



ARSINOE

Facing floods in Southern Denmark

A Case Study in the Wadden Sea
Region in Southern Denmark



Background



Southern Denmark is a geographical region characterised by its **low-lying coastal landscapes, bustling coastal cities, and sensitive natural resources**, all of which make it particularly vulnerable to climate-related challenges. The region frequently faces **extreme weather events**, including extreme sea levels, severe storms, cloud bursts and heavy runoff occurrences, which threaten economic activities, the built environment and the natural ecosystems. These frequent events not only strain the region's infrastructure but also **endanger local communities, agricultural lands, and biodiversity**. As climate change continues to accelerate, the risk of such events intensifying has become a critical concern for long-term resilience planning. Addressing these vulnerabilities requires innovative, integrated flood management solutions to protect the region's people, economy, and natural heritage from the escalating impacts of climate change.

Key Challenges

A significant challenge facing coastal regions in southern Denmark is **ensuring effective and comprehensive flood risk management** that safeguards both citizen safety and the protection of current and future investments. With rising flood risks due to sea-level rise, storm surges, and extreme rainfall events, it is crucial to **develop strategies that protect existing infrastructure and assets** while also **preparing for future developments**. Achieving this requires the creation of robust, adaptive solutions that balance large-scale, shared flood protection measures, such as flood walls or dikes, with more localised, individualised strategies for managing extreme rainfall. To be successful, these solutions **must be supported by a broad coalition of stakeholders**, including public authorities, local communities, and civil society. Securing shared financing mechanisms and fostering widespread public engagement will be key to building long-term resilience, ensuring that both people and property are protected from the growing risks of flooding in a changing climate.





Why was this Case Study selected for ARSINOE ?

Esbjerg and part of the nearby **island of Fanø** are among the **most flood prone areas** in Denmark. A nexus of local economic activities, Esbjerg is the largest city along the south-western coast. South of the city, the landscape is **dominated by protected nature**, including the Wadden Sea, a **UNESCO World Heritage Site**. The nearby city of **Ribe** with precious cultural heritage is perhaps the oldest town in Scandinavia. Together all of these suffer concerns of water from all sides, necessitating unprecedented holistic thinking while comprising a natural testing ground for adaptation solutions.



Main Goals

The main goal of the ARSINOE project in Southern Denmark was to **build sustainable resilience** to the increasing risks posed by climate change, including multi-hazards such as flooding and its cascading impacts on both societal and natural systems. To achieve this, the project **focused on co-designing and implementing systemic solutions** that address these risks **across multiple scales and socio-economic sectors**. The approach leveraged intelligent water management, innovative technologies, nature-based solutions, and new governance models. Additionally, the project aimed to **explore and integrate innovative financing instruments** to ensure the long-term sustainability and scalability of these solutions. By doing so, ARSINOE sought to enhance the region's resilience to climate-induced flooding and other extreme events.



Expected outcomes and benefits

The expected outcomes of the ARSINOE project include the successful implementation and scaling of innovative solutions to enhance resilience to flooding in Southern Denmark. By applying a **combination of advanced water management strategies**, conventional and nature-based solutions, the project aimed to create effective, adaptable systems that can **address both immediate and long-term flood risks**. Beyond the demonstration phase, ARSINOE aims to upscale these innovations within the Southern Denmark region and, in the longer term, to apply them on a national and international scale. The broader benefits include **greater protection for communities, infrastructure, and natural resources**, as well as improved climate resilience across multiple sectors, ultimately contributing to the region's long-term sustainability and economic stability.



Methodology & Approach

Innovative solutions developed, tested and implemented

Systemic planning and the **development of local resilience pathways** were developed through a **Living Lab** process, improved digital hazard and risk assessment tools were developed, and several new solutions for community engagement were tested.

Stakeholder engagement and participatory processes

Key stakeholders representing public, private sector organisations, emergency management and the local government were engaged through the **Systems Innovation Approach**. A **novel digital platform** and a **targeted workshop** concept for engaging with local stakeholders and citizens were piloted.



Open Tender for Innovation solutions selected and used

- A flexible digital platform to support Esbjerg municipality in engaging directly with the local community;
- A novel workshop concept for creating new insights on potential collaboration and citizens' active engagement for disaster risk management;
- An AI based digital twin solution for modelling floods and their consequences in the light of climate change adaptation and disaster risk management;
- An economic damage cost assessment tool to support risk analysis and planning.

Key results & Achievements

New digital tools for flood modelling and risk assessment, including multi-sectoral economic risk assessment were developed and/or implemented and tested. The propagation of cascading failures in Esbjerg due to flooding was qualitatively explored to pave the way for the development of a comprehensive scheme beyond the lifetime of the project. Esbjerg municipality's resilience to pluvial and coastal floods was investigated through **comprehensive modelling, yielding insights on the social, economic and environmental impacts** of climate change including the value of adaptation.

Local communities and ecosystems

Stakeholder and citizen engagement has been strengthened through the introduction of new solutions, leading the way for the **future co-development of ambitious, multi-functional, and nature-based coastal protection** aimed at enhancing climate resilience to extreme storm surges while greening the city of Esbjerg. The **climate awareness among citizens and businesses** prone to flood risk in Esbjerg as well as potential local investors has increased. The potential for **citizens' engagement** in disaster risk preparedness and climate change adaptation was explored.



Lessons learned

The **Living Lab** process served to be valuable as means to **raise awareness among stakeholders and investors** from the private sector, who were previously unaware about the flood risk of their activities and the “wicked problems” the local government faces in bringing about effective solutions. Hence, the **need for more holistic and long-term thinking** was brought up (a “master” plan). The potentially **widespread consequences of flooding to infrastructure**, affecting locations beyond flooded zones, attracted a lot of attention from the authorities, which was heightened by real-life events taking place in or close to the region over the course of the project.





Replicability & Scalability

This Case Study has a very high replication potential. From the beginning of the project, Esbjerg municipality served as a frontrunner with three neighbouring municipalities in the region of interest serving as followers to ensure an immediate and high level of replicability. In turn, many of the technical innovations have already been tested not only across the region but all over Denmark with Living Lab-like processes also taking place in several locations.

Key success factors and barriers to consider

The **capacity of local governments to build climate resilience is a consideration**. In Denmark, municipalities carry the main responsibility to fund and implement climate change adaptation. Facing what in some cases pose as **unsurmountable climatic and non-climatic challenges, lack of funding, human resources and inadequate legislation** can serve as critical barriers for sustainable and climate-resilient transformation. To exemplify, just within the lifetime of the ARSINOE project, several of the follower municipalities experienced major internal reorganisation due to financial challenges with loss of key capacity. Conversely, **the actions implemented** in the Southern Denmark/Esbjerg municipality **are very timely and benefit from synergies at the national level**, including the announcement of Stage 1 of the National Climate Adaptation Plan for Denmark, the “DK2020” initiative which prompts all Danish municipalities to develop sustainable and holistic climate plans, and other initiatives.



Next steps & sustainability

Key results generated within the ARSINOE project is already contributing to climate change adaptation planning in Esbjerg municipality both in the long and shorter term, where **initially a flood wall** and eventually, towards 2050, **a wide green multi-functional “wedge” will be built** to protect the city from coastal flooding. Both planned adaptations were considered in ARSINOE, and lessons learned are expected to play an important role in their design. The **“green wedge”** will dually serve as means to increase the urban quality of life, green the city and be a focal point for preserving cultural heritage. **Several of the technical innovations developed within ARSINOE have been taken up by the municipality.**

Conclusion

The further refinement and testing of a multi-sectorial economic risk assessment tool in this Case study has gone hand-in-hand with innovations at the national scale: the tool is now jointly maintained and **available for download** via the **OS2 Open Digital Community**, formed by Danish municipalities.

In late 2024, the tool was used to carry out the first ever national-scale assessment of the cost of climate change-induced flooding in Denmark including the potential effects of climate change adaptation. In 2025, the Danish Ministry of the Environment will fund a pilot project on the cascading effects of flooding on infrastructure derived in parts from the Esbjerg Case study. Other follow-up initiatives include the **CARMINE** project funded by Horizon Europe.



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The ARSINOE consortium



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