

# Embedding of project findings in educational curricula

## D3.3.4



Photo: Mischa Keijser



Adaptation  
to climate  
change

# **Embedding of project findings in educational curricula**

## **D3.3.4**

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**Authors:**

Vana Tsimopoulou

**Reviewers:**

Pieter Rauwoens, Robert Lanzafame, Ammar Aljer, Alexander Schmets

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# INTERREG Polder2C's project

The INTERREG Polder2C's is an international research project within the framework of the updated Sigmaplan for the river Schelde. The Hedwige-Prosperpolder will be transformed into tidal nature. Depoldering of Hedwige-Prosperpolder offers a unique testing ground, the Living Lab Hedwige-Prosperpolder, for flood defence and emergency response experts. In this environment current and innovative techniques, processes, methods and products can be tested for practical validation. Thirteen project partners, led by the Dutch Foundation of Applied Water Research (STOWA) and the Flemish Department of Mobility and Public Works (DMOW, Flanders Hydraulics Research), are working together. Together, they aim to improve the 2 Seas regions' capacity to adapt to the challenges caused by climate change.

## Flood Defence

The rising sea level is a serious threat to the countries in 2 Seas region. How strong are our current flood defences? What is the impact of environmental elements such as the weather, the presence of vegetation or man-made objects on our flood defences? To answer these questions numerous destructive field tests are carried out in the Living Lab to validate flood defence practices. The project entails in situ testing, guidance on levee maintenance and validation of flood defence infrastructure.

## Emergency Response

We aim to improve emergency response by developing the right tools for inspection of water defences, risk evaluation and solutions for flooding. If our water defences do not operate as designed, we must take the right measures to prevent flooding of valuable areas. The Hedwige-Prosperpolder Living Lab offers unique possibilities to exercise emergency management in the event of calamities under controlled but realistic circumstances. Activities that are part of the programme are levee surveillance and monitoring, emergency response exercises, breach initiation and the large European exercise.

## Knowledge Infrastructure

We aim to develop a knowledge infrastructure through which existing and new to be developed knowledge will become available and accessible. A necessary success factor for any initiative to improve knowledge is to have its outcomes integrated in practices of a wider community. Knowledge Infrastructure focuses therefore on the consolidation of knowledge acquired in the Living Lab with a variety of activities. Accessibility of data in a user-friendly manner, educational activities in the field and incorporation of knowledge in educational curricula are considered key elements.

## Field Station

How can we make sure that both experts in the field and the local public benefit from our project and the learnings about climate change, flood resilience, emergency response and the unique environment of the Hedwige-Prosperpolder? An important and unique way of reaching this goal is realising a Field Station at the project site. It will be used during and after the project for educational purposes, research and as a special meeting place for exclusive occasions.

# 1 Introduction

**This report provides an overview of the initiatives that were taken to disseminate information, lessons and knowledge acquired during Polder2C's via formal educational programmes and an evaluation of the extent that project findings have been embedded in educational curricula of relevant partner organisations.**

## 1.1 Target organisations

Within the consortium of Polder2C's there are five organisations that provide formal education; KU Leuven, Delft University of Technology, University of Lille, HZ University of Applied Sciences and the Netherlands Defence Academy that belongs to the Dutch Ministry of Defence. Educational units of these organisations were the primary targets for embedding project findings. However thanks to the extensive networks in which all partner organisations operate, various initiatives led to education of several students outside the abovementioned organisations through attendance of guest lectures, field exercises in the living lab Hedwige-Prosperpolder and internships in non-educational partners and observers.

## 1.2 Forms of embedding

Embedding was achieved in various forms. During the project the most straightforward way to embed knowledge and results to education was by developing study assignments that would answer directly technical and operational questions that the project partners had. Answers to those questions allowed to steer activities in the living lab in the right direction. For example, HZ had ten students work on a preliminary risk perception study in 2020, whose results were used to guide the design of an information experiment. The experiment was performed in 2021 by another group of students and led to the final outcome of the Polder2C's risk perception study. Assignments like this could be part of a course, a thesis project or an internship, and they would often include data collection activities in the living lab, literature reviews on relevant topics, interviews with experts and analysis of data collected in the living lab. Another form of embedding that took place during execution of Polder2C's was guest lectures of experts active in the project. In the final months of the project, and while the reporting of results, key findings and lessons is being completed, the educational partners are working towards consolidation of results in the curricula of their organisations. This entails making sure that data sets available in the Data Wizard will be used in future assignments and reported results will make their way to the content of upcoming lessons provided in their institutes. This will ensure that there is a legacy of the project in their education.

## 1.3 Embedding approach

In May 2020, the educational partners of Polder2C's convened to decide upon the most suitable way to steer the embedding process. The options were either to steer the process centrally with a unified approach for all partners, or to let every partner take their own initiatives and steer the process individually. Given the diversity in mission, vision and structure of educational programs in the five target organisations, it was deemed appropriate to let every partner choose the forms of embedding that were feasible and effective in the context of their organisations. In practice this meant that every educational partner had to identify opportunities for embedding and liaise with all relevant stakeholders in the network of Polder2C's on their own. In the following paragraph the embedding process that was followed per organisation is described and the impact of Polder2C's

in their curricula is presented in the form of number of students that have learned about the project and its results so far through various means (i.e. lectures, theses, assignments, field visits etc).



Figure 1. Animal burrows field survey in the living lab with participation of students from TU Delft, HZ, University of Lille and University of Antwerp.

## 2 KU Leuven

### 2.1 Embedding process

KU Leuven included Polder2C's themes in two master's programmes:

1. MSc Engineering Science: Civil Engineering
2. MSc Engineering Technology: Civil Engineering.

Embedding was achieved through theses writing on Polder2C's topics, update of the topics and learning goals of existing courses, or by introduction of new courses. Course coordinators are the end responsible for inclusion or not of new topics in their courses, yet a minimal list of topics has to be agreed upon at faculty level by the program coordinator. Introduction of new courses has to be approved by the faculty head. Because the process of a program reform was coincidentally aligned with the Polder2C's project, KU Leuven had the opportunity to introduce topics as part of the reformed program. As an example, the master course "Civil Engineering" was changed from an elective course to a mandatory course for students in Ghent and Bruges by 2023. This means that in the upcoming years more students will follow this course, which has an impact on the number of students that will learn about Polder2C's topics in the future. Another example is the introduction of a new module, "Duurzame Civiele Bouwkunde", from 2023 onwards, and the renaming of the course 'Hydraulics' to 'River and Waterways', which allows making a more explicit link with more Polder2C's topics.

A complete list of courses with topics that link to Polder2C's activities and results is given in the table below. All topics mentioned in this table were added in project work at the minimum. Before Polder2C's started, except for one lab experiment, levees were not part of the MSc Engineering Technology at all. Over the past three years topics related to levee design and maintenance, river management and climate adaptation gradually acquired a more prominent position in the curriculum through theory lectures, exercises, lab work, fieldwork and master thesis projects.

Table 1: Courses at KU Leuven that address topics related to Polder2C's

Course title	Topics that link to Polder2C's
Rivers and Waterways (Waterlopen en Rivieren)	<ol style="list-style-type: none"> <li>1. Intro to Failure Mechanisms of levees</li> <li>2. Hydraulic grade lines and erosion of a grass-covered levee</li> <li>3. Managed realignment</li> </ol>
Engineering experience 3 (Ingenieursbeleving 3: Duurzame Civiele bouwkunde)	Project on seepage through and stability of dikes: lab - software - field excursion
Coastal and River Engineering	Sigma-plan – river works – climate adaptation
Civil Engineering	<ol style="list-style-type: none"> <li>1. Influence of Climate Change on precipitation and groundwater statistics</li> <li>2. Failure mechanisms of levees</li> </ol>
Engineer and Sustainability (Ingenieur en Duurzaamheid)	Global Challenges: climate mitigation and adaptation
Road and Water Management (Weg- en Waterbeheer)	Influence of Climate Change on precipitation and groundwater statistics
MSc thesis	All

Besides the abovementioned curricular interventions, KU Leuven has invested in equipment that allows the development of laboratory experiments and exercises that showcase the physics of levee failures. In particular the university acquired experimental test rigs for levee seepage, wave overtopping and geotechnical levee failures. These have been used not only within the context of the two target master's programs, but also for demonstration and workshops for high school students, children and the general public. Apart from this, posters and banners were hung in the lab with information about Polder2C's and about the usefulness of the test setups related to real life levees.

The main challenge that KU Leuven faced in the embedding process was that the introduction of new topics in courses required that other topics had to be excluded or have a less prominent position in the curriculum.

## 2.2 People in charge of the embedding process

The embedding of Polder2C's results had to be initiated by course coordinators individually, but the whole process was steered and overseen by the heads of education and relevant faculty directors. The names of people that played a role in this process are listed below for the two campuses of KU Leuven at Bruges and Ghent.

### *Bruges campus*

Course coordinators: Pieter Rauwoens, George Anoyatis

Heads of education: Pieter Rauwoens, George Anoyatis, Elke Gruyaert

### *Ghent Campus*

Course coordinators: Pieter Rauwoens, George Anoyatis

Head of education: Rik Saey, Elke Gruyaert

### *Faculty level*

Program director Civil Engineering: Ann Van Gysel

Vice-Dean Education: Greet Langie -> Dorine Bruneel

### 2.3 Quantitative impact on KU Leuven education

Indicator	Quantity
Number of students that attended courses in which Polder2C's topics or examples were featured.	1014
Number of students that participated in fieldwork activities in the living lab as part of their formal study.	15
Number of students that participated in summer/winter schools.	0
Number of students that participated in the levee challenges.	11
Number of students that wrote a thesis that used data or knowledge from Polder2C's.	4
Number of children and high school students that participated in educational activities related to Polder2C's topics.	108



Figure 2. Left: Coastal Engineering Award ceremony in which students Alexander van Daele and Arthur Vandebussche of KU Leuven received a prize for their MSc thesis on a Polder2C's topic. Right: Students of KU Leuven applying an emergency levee repair during the Levee Challenge of Polder2C's.

## 3 Delft University of Technology

### 3.1 Embedding process

TU Delft included Polder2C's themes in the Hydraulic Engineering master's program of the faculty of Civil Engineering and Geosciences. Although the topics could also be relevant for students of other programs, the team of TU Delft decided to focus efforts on hydraulic engineering, which is the unit that participated in Polder2C's as a partner.

Embedding of project results was achieved through thesis writing, fieldwork in the living lab or by the inclusion of examples and case studies in relevant courses. The introduction of new material in a course is the direct choice of the respective course coordinators. Many of the topics that were studied within Polder2C's were already included in the curriculum of the hydraulic engineering program, such as the theory on design and maintenance of levees. Test results that have been lately made available in the Data Wizard will be incorporated into project-based educational activities. The team of TU Delft intends to refer students to the educational videos of Polder2C's and to project reports.

The courses at TU Delft in which Polder2C's results have been and will be embedded are presented in the table below.

Table 2: Courses at TU Delft that address topics related to Polder2C's

Course title	Topics that link to Polder2C's
Flood defences	<ol style="list-style-type: none"> <li>1. Intro to Failure Mechanisms of levees</li> <li>2. Design and maintenance of levees</li> <li>3. Erosion and hydraulic models</li> </ol>
Modeling, Uncertainty and Data for Engineers	Data analysis and numerical modeling
Building with Nature	Nature-based flood protection
Flood Risk	<ol style="list-style-type: none"> <li>1. Emergency response operations and governance</li> <li>2. Risk perception</li> <li>3. Safety assessments of levees</li> </ol>
Minor thesis / Internship	All
MSc thesis	All

The main challenge that TU Delft faced in the embedding process was two-fold: 1) there was little time for embedding of the results during the project duration, and 2) during the project a complete revision of the MSc programs in the Civil Engineering and Geosciences Faculty was underway (2022-23 is the first academic year). The project results were made available shortly before the official completion of the project, which means that the most meaningful interventions in the content of courses will take place after the project ends. As the programs are in a continual state of revision as they are being offered for the first time, it is difficult to specify exactly how Polder2C's results will be incorporated at this time. However, within the revised MSc Programme Civil Engineering, Polder2C's results will be incorporated in two tracks: Hydraulic Engineering and Hydraulic and Offshore Structures (approximately 100 students per year). Datasets and simple numerical models may also be incorporated into the faculty-wide module Modeling, Uncertainty and Data for Engineers (approximately 350 students per year).

### 3.2 People in charge of the embedding process

Robert Lanzafame (Lecturer in the Flood Defences course)  
Stephan Aarninkhof (Head of the Department).

### 3.3 Quantitative impact on TU Delft education

Indicator	Quantity
Number of students that attended courses in which Polder2C's topics or examples were featured.	60
Number of students that participated in fieldwork activities in the living lab as part of their formal study.	25
Number of students that participated in summer/winter schools.	10
Number of students that participated in the levee challenges.	4
Number of students that wrote a thesis that used data or knowledge from Polder2C's.	4



Figure 3. Left: Students of TU Delft volunteering as subjects in overtopping experiment in which overtopping discharges that a human can withstand were measured. Right: Johannes Idsinga, student of TU Delft participating in a concrete grout excavation activity in the living lab to collect data for his minor thesis.

## 4 University of Lille

### 4.1 Embedding process

Lille University embedded Polder2C's themes in the following educational units:

1. Civil Engineering-Common core (Master 1),
2. Civil engineering infrastructure (Master 2),
3. Urban Engineering and Habitant (international Master 2),
4. Hydraulic and geotechnical engineering (Master 2),
5. Civil Engineering (License 3).

Embedding was achieved through thesis writing and introduction of case studies and examples from Polder2C's in study assignments. This type of embedding can be decided by individual lecturers or course coordinators. Larger curricular interventions are not foreseen because they require a much longer time horizon than the Polder2C's timeline. In particular, the department organizes a meeting for the professors every five years to review the teaching plans. The committee proposes improvements and updates then the new proposal is sent to the national education committee to be approved. introduction of new courses requires a national accreditation, which is renewed every 5 years. The next accreditation for Lille University is scheduled for 2025.

The topics that have been included in the abovementioned educational curricula are the ones that the University of Lille worked on during Polder2C's. These are geophysical surveys of levees with the ground penetrating radar and data management. The following table shows which topics were included in every relevant course.

Table 3: Courses at Lille University that address topics related to Polder2C's

Course title	Topics that link to Polder2C's
Soil Mechanics	GPR surveys Risk assessment
Sustainable Cities	Data management Sustainability and Smart Infrastructure
Hydrology	GPR surveys Data management

	Risk assessment
Urban Information System	Data management Sustainability and Smart Infrastructure
Thesis	GPR surveys Data management

Apart from the abovementioned formal embedding, the team of Lille University presented results of Polder2C's in conferences that included several students in the audience and in online seminars for their PhD students and staff members.

The greatest challenge that Lille University faced in the embedding process was lack of time for embedding during the project duration. Since project results were made available shortly before the end of the project, there was no time to introduce final lessons in existing courses. Similarly to Delft University, there is the intention to continue incorporating project results in education the coming years.

**4.2 People in charge of the embedding process**

Prof Isam Shahrour (Professor in Civil and Geo-environmental Engineering Laboratory)

Dr. Hanbing Bian (Lecturer)

Dr. Ammar Aljer (Research Engineer).

**4.3 Quantitative impact on the University of Lille education**

Indicator	Quantity
Number of students that attended courses in which Polder2C's topics or examples were featured.	240
Number of students that participated in fieldwork activities in the living lab as part of their formal study.	3
Number of students that participated in summer/winter schools.	3
Number of students that participated in the levee challenges.	0
Number of students that wrote a thesis that used data or knowledge from Polder2C's.	3



Figure 4: Hoang Dung Nguyens, PhD student of Lille University, performing a GPR scan in the living lab with the support of students from HZ and TU Delft.

## 5 HZ University of Applied Sciences

### 5.1 Embedding process

HZ embedded Polder2C's themes in the following educational programs:

1. [BSc Civil Engineering](#)
2. [BSc Water Management](#)
3. [MSc River Delta Development](#)

Embedding was achieved through introduction of Polder2C's topics in theory lectures, course assignments, field exercises and a small number of bachelor's theses. The introduction of new topics in an educational unit is possible only when the content and learning method allows the student to acquire a set of predefined competences. Individual lecturers can propose changes in a course, but those changes have to be approved by the course coordinator based on the aforementioned criterion. The introduction of new courses requires first approval by the curriculum committee, and can be planned in a time horizon of one to two years. Given the complexity that this process entails, the HZ team decided to focus their efforts on updating the content of existing relevant courses.

The courses that were updated with Polder2C's content are presented in the table below. It is worth mentioning that the Coastal Engineering course incorporated a field week for its enrolled students that is going to take place every year in May in the Hedwige-Prosperpolder, at the exact location of the Polder2C's Late Summer School. During that week students are going to follow a curriculum similar to the one of the Late Summer School, but in a simplified version that fits the needs and the level of 2nd year bachelor's students. This year the field week is scheduled in the period 30th May till 2nd June.

Table 4: Courses at HZ University of Applied Sciences that address topics related to Polder2C's

Course title	Topics that link to Polder2C's
Coastal engineering	<ol style="list-style-type: none"> <li>1. Intro to Failure Mechanisms of levees</li> <li>2. Design and safety assessment of levees</li> <li>3. Levee inspection and monitoring of burrows</li> <li>4. Emergency response and coordination</li> </ol>
Integrated Coastal Challenge	<ol style="list-style-type: none"> <li>1. Nature-based flood protection</li> <li>2. Managed realignment</li> <li>3. Risk perception and mindscapes</li> <li>4. Crisis governance</li> </ol>
Ecological engineering	<ol style="list-style-type: none"> <li>1. Nature-based flood protection</li> <li>2. Flood resilience building</li> </ol>
Living labs for MSc assignments	<ol style="list-style-type: none"> <li>1. Risk perception and mindscapes</li> <li>2. Coastal landscape transitions</li> </ol>
BSc thesis	All

Apart from the abovementioned interventions, HZ invested in equipment that will allow setting up a laboratory exercise for 50 students on monitoring of animal burrows in the newly built Joint Research Centre of Zeeland that opened in December 2021. The goal is to use this exercise as an extension of the field week for the students of the coastal engineering course. This may not be

possible in 2023 yet, as the equipment hasn't been received yet due to procurement delays related to the current disruptions of supply chains.

The main challenge that HZ faced in this process is the fact that most of the topics addressed in Polder2C's were only marginally discussed in the curricula of HZ before commencement of Polder2C's. Creation of space for the inclusion of a variety of new topics requires more time than the time that was available during Polder2C's. Hence the embedding process is going to be continued in the coming years.

## 5.2 People in charge of the embedding process

### *Coastal engineering course*

Course coordinators: Joachim de Keijzer, Marco Gatto, Vana Tsimopoulou  
 Program manager: Giuliana Scuderi

### *Integrated Coastal Challenge*

Course coordinator: Marianna Ansiliero de Oliveira Coelho  
 Lecturer & coach: Vana Tsimopoulou  
 Program managers: Giuliana Scuderi, Clazina Dingemans

### *Ecological Engineering*

Course coordinator: Anco Nijssen  
 Lecturers: Vana Tsimopoulou, Wietse van de Lageweg  
 Program manager: Clazina Dingemans

### *Living labs for MSc assignments*

Living lab coordinators: Wietse van de Lageweg, Teun Terpstra, Jean Marie Buijs  
 Program manager: Marco Lengton

## 5.3 Quantitative impact on the HZ education

Indicator	Quantity
Number of students that attended courses in which Polder2C's topics or examples were featured.	350
Number of students that participated in fieldwork activities in the living lab as part of their formal study.	17
Number of students that participated in summer/winter schools.	5
Number of students that participated in the levee challenges.	1
Number of students that wrote a thesis that used data or knowledge from Polder2C's.	2



Figure 5. Students of HZ performing a vegetation mapping activity in the foreshore of the living lab with the guidance of Belgian experts.

## 6 Netherlands Defence Academy

### 6.1 Embedding process

NLDA embedded Polder2C's themes in the programme of Military Engineering of the Faculty of Military Sciences.

New topics can be introduced whenever they fit into the course programme (if it is aligned with the learning objectives of the course). It is the individual responsibility of the lecturing staff to introduce new topics. Whenever it is a major change, it will be discussed first within the context of the regular Military Engineering staff meetings. The introduction of new courses in the curriculum is usually first discussed with the military (operational) stakeholders. Introduction of a completely new course usually has to replace existing courses of the same number of credits (ECTS). The time frame for this is at least one year, but more likely two years.

Aspects of Polder2C's are used or mentioned in most of our courses, but especially in the courses (course code / ECTS):

Waterbeheer & Management (TWAT / 5 ECTS)

Grondmechanica I (TGRM / 3 ECTS)

Grondmechanica II / Grondkerende Constructies & Funderingstechniek (TGCF / 3 ECTS)

Pyrotechniek & Beschermingsconstructies (TPTB / 5 ECTS)

Capita Selecta Military Engineering (TCAPS / 2 ECTS)

Bachelor Thesis Work (TEOP / 15 ECTS)

In the abovementioned courses the NLDA team organized practicals in the Living Lab Hedwige-Prosperpolder (soil mechanics), excursions to 'disaster areas'(Limburg), and to specific hydraulic structures. In recent years, the examples in all of these classes (as well as exam questions) have often been inspired by specific issues that popped up during Polder2C's.

NLDA did not face any challenges in incorporating the Polder2C's content in their curriculum.

### 6.2 People in charge of the embedding process

The implementation of curricular updates at NLDA are overseen by the Education Board (Opleidings Bestuur) of the Military Systems & Technology department (MS&T), together with the teaching staff of Military Engineering. Responsible within the section (and OB) is Edwin Dado.

### 6.3 Quantitative impact on NLDA education

Indicator	Quantity
Number of students that attended courses in which Polder2C's topics or examples were featured.	200
Number of students that participated in fieldwork activities in the living lab as part of their formal study.	66
Number of students that participated in summer/winter schools.	0
Number of students that participated in the levee challenges.	0
Number of students that wrote a thesis that used data or knowledge from Polder2C's.	16



Figure 6. Left: Military working student, Demi de Rijke supervising the application and testing of the French mobile barrier Cuirassier in the living lab. Right: PhD student of NLDA and TU Delft, Danny Janssen taking water level measurements at the Hedwige pool, to be used in the preparation of the BresDefender experiments.

## 7 Overall assessment

As explained in the previous sections, embedding project themes and findings in formal education is not a straightforward process, but it requires timely planning and thorough understanding of operational and educational processes in the organisations of interest. The experience of updating curricula in five different organisations during Polder2C's, gave the opportunity to make a preliminary assessment of the factors that influenced positively or negatively the embedding process. Those are listed in the following paragraphs.

### 7.1 Drivers of success

1. Working in the field with real professionals is usually attractive and motivates students. This made it easier to have large groups of students willing to participate in activities in the living lab.
2. The broad network of partners and the variety of topics tackled within Polder2C's made it possible to cater to students with a wide spectrum of interests.
3. All partners in education paid close attention to the matching process of students with topics and organisations of interest for their internships. The earlier they started bilateral exchanges of partners that could hire students for internships or thesis writing, the more likely it was to find a suitable candidate and start the project in time.
4. Regarding the legacy of the project in the curriculum, it is very positive that all data that were produced during the project will be available and accessible in the future. This will enable students to work in the future.
5. Embedding was made possible because people involved in Polder2C's from the five educational partners had a direct involvement in education, as lecturers or course coordinators. This allowed them to identify realistic opportunities to update course material in ways that are acceptable for educational standards.

### 7.2 Challenges

The most important challenges that were faced in the embedding process were the following:

1. The outbreak of covid-19 limited to a very important extent the possibilities of educational partners to bring students in the field during the project duration. This reduced drastically direct interactions of students with professionals and experts that were active in the field, which could have been useful for motivating students to continue their studies or career in fields covered by Polder2C's.
2. Education has a very strict planning (i.e. academic calendar) that is known one year in advance and has to be respected. Because of covid, but also other operational constraints in the living lab, many project activities had to be rescheduled in the last minute, which made it always difficult to plan a good educational activity in the field around activities of the Polder2C's studies.
3. Every course in a curriculum has its learning objectives, and updating those objectives requires long term planning. This makes it difficult to incorporate new content in an existing educational unit that is radically different than what was taught before.
4. All educational activities have to have objective assessment criteria. Due to the unconventional nature of the Polder2C's activities, it was not always easy to devise educational initiatives that could be assessed based on the assessment rules of every university.
5. Students' products can be of high quality but in many occasions the quality that is delivered is not very high. This means that non-educational partners had to be careful not to overrely on students' work for the achievement of their objectives in the project.