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Report on Virtual Mobility Course "Water Resources Management and Treatment Technologies under Climate Change"

CC WATER

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Task leader	Harsha Ratnaweera
Author(s)	Harsha Ratnaweera
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1 Background

Water resources management and water and wastewater treatment are subjects/courses covered by all universities. In most cases, content of these subjects/courses are mostly focusing on the conventional and decentralized methods addressing the general conditions. However, all regions are experiencing impacts of Climate Change to variable degrees. Thus there is a need to include specific learning material either as specific courses or to supplement the existing courses. Establishing these supplementary learning opportunities will enable a larger audience of students to follow them, in between their busy schedules.

There is also a need to provide updated and supplementary knowledge to the professional staff already performing their duties, as during their graduate studies these topics, in most cases, were not in focus at all. On the other hand, many of these professionals do not have sufficient time to physically present in lectures. Providing learning options via distance learning as virtual or hybrid courses.

The CC Water project developed numerous lectures under three topics/courses related to Climate Change.

Course 1: Big Data for integrated Climate Change & Water management.
Course 2: Storm Water management with low impact development and non-conventional water reuse.
Course 3: Integrated Water Resource Management under Climate Change.

Lectures and teaching material developed within these topics are presented as deliverables in the WP2. Selected lecture materials were utilized in various courses and this report presents an outline on how to use them in a virtual or hybrid mode.

2 Collaborative Online International Learning (COIL) as a tool for Virtual Mobility

The benefits of traditional mobility programs, such as improved attitudes, self-confidence, adaptability, and cooperative skills, are primarily due to the exposure to diverse situations, contexts, and people. This exposure requires individuals to adapt in order to achieve success both academically and non-academically. Given these benefits, it is logical to design 'virtual mobility' or 'virtual exchange' activities to replicate this significant effect of exposure.

The Collaborative Online International Learning (COIL) model has been developed over the past 20 years to achieve these goals. The COIL model is designed to provide similar or even superior outcomes to physical mobility in terms of enhancing international and intercultural competencies. Typically, the COIL model is integrated into a course or a portion of a course within a larger degree program, referred to as a 'COIL module'.

2.1 Four criteria: C-O-I-L

In order to qualify as COIL, activities must absolutely meet the cumulative conditions of being:

- **Collaborative**: staff are co-teaching the module on equal footing; students are put in a position of needing to cooperate effectively and efficiently to produce the required outputs of the activity.

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- **Online**: the interaction between the students and staff in question takes place (mostly or exclusively) online.
- **International**: there is meaningful interaction between staff and students in two (or more) different countries, leading to the development of international and intercultural competences.
- **Learning**: COIL modules are learning activities, and should be an integral part of the curriculum, not an optional and inconsequential 'extra'.

In summary, an activity should be recognized as a true 'virtual exchange' only if it meets all the specified characteristics. These four conditions are cumulative and stringent.

Once these criteria are fulfilled, COIL modules can take various forms. They can also complement short-term physical mobility for both staff and students, forming what is known as 'blended mobility.' For instance, an 'international project week' could be organized where students and staff meet in person, in addition to their ongoing online collaboration. It is particularly beneficial for staff members involved in a COIL module to meet physically during the planning phase to establish the trust necessary for successful co-teaching.

2.2 Assuring high-quality COIL

For COIL modules to be effective, they must be solidly embedded within the institution, not just championed by individual staff members. COIL should be recognized as a crucial component of internationalization at every institutional level.

Successful implementation requires contributions from various parts of the institution, drawing on diverse skills, expertise, and time. Teaching staff will need to redesign course modules, rethinking content, learning outcomes, delivery, teaching materials, and assignments to facilitate online co-teaching with an international partner. This process demands a significant initial time investment.

COIL is neither a cheap nor easy alternative to traditional mobility. For COIL to thrive, it requires strong institutional support, recognition, and resources.

Teachers will need intensive support from specialized staff in educational methodology, such as instructional designers and teaching and learning specialists. The COIL methodology, developed over the past 20 years, includes well-documented protocols, best practices, and lessons from past failures. Support staff should be well-trained in COIL concepts, methodologies, and resources to provide necessary support to teaching staff, helping them avoid the pitfalls of online interaction and maximize the chances of success.

While educational considerations are paramount, effective use of technology is also essential. Reliable technological support must be available at all times to prevent communication breakdowns and frustrations.

Finally, COIL modules depend on strong international partnerships between universities. Specialists in international offices should assist faculty in establishing and managing these partnerships to ensure the success of COIL modules.

2.3 Ensuring recognition of COIL activities

Once you've got good COIL modules up and running at your institution, the final step is making sure that it all counts for something. In this context, 'recognition' can mean two things:

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At the level of the individual student: how do we make sure the activities undertaken during 'virtual mobility' (ie, as part of a COIL module) are recognised within their curriculum and are awarded credits? In this regard, the COIL model can be quite simple: since the COIL module is carried out in constant cooperation between the two (or more) professors and their respective students, the students can in fact stay under the formal authority of their home professor at all times. There is no need to create a formal 'joint course' with shared authority over the entire group, although this is a possibility. The simple solution is that the credits and grades be simply awarded by the home institution of the student.

At the institutional level or supra-institutional level: how can 'virtual mobility' be recognised, measured and potentially funded? In the case of COIL modules, this could simply be accounted for and quantified as follows:

- **Confirmation** that the activities a specific professor is undertaking within their course or module meet the four basic conditions listed above (collaborative, online, international, learning). This could be documented in a work plan.

- **Calculation of:** number of students involved, number of credits (how large is the part of the course taken up by the COIL activities in terms of student workload? For example, within a 6 ECTS course, half of the student's workload is directly related to the COIL activities, thus 3 ECTS credits). This calculation could serve as a basis for awarding financial and other support.

While 'virtual mobility' and 'virtual exchange' may be somewhat vague concepts, the COIL model offers a well-defined and proven methodology for integrating international and intercultural experiences into the core curriculum for all students. However, COIL is not a cheap or easy substitute for traditional mobility. For it to thrive, it requires strong institutional support, recognition, and integration. Its success and sustainability hinge on the ongoing dedication and collaboration of various stakeholders within the institutions involved.

2.4 Cross-boundary collaboration with COIL

COIL is a teaching and learning method used to internationalise the curriculum and facilitate students' intercultural and curriculum content learning. COIL can be seen as one of the most intensive forms of intercultural and interdisciplinary collaboration for both students and educators within higher education.

COIL adds an intercultural dimension to the curriculum, in any course, and COIL: what's in an acronym? as an essential form of internationalisation at all levels within universities. It is a unique form of virtual exchange as it revolves entirely around the collaboration of two or more educators, from different universities located in different countries, co-developing and co-facilitating online collaborative assignments for their students. With its foundations in social constructivism and collaborative learning, COIL in practice is highly interdependent as it relies on social interaction and brings educators and students from multiple diverse backgrounds, cultures and disciplines together, interacting and collaborating on a common goal.

The university alliances created through the European Universities Initiative often use COIL because of its project-based learning approach, which involves connecting various subjects and developing different skills to complete a project. It merges different ways of thinking and behaving, different values, beliefs and norms and different university cultures, and it can also involve collaboration between leaders at different levels.

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2.4.1 Challenging assumptions

Traditionally, the ultimate goal of COIL—and the broader internationalization of higher education—is to facilitate the development of students' intercultural competence. This is generally seen as relating to 'soft skills,' rather than the 'hard skills' specific to a particular field of study. However, 'intercultural' can also apply to disciplines. By viewing 'culture' as a collective set of beliefs, behaviors, ideas, philosophies, and practices shared by a specific group, we can recognize that each discipline has its own culture (e.g., medicine versus philosophy). From this perspective, 'intercultural learning' encompasses crossing the boundaries between different disciplines.

The interdisciplinary element within COIL is fundamental. The COIL experience is truly transformative when both educators and students step out of their comfort zones. The goal is not merely to reach a common objective despite our differences but to achieve a higher objective because of our differences. Engaging in COIL challenges our assumptions about our differences, revealing unexpected distinctions and often showing that presumed differences are smaller than we initially thought.

2.4.2 Learning from each other

One of the first steps in implementing COIL involves navigating organizational cultures. Educators must find a suitable COIL partner from an overseas university with whom they can co-develop and co-facilitate the course. This requires careful consideration of various elements that can differ significantly even between universities in the same country, let alone in different countries. These differences can either facilitate or hinder the successful implementation of COIL. When co-designing a COIL course, educators need to consider variations in educational levels, academic calendars, time zones, class sizes, assessment formats, data protection regulations, technology, and more.

For example, one COIL course brought together physical education (PE) teacher training students from the Netherlands and primary school teacher training students from Ireland to develop an inclusive physical education lesson plan. In Ireland, teacher training bachelor's courses are offered at research universities, while in the Netherlands, most teacher training courses are offered at vocational universities. Additionally, the Irish students were training to be generalist primary school teachers, teaching various subjects, whereas the Dutch students were training specifically in PE across different educational levels.

These students had different levels of knowledge and training; the Irish students had more theoretical knowledge, while the Dutch students had more practical, specialized knowledge. Initially, educators feared these differences could be problematic. However, as the course progressed, these varying levels of knowledge and experience complemented each other, resulting in a well-designed lesson plan that incorporated diverse perspectives.

There are many examples of how differences between programs can enhance students' curriculum content and intercultural learning. Numerous COIL initiatives involve students and lecturers from diverse disciplines collaborating and learning from one another, demonstrating the value of these varied perspectives.

2.4.3 Limitless potential

COIL has immense potential and its possibilities are limitless. As universities and educators recognize its benefits, COIL will become increasingly popular as an inclusive teaching and learning method that enhances both curriculum content and intercultural learning across countries and disciplines. We

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anticipate COIL becoming even more impactful as it is intentionally used to facilitate teaching and learning across various boundaries.

2.5 A student perspective on COIL

COIL and other forms of virtual exchange have surged in popularity since the onset of the COVID-19 pandemic. The growing discourse around COIL in recent years has examined it from various perspectives, including institutional strategy, teaching and learning, and the student experience.

One of the most significant benefits of the COIL project has been the opportunity to build a global network. By connecting with peers and professionals from New York, students developed relationships that have continued to provide insights and opportunities beyond the project's duration. These connections have enriched students' personal lives and opened doors to future professional collaborations.

Reflecting on their experiences, students noted how each interaction and challenge contributed to their personal growth. The COIL experiences acted as catalysts for developing a deeper sense of self-awareness and a better understanding of their roles in a multicultural world. They learned the importance of continuous learning and adapting—qualities essential for success in today's ever-evolving global environment.

In conclusion, students who participated in the COIL project as part of their graduate or undergraduate programs reported immense personal and professional growth. The project equipped them with invaluable skills and fostered a lifelong appreciation for diverse narratives and intercultural understanding. This experience has not only prepared them for successful careers by teaching them how to excel in virtual and international teamwork but also instilled a passion for fostering cross-cultural collaboration.

2.6 Perspective from a teacher

The author (Ratnaweera) participated in a Virtual Mobility/COIL training and teaching program organized by the American Council on Education (ACE) and the Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education (Diku), supported by the Norwegian Ministry of Education and Research. This program provided rapid-response, intensive virtual exchange (VE) and collaborative online international learning (COIL) training to U.S. and Norwegian higher education institutions.

Hybrid lectures were conducted, involving students from NMBU (including those from Eurasia) and the State University of New York at Stony Brook. These lectures were delivered both synchronously and asynchronously, with some students physically present and others participating remotely.

Key conclusions from the program include:

- The VE/COIL course made lecturers more aware of cultural and language aspects that were not always considered during previous physical lectures, leading to improved student reception.
- Synchronous lectures allowed teachers to receive real-time feedback and questions, as well as utilize digital teaching tools effectively.
- Due to time zone differences, it was not always possible to conduct lectures synchronously. Asynchronous modes (video, video-on-demand) enabled a broader audience to access the lectures.

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- Asynchronous lectures required pre-recording, which allowed for reuse and easy access for more students.
- Hybrid lectures with students from different countries were followed by joint project reports. Groups consisting of students from various countries provided international networking opportunities and enhanced student participation.

3 Conducting virtual lectures

Within the CC Water project framework, 15 lectures were developed. 6 were on BigData and IoT, 5 on storm water management and 4 on IWRM in the context of Climate Change. Majority of these lectures were conducted as physical lectures at the summer/winter schools in Kandy (July 2023), Shenzhen (January 2024) , Ås (2022 and 2024) with good responses. The evaluation by staff and students are presented in T2.3.3 and T2.3.4.

3.1 Examples of Virtual courses/lectures conducted:

- " Visualization with big data", by Dr Ayurzana Badarch, MUST-MN, 40 participants, 10.01.2024, Shenzhen, SIAT
- "Urban stormwater and impacts", by Dr Wei Liu, IMUEF-CN, 40 participants, 11.01.2024, Shenzhen, SIAT
- "Urban Stormwater Management" by Dr Wei Liu, IMUEF-CN, 40 participants, 11.01.2024, Shenzhen, SIAT
- "Concepts of Low Impact Development (LID)", by Prof Katarzyna Glińska-Lewczuk, UWM-PL, 40 participants, 11.01.2024, Shenzhen, SIAT
- "Integrated Management Strategies", Dr A.C.A. Suja, SEUSL-SL, 40 participants, 11.01.2024, Shenzhen, SIAT
- "Stormwater management models and SWMM" by Prof S B Weerakoon, UOP-SL. 40 participants, 12.01.2024, Shenzhen, SIAT
- "Wastewater treatment processes – general process configuration", by Prof Harsha Ratnaweera, NMBU-NO. 40 participants, 16.01.2024, Shenzhen, SIAT
- "Wastewater treatment process modelling & simulations", by Prof Martin Oldenburg, THOWL-DE. 40 participants, 16.01.2024, Shenzhen, SIAT
- "Water utilization and sectoral demands", by Dr Pavel Burandt, UWM-PL. 40 participants, 12.01.2024, Shenzhen, SIAT
- "Affordable real-time water quality monitoring with virtual sensors", by Harsha Ratnaweera, 130 participants, 27.09.2024, National Technical University og Ukraine
- "Climate Change Impacts on Water Services and Utilities".by Harsha Ratnaweera, 200 participants, 10.05.2023, RUSL, Anuradhapura, Sri Lanka
- "Digitalisation of the water sector: opportunities and challenges", by Harsha Ratnaweera, 100 participants, 28.11.2022, UoP, Kandy, Sri Lanka

3.2 Examples of hybrid lectures conducted

NMBU's THT311 (10 ECTS) and THT313 (5 ECTS) were conducted as hybrid lectures with 42-60 physical participants and 10-20 virtual participants.

THT311 course: Water resources management and water and wastewater treatment

Monday 17th June	
Module 1: Meeting the global challenges in the water sector (Thaulow)	09:30-12:00
Tuesday 18th June	

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Module 2: Research skills and visibility	
Research publication writing (Ratnaweera)	09:00-09:45
Increasing visibility: ResearchGate, Google Scholas, Scopus, LinkedIn etc (Maletskyi)	10:00-10:45
Wednesday 19nd June	
Module 3: Planning for the future and emerging water challenges (Hem)	09:00-12:00
Thursday 20rd June	
Module 4: Process control and flood simulations	
Process control (Ratnaweera)	09:00-09:45
Introduction to flood simulation (Kandasamy)	10:00-11:30
Introduction on the project work (Maletskyi)	11:30-12:00
Friday 21th June	
Module 5: Sustainable Urban Drainage Systems (Kandasamy)	09:00-12:00
Monday 24th June	
Module 6: Integrated water resources management & Water quality (Vermaat)	09:00-12:00
Module 7: Sludge treatment	
Sludge treatment- general & innovations (Morken, Hybrid)	13.00-14:00
Digital tools in sludge management (Ratnaweera, Hybrid)	14:15-15:15
Tuesday 25th June	
Module 8: Design principles and excursion	
Managing scientific references –NMBU data bases (Hølvod)	09:00-10:00
Design principles WWTP/Exam info (Ratnaweera)	10:15-11:15
Wednesday 26th June	
Module 8: Water distribution and wastewater transport	
Introduction to urban hydrology (Paus)	09:00-09:30
ChatGPT in water management (Paus)	09:30-10:00
Lunch	12:00-13:00
Monitoring the lifecycle of pharmaceuticals in the environment / serious games (Cuprys)	13:00-16:00
Thursday 27th June	
Module 9: Digitalisation of the water sector	
Data-driven water quality monitoring and process control (Ratnaweera),	09:00-10:00
Using graph theory for new AI/ML capabilities with utility network data (InfoTiles)	10:00-12:00
Introduction to simulation programs in the water sector (Ratnaweera)	13:00-13:30
Simulation program STOAT (Ratnaweera/Fanjing)	13:30-15:00
Friday 28th Juny	
Module 10: Design of DWTPs & WWTPs and Exam	
Design & troubleshooting in DWTPs and WWTPs (Ratnaweera)	09:00-11:00

THT313: Water management in changing conditions (including Climate Change impacts)

1st July, Monday		
	Module 1: Challenges in Cold Climates	
09:15-10:30	Impacts and management of water supply	Ratnaweera
10:45-12:00	Impacts and management of wastewater	Ratnaweera
2nd July, Tuesday		
	Module 2: Change of serving population	
09:00-09:45	Impacts and management of water supply	Vigneswaran

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10:00-11:00	Impacts and management of wastewater: decentralised systems	Heistad
11:15-12:00	Impacts and management of wastewater: centralised systems	Vigneswaran
3rd July, Wednesday		
	Module 3: Digital tools	
09:00-10:15	Digitalisation of the water sector: opportunities and challenges	Ratnaweera
10:30-12:00	Process surveillance and control in practice	Sivchenko
13:00-15:00	Data analysis and applications in green roofs	Furman/ Brynlund-Lima
4th July, Thursday		
	Module 4: Change in temperature: Cold climates	
09:00-10:30	Arctic environment: pollution sources, statues, and management	Kallenborn
5th July, Friday		
09:00-10:30	**Module 5: Impacts of Climate Change**	
09:00-10:30	Climate change impacts on water/wastewater transport systems with focus on precipitation	Roozbahani
10:45-12:00	Impacts on W&WWT	Ratnaweera

Virtual tours to wastewater treatment plant was conducted on the 3rd July 2024. Students received a link and a password to "walk through" the WWTP together with the teacher. It was an interesting activity appreciated by both physical and virtual students.

A digital collaborative workspace was used to design surveillance flow sheets by groups (software: Miro). Students showed a fully and comprehensive engagement during the activity.

3.3 Lessons learned from virtual mobilities

- Most lecture materials were provided via a moodle/repository system, and was quite helpful for students to follow.
- Virtual Mobility increases the accessibility for lectures, and thus also possible to reach a larger audience.
- Use of digital learning tools as surveys were used during lectures. Participation of virtual students were satisfactory. With improved planning it should be possible to increase the use of digital tools in virtual courses/lectures
- To carry out practical/hands-on assignments with virtual students is too complicated. This could be due to the various levels of internet access.
- IF certification of attendance or/and ECTS can be provided also for virtual students, there will be higher interest to enrol in virtual courses.
- Virtual tours to treatment plants, dashboards, use of digital collaborative work space (such as Miro) increase the engagement of students.

4 Summary

Virtual Mobility is an important concept which will increase the accessibility, affordability and engagement of students. Since it is challenge to have the continuous attention of virtual students during the lectures, the lectures must be planned considering the differences among the participants. Digital tools including recording of lectures can be reused and also could be included in distance learning/lifelong learning courses.

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