

Coastal- and Flood Protection

Selected references

3rd of May 2023



NIRAS provides modern sustainable solutions to flood risk management and coastal protection

The wide ranging effects of climate change demand innovative solutions regarding coastal protection and flood protection.

NIRAS has established a broad level of experience in coastal engineering through the many integrated coastal projects we have implemented across the world. Coastal engineering is a complex discipline that requires extensive theoretical knowledge and genuine practical experience. Additionally, coastal engineering projects are often multidisciplinary and concern several stakeholders making it crucial to successfully manage and combine all interfaces involved.



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Optimized and tailored solutions

NIRAS stresses the importance of establishing a fundamental understanding of the natural environment and local conditions when developing sustainable solutions. We hold state-of-the-art numerical models (MIKE-software and CFD-models), GIS and 3D CAD software, which enable us to assist our clients in managing and monitoring the coastal environment as well as developing, optimizing and presenting our assessments and designs.



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We develop tailor-made solutions in close collaboration with our clients and other stakeholders, meeting the client's individual requirements. Furthermore, we have extensive experience with stakeholder meetings and collaboration with authorities.

A wide range of services

We develop our projects based on a holistic perspective often including disciplines such as surveying, environment, master planning, landscape architecture and economics to form robust and integrated solutions that provide additional recreative value. Our in-house specialists cover all required disciplines and have decades of experience in solving complex coastal challenges including:

- Integrated coastal zone and shoreline management plans (ICZM)
- Climate adaptation of coastal zones
- Coastal and marine structures including breakwaters, seawalls, revetments and offshore turbines
- Environmental impact assessment of marine constructions and dispersion of sediment and environmentally dangerous substances
- Dredging, reclamation and beach nourishment
- Coastal and waterfront development
- Sustainable solutions



Future of the North Coast of Zealand – Shoreline management plan and EIA

The North Coast of Zeeland, Denmark erodes back along most of the stretch between Hundested and Elsinore due to a general deficit in the sediment budget. Over the past 100 years extensive hard coastal protection has been constructed along more than half of the 60 km coast. The coastal protection structures helps protect the properties along the beach, but cannot mitigate the ongoing erosion problem. Despite the hard coastal protection structures, the erosion continues in front leading to undermining of the structures as the water depth increases.

NIRAS is developing a long-term sustainable shoreline management plan for the entire 60 km coast for the three municipalities Halsnæs Municipality, Gribskov Municipality and Elsinore Municipality. The study is based on extensive numerical modelling of waves, water levels, and sediment transport as well as extensive field surveys. The shoreline management plan primarily concerns large scale regionally coordinated beach nourishment at threatened properties. The nourishment scheme includes approximately 35 km of beach in total and covers all three municipalities. The nourishment strategy includes initial beach nourishment and maintenance nourishment at years interval. The beach nourishment will protect the existing coastal protection structures and properties increasing the durability of the scheme.

The shoreline management plan forms the basic guidelines for authorities future evaluation of applications from private landowners for additional coastal protection structures. The shoreline management plan defines standard cross sections for revetments and beach breakwaters that are optimized according to the beach nourishment scheme. NIRAS has made a full EIA for the beach nourishment scheme.

Year

2017 - 2025

Customer

Gribskov Kommune

Contract Fee

6,000,000 DKK

Project Category

Harbours and Marine Structures



Restoration and Climate Adaptation of Liseleje Beach, Denmark

Liseleje beach is experiencing challenges with chronic erosion, causing a retreat of the beach. As a consequence of this, the citizens have difficulties accessing the beach, as the beach has disappeared on parts of the coast. Additionally, there are challenges with acute erosion in front of the revetments and the properties during storm events.

NIRAS has on behalf of Hyllingebjerg-Liseleje Coastal Protection Association made proposals for optimisation of the existing breakwaters, in close collaboration with the client and based on the long experience and knowledge that NIRAS has within the field. The proposed optimisation of the breakwaters included changes in the structural shapes as well as an extension of selected breakwaters, with the aim of improving the structures' ability to stabilise the beach. Moreover, NIRAS made an outline proposal for the construction of four new breakwaters. Finally, NIRAS was responsible for proposals on beach nourishment, both as a part of the beach restoration and also as a continuous element in creating a sustainable coastal protection at Liseleje.

The restoration of the beach at Liseleje contributes with increased recreational value to the landowners and to the visitors of Liseleje Beach. NIRAS has additionally assisted with the permitting in relation to the design for application. The presented proposals are in agreement with the municipal strategy on the area, known as Nordkystens Fremtid. The project is thereby an example of NIRAS's ability to apply a holistic perspective when completing projects. The project is an example of strong collaboration between landowners, local stakeholders and municipality in accordance with UN's sustainable development goal no. 11: Sustainable Cities and Communities, collaborating with the aim of ensuring the access to the nature at Liseleje beach.

Year

2018 - 2020

Customer

Hyllingebjerg-Liseleje Kystbeskyttelseslag

Contract Fee

142,585 DKK

Project Category

Harbours and Marine Structures



Shoreline Management Plan for Hjørring Municipality, Denmark

NIRAS has developed a shoreline management plan for Hjørring Municipality including around 50 km exposed coast-line towards the North Sea. A number of villages along the coast are threatened by coastal erosion and over the years several houses have been lost to the sea.

The project includes site inspection and description of the coast as well as existing coastal protection structures and their effect on the coast. The assessed coast also includes the Port of Hirtshals and the impact on the sediment dynamics along the coast. A sediment budget has been developed for the coast based on analyses of historic shoreline development and existing topography to support the shore-line management plan. The project also includes a literature review of existing studies to support the assessments and recommendations. The shoreline management plan will form the background for handling future applications for coastal protection and for optimizing back-pass and bypass of dredge sediment from the port of Hirtshals and beach nourishment in general.

Year

2019 - 2020

Customer

Hjørring Kommune

Contract Fee

205,969 DKK

Project Category

Harbours and Marine Structures



Flood Protection of Korsør and Halsskov, Denmark

The Floods Directive has pointed out the urban areas of Korsør and Halsskov as in particular risk of flooding. Based on this, Slagelse Municipality chose to commence the flood protection of the area. This was done by starting three municipal joint projects in the urban areas of Halsskov together with the affected citizens. NIRAS prepared the outline proposals for each of the three sub-areas based on several citizen meetings organised by Slagelse Municipality and a hearing at the Danish Coastal Authority. The draft proposals contains construction programs as well as suggestions on distribution of contribution.

Subsequently, NIRAS has upgraded the three outline proposals to design for applications and has prepared the application for permission on construction of the coastal protection measures. This included geotechnical investigations, model calculations of the connected wave- and water level conditions on which the dimensioning ratios of the protection measures were based. Furthermore it included registration and digitalisation of the existing conditions by inspection and drone surveying, preparation of construction estimates and making of operation- and maintenance budgets and plans. Moreover, relatively detailed 3D CAD drawings of all constructions have been made. The distribution of contribution has been described and the prices for each party covering construction and maintenance have been calculated.

The prepared idea proposals, outline proposals and design for application have been based on a holistic approach especially regarding climate protection and adaptation. There has been incorporated projections on sea-level-rising, changing storm conditions as well as increased precipitation. NIRAS has focused on communicating how climate change is expected to be in order for the area to continue to be resistant towards climate change and for the citizens to live together with the nature.

Year

2019 - 2020

Customer

Slagelse Kommune - Center for Miljø, Plan og Teknik

Contract Fee

1,054,155 DKK

Project Category

Harbours and Marine Structures



International Port at Gulhifalhu, the Maldives

The capital of The Maldives is Male, which is an island with a population of over 140,000 people in approximately 2 km². The existing port of Male is the primary port in the Maldives and is used as the hub for import and general cargo to serve the local population as well as the numerous resort islands in the country. The current port is surrounded by rapid urban development which renders any expansion impossible. As such the Government of Maldives contracted NIRAS in partnership with MTBS and local consultants to lead the development of an ambitious project to relocate the primary international port to a new reclaimed island; creating much needed space for not only the port, but also further industrial development in the greater Male region.

The project consists of preparation of a detailed masterplan of the new commercial island of Gulhifalhu, encompassing the new international port, a local distribution port, residential and commercial space and associated utilities such as power, water and sewerage. As a part of the project, specifications and geotechnical investigations were made. Hydrodynamic studies were also undertaken to determine the design wave climate, future sea level rise and associated metocean parameters.

NIRAS has made the detailed design of the reclamation scheme for the new island, including the detailed design of shore- and flood protection revetments to protect the new island from extreme metocean conditions. The design of the revetments are made so that their appearance was in keeping with existing measures in the local area. The design of the port encompassed the design of all components to a level suitable for the letting of an EPC contract. A full Environmental Impact Assessment of the scheme was undertaken to identify any negative effects to the environment, as well as propose any mitigation measures. Finally, NIRAS has produced two sets of tender documents and will continue to support the client with technical assistance.

Year

2019 - 2021

Customer

Government of Maldives

Contract Fee

1,920,000 USD

Partnership

MTBS

Project Category

Harbours and Marine Structures



Coastal Protection for Five Islands in the Maldives

Ministry of National Planning and Infrastructure has on behalf of the Government of Maldives engaged Riyan and NIRAS as a sub consult for conducting detailed investigations and Design development for Coastal Protection at M.Kolhufushi, M.Mulah, M.Dhiggaru, Buruni and Vandhoo in the Maldives. These are all settlements in remote atolls in the Maldives subject to erosion, flooding and are vulnerable to climate change and sea-level rise.

NIRAS has provided detailed coastal analysis regarding existing conditions of the five islands with regards to flooding and erosion. Based on the coastal analysis NIRAS has developed feasible concepts for coastal protection schemes with regards to flooding and erosion. The analysis forms the basis for a detailed numerical modelling study of waves, water levels and currents at the islands applying MIKE 21 SW and HD.

NIRAS has modelled 20 years of regional and local waves, water levels and currents around the Maldives to determine the local design parameters at each island. The focus is particularly on the technically challenging transformation of waves over steep coral reefs. The modelling includes the fully coupled waves and currents MIKE 21 model, that has high enough resolution to cover flow over complicated coral reefs. Furthermore, NIRAS has analyzed the littoral processes including annual littoral drift and stable shoreline orientations and cross-shore transport during storms at two of the islands applying LITPACK. Finally, NIRAS has analyzed the coastal processes and the complex hydrodynamics, suggested possible coastal protection solutions, carried out detailed numerical modeling of hydrodynamics and sediment transport, and provided design parameters for the design of the final coastal protection solution.

Year

2019 - 2020

Customer

Riyan Pte. Ltd

Contract Fee

84.000 EUR

Project Category

Harbours and Marine Structures



Climate Change Vulnerability and Risk Assessment, Gambia

The beaches and the physical infrastructure of the hotels along the 1 km long Kololi Beach are highly exposed and vulnerable to the weather and climate induced hazards causing an annual erosion moving the shoreline 0.5 to 1 m landwards every year. To mitigate this erosion a coastal protection scheme was developed by NIRAS in 2015. It consists of 1 km long revetment, 4 detached beach breakwaters and 75,000 m³ of sand beach nourishment.

With the implementation of the plan, the shores are protected against further erosion, the width of the beach extended, and the risk of physical impact on the properties diminished. The scope of the project was to conduct a Vulnerability and Risk Assessment of the impact of the coastal protection scheme along Kololi Beach and adjacent beaches due to climate changes – a Climate Change Vulnerability and Risk Assessment (CVRA). As part of the CVRA numerical modelling was undertaken to assess the physical impacts from the climate changes along the project area. The physical impacts were mainly changes in erosion and accretion along the shoreline. Both the scenario without coastal protection along Kololi Beach and with the coastal protection were investigated. The analysis took the changes in wave climate into account.

Afterwards, an initial assessment of the social and economic consequences was made. The fully implemented coastal protection combined with an annual sand nourishment in the order of 3-6,000 m³ will secure the beach. Thus, the most important attractions for the tourists in Gambia is secured the next 60 years. This will mean a safe economic background for further investment and development in the area, which is in line with the Sustainable Development Goal number 11 – Sustainable cities and communities.

Year

2019 - 2020

Customer

UNDP

Contract Fee

79,000 USD

Project Category

Harbours and Marine Structures

#9

Industry, innovation
and infrastructure

#11

Sustainable cities
and communities

#13

Climate
action



Coastal and Client Consultancy in Hørsholm, Denmark

On behalf of Hørsholm Municipality, NIRAS has applied for permission for coastal protection on part of the municipality's coastline. The stretch runs from Bukkeballevvej in the south to the existing hip at Mikkelborg in the north. It only includes the municipality's own cadastres.

Rungsted Strandvej has several times been exposed to flooding from the sea during storm conditions, where wave overtopping of the current slope protection have resulted in water masses on the road. Furthermore, large parts of the stretch are exposed to erosion, which can contribute to the current coastal protection being damaged.

The desired coastal protection consists primarily of a sand feeder which is designed as a beach with a vegetated low dune landscape. The beach's function is to protect the underlying terrain from erosion and flooding. It is fed with approx. 50,000 m³ of sand on an approx. 950 m long stretch. At the southern end, the coastline will move approx. 25 m forward and at the northern end approx. 15 m forward. At the highest point, the feeding reaches up to 2.8m above the water table, corresponding to half a meter above the road.

The sand feeding affects areas covered by § 3 of the Nature Conservation Act. In order to carry out the sand claim, a dispensation for § 3 of the Nature Protection Act must be applied for. It is estimated that the salt meadow area will initially be reduced, but in the long term the area will be increased.

Year

2020 - 2023

Customer

Hørsholm Kommune - By og Miljø

Contract Fee

703.403 DKK

Project Category

Harbours and Marine Structures



Køge Dike, Denmark

NIRAS is together with LYTT composing a suggestion for Køge Dike coastal protection project for Køge Municipality. Køge Bugt has been designated as a risk area for flooding by the Danish government in accordance with the EU's flood directive. As a result Køge Municipality has initiated a coastal protection project - Køge Dike, which is to protect Køge Municipality's coastal urban areas from flooding from the sea. Køge Dike includes protection of approx. 11 km coastline, and the protection must be carried out with dikes, flood walls and flood gates.

NIRAS performs detailed design for a limited EU tender, in which consultancy for the assessment of contract tenders and contracting is also performed. The consultancy involves tender design of dikes and flood walls in nature areas where it is essential that special consideration is given to aesthetics and the landscape appearance. At the same time, the many open and closed streams must be secured with flood gates, counter flaps and pumping stations to ensure effective protection while the surface water still unhindered can flow out into Køge Bay.

The contract sum is estimated at USD 15.58 million and Køge Dike will be one of Denmark's largest flood protection projects which will protect 19,000 citizens in Køge Municipality's coastal urban areas against floods by storm surge. If the Køge area is hit by floods in the magnitude of the great storm flood from 1872, it is estimated that it could cause damage to approx. 460-780 million USD, if Køge Dike is not built.

Year

2020 - 2022

Customer

Køge Kommune - Teknik- og Miljøforvaltning

Contract Fee

3.500.000 DKK

Partnership

LYTT Architecture

Project Category

Harbours and Marine Structures



Screening of Protection Level for Flood Protection for Odense Municipality, Denmark

The coastal areas and some of the areas behind the coast along Odense Fjord and Odense Canal in Odense Municipality, are low-lying connected areas through which flooding can spread far into the land. Odense Municipality wishes to know to what protection level the individual areas and stretches of coast are protected today, in 50 years and in 80 years (year 2020, 2070 and 2100).

Furthermore, Odense Municipality wishes to know to which statistical protection level in year 2070 and 2100 the areas and stretches will be secured, provided that the terrain and flood protection measures are raised to a height of +2.5 m DVR90. A terrain-/crest height of +2.5 m DVR90 is in the latest climate adaptation plan determined as the goal for protection against sea water.

NIRAS has analysed the above using extensive GIS-analyses, making and evaluating of concurrent statistics of Odense Fjord, calculations of the hydraulic impact and the necessary crest height for all stretches for events with different return periods and different lifetimes (protection levels).

Furthermore, overall suggestions have been set up on how the areas can be protected to height +2.5 m DVR90 using different concept.

Year

2020 - 2020

Customer

Odense Kommune - By- og Kulturforvaltningen - Afd. Park og Vej

Contract Fee

74.950 DKK

Project Category

Harbours and Marine Structures



Shoreline Management Plan for Nyborg Municipality, Denmark

NIRAS has developed a shoreline management plan for Nyborg Municipality, which cover the 40 km long coastline of the municipality. The management plan forms the background for handling future applications for coastal protection along the coastline.

Along several stretches buildings are located just behind the beach. These are to a varying degree protected against erosion to day. In the future the need for protection will increase due to the climate related sea rise. There therefore exist a need for a joined plan on how Nyborg Municipality shall protect their coastal zone.

As a start NIRAS conducted an inspection of the coastline, where all physical conditions was surveyed, the conditions of the existing coastal structures was analysed and historical displacements of the shoreline was calculated in order to estimate the size of the sediment transport along the coastline. In addition to the inspection, the management plan is based on available data such as high water statistics, wave conditions, topography, and historical aerial photos and orthophotos.

Moreover, NIRAS has prepared a GIS database with all the processed data which is available for all citizens. The management plan is thereby a tool, which both can assist a citizen, who want to apply for coastal protection and it can assist the administrative procedure of the municipality.

Year

2020 - 2021

Customer

Nyborg Kommune

Contract Fee

200.000 DKK

Project Category

Harbours and Marine Structures



Environmental Impact Assessment for Coastal Protection at Enø, Denmark

NIRAS has the total consultancy for Næstved Municipality in the establishment of new flood protection of large parts of the area at Enø and Lungshave. In that connection, NIRAS has contributed with making an environmental impact assessment, including making of the Natura 2000-impact assessment in the design for application, amongst other contributions. The scenic areas of Enø and Lungshave are covered by a Natura 2000-habitat site with several priority and non-priority open and marine habitat types. Additionally, there is a number of Annex IV-species as well as other protected habitat types and species present in the area. Moreover, the construction site for the suggested flood protection has areas of cultural heritage and several areas with soil contamination, emphasizing the complexity of the area.

NIRAS has made and adjusted a technical solution, securing Enø and Lungshave by the use of floodwalls and -barriers, earth dikes as well as revetments and beach nourishment. This is done alongside ensuring and protecting the particular vulnerable habitat types and species.

An environmental impact assessment and a Natura 2000-impact assessment for flood protection of the housing of Lungshave and Enø in Næstved Municipality have been a part of the foundation for the adaptation and shaping of the final project. Consultancy in regards to the environmental impacts and the EU habitat regulations has included the making and shaping of the content for the environmental impact assessment report, visualizations for the appearance of the project in the landscape, and preparation of a report on environmental impact assessment, including Natura 2000-impact assessment. As well as continuous adjustment of main proposal of the project and its alternatives.

Year

2020 - 2022

Customer

Næstved Municipality

Contract Fee

505.000 DKK

Project Category

Nature and surfacewater; Water environment



Integrated Coastal Zone Management Plan for the North Coast of Egypt

The Enhancing Climate Change Adaptation in the North Coast and Nile Delta Regions in Egypt Project (ECCADP) aims at supporting the adaptation efforts of Egypt in the North coast and in particular the Nile Delta which is identified by the Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report as one of the world's three "extremely" vulnerable deltas in the world.

The objective of the ECCADP is to reduce coastal flooding risks in Egypt's North Coast due to the combination of projected sea level rise and more frequent and intense extreme storm events.

Output 1 focuses on constructing 69 km of sand dune dikes at five vulnerable hotspots within the Nile Delta that were identified during an engineering scoping assessment and technical feasibility study.

Output 2 focuses on the development of a climate resilient Integrated Coastal Zone Management (ICZM) plan for the entire North Coast of Egypt, to manage long-term risks including climate change.

These outputs include, but not limited to, the following: Compilation, analysis and integration of existing information of the North Coastal zone in Egypt to identify physical, ecological and socio-economic aspects, key issues and management priorities. Awareness raising material to coastal stakeholders, including, governmental authorities, public agencies, private sector, NGOs, society, etc. Assessment of the legal and institutional frameworks that govern the coastal zone in the North Coast in Egypt.

Year

2021 - 2024

Customer

UNDP Egypt

Contract Fee

2,841,146 USD

Partnership

DHI, Wageningen, EcoConServ

Project Category

Harbours and Marine Structures



Flood Protection of Hyllingeriis, Denmark

In its climate adaptation plan from 2014, Frederikssund Municipality has appointed an area around Hyllingeriis, Denmark, as in risk of flooding during events of high water level. With rising sea level and more frequent events of storm surge due to climate change, Frederikssund Municipality has requested the expertise of NIRAS to protect the area around Hyllingeriis against flooding. The area, located close by Roskilde Fjord, contains summer houses and a wastewater treatment plant.

NIRAS has made future-proof flood protection consisting of three earth dikes, two flood walls as well as an elevation of the road leading to the wastewater treatment plant. NIRAS has been in charge of the preliminary geotechnical investigations upon which the project is made. NIRAS' work is aligned with UN's sustainable development goal no. 13 on climate action, as the project contributes to making the area around Hyllingeriis more resilient in a changing climate, and thereby also ensuring peace of mind amongst local landowners.

Special for the project at Hyllingeriis is its location right by a Natura 2000-area: Roskilde Fjord and Jægerspris Nordskov, along which one of the two flood walls will be located. NIRAS has therefore made a screening assessment of the Natura 2000-area and further ensured cautious construction work of the protection measures. In that way, NIRAS has prevented substantial effects on the Natura 2000-area when flood protecting at Hyllingeriis. Furthermore, NIRAS has made the application for an Environmental Impact Assessment of the project. The considerations of nature and the environment are a part of NIRAS' work with the UN's sustainable development goals, among these no. 14 and 15: life below water and life on land.

Year

2021 - 2022

Customer

Frederikssund Kommune - Teknik, Miljø og Erhverv

Contract Fee

460,000 DKK

Project Category

Harbours and Marine Structures



Detailed Design of Revetment on Fuvahmulah, the Maldives

NIRAS is sub-consultant for MTH Højgaard in establishing coastal protection along a 2.6 km coastal stretch on Fuvahmulah, the Maldives, where the sea level rise already is very evident. Especially the Eastern side of the island is exposed to large waves due to the fetch from the South Pole. The island is located on a coral reef, and when the waves hit the reef, large amounts of water is pushed upon the reef. This can lead to flooding of the island, which is only 2 m above mean sea level at its highest point. The processes on the reef are special, which is why the project has included hydraulic model experiments to verify and adapt the numerical models as well as the design of the revetment.

The coastal protection is made to protect against erosion as well as flooding. The protection of the coastline consists of 2.6 km revetment and seawall, five staircases to access the beach, one rainwater drainage outlet as well as protection of swimming area using breakwaters.

NIRAS has made the preliminary design for tender, inspected the coastline and the existing facilities as well as made geotechnical investigations, made the outline proposal, detailed design and drawings for the contractor using CAD. Additionally, NIRAS has defined the setup for 2D physical model experiments, assisted with tests, made MIKE modelling regionally as well as locally and done CFD modelling of waves propagating across the reef.

Year

2021 - 2025

Customer

MT Højgaard Private Limited

Contract Fee

334.310 USD

Project Category

Harbours and Marine Structures



Beach Nourishment Enø Kystvej, Denmark

On the southern part of Enø is a low and coastal parking lot that also provides the access to the southernmost part of the island. This road is often flooded which won't be a problem as long as no erosion occurs. However this happens sometimes at medium-high water levels and strong water impact. Besides this the coast is also slowly moving further inwards. Through the years there has been built revetments and groynes, however these are now in bad shape and are no longer protecting the road from erosion. Since NIRAS has worked with Næstved municipal office on a larger coastal protection project nearby, where they have worked on large beach nourishments in the Autumn of 2022, Næstved municipal office wishes to expand the work to nourishment of the area close to the parking lot.

NIRAS has completed hydraulic calculations (concurrency statistics, MIKE 21, and LIT-PACK) in order to estimate how large a reduction of the wave impact on the road is necessary. Further, NIRAS has worked on a report on the design for application with suitable drawings (3D CAD), Natura 2000-evaluation of materiality (since the bay is appointed habitat nature types), application form on coastal protection and on EIA-screening.

During the summer of 2022 the application was sent and the beach nourishment is expected to be carried out during the Autumn/Winter 2022. NIRAS is drawing up the detail drawings and specifications for the entrepreneur.

Year

2022 - 2023

Customer

Næstved Kommune

Contract Fee

174,941 DKK

Project Category

Harbours and Marine Structures



Flood Protection at Eastern Kulhuse, Denmark

The eastern part of Kulhuse consists of a low lying area with holiday houses. The area has been exposed to and continue to be in risk of flooding from Roskilde Fjord. Land owners and Frederikssund Municipality have worked on a KYBL Chapter 1 project for construction of flood protection (2 km dikes) since 2014. NIRAS is making the conceptual design, design for application, drawings for application material both in regards of coastal protection and environmental assessments. NIRAS furthermore assists Frederikssund Municipality with the process until approval of the project has been granted.

The project affects 12 landowner associations and there are multiple different natural, coastal, financial and planning circumstances to be taken into account. Therefore a lot of focus is on a tight and constructive dialogue between NIRAS, Frederikssund Municipality, the Dike Association and the affected landowners. With this dialogue and the below mentioned calculations, the process of optimizing the layout of the flood protection is at present day underway.

NIRAS has made considerable GIS-analysis, bathy surveys with dGPS and assessed the hydraulic conditions using MIKE21 and LITPACK amongst other to model a storm surge in order to calculate the impact of the waves along the flood protection and to calculate the level of protection. To handle wave overtopping and drainage conditions of the area, NIRAS is analyzing reservoir areas, trenches, pipe penetrations and pumps. The project is close to a Natura 2000-area and touches upon many appointed nature protections, why NIRAS is making various EIAs. NIRAS has set up a 3D CAD model of the project and from this determines amounts, footprints and construction budget.

Year

2022 - 2022

Customer

Frederikssund Kommune - Teknik, Miljø og Erhverv

Contract Fee

492,767 DKK

Project Category

Harbours and Marine Structures



Urban Development and Climate Protection of Grenaa, Denmark

NIRAS, LYTT and Norrøn architects have won the architectural competition for urban development and climate protection of Grenå City and Harbour. NIRAS, LYTT and Norrøn architects have prepared a new innovative proposal for urban development and climate protection and of Grenå City and Harbour. The main task was to protect the lower part of Grenå City and the harbour, and secondarily to tie the town and the harbour together better. Extensive user surveys and citizen involvement have been carried out in order to explore the needs of the inhabitants and port users. Subsequently, a thorough urban development and climate protection plan was drawn up.

The main measures in the climate protection of Grenå are a rear protection, which ensures that water coming from the harbour does not penetrate into the city. This protection consists of a multifunctional barrier and a high water gate. In addition, local safeguards are made at the port, where the port's buildings are either raised or secured individually. This applies, for example, to Grenå Marina and the Kattegat Center. Securing the Kattegat Center entails special challenges as the seals in the center are not allowed to escape during storm surges. Selected channels are introduced to break the flow paths of runoff and rainwater, and to expand the maritime environment.

NIRA's role in the project is to be an active participant in the creative process of development while also being a technical advisor on all technical disciplines. The project includes new innovative approaches to climate protection of the city; including redesign of parts of the harbour that reduces wave overwash and backwater at the same time, new solutions for parking, as well as a new way of creating a connection between the city and harbour.

Year

2022 - 2023

Customer

Lytt Architecture as

Contract Fee

630,000 DKK

Partner

LYTT; NORRØN

Project Category

Harbours and Marine Structures



Strategy Plan for Climate Protection of the Coastline in Nykøbing Falster, Denmark

Historically, Nykøbing has experienced several damaging floods from Guldborgsund, and the need for climate protection along the coastline and of the urban areas along the Tingsted River is therefore increasing. The climate protection of Nykøbing is part of the project "The Cities and the Rising Sea Level", where a number of municipalities develop and implement knowledge sharing in projects related to securing Danish cities against storm surges.

NIRAS has developed a plan for flood protection of Nykøbing Falster city. The plan includes proposals for a protection line against Guldborgsund, proposals for solving flood challenges along the Tingsted River, and proposals for reducing the risk of flooding during heavy rainfall.

The plan includes a specific proposal for the placement of flood protection structures such as dikes and flood walls. The plan also includes various alternatives for several sections of the project area as well as cost estimates for the stages. In addition, a proposal for the process for the further course has been developed, including official work, political decisions, surveys, and citizen involvement.

There is a significant need for flood protection of Nykøbing Falster city today, and with the implementation of NIRAS' strategic plan for climate protection of Nykøbing, the city and its citizens will be protected against a 100-year event equivalent to 2.5 meters above daily water level, which can subsequently be expanded to 3.0 meters.

Year

2022 - 2023

Customer

Guldborgsund Kommune

Contract Fee

317.292 DKK

Project Category

Harbours and Marine Structures;
Surface water



Coastal Plan for Kerteminde Municipality, Denmark

NIRAS has developed a coastal plan for Kerteminde Municipality. Along several stretches of the coastline there is a risk of flooding, particularly in the low-lying western and northern parts of the municipality. The need for coastal protection is expected to increase with future sea level rise and changes in storm activity.

Along the coast in Kerteminde Municipality there are buildings, roads, and Natura 2000 conservation areas that need to be preserved. The current coastal protection consists of various types of hard structures. The condition of the structures varies, and the different solutions give the coast an uneven appearance. The coastal plan divides the coast into 17 sections with local recommendations for possible coastal protection measures that take into account nature conservation, near coast buildings and roads, existing coastal protection as well as expectations of erosion and flooding.

The coastal plan considers elevation maps, satellite photos and a coastal inspection. The coastal plan is based on previous and ongoing analyses in the area, and contains coastal technical information, mapping of the existing coast, and coastal cell division into different administrative units based on erosion- and flood analyses. During the project, a GIS database was created with all relevant information. NIRAS has also prepared an administrative basis for a new coastal management plan, which can form the basis for a future comprehensive plan and authority management of the coast in Kerteminde Municipality.

Year

2022 - 2023

Customer

Kerteminde Kommune

Contract Fee

202.072 DKK

Project Category

Harbours and Marine Structures



Storm Surge Protection and Climate Adaptation of Enø, Denmark

The low-lying connected islands of Enø and Lungshave near Karrebæksminde, have several times been flooded due to storm surge. The area is exposed to the sea from two sides and is therefore especially vulnerable to rising sea levels and more frequent events of storm surges.

On the request of Næstved Municipality, NIRAS is doing total consultancy on the project. In this context, NIRAS has performed a comprehensive study of the area and the complex issues that its inhabitants are facing. This includes registration and digitalisation of existing conditions, drone surveying of the terrain, geotechnical investigations and geomorphological assessment of the area. Based on the preliminary studies, NIRAS has made extensive GIS-analyses, assessed the chronic erosion along the seaside and reviewed the hydraulic conditions on all sides of the islands by analysing historical flooding and storm events as well as controlling meteorological scenarios. Additionally, NIRAS has applied its expertise in modelling of the wave impacts (MIKE LITDRIFT and LITPROF) and has set up the constructions as 3D models in CAD.

NIRAS has made a solution securing that Enø and Lungshave will be resilient in the future, in accordance with UN's Sustainable Development Goal no. 13 on Climate Action. The project area contains a Natura 2000 habitat area. NIRAS has therefore made the application for an EIA-screening and made the Environmental Impact Assessment, in order to protect the significant and preserved nature, which especially Enø offers. Thereby, the project works within the framework of UN's 14th and 15th Sustainable Development Goals: Life Below Water and Life on Land.

Year

2017 - 2020

Customer

Næstved Kommune

Contract Fee

2,175,000 DKK

Project Category

Harbours and Marine Structures



Rehabilitation of Scour Protection Apron of Peterhead South Breakwater, Scotland

The Southern breakwater of Port of Peterhead has in recent years shown signs of instability. The breakwater is a vertical wall with a rubble mound at the bed and a scour protection apron. Located on the North East coast of Scotland, facing the North Sea, the breakwater is occasionally exposed to large waves, at times exceeding wave heights of 10 m. Peterhead Port Authority fears that the signs of instability with time will affect the overall structural integrity of the breakwater. As a consequence, they have identified the need for rehabilitation of the scour protection apron.

NIRAS has been chosen to make a feasibility study of the identified repair works. Within the current status of the project, NIRAS has made historical surveys and assessments of the state of the breakwater and previous repair events, supervised surveys, assessed the current conditions of the rubble mound and apron and identified the potential cause of previous observed damages. Additionally, NIRAS have made site visits and held project meetings. Furthermore, the study makes use of extensive site data including sea level rise, thereby accounting for climate change.

Based on this, NIRAS has made a design concept for the rehabilitation of the breakwater apron. The design parameters for the apron consists of the design wave height and design water level, which the apron must be able to withstand within the estimated life time. Finally, NIRAS has proposed several solutions for rehabilitation of the scour protection apron of the breakwater. The solutions were analysed, compared and discussed, thereby mapping possible lines of action.

Year

2022 - 2023

Customer

Peterhead Port Authority

Contract Fee

105.010 GBP

Project Category

Harbours and Marine Structures