Further Information

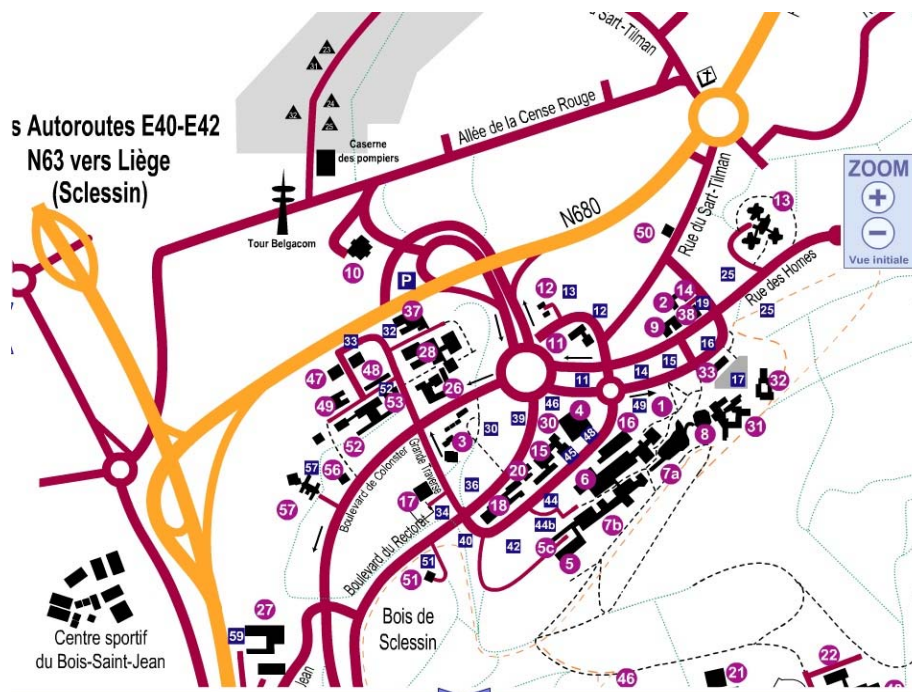


Figure 1. University of Liège North Campus map (red circles = buildings, blue squares = parking)

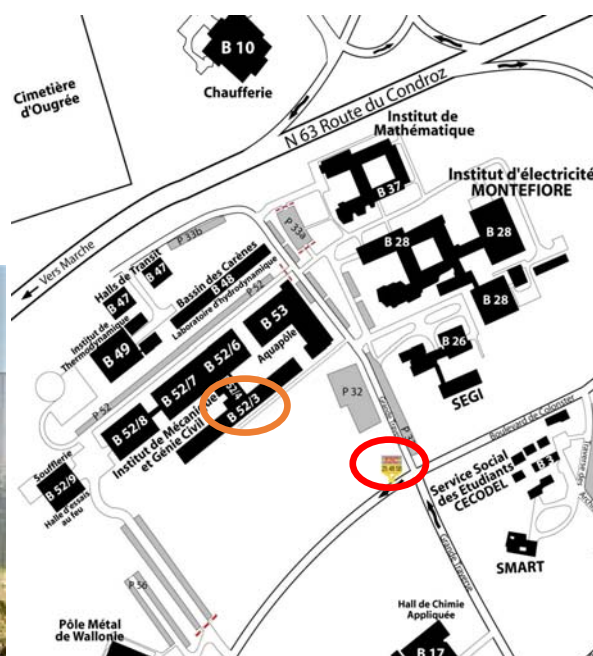


Figure 2. Institut de Mécanique et du Génie civil (view of the building and detailed map)  
In orange: B52/3 Meeting / Class rooms; in red: bus stop from Liège city (48 and 58)

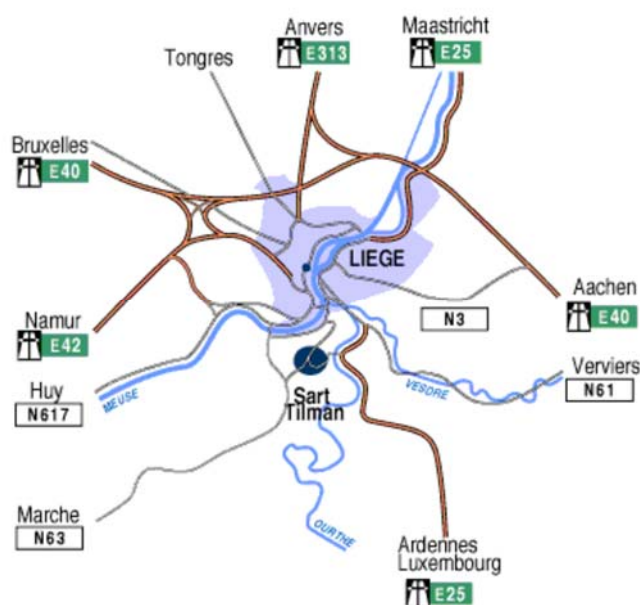
# Further Information

## Access to Liège and to the Sart-Tilman campus

Extensive motorway and railway networks allow easy access to the city and campus. Be careful when travelling in Belgium: Liège may be written in French: Liège, in Dutch: Luik or in German: Lüttich.

## Travel to Liège by car

The road and motorway network (E40, E25, E42, E313) makes getting to Liège and the Sart Tilman campus easy by car. The map below provides details.



## Travel to Liège by train

Trains to Liège arrive at the Liège Guillemins railway station in Liège. For further information on this option, check <https://www.belgiantrain.be/en/home>

There is a regular bus service from the railway station to the city centre (nb 1 and 4) and to Sart Tilman (nb 48 or 58).

## Travel to Liège by plane

The main airport in Belgium is **Brussels National Airport** located near Brussels. <http://www.brusselsairport.be/en/>

From this airport you can reach Liège by car or by train. By car, there are car rental desks in the arrival hall.

Itinerary: follow "RO – Ring" / E40-Luik / once on the E40 to Liège, the journey lasts approximately 1 hour.

By train, Brussels National Airport is less than twenty minutes from the city centre of Brussels. From 05:30 until nearly midnight, the Airport City Express links the airport with Brussels Midi, Central and North four times an hour. The airport train station is located in the basement (level -1) of the terminal building. There is no direct train to Liège; you will always have a change at Brussels North Station or at Leuven Station.

## Further Information

You can also travel by plane to **Brussels South Charleroi Airport**.

<http://www.charleroi-airport.com/en/brussels-south-charleroi-airport/index.html>

From this airport you can reach Liège by car or by train. By car, there is a car rental desk in the airport. Itinerary: follow E42-Liège/ once on the E42 to Liège, the journey lasts approximately 45 minutes.

By train, first take a bus (bus A) to Charleroi-Sud railway station. The journey lasts around 20 minutes. Outside the airport, near Door 2, there are two ticket dispensers where you can buy a single or a return ticket (return on the same day) valid for "any Belgian destination". This ticket covers a journey in a TEC bus (from the airport to Charleroi-Sud railway station) and a train journey (from Charleroi-Sud to any railway station in Belgium). At Charleroi-Sud railway station, you have 1 train per hour to Liège and the journey lasts around 1 hour.

### *Travel to the Sart-Tilman campus by bus*

The Sart Tilman campus is serviced by two TEC bus lines (nb 48 and nb 58). Line 48 starts from the city centre (Opera and Pont d'Avroy), stops at the railway station "Gare des Guillemins" and several other places in town, before reaching your destination. The journey lasts about 30 minutes. Line 58 starts from the railway station (Liège Guillemins), takes the motorway, with a journey time of about 20 minutes. For both lines, you have to follow the direction "Sart-Tilman CHU" and to get off the bus at the bus-stop called "SART-TILMAN Polytech".

### *Travel to the Sart Tilman campus by car*

GPS coordinates for the building B52 : Longitude: 5° 33' 27.6948" (5.557692646980286) - Latitude: 50° 35' 7.5372" (50.585426732772994)

From motorway E40 (Brussels or Aachen) or motorway E25 (Maastricht), see map above:

- Follow "E25-Liège", then "E25-Spa-Luxembourg-Ardenne-Bastogne"
- Take the exit Nr 40 "Sart Tilman-ULg-CHU-Embourg"
- Turn right and cross the river
- Then turn left to the Sart Tilman

Follow the main road and you will arrive on the campus. Once you are there, follow the direction Parking 52 (P52) or Building B52.

### **Accommodation in Liège**

A range of accommodation to suit all budgets is available in Liège. Participants should make their own arrangements for accommodation and contact specific providers directly with enquiries. The following websites provide examples of the options available:

<https://www.liegetourisme.be/hotels.html>

Reduced prices are available in some hotels for researchers visiting the University of Liège. Information on this option will be provided to eligible participants after registration.

