



3rd IMMERSE

Transnational Estuary Exchange Lab: 'Local Flood Protection Strategies and Technical Modelling'

10 June 2021, Online

Workshop Report

The IMMERSE Transnational Estuary Exchange Labs (TEEL) provide a platform to share practices and progress on the development of solutions for estuarine management issues. The purpose is to advance development and transfer of solutions across those involved in estuary management in the North Sea Region.

IMMERSE organised the third TEEL on Thursday 10 June 2021 online. Through interactive online discussions, it offered a platform for transnational exchange, for both IMMERSE partners, North Sea Region estuary managers as well as further relevant stakeholders who jointly explored solutions and shared experiences during an introduction session and two dedicated topical sessions. The focus of the TEEL was on developing **local flood protection strategies**, with a geographic focus on **Holbaek, Roskilde and Isefjord in Denmark**. Key aspects included the role of **numerical models** in informing and testing solution designs, approaches for **working with landowners and relevant stakeholders** in developing holistic, short- and long-term flood projection strategies; as well as **investment and added value of flood protection measures**.

The following report presents a summary of the presentations, discussions and audience engagement from the three sessions, starting off with the **Introductory Session - 'Setting the Scene,'** which introduced participants to the IMMERSE project, the TEEL concept, and the topic of flood protection. The introductory session also set the scene for the Danish situation related to flood protection including both the national perspective as well as a local view to the situation/pressure. The next session was dedicated to the topic of **Regional Approaches to Flood Risk Management** and discussed differences and difficulties in regional approaches to flood risk management across the North Sea Region. The final session **Technical Modelling approaches used in solution development and testing** saw presentations and discussions about how technical modelling can be applied to North sea Region estuaries, and help in the development of measures for flood protection. The TEEL was attended by 36 individuals and closed off with a wrap-up session. All materials from the TEEL can be found on the IMMERSE TEEL webpage: <https://northsearegion.eu/immerse/transnational-exchange-labs/>.



Introductory Session: Setting the Scene

Kicking off the TEEL, the IMMERSE Project Coordinator (**Frederik Roose**, Department of Mobility and Public Works, Flanders, Belgium) introduced the IMMERSE project and the topic of flood protection. During this session, two Danish speakers presented the Danish Coastal Law and the situation in the Danish municipality of Holbaek. In Denmark, regional and local models investigate potential solutions against floodings. The models work well, but the goal is to gain a **dynamic adaptation plan**. The session highlighted how general **stakeholder engagement** is important, but often also very challenging.

Flood Risk Management in Denmark (Per Sørensen – Danish Coastal Authority) Summary

Per Sørensen from the Danish Coastal Authority gave insight into the Danish Coastal Law, which stipulates that Danish landowners are responsible for ensuring coastal protection (including bearing responsibility for the costs). In Denmark, the municipalities are responsible for issuing permits for flood solutions/measures which reduce flood risks. The Danish Coastal Authority encourages the use of 'Cloud to Coast', a holistic approach which consists of 12 steps. This has also been applied in the Interreg NSR C5A project where they addressed four types of flooding.

Materials: [Presentation on flood risk management in Denmark by Per Sørensen](#)

Questions & Answers

Q1: Are municipalities in Denmark stricter regarding building permits for structures closer to the coastline, due to risks of flooding?

A1: This is unfortunately not always the case, and it often depends on the municipality and the priorities they set. The building of new homes as well as holiday homes in flood prone areas, of course always brings along a lot of risk.

Holbaek Municipality's flood management plan (Jørgen Grubbe – Danish Holbaek Municipality) Summary

Jørgen Grubbe from the Danish Holbæk Municipality explained how the municipality is preparing a plan for flood management. The aim is to develop a holistic flood protection management strategy that includes climate adaptation and that considers the risk of water coming from all sides (e.g. from the sea, but also from rainfall and rivers). They have started off with a mapping of risks and a subsequent risk analysis. The Holbæk Municipality's Coastal Protection Service is trying to create an inclusive and positive stakeholder dialogue, which can sometimes be challenging. For example, a difficulty includes different landowner associations, which do not have a unified idea of their aims. Another difficulty includes the fact that many citizens are not in favour of building a



dyke. Recently, the Danish Arts Foundation funded an artist to develop an artistic installation for the coastal protection of a recently flooded area, with the aim of using it as a tool for creating a positive stakeholder dialogue.

Materials: [Presentation on Holbæk municipality's flood management plan by Jørgen Grubbe](#)

Questions & Answers

Q1: Does the Holbæk municipality explore *combination flooding* (river run-off, flood and tidal flood at the same time – so-called '*Black Swan events*') and if so, is this incorporated into the spatial planning?

A1: When the coast of Denmark is screened for flood risks, they consider the runoff from different rivers and creeks and run a statistical analysis to see how likely it is that 'Black Swans' will happen. When making assessments of risks, the scale (national or local) is also very important in spatial planning.



Session 1: Regional Approaches to Flood Risk Management

Introducing the session, moderator **Daniel Parsons** from the University of Hull started off by explaining the differences that exist in regional approaches to flood risk management. Estuaries have a wide range of interested stakeholders and there are many drivers for making estuary management decisions. Flood management is just one of them, where others can be for instance land use, carbon capture or biodiversity. This means that we need to consider a broader holistic view, as estuaries are dynamic over a whole range of space- and time scales and impacted by climate change (especially considering that estuaries are also very often the place where carbon-intensive industries are situated). The session featured three speakers, introducing the Humber 2100+ Strategy in the UK, the situation in the German state of Schleswig-Holstein, as well as the Interreg C5A project.

Humber 2100 Strategy (Sue Manson – UK Environment Agency) Summary

Sue Manson from the UK Environment Agency presented the Humber 2100+ Strategy, which identifies areas around the Humber estuary that could be good locations for improving flood defences, or where there are significant environmental issues, planned realignment sites, storage sites and existing defences. Six local authorities are engaged in the implementation of the Strategy through a stakeholder engagement forum which set out to develop the strategy in an adaptive fashion. It is crucial to implement the Strategy, especially since in 2013 a large tidal surge flooded 1.200 properties in the Humber, but luckily 150.000 properties were protected by existing flood measures. The Strategy focuses on 20-25 years in the future, incorporating recent sea level rise projections. Habitat creation projects, which are part of the Strategy, can be very complex and potentially unpopular among stakeholders, meaning that they require extensive engagement efforts. Stakeholders may not immediately see the need for specific interventions, so considering their concerns and clear communication both ways is key if you want to implement any flood protection or habitat creation projects.

Materials: [Presentation about the Humber 2100 Strategy by Sue Manson](#)

Questions & Answers

Q1: Is the sea level rise of 1 meter predicted for 2100+ still valid for the Humber region, considering the latest IPCC reports – and what is meant exactly with “1 meter”? Does this refer to the accelerated sea level rise?

A1: The prediction is between 0.3 and 1.15 meters for the North Sea region. It also depends on the relative ice sheet melting rates between Greenland and Antarctica, as well as things like gravity; coastal uplift on near-field; and far-field sea-level rise. The climate change allowances used in the Humber 2100+ Strategy can be found here: <https://www.gov.uk/guidance/flood-and-coastal-risk>



[projects-schemes-and-strategies-climate-change-allowances.](#) The worst-case working assumptions currently refer to 1.4 meter sea-level rise.

*Planning and implementation of a municipal coastal flood defence in the Lübeck Bight
(Jacob Hofstede - Schleswig-Holstein Ministry for Energy Transition, Agriculture,
Environment, Nature and Digitalization)
Summary*

Jacob Hofstede introduced the situation in the German state of Schleswig-Holstein, which covers 4000 km² of flood-prone coasts. The area relies heavily on the tourist economy and in 2001, there were already huge sea level rise projections, and the existing coastal flood defence (a natural beach ridge) became deficient. But of course, citizens demanded that there be adequate coastal protection against flooding. Two pilot studies were organised in response: a sensitivity analysis and an ideas competition, in order to function as a 'wake-up call' with respect to informing citizens about the challenges of accelerated sea-level rise for long-term flood safety in their living area. The citizen involvement worked really well, and citizens transformed from sceptics into advocates of a flood defence scheme that 'fits in the landscape'. Up next was an ideas competition about what this could mean in practice.

Materials: [Presentation about Schleswig-Holstein by Jacob Hofstede](#)

Questions & Answers

Q1: How successful are citizens assemblies as a stakeholder engagement tool?

A1: The sensitivity analysis was presented as a radical new tool and citizens were asked if they wanted to use it to co-design a possible flood protection measure, together with the appropriate authorities. This means that in the case of Mecklenburg-Vorpommern, citizens were given the chance to really check for themselves what would happen if you would implement different measures to try and protect against floods, with the help of specialist models.

*C5A project and the Cloud to Coast Framework (Erwin Nugraha – University of Twente)
Summary*

Erwin Nugraha from the University of Twente introduced the C5A project (or: **Cluster for Cloud to Coast Climate Change Adaptation**), which is a project that considers the urgent need for climate change adaptation, from up in the clouds, all the way down to the North Sea Region coasts. Climate change adaptation of course includes flood-resilience. Using something called the 'Cloud-to-Coast Framework', the project is building up a flood-resilient society based on an adaptive approach, systems thinking and a continuous dialogue with all relevant stakeholders (including through workshops and case studies). Through putting an emphasis on mutual learning, collaborations between stakeholders can be strengthened, so that priorities for positive change can be identified, in an effort to combat climate change and increase flood resilience.

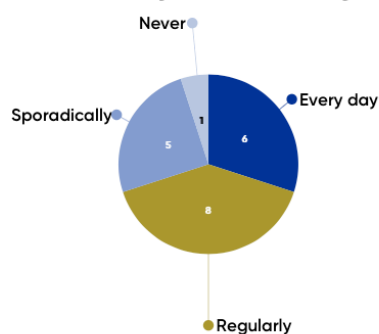
Materials: [Presentation about the C5A project and the Cloud to Coast Framework by Erwin Nugraha](#)



Session 2: Technical Modelling approaches used in solution development and testing

During this session, participants discussed how technical modelling can be applied to North Sea Region estuaries as a climate-smart tool to help develop solutions. Participants also learned more about similarities and differences in approaches of three NSR estuaries and how they deal with challenges. The session was moderated by **Frederik Roose** from the Flemish Department of Mobility and Public Works (IMMERSE Lead Partner). The session featured three speakers, presenting a regional climate adaptation investigation by use of numerical modelling in Denmark; the use of technical modelling for managed realignment in the Humber estuary; and a presentation about modelling biomorphodynamics. The main discussion topics for Session 2 included how technical models deal with uncertainties, how they can be used for discussions with stakeholders as well as how technical models can be used in decision-making processes.

How often do you use (technical) modelling results in your daily work?



Regional climate adaptation investigation by use of numerical modelling (Lotte Pedersen – Sweco Denmark) Summary

Lotte Meldgaard Pedersen from Sweco Denmark talked about how numerical modelling is used in Denmark to aid climate change adaptation and to increase flood resilience. In 2013, the storm

‘Bodil’ created a major storm surge in Denmark and caused serious damages because of floodings, with the water level reaching 2 meters high in the municipalities of Holbaek and Roskilde. Numerical modelling is now being used for the coastal regions of Denmark, based on available data from between 1979 and 2019. With numerical simulations, you can run as many as you like, for very little cost, allowing you to evaluate several options, estimate uncertainties, and include multiple parameters. However, numerical modelling is highly dependent on reliable input: ‘garbage in, garbage out’. Following up on Session 1, early involvement and the use of ambassadors can increase citizen support for the instalment of flood protection and climate change adaptation measures, and you can use numerical modelling as a convincing tool to highlight your arguments.



Materials: Presentation on regional climate adaptation investigation by use of numerical modelling by Lotte Pedersen

Questions & Answers

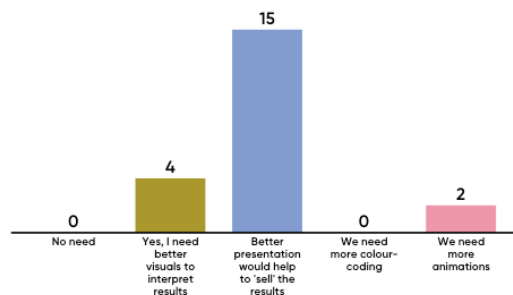
Q1: How does the model deal with uncertainties, and are some sensitivity analyses included to see how much the results would change with different input parameters?

A1: The more technical parts are calibrated against uncertainties, and the researchers are also studying the input of sea-level rise: to see what would happen if the projections would increase. It's quite striking that sometimes modelers spend more time on the **uncertainties** of the model, to **increase acceptance** of its results

Q2: Are the scenarios that the model has produced for the Isefjord and Roskildefjord, discussed with citizens and stakeholders?

A2: This is still at an early stage: initial efforts have gathered local municipalities and landowners to discuss a common regional solution to protect against future floodings, and the model is being used for these talks, but results from models alone are not enough to base a decision on.

Should modellers spend more time on the presentation of model results?



*Technical modelling for managed realignment (Lisa Harrison – University of Hull)
Summary*

Lisa Harrison from the University of Hull presented how in the Humber estuary, they are using technical modelling for managed realignment, and she explained how estuarine modelling for natural flood defence location works in practice. She also highlighted how the model could also be used as an early warning system against floodings, using 2D modelling to quickly map out flood behaviour, to see if a potential solution is viable long-term and whether it adequately considers climate change. The model has shown that managed realignment is beneficial for flood protection in some areas, but careful consideration is needed, as heavy use of soft engineering as a stand-alone measure will not provide sufficient protection against floodings. In the Humber, **2D**



modelling was effectively applied to see the effects of **storm surges** and **sea level rise**. The model **advises estuary managers which measures to apply** and their **long-term effects**.

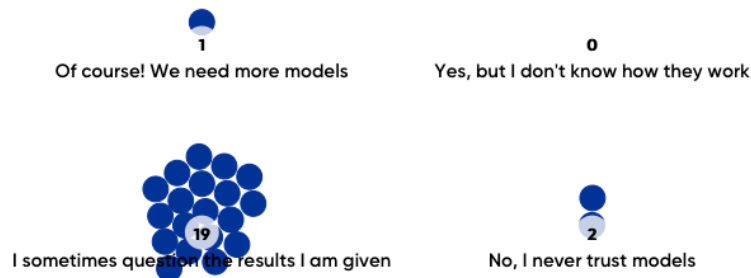
Materials: [Presentation about technical modelling for managed realignment by Lisa Harrison](#)

Questions & Answers

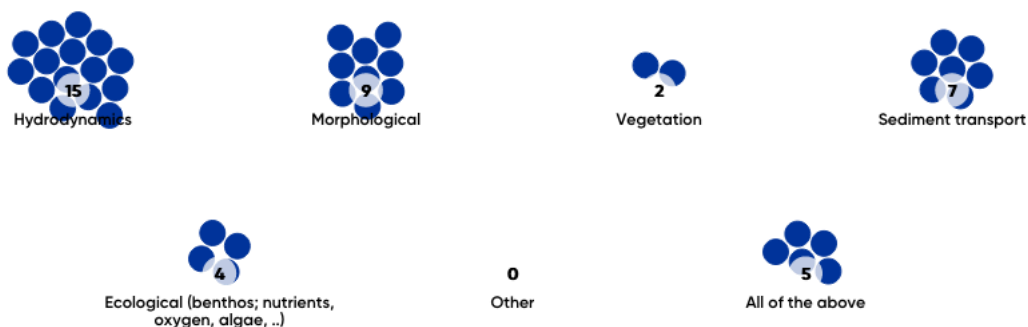
Q1: For the different scenarios produced by the model for the Humber, is there a common process with stakeholders to evaluate the different options for flood management or managed realignment?

A1: In IMMERSE, engagement with stakeholders is done to create a bridge between the science that we are doing and the information that the estuary managers and local stakeholders need to come to jointly agreed upon decisions. In the Humber estuary, the Environment Agency works together closely with stakeholders and transparent knowledge-sharing is a core value.

Are models always right? Do you trust the model results presented to you?



What kind of models do you find most useful?





Modelling biomorphodynamics (Anne Baar – University of Hull)

Summary

Anne Baar from the University of Hull presented another important application of modelling, namely for considering biomorphodynamics. Organisms that live in mud can actually alter the conditions of the environment that they live in, and vegetation modelling can show how vegetation can slow down flow velocities in estuaries. Two models were applied in the Western Scheldt in a case study, **predicting** the presence of species and vegetation. Here, the field data was compared with model results and it turned out that the model accurately predicted biomorphodynamics, and can actually also accurately track erosion rates in an estuary, which are key elements to consider in the fight against floodings.

Materials: [Presentation about modelling biomorphodynamics by Anne Baar](#)

Questions & Answers

Q1: If hydrodynamics are kind of the basis for other models: is it always a good idea to start with the hydrodynamic model, and does that mean that it is also the most useful?

A1: Morpho- and hydrodynamic models are very important, but they don't show the full picture. Often, these are the first steps, and they then can provide input for other types of models, such as ecological models. Deciding on which models to use, also depends heavily on the specific task at hand. Perhaps one should first model hydrodynamics, then sediment, and then hydrological models – and then you could also continue to research what happens in the water column, model primary production or even consider trophic relationships in ecological models. But of course, the more complex the site that you are researching, the more your models will require reliable input.

Q2: If we consider that *any* model is a simplification of reality, there will always be uncertainties. How do you present these uncertainties in your results, and how do you communicate about it?

A2: We are continuously learning how to best use the model, and actually also how to best present the results that it produces. Oftentimes, it is an informed 'current best guess', as all models will indeed always have some limitations. So, it's good to keep this in mind when interpreting the results, especially considering long-term studies.



Conclusion

The discussions from Session 1 were focused mainly on the presented regional approaches to flood risk management in the UK as well as in Germany. Participants talked about how flood risk management is or should also be focused on climate change, which comes with additional potential challenges. The topic of stakeholder engagement was also brought up, especially with regard to the use of citizen assemblies, used both in Mecklenburg-Vorpommern in Germany, as well as in the C5A project – and the Humber 2100+ Strategy also employs stakeholder management, but in different ways. **Cynthia Pauwels** from the Antwerp Port Authority summarized the discussions from Session 2. Participants agreed that what we often really want to know, is how to realize a **balanced ecosystem**. In Denmark, a regional and a local model investigated solutions against flooding. The models work well, and the goal is to gain a dynamic adaptation plan. General stakeholder engagement is important, but also challenging. In the Humber, 2D modelling was effectively applied to see the effects of storm surges and sea level rise. Benthic and vegetation organisms offer new opportunities for research pertaining the role of sediment transport and morphology changes – as a case study, two models were applied to the Western Scheldt, predicting the presence of species and vegetation. It is quite striking that modelers often spend a lot of time on the uncertainties of the model, in order to try and increase the acceptance of its results. But one should always stay aware that models often deliver informed ‘best guesses’: uncertainties should always be kept in mind, and cannot be avoided.

Participants

Ann-Margret	Strömvall	Chalmers University of Technology
Anne	Baar	University of Hull
Ben	Lamb	Tees Rivers Trust
Cecilia	De Ita	University of Hull
Christian	Ceyssens	De Vlaamse Waterweg
Cynthia	Pauwels	Port Of Antwerp
Daniel	Parsons	University of Hull
David Conrad	Konge	ENVIRONMENT SOLUTIONS
Eline	Van Malderen	MOW
Erik	Nyberg	Swedish National Road and Transport Research Institute
Erwin	Nugraha	University of Twente / C5a Project
Eva	Mathsson	Trafikkontoret, Göteborgs stad
Frederick	Bruce	s.Pro
Frederik	Roose	Department of Mobility and Public Works
Holger	Rahlf	Federal Waterways Engineering and Research Institute (BAW)



Jacobus	Hofstede	Schleswig-Holstein State Government
Jannie	Dhondt	De Vlaamse Waterweg nv
Jenny	Spear	University of Hull
Jens Rønnow	Lønholdt	LYCEUM Innovation and Process Consultancy
Jørgen	Grubbe	Holbaek Municipality
Judy	Power	Tees Rivers Trust
Karin	Karlfeldt Fedje	Chalmers/Renova
Kirsten	Wolfstein	HPA
Lisa Simone	de Grunt	s.Pro
Lisa	Harrison	EEl
Lisa	Ekström	Göteborgs Stad Stadsbyggnadskontoret
Lotte	Meldgaard	Sweco
Marta	Merino	Kystdirektoratet
Michaël	De Beukelaer-Dossche	De Vlaamse Waterweg NV
Oliver	Ries	Sweco
Per	Sørensen	Danish coastal authority
Philip Lange	Møller	Fjordgruppen
Sebastien	Rauch	Chalmers University of Technology
Steven	Kaptein	Flanders Hydraulics Research (DMOW)
Sue	Manson	Environment Agency
Victoria	Ortiz	Federal Waterways Engineering and Research Institute (BAW)