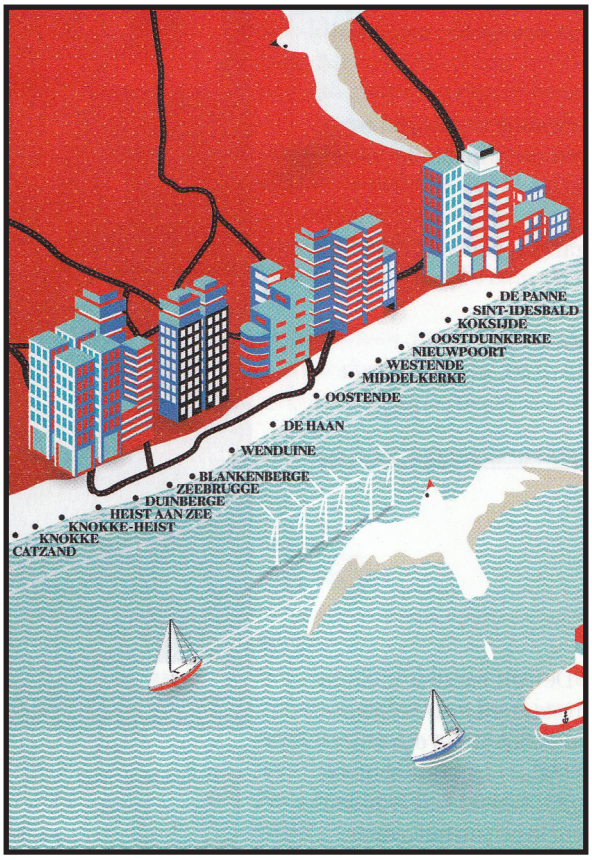
"**Politecnico di Milano**, sede piazza Leonardo, Scuola in Architettura e Società,
Master internazionale in architettura"

Moments before the sand

-De Belgische Kust-



Research- & design-thesis about the Belgian coast
from De Panne to Catzand

2012 - 2013

PROMOTER **PAOLO BELLONI**
STUDENT **ENEA FACOETTI** 770488

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“MOMENTS BEFORE THE SAND”

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RESEARCH BASED ON:

Master Plan *Kustveiligheid* / M.E.R. *Milieu Effect Rapportage* / GAUFRE / Happy Isles (West 8 & Svasek) / Vlaamse Baaien 2100 / CCASPAR *Climate Change and Changes in Climate Structures Research Project* / The Road Map 2050 (OMA) / M.U.D. *Multi User Domain* / The Future Commons 2070 (C. Geldhof) / Land & Zee 2070 (MikeViktorViktor) // Moments before the sand (own research) //

A would like to thank my promoter Paolo Belloni for his guidance and wisdom, which have constantly challenged me and enhance the way I design.

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Thanks a lot to Sybil, for her precious advices and irreplaceable translations.

“Protection against the sea cannot be seen as separated from the other tasks in the coastal zone: natural development, economic development, the development of a coast that is attractive to tourists and residents and the development of sustainable energy are the basic principles of an integrated formulation of each project for the coastal area.

Vlaams Bouwmeester. OO2404 Open Oproep.

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1.1 ABSTRACT
1.1.1 Abstract - in italian

Studi recenti hanno dimostrato che un terzo della costa Belga non sarebbe sufficientemente protetta in caso di maremoti. Pertanto è stato redatto un Piano Integrato per la Difesa Costiera (Kustveiligheidsplan). Il Piano costituisce le basi per lo sviluppo del fronte costiero lungo la costa Belga in un prossimo futuro, fino al 2050, ponendo la sicurezza della costa come obbiettivo principale.
La fase di realizzazione del Piano è stata prevista dal 2011 al 2015. Il documento è stao approvato dal governo nel 2011.
Dal 2007 al 2011 sono stati condotti studi di vario genere, uno di questi è stato lo Studio di Impatto Ambientale Milieu Effect Rapportage, portato avanti da un gruppo di esperti per il Governo Fiammingo. Secondo lo Studio di Impatto Ambientale c'erano sette strategie possibili di intervento per affrontare la questione.
Le prime cinque proponevano come intervento principale i ripascimenti di sabbia, approccio già in uso per poter riparare agli effetti dell'erosione costiera durante l'inverno. Aggiungendo sabbia la spiaggia diventa più alta con una pendenza più dolce e agisce da difesa tenendo il mare distante, secondo un "strategia meno invasiva".
La sesta strategia proponeva l'ispessimento di alcuni dei frangi onda esistenti, perpendicolari alla costa, a implementazione dei ripascimenti.
La settima invece riguardava il progetto di nuovi frangi onda, paralleli alla costa, posizionati dopo la linea della bassa marea.
Il Masterplan ha approvato i ripascimenti di sabbia come soluzione primaria. La ragione è principalmente economica. La sabbia è meno costosa e a breve termine garantisce più spiagga ai turisti.
L'ispessimento dei frangi onda potrebbe in tal senso essere ausiliario ai ripascimenti, aiutando a ridurre gli ingenti costi di manutenzione dei ripascimenti, secondo una strategia a lungo termine.

L'obbiettivo della tesi è la progettazione di un possibile ispessimento di uno dei frangi onda a Knokke Heist , al fine di garantire una migliore percezione e qualità di queste infrastrutture. E questo attraverso una superficie intermedia, che consenta l'utilizzo del bagnasciuga e la creazione di un "luogo" nel paesaggio delle maree.

1.1.2 Abstract - in english

Recent studies showed that one third of the Belgian coastline is not sufficiently protected against severe storm events. Therefore an Integrated Master Plan for Coastal Safety (Kustveiligheidsplan) has been set up which forms the basis for the development of the seafront along the Belgian coast in the nearby and distant future up till 2050, with safety against flooding as its main objective.
The achievement phase of the Master Plan was planned between 2011 and 2015. The document has been approved by the government in 2011.
From the 2007 to the 2011 several studies have been done, one of those is the M.E.R Milieu Effect Rapportage, led by a group of experts for the Flemish government.
According to the M.E.R. there were seven valid strategies to approach the matter.
The first five were dealing with the sand nourishments, approach already in use to supply at the coastal erosion during the winter. By adding sand, the beach is becoming higher, in a better slop and is keeping the sea further, according to a "soft strategy".
The sixth was the selective implementation of the existing groynes, together with the sand nourishments.
The seventh was the design of new wave breakers, parallel to the coast, at the end of the groynes.
The Masterplan is following the first strategies. The reasons are mostly economical. The sand is cheaper in a short term and provide more beaches for the tourists.
In that sense the implementation of the groynes, second strategy, may help to reduce the significant costs of maintenance of the sand, keeping the nourishments, according to a long term strategy.

The aim of the thesis is to design a possible implementation of one of the existing groynes at the sea side of Knokke Heist , in order to achieve a better quality and perception of the existing infrastructure: the design of an intermediate structures to make possible the use of the tidal landscape in the foreshore.

1.2 RESEARCH
1.2.1 introduction

The Belgian coast is situated at the southern part of the North Sea between The Netherlands and France. The coastline is 67 km long consisting mostly of sandy beaches with sea walls in front of the cities and dunes in between. There are 4 harbours at Nieuwpoort, Oostende, Blankenberge and Zeebrugge and a tidal inlet at the border with the Netherlands, called the Zwin. This small stretch of land is intensively used by different stakeholders. Aside from housing the coastline is landmarked by nature reserves, tourism and industry. Nevertheless, the low-lying polders in the hinterland form a 15 kilometer wide flood prone area of approximately 600km2 in which about 400.000 people live. This area is situated about 2 meters under the level of an average storm and without appropriate coastal protection it would flood every year.
In 2007, the Belgian Coastal Division initiated an Integrated Master Plan for Coastal Safety to provide a minimum safety standard of once in 1000 year for the entire coastline. The combined evaluation of environmental impacts, flood risk reductions and costs versus benefits supported the selection of integrated protection measures for every weak link.

1.2.2 Overlapping strategies

1.2.2.1 MASTER PLAN KUSTVEILIGHEIDSPLAN. POLICY: HOLD THE LINE 2009 - 2015 > 2050

According to the "Coastal flooding risk calculations for the Belgian coast", at the 31st International Conference on Coastal Engineering 2008 from the August - September 2008 in Hamburg a worst credible storm can result 3300 casualties, mainly on the sea defense itself, and € 6.5 billion economic damage. The harbors and the several coastal communities quay walls and dyke levels are too low, resulting in overflow and breaches during extreme storms, thus causing major flooding for dozens of kilometers land inwards.
"Locks and weirs" need special attention, as structural strengthening or an adjusted operation is needed for these structures to resist the impact of water forces during storms. The contribution of each weak link to the overall number of risks enabled to prioritize specific protection measures in the final Master Plan.
Potential protection measures, such as beach or dune nourishments, storm return walls, stilling wave basins and storm surge barriers have been selected and studied to account for their flood risk reduction, environmental impacts, costs vs. benefits, plus expert judgment for the evaluation of nonmonetary values.
The project includes the following topics:

Safety assessment: control of the actual coastal protection level: a methodology for the control of the coastal protection (dykes, dunes, beaches, harbours) has been established. Application to a 1000 and 4000 year storm event and this for current and future (2050) hydraulic conditions.

Flood risk calculations: flood risk maps for the present and future (2050) situation have been produced as a base for the Social Cost Benefit Analysis.

Solutions and alternatives: different measures and alternatives to reduce present and future flooding and flood risks are being worked out. Protection against 1.000 and 4.000 year storm events, as well as the possibilities towards a differentiated protection level will be identified by combining various 'soft' and 'hard' protection measures.

Social Cost Benefit Analysis (SCBA): the different solutions have been evaluated in a Social Cost Benefit Analysis. Costs and benefit along with possible side effects of all solutions are inventoried, quantified and evaluated to result in optimal safety levels along the Flemish coastline and the best combination of safety measures for protection against erosion and coastal flooding. Not only the technical costs and benefits are important, also social, ecological and economic impacts and especially impacts on recreation and tourism have been looked at. On the cost side, the necessary investment costs for the flood protection works have to be considered, and all necessary maintenance and operation costs during project life time approximately 50 years.

Environmental Impact Assessment (EIA): the necessity of an Environmental Impact Assessment will be investigated on two levels: the global master plan along the entire coastline and local plans, which are extracted from the global plan. Possible compensation measures are also worked out. This action has a strong interconnection with the SCBA.

Legal framework: the legislation has being evaluated to define possible gaps and needs for changes. The need for a safety decree on the Flemish coastal defense is also being studied. The juridical part aims at inventorying the license pathway for the presented measures and their implementation alternatives by offering a step-by-step guide under the form of a procedure handbook.

Master plan: two actions have been undertaken, the Comparison and analysis of existing master plans in partner countries of the Safe-coast project and the set-up of a master plan for Flanders.

Risk Management: the possible risks that may occur during the implementation of the safety measures proposed in the master plan are being analysed (budget, timing,…). For all large infrastructure projects in Flanders the decree concerning monitoring of large infrastructure projects applies. This decree has the aim to prevent or at least restrict incidents (juridical problems, exceedings of construction budget, technical problems during realisation, …) that might jeopardize the realization of the objectives for a given project. The project risk management has the following aims:

- Determination of the aims for the risk management
- Identification of the possible risks;
- Analysis of the possible risks;
- Management of the most important possible risks;

Contribution EU-project Chain of Safety: continuous technical and scientific support has been provided to the Coastal Division for the EU-project: Chain of Safety.

Communication: during the entire study different communication moments and products are developed: articles, brochures, leaflets, information sessions, public inquiry. In the course of the study special attention is given to the communication with different stakeholders and the broader public (questionnaires, presentations, brochures, digital newsletter. A poll that was organized at two coastal towns to evaluate the visual impact of possible protection measures, 300 surveys were performed by means of digital simulations. The main results were:

- most people are in favour of ‘hard’ measures;
- young people prefer larger beaches (playground for children);
- old people complain about the sand transport on the sea walls (coming from beach nourishments).

According to the alternatives raised during the four years of process they opted for a “soft strategy”. The “soft strategy” regards a intense use of the sand nourishments as a defense infrastructure tool. Aligning the slope of the beach by raising the level of sand is a valid option to keep the sea further and guaranty more m2 of sand surface for the bathing facilities.

Before to validate this choice as a long term strategy, it’s necessary to include the costs of maintenance, which are approximately one third of the total. The sand nourishments must be monitored each 6-10 years, by a commission, and eventually complemented by new addictions of sand. The Master plan expects the extraction of 20’000’000 m3 of sand from an off-shore exploration zone.

The Master plan intends to operate by 8 possible alternative measures:

1. Beach Supplementation with a low beach: the level of the beach is increased up to +7 m TAW.
2. Beach Supplementation with high beach: the level of the beach is raised to the level of the seawall. An addi
tional alternative is a maximum increase to 1 meter above the level of the seawall.
3. Beach Supplementation with a low beach combined with a dyke extension for the wave damping: the wave damping development is situated seaward, located about 1 m lower, the a width is about 10 meters.
4. Beach Supplementation with a low beach combined with low storm wall 0.6 m high.
5. Beach Supplementation with a low beach combined with a high storm wall 1.2 m high;

6. Beach Supplementation with a low beach combined with groynes,
7. Beach Supplementation with a low beach combined with breakwaters,
8. Beach Supplementation with a steep beach combined with groynes. (This measure is only applicable for the zone Knokke-Heist because of its proximity to the Appelzak pit).

The final Master plan has been approved the 10/06/2011 by the Flemish government, after the acceptance by the coastal towns involved in the maintenance interventions.
This is a list of the coastal towns and a summary of the measures:

- De Panne - (section 8): dune Supplementation.
- De Panne - center (section 13 to 18): beach supplementation with high beach.
- St. Idesbald - Koksijde Centre (Section 21 to 31): beach supplementation with high beach beach.
- Koksijde (section 39): Raising the dunes through the passage in conjunction with the road reconstruction.
- The Newport Harbor Building flood barrier.
- Middelkerke – Westend (Section 74 to 88): beach supplementation with low beach combined with storm wall seaward of casino.
- Raversijde - Wellington Ostend (Section 97 to 108): beach supplementation with low beach combined with high storm wall or custom seawall slope.
- Ostend center (section 109 to 117) + Port of Ostend Ostend + East (section 118 to 120): “O.W. plan”: the Master plan for the entrance of the harbor of Oostende with the extension of the wave breakers.
- Ostend - East (section 121): beach supplementation in connection with the “O.W. plan”, a sub-plan for integrated coastal zone management of Oosteroever (section 119 and 120).
- De Haan-Wenduine (section 172 to 176): beach supplementation with low beach from west to east, combined with storm roundabout and parapet wall on embankment.
- Haven Blankenberge: construction storm wall at +8 m TAW combined with anti-erosion slope around the port.
- Blankenberge (section 185 to 195): beach supplementationwith low beach.
- Port of Zeebrugge: construction storm wall at +8 m TAW around Prince Albert dock and following locks in combination with an anti-erosion slope around port.
- Knokke-Heist (section 225 to 243): beach Supplementation (profile between steep and low beach).
- The Zwin (nature reserve) section 250 to 255): Zwin Project.
- Ports of Blankenberge, Ostend and Zeebrugge: Renovation dams and locks.

The association which cooperate for the Master plan elaboration are:

- MDK Maritieme Dienstverlening en Kust: the Agency for Maritime and Coastal Services (MDK) of the Flemish government, ensuring safe and efficient shipping to and from the Flemish ports. They are responsible for the security of the Flemish coast from flooding and strive for an integrated and sustainable management of the coastal zone.
- Afdeling Kust :the Coastal Division is part of the Agency for Maritime and Coastal Services, which falls under the Flemish Ministry of Mobility and Public Works.
- Waterboukundig Laboratorium: the Hydraulic Laboratory is an expertise that scientific research into the effects of water in motion. They investigate the impact of human activity and the nature of water and its implications for shipping and for water-related infrastructure.
- Universiteit Gent: Ghent University, abbreviated to UGent, is one of the major universities in the Dutch-speaking region.

- Vito Vision on Technology: As independent and customer-oriented research organisation, VITO provides innovative technological solutions as well as scientifically based advice and support in order to stimulate sustainable development and reinforce the economic and social fabric of Flanders.
- IMDC International Marine & Dredging Consultants: International Marine and Dredging Consultants (IMDC) is an engineering and consultancy company specialised in a vast range of water related projects.
- TRITEL: multidisciplinary engineering and consultancy provider . Their services include project management, studies, design and consultancy in buildings, port and hydraulic engineering, transport infrastructure , urban development and strategic consultancy and analysis.
- CIBE communicatie: The Hydraulic Laboratory is an expertise that scientific research into the effects of water in motion. We investigate the impact of human activity and the nature of water and its implications for shipping and for water-related infrastructure.
- Pantarein publishing: Publications Office for government and business.

1.2.2.2 M.E.R. MILIEU EFFECT RAPPORTAGE ENVIRONMENTAL IMPACT ASSESSMENT 2007 - 2009 > 2050

The M.E.R is a research group requested by the Master plan commission, based on the collaboration of several experts from different disciplines, guided by a coordinator, meant to address the whole amount of studies in the same out-put. The aim of the research group was to rise an analysis of the coast problems, and according to the “hold the line” policy, try to find the weaknesses of the existing dijk.
At the end the group have proposed several alternatives to re-establish the necessary defense infrastructures.
The research was going to define isn detail the necessary implementations, both considering soft and hard coastal defense infrastructures.
The document displays possible solutions, considering both the kind of interventions, the periods of realization, the costs, the effects from the environmental, and social point of view.
The M.E.R. shows apparently three main possible actions: the sand nourishments, the groynes rising and the new wave breakers realization. Both of them are explained precisely through schematic sections, descriptions of the choices of the maintenance interventions.
The proposals, raised up by the M.E.R in 2009, has been the framework of the Master plan Kustveiligheidsplan.

The following list is about the “warning zones” and not along the beaches of the Flemish coast. In the condiction of a 1000-year storm and taking into account 30 cm sea level rise by 2050:

- De Panne (1 – 18 section 8, section 13 en section 15 to 18): assestment uncertain.
- Koksijde St. Idesbald (19 - 25 section 21 to 25): warning zone.
- Koksijde (26 - 39 section 26, 31 end 39): warning zone.
- Oostduinkerke (40 - 54 no warning zone): warning zone.
- Nieuwpoort (55 - 59): no warning zone and on going maintenance operations.
- Middelkerke Lombardsijde (60 - 73): no warning zone.
- Westende (74 - 78 section 74 to 78): warning zone.
- De Krokodille (79 - 82 section 80 to 82): warning zone.
- Middelkerke (83 - 92 sections 83 to 88): warning zone.
- Oostende Raversijde (93 -102 section 97 to 100): warning zone.
- Mariakerke (103-105 section 103 to 105): warning zone.
- Oostende Wellington (106 – 108 section 106 to 108): warning zone.
- Oostende Centrum (109 - 117 section 109 to 117): separate study development.
- Oostende Oost (118 - 121 section 121): warning zone.
- Bredene Bredene (122 - 131): no warning zone.
- De Haan Hippodroom-Vosseslag (132 - 145): no warning zone.
- De Haan (146 - 155): no warning zone.
- Vlissegem - Nieuwmunster (156 - 167): no warning zone.
- Wenduine (168 - 184 section 172 to 176): warning zone.
- Blankenberge (185 - 195 section 185 to 187, 189, 190, 192 end 193): warning zone.
- Fonteintjes (196 - 210): no warning zone.
- Brugge Zeebrugge (211 - 216): no warning zone.
- Knokke-Heist Heist (217 – 221): no warning zone.
- Duinbergen (222 - 226 section 225): warning zone.
- Albertstrand (227 -232): no warning zone.
- Knokke - Zoute (233 - 241 section 233 to 237 end 239 to 241): warning zone.
- Lekkerbek (242 - 249 section 242 end 243): warning zone.
- Zwin (250 – 255) : no warning zone and separate study development.

M.E.R. Chapter 9. Representation Of The Studied Alternatives

In this chapter all alternatives on the MER-plan are studied for three types of environment: 1) bathing areas, 2) dunes
3) harbors. Seven standard alternatives are studied for these three environmental types.

1. Sand-nourishment (low beach profile)
2. Sand-nourishment (high beach profile)
3. Sand-nourishment with wave smoothing extention
4. Sand-nourishment with low wall (60cm)
5. Sand-nourishment with higher wall (120cm)
6. Sand-nourishment with strandhoofden, groynes
7. Sand-nourishment with golfbrekers, wave-breakers

The paragraph “9.1.7” , “ALTERNATIVE 6” displays the alternative of sand-nourishment with strandhoofden, groynes. For the alternative with sand-nourishment and groynes, in general they considered a low beach-profile, (grain-diameter nourish-sand: 300 mu), whereby groynes are placed transverse to the waterline to avoid erosion. The top of a groyne is typically 1m above the sand and changes from just above the water-level to just under it in an ideal situation. The level of the sand is constantly varying because of different reasons:

1. Summer-winter: there is a lower level in winter and higher in summer.
2. Frequency for the need to restore: The more frequent the profile of the sand will be restored, the less it will vary in time. After restoration the sand is higher and the groynes are jutting out less above the sand. When there is again erosion, the level-difference rises and the groynes will become more effective again.

3. The groyne is a more rough action compared to the supplementation. Because of this, the rise of the sea-level (30cm) within 50 years is kept in mind by designing. When the sea-level rises, the profile of the groyne will need to be adapted as well in hight, for sefety reasons. Because of this, the level of the sand will always become higher in time and the hight of the groyne lower. The location-specific alternative per city will be described underneath, for some cities there will be some extra rules necessary.

The location-specific alternative per city is described underneath, for some cities there will be some extra rules necessary.

1. De Panne (centre)

In this area, there is only mere erosion, so it wouldn’t be useful to foresee groynes. That’s why the alternative for De Panne (centre) will not be considered.

2. St-Idesbald - Koksijde (centre)

Also in this area there is mere erosion, so it wouldn’t be useful to foresee groynes. That’s why also the alternative for St-Idesbald will not be considered.

3. Middelkerke-Westende (section 74 to 88)

Taking into account the sea-level-rise and inclusive buffer for 10 years, the sand-level will rise 1m compared to the minimum profile. The existing groynes in Middelkerke-Westernde could be rised, so they are adapted to the new situation in this alternative. The groyne has a length of 325 to 350m + 50m (inclusive buffer and sea level-rise) and the height will differ from the dike up to -2m. The groyne will be built above the existing groyne, on the rotunda. The groynes starts at the dike and the height goes up to -2m. The length will be 350m. The groyne will always be 1m above the (additional) sand. There will be 50m extra length and 1m extra height at the crown,

taking the sea level-rising and the maintenance-buffer into account.
When the crown would be raised with 2m height over 10m length, there would be 7000m³ stones necessary per groyne. To rise all 14 groynes, 100 000m³ will be necessary. The groynes are designed, taking the storm-conditions over the next 50 years in account (inclusive sea level-rise). In case of extreme-storms there will be damage.

4. Raversijde - Oostende Wellington (section 97 to 117)

According to the minimal required sand profile for Raversijde-Wellington, keeping the sea level-rise and buffer for 10 year into account, the sand will rise 1m above the minimum profile. The groynes at Reversijde-Oostende Wellington have a length of 375 to 400m + 50m inclusive buffer and sea level-rise and the height differs from the dike up to -2m in height. The groynes will be built on the 10 existing groynes but not between the sections 99-100 and between 101-102, in stead they will be built between 100 and 101. The presence of the groynes at the sections 100-101 and 102-103 make the transitional added sand on dune-sections 101 and 102 superfluous. Because of this, 350 000m³ sand can be saved. When the crown would be 2m higher over 10m length, 8000m³ stones would be necessary per groyne. To rise all 10 groynes, 80 000m³ stones would be necessary. The groynes are designed to maintain in 50 years of storm conditions (inclusive sea level-rise) because they are meant to function under normal circumstances. In case of extreme weather conditions there could be damage.

5. Wenduine (section 172 to 176)

Each of the sand-nourishments (weather or not in combination with walls or wave-smoothing extension at the dike) at Wenduine, will be done in combination with a groyne at the rotunda. The main purpose of the groyne is reducing the erosion of the sand at the rotunda (where also the bending of the coast-line is situated). Another advantage of this groyne is that the sand only in the centre of Wenduine needs to be nourished and not in the West of the rotunda. These rules are meant specifically for the places where safety needs to be better. The minimal required sand-profile at the height of Wenduine is described in the alternatives. According to these profiles the sand will be 1m above the minimum profile. The groyne at Wenduine has a length of 325 to 350m + 50m inclusive buffer and sea level-rising. The height differs from the dike up to -2m. The groyne will be built on top of the existing groyne at the rotunda, in this way the contact with the sea on the rotunda can be maintained on the West side, which is important for fishermen. It's important to know that additional safety matters (for ex. walls, wave-smoothing extensions of the dike,...) will be necessary at the rotunda to keep the overtopping discharge small enough and to avoid gap formation. As mentioned earlier, also here additional safety-matters at the rotunda are taken into account. The groynes start at the dike and goes up to -2m height. The length will be 350m. The groyne will be up to 1m above the nourished sand. Also there will be 50m extra length and 1m extra height at the crown to keep the sea level-rise and the maintenance buffer into account. When the crown would be 2m large, the height of the groyne 4m (partly under the level of the sand) and the slope would have a ratio of 1:2, 6500m³ stones will be necessary for the construction. One should notice the sand on the west-side of the groyne will be lower than the sand on the east-side (which will be nourished). The groynes are designed to maintain 50 years in storm conditions.(inclusive sea level-rise) because they are meant to function under normal circumstances. In case of extreme weather conditions there could be damage.

Additional safety-rules rotunda:

When (a part of) the rotunda in Wenduine wouldn't be nourished with sand, there are, as mentioned earlier, safety-rules necessary at the rotunda for all the alternatives, to limit the overtopping discharge towards the inland. So, these are the additional safety-rules at the rotunda in Wenduine which are also described in previous chapters. The safety rules subscribed in this paragraph are necessary in case there would be a new groyne built and when the sand wouldn't

be nourished at the west side of the groyne (section 172). In section 173 a limited nourishment is proposed (with walls of 120cm at the dike in the centre, so this is the smallest nourishment of all the alternatives). So the proposed safety-matters are also applicable for the alternatives without groyne, and in these cases they will even foresee a higher safety. Since the additional safety-matters consider hard constructions, the sea level-rise within 50 years will be considered.
In front of the rotunda there are two different profiles visible: at the west side, the level of the dike is 9,5m, at the east side the level is 8,7m. The slope of the dike is the same on both sides. The proposed location for the built of a new (longer and higher) groyne will be on top of the existing groyne, at the east side of the rotunda. A lower part of the profile will be without sand nourishment. Overtopping discharges on this location could run from the square towards the inland in case of emergency. On the rotunda, however, there is already a windshield present. Constructing a wall with a height of 11,7m (thus 2,2 - 3m above the top of the dike (material: bluestone)) suffices to reduce the overtopping discharge (Q<1l/m/s with 'a 1000 year storm', inclusive sealevel-rise).
Therefore the reinforcement of the windshield is proposed and if necessary the construction can be increased. Another possibility is to apply this safety-rule further towards the inland for example on or under the existing parking. Even when the windshield is strong enough (or when it's reinforced to resist to the impact of the waves), there are some points of attention. A first point is the transition between the rotunda and the dunes in the west. In this case there is no windshield, only a lower precipitous passage. There should be a wall constructed or this passage could be increased locally, in order to keep the overtopping discharge under control. With safety-rules above the Wielingen-swimming pool is not explicitly protected (no living area). Besides the construction of one groyne to limit the volume, also more groyne could be constructed, like in the other bathing areas, to limit the maintenance.

6. Blankenberge (section 185 to 195)

Also for the city Blankenberge the alternative with groynes is proposed, because the existing groynes will disappear under the proposed sand-nourishment decreasing in the effectiveness. In the current situation, the groynes are only working on 4 places: on the border between section 185 and 186, in section 187, in section 188 and in section 193. Since there will not be sand-nourishment at the groyne in section 193, there will be necessary any adaption. In section 186 the sand nourishment will be maximum 1m above the existing sand, in sections 187 and 188 only 0,5m.
Taking the expected sea level-rise and the necessary sand-buffer between two maintenances into account, these groynes could be increased with 1,5 (section 187 and 188) to 2m (section 186). In this way the groynes will still be working after the sea level-rise and the sand-nourishment. Next to the east-pier there is now a low dam, at the same height as the existing sand level. Because the nourishment can be up to 1,5m on this place also the dam/groyne should be raised to prevent the sand from going into the channel. Keeping the buffer and sea level-rising into account, a rise of 2,5m will be necessary. The length of the groynes varies between 330 and 360m. They start at the dry-sand and go up to -1 or -2m height. When the crown of 10m (large), and a length of 360m would be raised with 2m, 7000 m³ of stones would be necessary per groyne. To increase all 4 of the groynes, about 29 000 m³ of stones would be
required. The groynes are designed for 50 year storming conditions (inclusive se alevel-rise) because they are meant to function under normal circumstances. With extreme weather conditions, there could possibly be damage.

7. Knokke-Heist (section 225 to 243)

The presence of the existing groynes in Knokke-Heist are keeping 'de Appelzak' away from the coast and they keep the sand in front of the dike as well. The current beach has a steep profile, also under the low tide waterline. When the sand would be nourished according to the beach

profile of the steep sand more or less the same slope as the current profile will be maintained, but it will be situated more in the direction of the sea. When the groynes will be constructed on the same way as the current groynes (first nourishment, than the groyne on top of it), the enlargement and rise of the existing 11 groynes in Knokke-Heist could be a possible strategy.
Since the outlines move in the direction of the sea, because of the sand nourishment, the groyne needs to be extended towards the sea as well. When the existing configuration of groynes and a steep beach could be used for the new beach as well, the existing groynes should be increased. When a groyne of 350m length and 10m width would be raised with 2m (because of the nourishment, the buffer and the sea level-raise), 7000 m³ of stones would be necessary for the construction. To built all 11 groynes in the nourished area, 80 000 m³ stones would be necessary.

The paragraph “9.1.8” , “ALTERNATIVE 7” displays the alternative of sand-nourishment with golfbrekers, wave-breakers. In general it’s maintained a low beach-profile (grain-diameter nourish-sand: 300 mu), whereby wave-breakers off shore parallel to the coastline and as high as the water-level will be built to limit erosion. Underneath the result of the basic-alternative is presented per city, for some locations specific safety rules are described.

1. De Panne (centre)

Because of the limited erosion in this area it would not be useful to foresee wave-breakers. Therefore this alternative will not be studies for De Panne.

2. St-Idesbald - Koksijde (centre)

Because of the limited erosion in this area it would not be useful to foresee wave-breakers. Therefore this alternative will not be studies for St-Idesbald-Koksijde (centre).

3. Middelkerke - Westende (section 74 to 88)

Also the offshore wave-breakers in Middelkerke-Westende will need to be combined with one of the sand-nourishments alternatives for the required safety-level. The offshore wave-breakers need to diminish erosion in Middelkerke under normal circumstances. Because the crown of these wave-breakers is at the same level of the high tide waterline, these structures don’t suffice to give enough protection also under extreme weather conditions. The weave-breakers will look as follows:

- Position on a depth of -5m
- Distance to the shore: 470 -550m from the dike
- Length: 250m
- Distance in between two wave-breakers: 200m
- Height top: 5m
- Width: 5m
- Slope: 45°

The section of the wave-breakers for Middelkerke is presented in combination with the sand nourishment on the low beach. For this type of wave-breakers 38 000 m³ will be necessary per wave-breaker. For the 11 suggested wavebreakers in Midderlkerke-Westende an amount of 418 000 m³ stones will be needed. The wave-breakers will be designed for 50 years of storm-conditions (inclusive sea level-rising) because they are meant to function under normal circumstances. In case of extreme weather-conditions there could be damage.

4. Raversijde - Oostende Wellington (section 97 to 117)

Also the offshore wave-breakers in Raversijde-Wellington need to be combined c. The off-

shore wave-breakers need to diminish the erosion in Middelkerke under normal circumstances. Because the crown of the wave- breaker is at the same level of the high water, these structures won't suffice to give enough protection under extreme weather conditions. The wave-breakers will look as follows:

- Position on a depth of -5m
- Distance to the shore: 500 -550m from the dike
- Length: 250m
- Distance in between two wave-breakers: 200m
- Hight top: 5m
- Width: 5m
- Slope: 45°

For this type of wave-breakers 38 000 m³ will be necessary per wave-breaker. For the 8 suggested wavebreakers this would be an amount of 304 000 m³ stones will be needed. The wave-breakers will be designed for 50 years of storm-conditions (inclusive sea level-rising) because they are meant to function under normal circumstances. In case of extreme weather-conditions there could be damage.

5. Wenduine (secion 172 to 176)

Also the offshore wave-breakers in Wenduine need to be combined with one of the sand-nourishments alternatives for the required safety-level. The offshore wave-breakers need to diminish the erosion in Wenduine under normal circumstances. Because the crown of the wave-breaker is at the same level of the high water, these structures won't suffice to give enough protection under extreme weather conditions. The wave-breakers will look as follows:

- Position on a depth of -5m
- Distance to the shore: 470 -550m from the dike
- Length: 250m
- Distance in between two wave-breakers: 200m
- Hight top: 5m
- Width: 5m
- Slope: 45°

For this type of wave-breakers 38 000 m³ will be necessary per wave-breaker. For the 3 suggested wave breakers in Wenduine this would be an amount of 114 000 m³ stones will be needed. The wave-breakers will be designed for 50 years of storm-conditions (inclusive sea level-rising) because they are meant to function under normal circumstances. In case of extreme weather-conditions there could be damage.

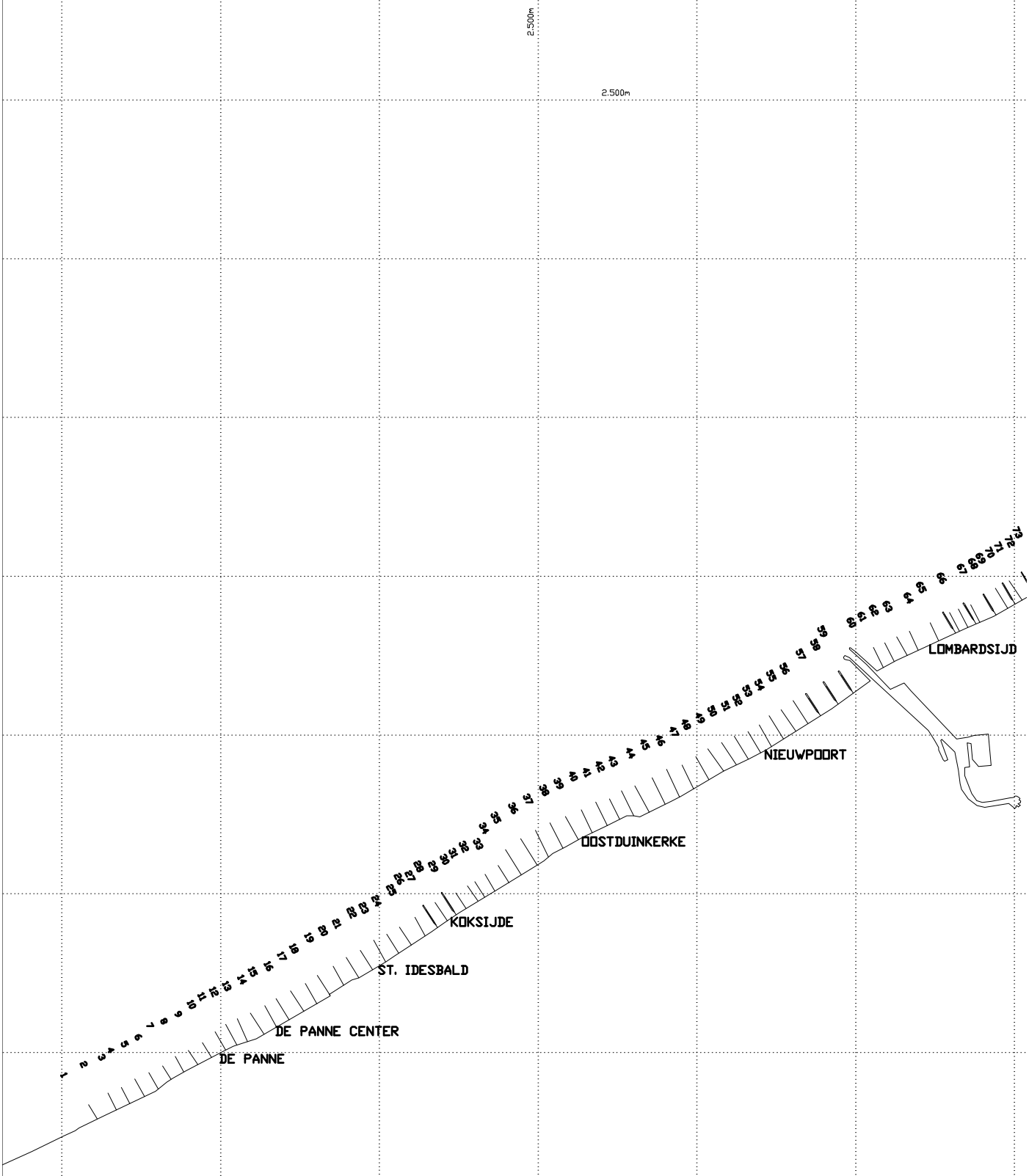
6. Blankenberge (section 185 to 195)

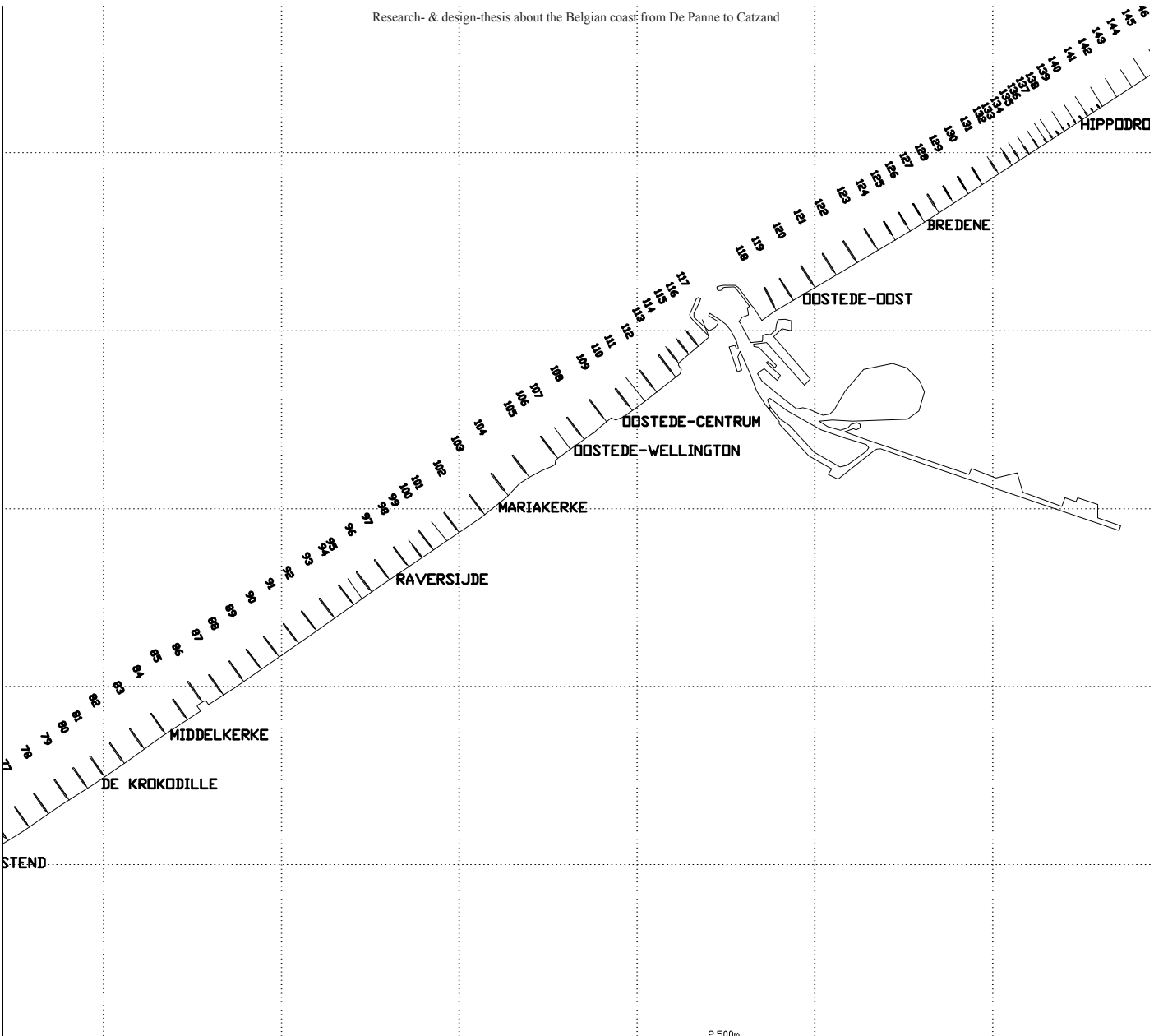
Offshore wave-breakers will not be considered in Blankenberge, because of the limited amount of problems at the attention-points and the positions close to the harbor-entrance. To built offshore wave-breakers close to the harbor-entrance would diminish the accessibility, which wouldn't be eligible.

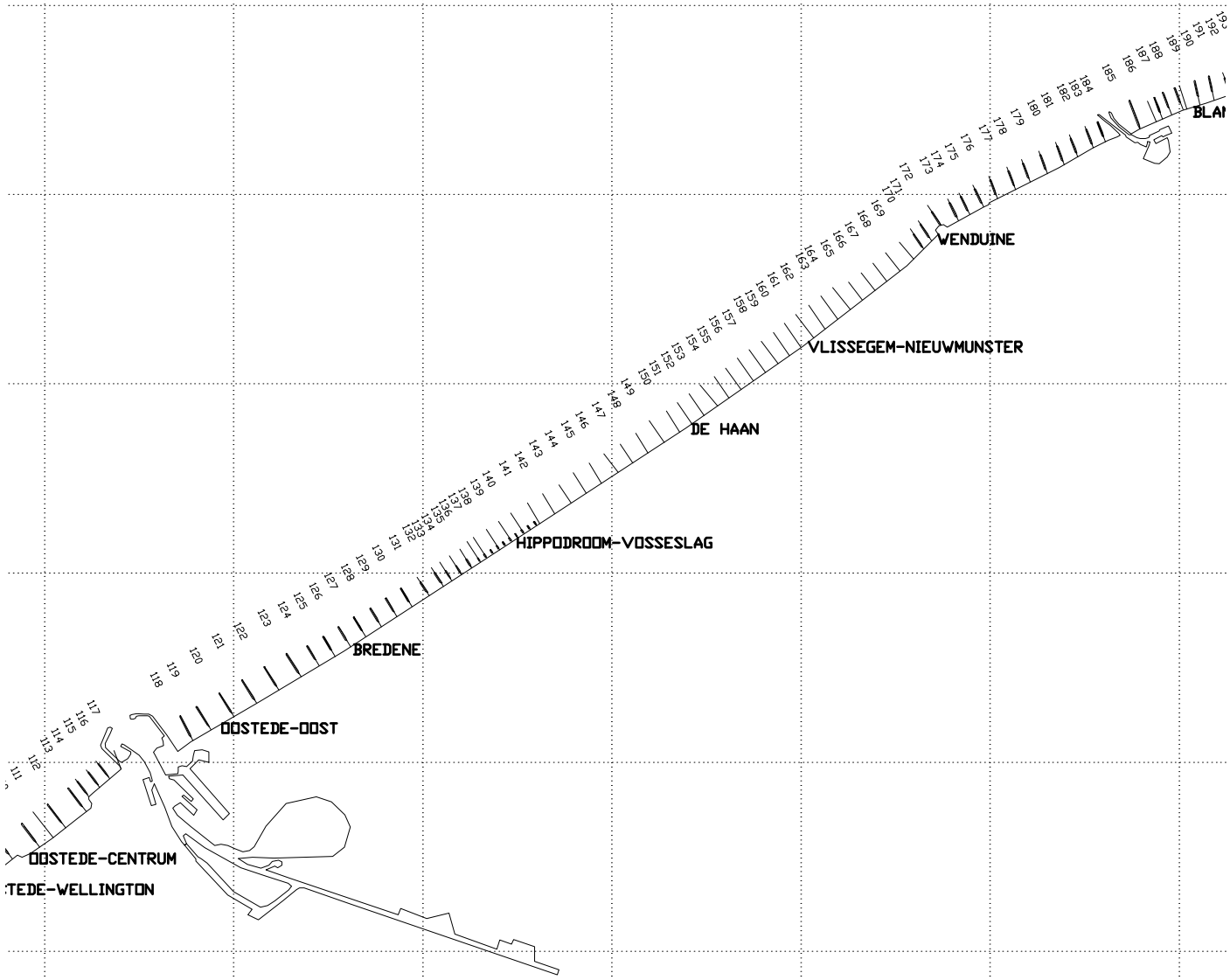
7. Knokke-Heist (section 225-243)

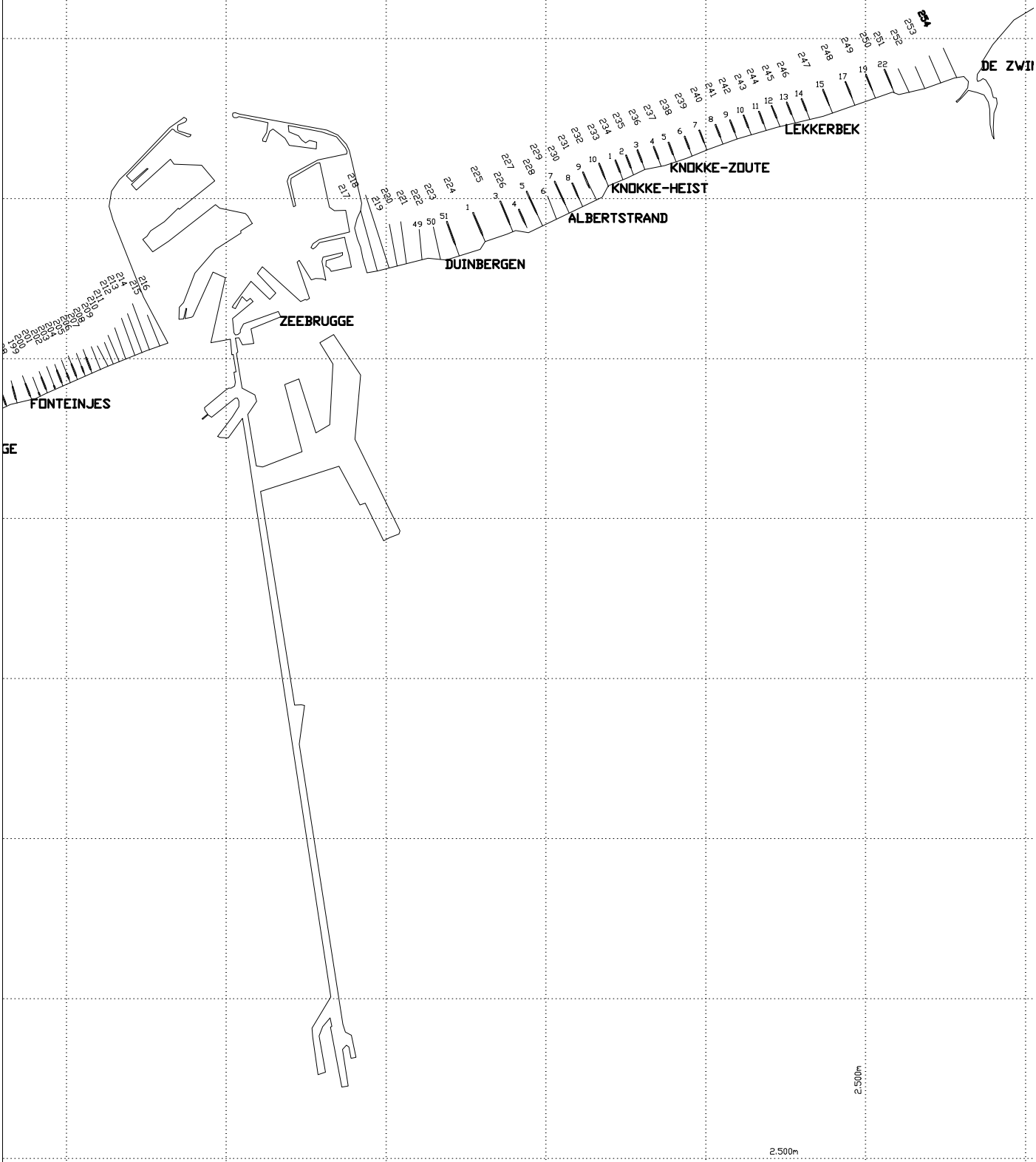
The offshore wave-breakers in Knokke-Heist need to be combined with one of the sand-nourishments alternatives for the required safety-level. The wave-breakers will need to protect the beach under normal circumstances, whereby erosion will be diminished. In this way maintenance can be reduced. Because the crown of the wave-breaker is at the same level of the high tide water-

COASTLINE WITH THE SECTIONS DESCRIPTION

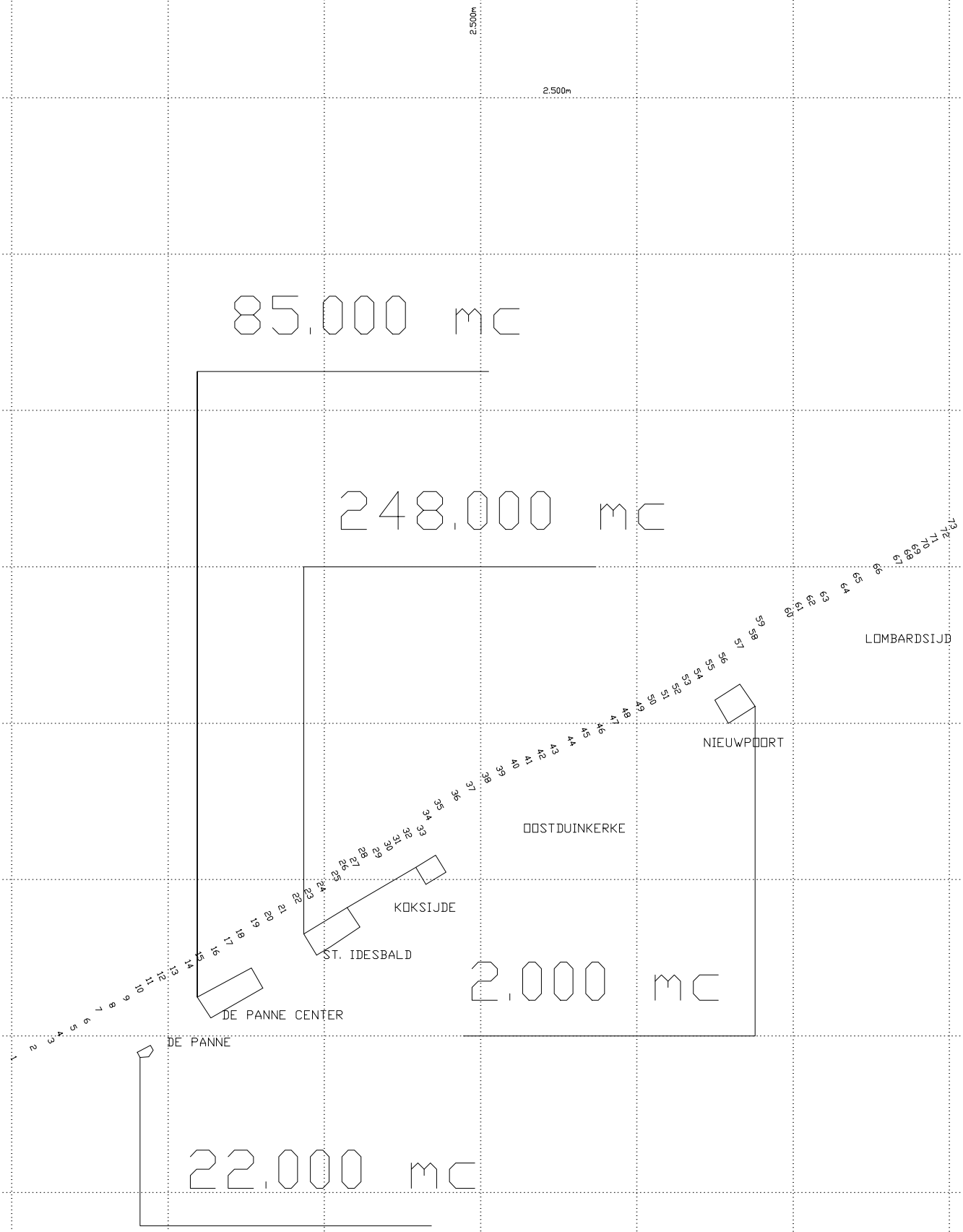


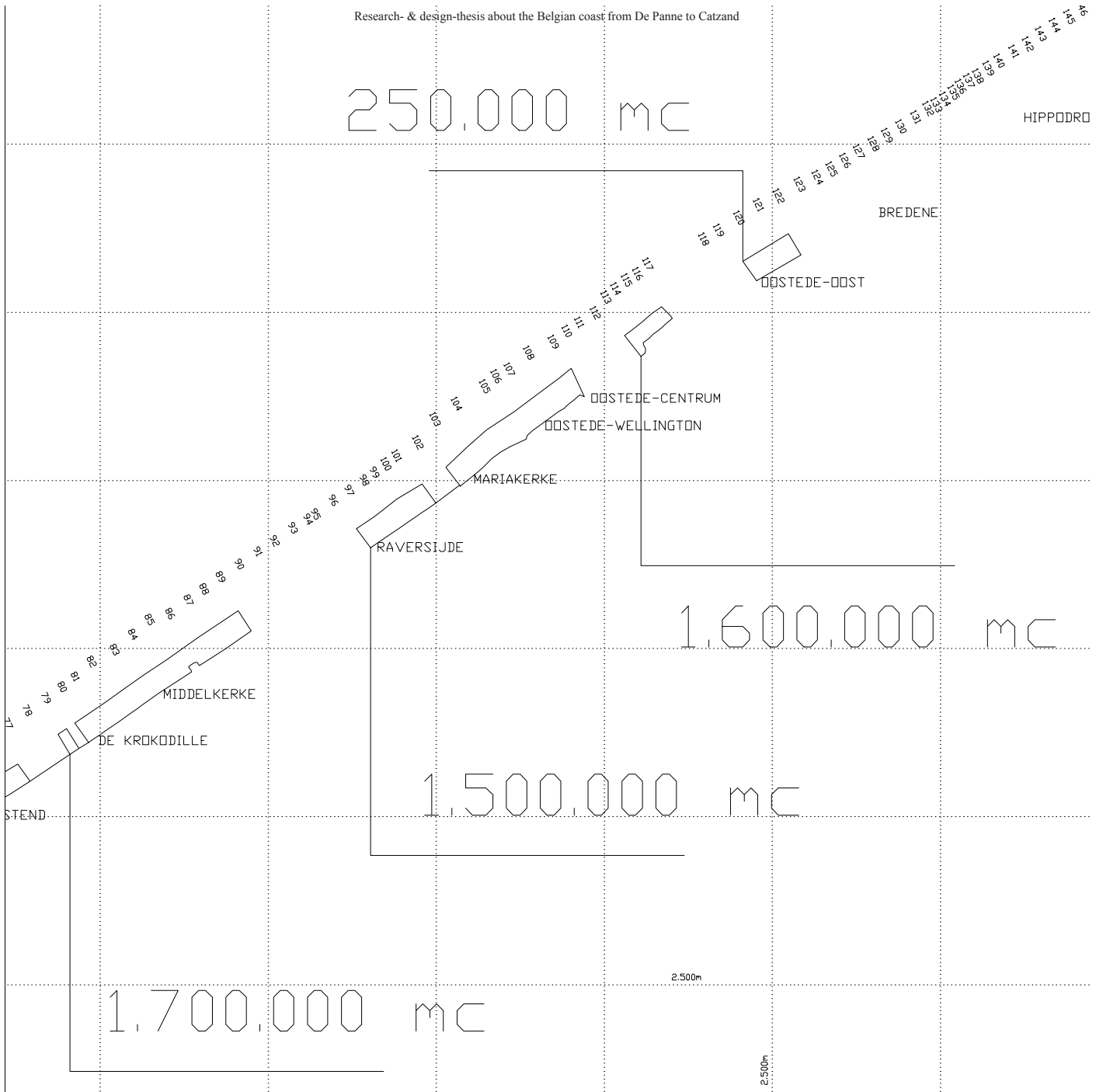

HIPPODRO
BREDENE
OOSTEDE-OOST
OOSTEDE-CENTRUM
OOSTEDE-WELLINGTON
MARIAKERKE
RAVERSIJDE
MIDDELKERKE
DE KROKODILLE
STEND
2.500m
2.500m

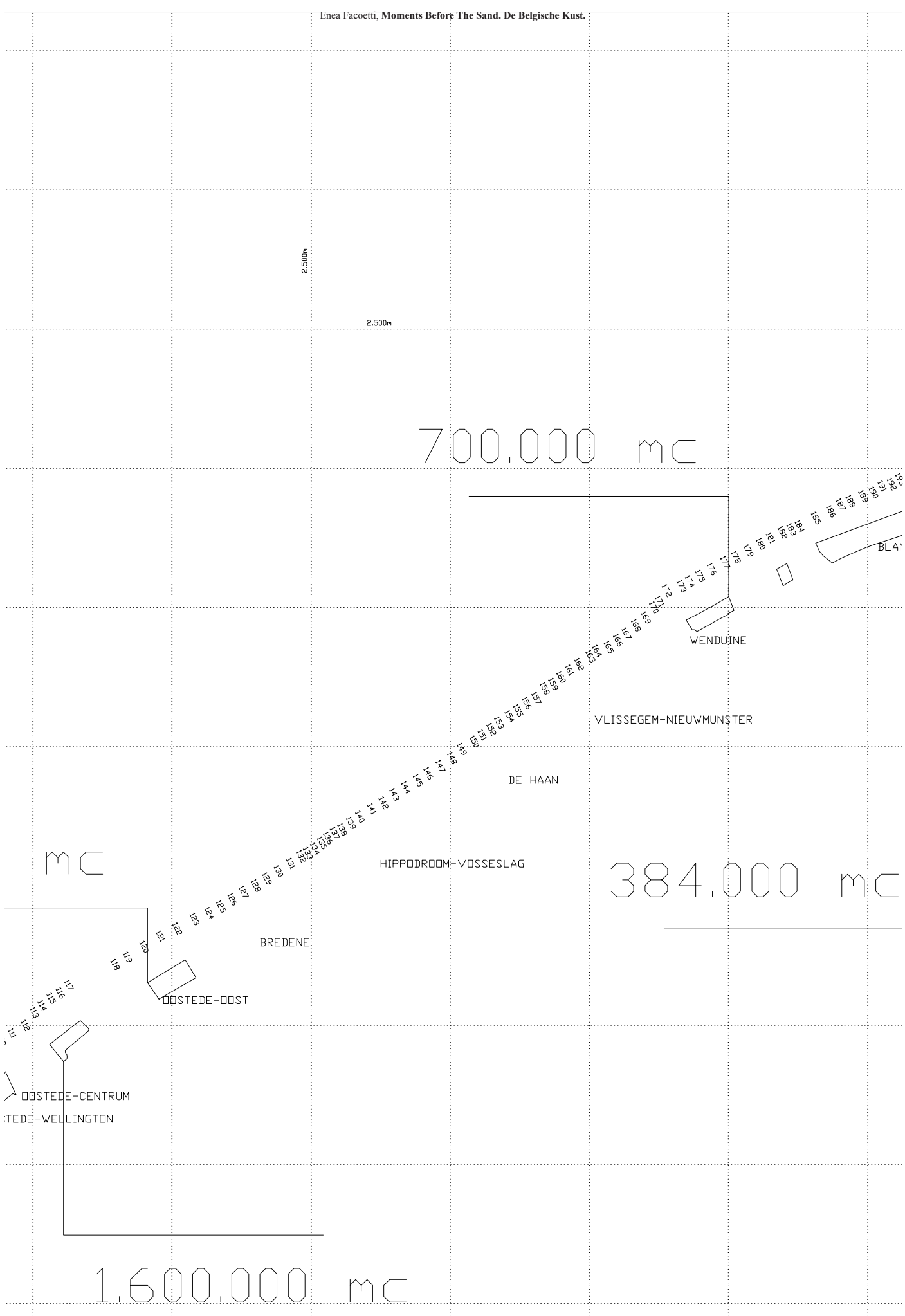

2.500m
2.500m
OOSTEDE-CENTRUM
TEDE-WELLINGTON
OOSTEDE-OOST
BREDENE
HIPPODROOM-VOSSESLAG
DE HAAN
VLISSEGEM-NIEUWMUNSTER
WENDUINE

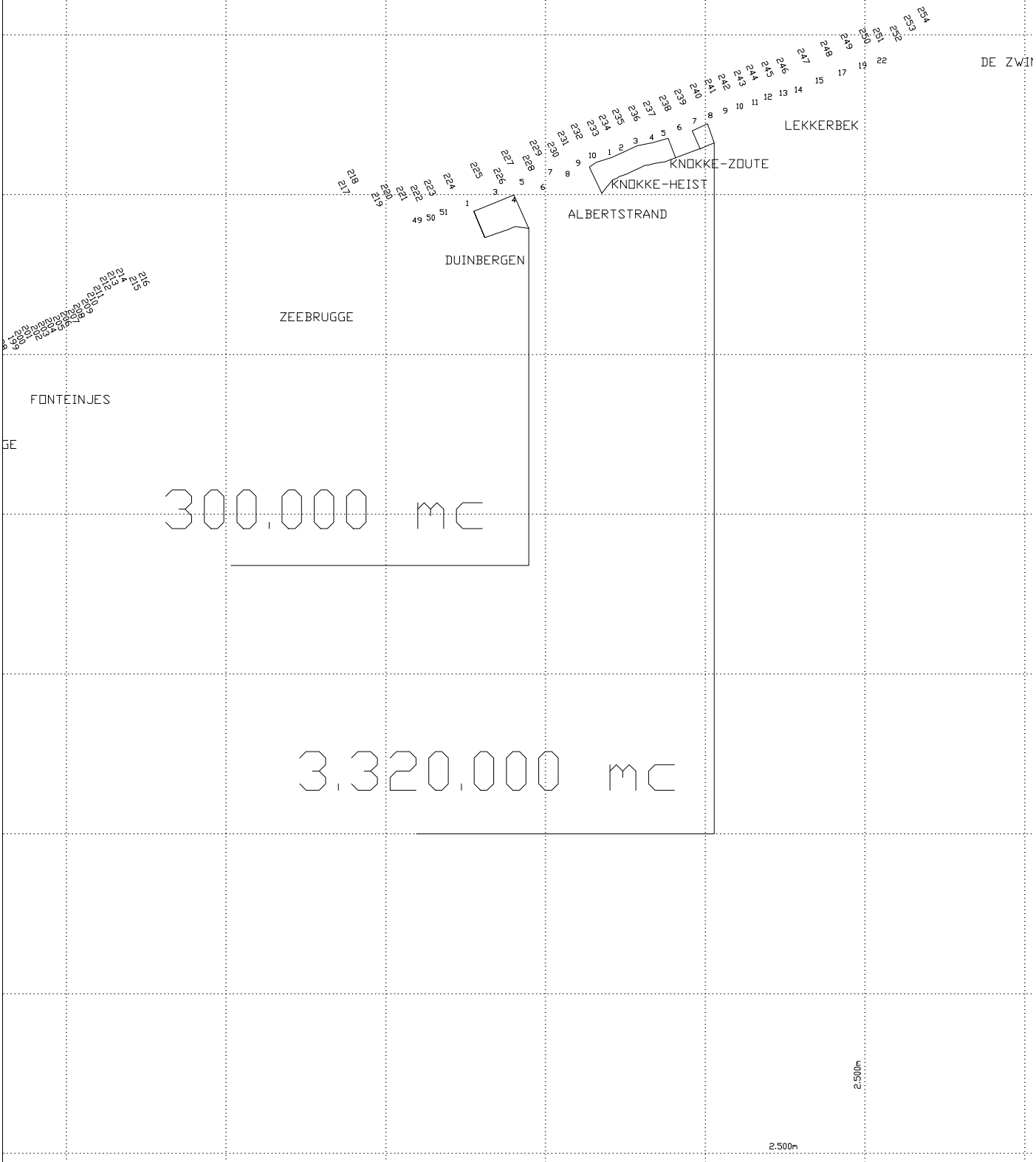

DE ZWI
LEKKERBEK
KNOKKE-ZOUTE
KNOKKE-HEIST
ALBERTSTRAND
DUINBERGEN
ZEEBRUGGE
FONTEINJES
GE
2.500m
2.500m

COASTLINE WITH THE SAND NOURISHMENTS QUANTITIES

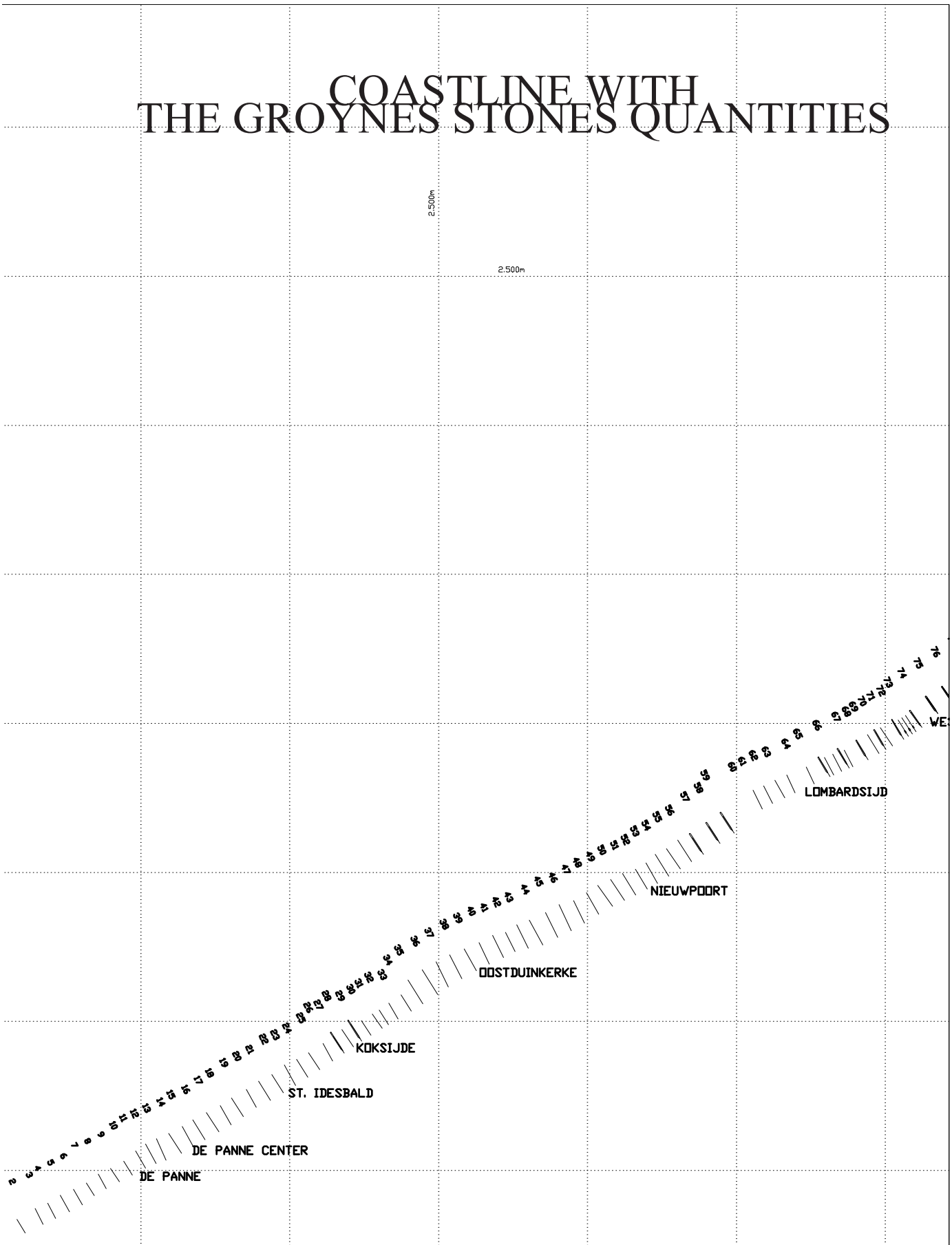


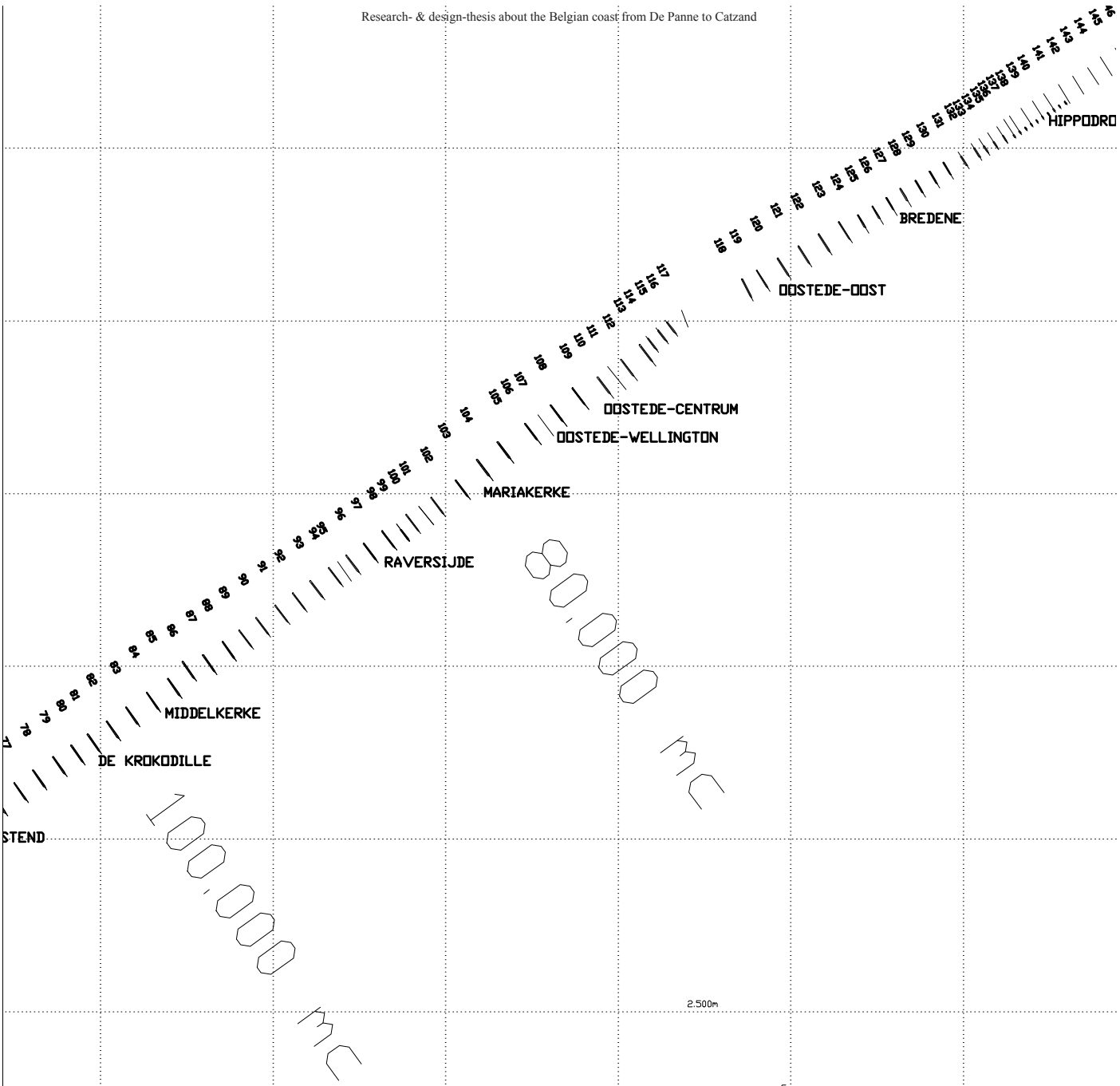

250.000 mc
HIPPODRO
BREDENE
OOSTEDE-OOST
OOSTEDE-CENTRUM
OOSTEDE-WELLINGTON
MARIAKERKE
RAVERSIJDE
1.600.000 mc
MIDDELKERKE
DE KROKODILLE
STEND
1.500.000 mc
2.500m
1.700.000 mc
2.500m

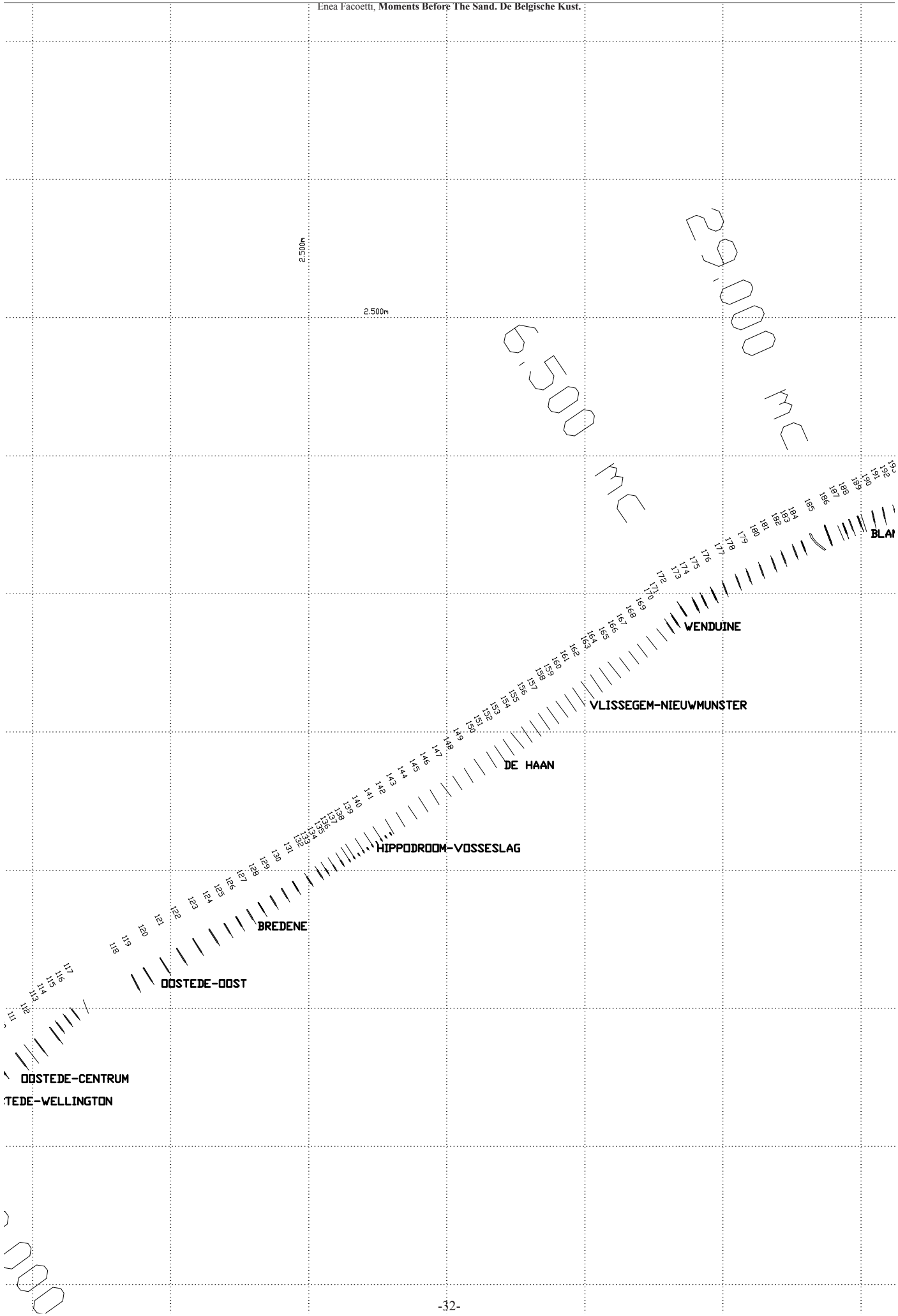

2.500m
2.500m
700.000 mc
WENDUINE
VLISSEGEM-NIEUWMUNSTER
DE HAAN
HIPPODROOM-VOSSESLAG
384.000 mc
BREDENE
OOSTEDE-OOST
OOSTEDE-CENTRUM
1.600.000 mc

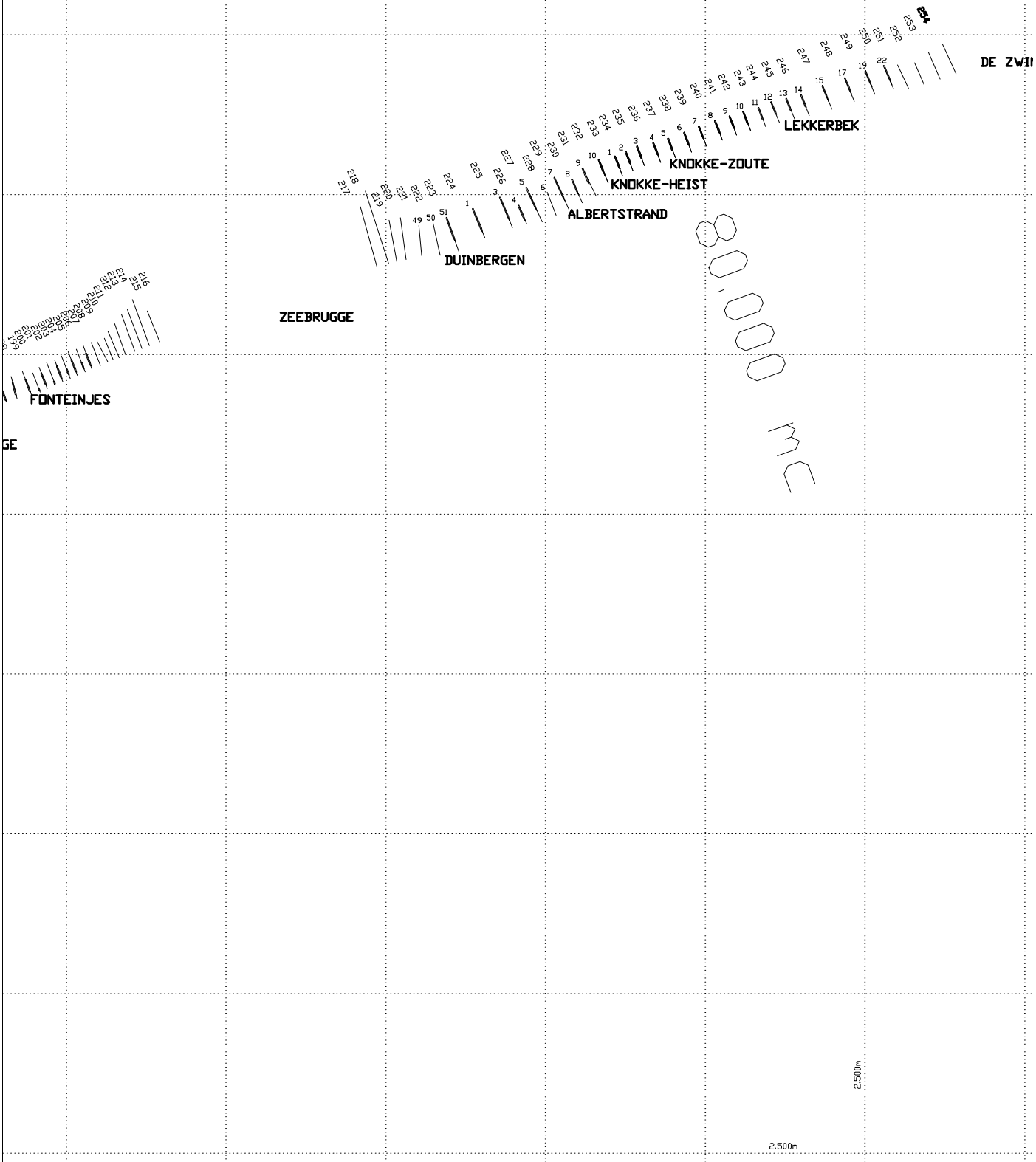

DE ZWI
LEKKERBEK
KNOKKE-ZOUTE
KNOKKE-HEIST
ALBERTSTRAND
DUINBERGEN
ZEEBRUGGE
FONTEINJES
GE
300.000 mc
3.320.000 mc
2.500m
2.500m

COASTLINE WITH THE GROYNES STONES QUANTITIES




HIPPODRO
BREDENE
OOSTEDE-OOST
OOSTEDE-CENTRUM
OOSTEDE-WELLINGTON
MARIAKERKE
RAVERSIJDE
MIDDELKERKE
DE KROKODILLE
STEND
80.000 MC
100.000 MC
2.500m
2.500m


2.500m
2.500m
6.500 mc
2.000 mc
OOSTEDE-CENTRUM
TEDE-WELLINGTON
OOSTEDE-OOST
BREDENE
HIPPODROOM-VOSSESLAG
DE HAAN
VLISSEGEM-NIEUWMUNSTER
WENDUINE
BLA


DE ZWI
LEKKERBEK
KNOKKE-ZOUTE
KNOKKE-HEIST
ALBERTSTRAND
DUINBERGEN
ZEEBRUGGE
FONTEINJES
GE
2.500m
2.500m

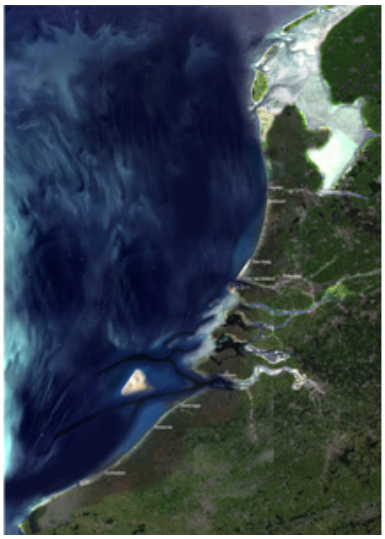
1.2.2.3 GAUFRE. TOWARDS A SPATIAL STRUCTURE PLAN FOR THE BELGIAN PART OF THE NORTH SEA. 2003 - 2005 > …

It's a overview of the Belgium seaside. Collects the research materials developed within two workshop from 2003 to 2005. Displays a selective analysis from the Belgium north sea boundaries to the coast line by diagrammatic maps. The maps figure the several "layers" of the BPNS Belgian Part of the North Sea in order to show its complexity. The designers in the GAUFRE team from the Maritime Institute at Ghent University present an Atlas of the Sea. For years, planners all over the world have been planning with their backs to the sea. These planners have been considering the sea as a vast surface of water, an empty space against which we should protect ourselves and which can be exploited without limitations. In fact the sea is a conurbation of activities that have non proper rationalization due to the fact that doesn't exist right of ownership on the sea. Since 1609 the dutch man Hugo Grotius introduced the Mare Liberatum doctrine, he considered the sea to be free for all pioneers and explorers. On land, ownership is the starting point of each form of planning. But ownership doesn't exist at sea and due to the entrenched principle of the Mare Liberum, each user considers the sea as his own territory to use or to explore. In the GAUFRE project, the University of Gent initiated a new attitude towards planning at sea. This new form of planning is sea-oriented, taking into account the differences between sea and land and their interactions. The GAUFRE does a superimposed projection of all the users enhancing the complexity. Aware of an analysis of the conflicts and the positive effects of this complexity the GAUFRE proposed an up graded version of the sea, optimized by the making in relation of certain of the users, by the description of visions and suggestions.
The Gaufre book is the result of a collaboration between the University of Gent (The Maritime Institute, The Reynard Center for Marine Geology and the Marine Biology Section) and ECOLAS an environmental consulting group.

THE COMPLEXITY OF THE BELGIAN SEA

1.2.2.4 HAPPY ISLES. WEST 8 & SVASEK 2006 > …

The Happy Isles Consortium, by West 8 and Svasek, drew up a plan which combines an agenda for safety, and the necessity of new land. The participants offer the metropolis a new perspective by proposing a series of new, sprayed-up sand islands off the coast of Belgium and The Netherlands. These dune islands, measuring up to 150.000 hectares in size, will break the increasing waves. Also, thanks to ingenious engineering of the gullies, the off-shore under tow will cause the sea level to drop during north-western storms.
On the biggest island, Hollandsoog, 150.000-200.000 ha. in size, a broad representation of the community will be able to obtain a lease. The economy of this island will be based on leisure and nature experience; a happy island for family, lonely-hearts, poets and festivals.



HEPPY ISLES

1.2.2.5 VLAAMSE BAAIEN. FLANDERS BAYS. 2008>2015-2020>2100

" From a narrow, hard strip to a broad, soft coast". The design team believe that is necessary to go back to the situation of a wide and soft coast, where sand in outstretched dunes, sand-banks and islands provides a natural and flexible protection zone. The so called "sandy coastal area" can offer opportunities for new economic or tourist developments such as port expansions, a multifunctional island or a recreation area. The sand-banks and islands could provide also a new habitat for sea lions. One of the main topics of the proposal is to have a flexible long term strategy, adaptable to future adaptation of the sea level rise, and "changed desires and needs".
The intervention consists in the raising of specific sand banks in order to make islands next to the coast. The islands should provide protection against the storms, before they waves can reach the coast line.
The strategy coordinates several projects:

"Coastal protection by raising Flemish banks": the soft strategy is based on the concept of make sand by sand, according to already proved dutch coast. On one side the sand is going to protect the sand on the beach, on the other side part of the sand of the banks will be carried by the waves on the shore making new sand, new beach. The island will be partially filled by hard platforms which will be the surface for new development and the structure of the islands.

"Port of Zeebrugge": the port of Zeebrugge is extended of one time and a half, according to a possible growth of the transhipment business to the north sea.

"Beach Knokke Heist and Zwin": the Paardenmarkt Bank is going to be raised as a dam of sand, extended from the harbour of Zeebrugge east-side. The sand dam could be developed into a nature area. It is also possible that, depending on future needs and wishes, partly will be developed for apartments blocks.

"Blankeberge sea side": the port of Blankeberge will be extended by wave breakers to have a touristic harbor. The extension in the sea will favor the deposit of sand and the enlargement of the beach between Blankeberge and the wave breakers of Zeebrugge, which includes the existing only pier of the Belgian coast. In the future a new line of banks will be raised parallel to the new beach, making so a lagoon. Which will be developed by natural areas and apartment blocks.

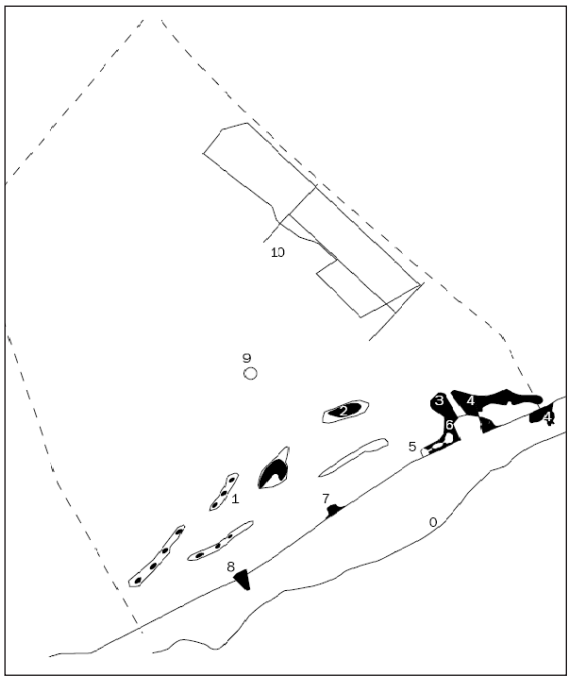
"Port of Oostende": the design starts coherently with the nowadays already built extension of the wave brekers at the harbor of Zeebrugge. The idea is also implementing the zones on the sides providing a tourist harbor, a project for the natural area next to the ruin of the Napoleon's Fort and designing a new pier in front of the Casino of Oostende as a land-mark.

Nieuwpoort European Sailing and water sports: Nieuwpoort is already an important tourist harbor. This feature is currently supported by new developments. The position of Newport can be further improved by the Flemish coastal zone, center for sports and recreation and natural areas tourism.

“Multifunctional island”: The concept involves the construction of an infrastructure that serves as a shelter port in the sea.

“Infrastructure for marine energy extraction”: according to the future developments of the off shore wind mills areas the strategy propose the addiction of servicies and facilities in multifunctional islands. Which serves the “wind farms”, connected in the future with the European grid of wind energy production.

The project started in 2010 and includes three benchmarks: 2020, 2050 and 2100. The first phase, until 2020, offers an answer to the current problem increasing the defense infrastructure by islands. The same islands will be the foundation, meant to build new apartment blocks and facilities by 2050 . About the long term, by 2100, it hypothesizes a raising of the islands and the settlements.

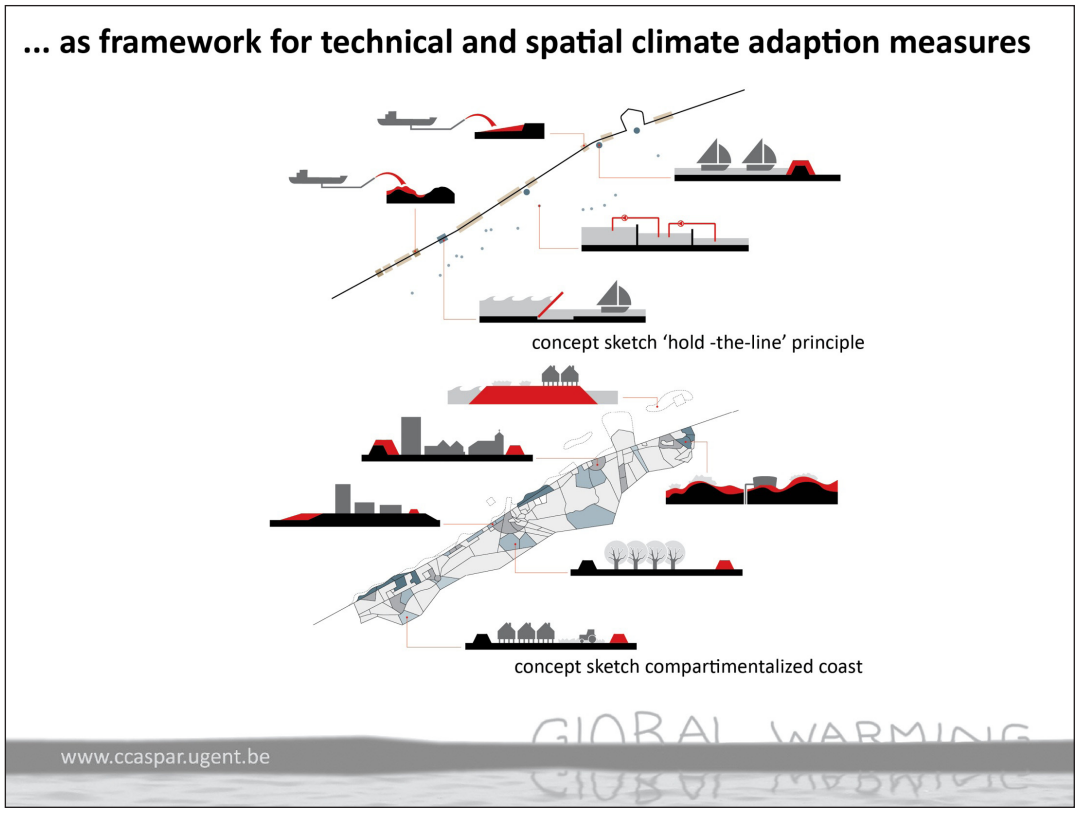


VLAAMSE BAYEN

1.2.2.6 CCASPAR. CLIMATE CHANGE AND CHANGES IN CLIMATE STRUCTURES RESEARCH PROJECT. 2006 > 2100

The CcASPAR project researched a new concept as framework for technical and spatial adaptation measures as an answer to the climate related challenges: compartmentalization. Within the compartmentalization concept, the current system and its safety levels are revisited at a local scale. As all climate impacts are water related , new embankments are added to split up the coastal zone into different compartments, each with its own water management.
Such division creates a possibility to rescale the adaptation debate. Whether or not coastal erosion, fluvial and pluvial flooding, drought and salinization occur and whether or not this will cause problems.
Furthermore, the system within each compartment : its land use, its socio-economic characteristics and its landscape can be revisited separately.
If one wishes to maintain the existing system, technical strategies (dyke reinforcement, new pumps and increased water supply) are in order. If not, the climate impacts could be integrated into the compartment through conditions. Such conditions are not particular destinations but guidelines for local land use.
In this way, space and spatial measures (elevated buildings, salt resistant crops and building restrictions) become part of the climate adaptation planning.

The compartmentalization concept has several benefits and puts current developments in perspective.
Firstly, the new pattern of embankments offers opportunities to balance the system and its safety levels at a local scale. As such, one can avoid implementing extreme protection measures wherever they are unnecessary or undesirable. Especially when sea level keeps rising and dyke reinforcement gets more and more expensive, this may be an important benefit. Moreover, investments can be spread over time. The proposed framework of dykes does not have to be developed immediately and the embankments might be purely theoretical. Only when the safety level is locally modified, they must be constructed.
Secondly, the compartmentalization strategy creates opportunities to build with nature. Several dynamic processes are now counteracted by current policies, while these processes actually insure a natural adaptation of the coastal landscape. By redefining the system at a local scale this natural adaptation can be put to use. For each compartment strategies can be developed that integrate the natural dynamic and the local socio-economic development.



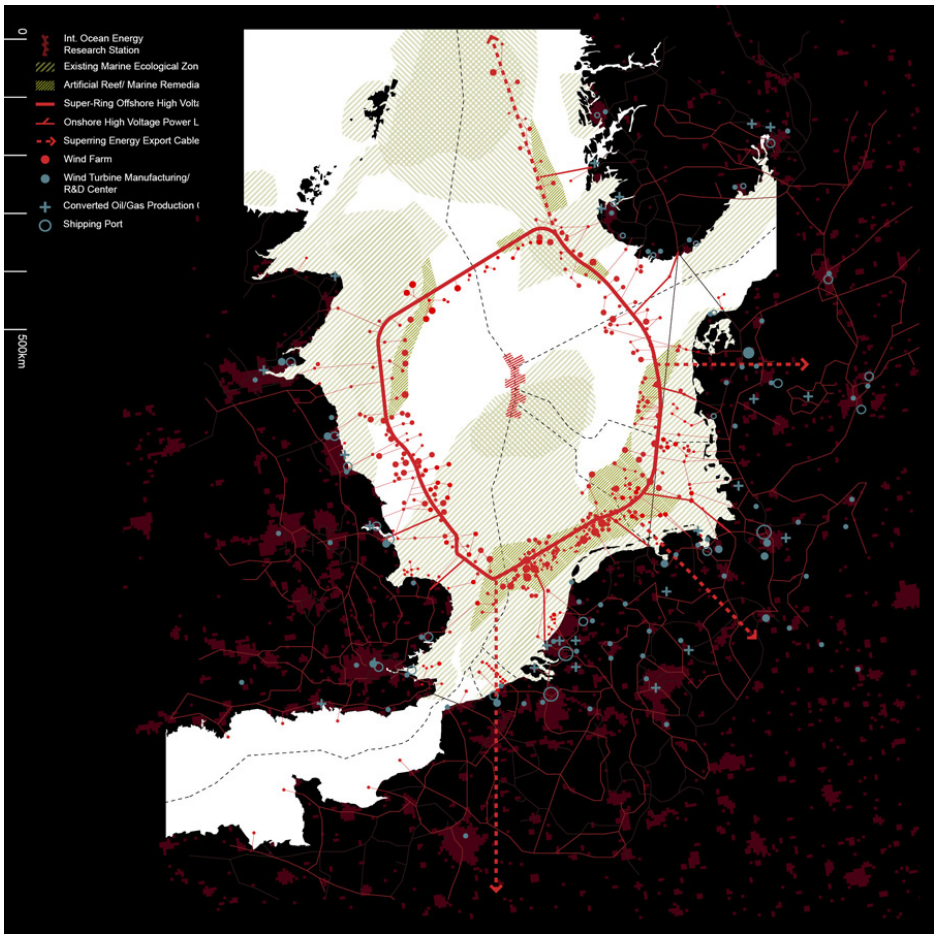
THE COMPARTIMENTALIZATION

1.2.2.7 THE ROAD MAP 2050. OMA. 2009 > 2050

In October 2009, European leaders' committed to an 80-95 percent reduction in CO2 emissions by 2050; Roadmap 2050 was commissioned to determine how these emissions reductions goals could efficiently be met. The technical and economic analyses of the report outline why a zero-carbon power sector is required to meet this commitment and illustrate its feasibility by 2050 given current technology.

AMO contributed to the content development through the production of a graphic narrative about the geographic, political, and cultural implications of a zero carbon power sector. The graphic narrative shows how through the complete integration and synchronization of the EU's energy infrastructure, Europe can take maximum advantage of its geographical diversity: if the Roadmap is followed, by 2050, the simultaneous presence of various renewable energy sources within the EU will create a complementary system of energy provision ensuring energy security for future generations.

Roadmap 2050 was commissioned by the European Climate Foundation, and the full report, published in April 2010, includes extensive technical, economic and policy analyses conducted by five leading consultancies: Imperial College London, KEMA, McKinsey & Company, Oxford Economics and AMO.



ROADMAP 2050, THE NORTH SEA

1.2.2.8 M.U.D. MULTI USER DOMAIN
2005 > 2100

The Flood, theme of the second International Architecture Biennale Rotterdam, is expressed in the three main Biennale exhibitions: The Water City, Mare Nostrum, and Polders. These examine urban developments in relation to water. Mare Nostrum surveys the development of the bathing resort since the nineteenth century, and devotes particular attention to today's coastlines that are swamped by tourism. Mare Meum, part of the Mare Nostrum exhibition, presents a full spatial approach to both the urban and natural landscapes. "FLC extended", the author of the research, simulate a spatial scenario for the "man-made landscape" between Calais and the Scheldt estuary.
The Belgian Atlantic Wall separates the sea from the polder landscape almost uninterruptedly.

"All 67 kilometres of the Belgian coast have been subjected to total tourist development held together by the coastal road and the coastal tram route."

This coastline, propelled by speculation, private initiative and pragmatism, has transformed into an elongated but extremely narrow urban entity. Where hyper-individualism and the economy of experience intersect, that's where Mare Nostrum becomes Mare Meum.
The pressure imposed on this ribbon city and the landscape behind it by exclusive housing, (mass) tourism, leisure and recreation continues to increase. The hinterland is gradually being taken over by agrarian tourism, holiday villages and recreation in the landscape. But the sea too can potentially be put to use: "sea-scaping". Flood, capsular society, hyper-economy are three the ingredients, three social trends which the design team picked up.

- The flood is meant as a tool to come back to a plestisocene coast line wich reveal the weaknesses of the existing dyke and bring to a condiction where territory and ownership are subject to the dynamics of the sea.

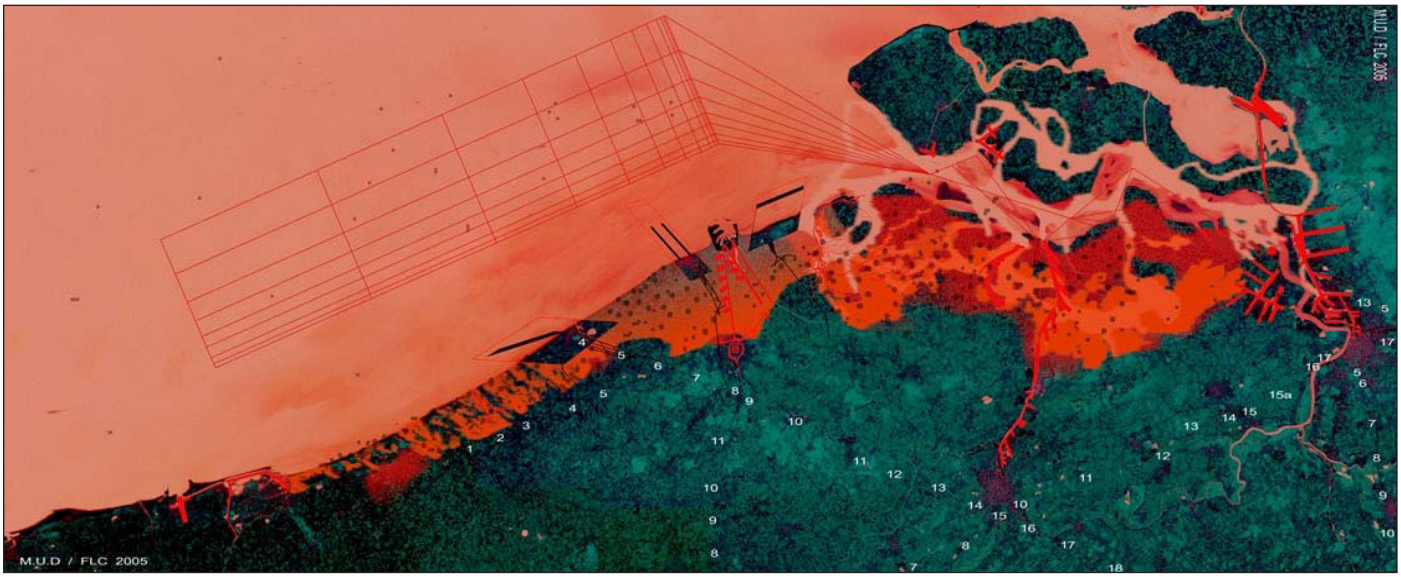
- The capsular society is the society which barricade itself instead of to find a relation with the surrounding landscape and built environment. In that sense Oostende is a "cultural paradise", Blankenberge is a "family resort" and Knokke-Heist-Duinbergen a "luxury island".

- The term 'hyper-economy' refers to the vaporization of the economy. The evolution from a commodity economy to a data and service economy means that the role of the polders as an agricultural area and so the reason this area was reclaimed from the sea and protected by the defence infrastructure is now outdated, incoherent with the time.

M.U.D stands for mud, the substance that is a mixture of water and land, but also M.U.D also stands for Multi-Users Dimension. When territory and ownership are subject to the dynamics of the sea, newly interested parties negotiate again and again on varying points inside the conflict zone.

IThe materials of the exhibition were a carpet map, videos and interactive diagrams.

Design research by Katrien Vandermarliere, Roeland Dudal, Carl Bourgeois, Marc Godts, Wim Van Der Vurst, Nel Janssens, Charlotte Geldof and Koen Pauwels.



MUD, MARE MEUM

1.2.2.9 THE FUTURE COMMONS 2070
2010>2070

The Future Commons 2070 is a map. it's an example of simultaneous representation of the spatial planning for the marine area off the Belgian coast and the adjacent inland coastal zone areas in 2070. It proposes to bring the former EEZ (Exclusive Economic Zone), or rather the sea without property, and the Contiguous Zone under management of the European Union and divide it into larger supra-national jurisdictional parts, based on its constituent ecosystems. The 'Future Commons' project advocates conservation of the sea as a common and recognition of its growing importance, strongly regulated by the European Union. Just like forests, water and the atmosphere, the sea can be considered as a 'common-pool resource', a natural common resource, quasi-free for anybody to enjoy. The Maps makes clear what the commons are and could be, by providing a survey of the density of commons on land and at sea with gradations of black proportionate with the presence of commons.

1. The commons on land 2070 are:

- Natural commons: forests provide, amongst other beneficiary effects, biodiversity and a reduction of CO2-emissions. They serve as recreation areas for the new population of coastal communities.

- Community commons: infrastructures required for the functioning of the community (ports, road networks, power lines, wireless networks...) are also considered to be commons. The tendency to privatize traffic systems has been reversed in favour of a significant upgrading of the role of public infrastructure.

- Cultural commons: historical castles, churches, cemeteries, cooling towers, windmills and turbines are designated as commons, as are belfries (Unesco Heritage).

2. The commons on the maritime coastal zone 2070 are:

- Natural commons: the new porous hybrid coastal areas, dunes, shallow intertidal areas and temporary wet zones, are designated as commons because they are of common interest for natural coastal defense and the conservation of biodiversity and ecosystems.

- Community commons: junctions and landing points of, for instance, the electric network, established on former traditional energy production sites are commons, airports are partially commons, dunes and temporary wetlands are also designated as commons, because of their ecosystem services to the community.

- Cultural commons: besides their value as nature reserves, the newly arisen waterscapes also function as significant relaxation and recreation zones for inhabitants of the coastland. Historical wreck clusters and the sea horizon belong.

3. The commons at sea 2070 are:

- Natural commons: thanks to the fact that the European Union has transformed the EEZ into a European Union Maritime Commons (EU-MC), the threat of privatization of maritime areas has been averted, for the benefit of the common good. Natural structures and elements on and beneath the sea floor, the water column and the surface of the sea are all part of the commons. Strict policies preclude any disturbance or exhaustion of the existing ecosystems (sand banks, sea floor life…) The swarm symbols future evolutions in natural elements and is reserving the necessary physical and mental space for these evolutions.

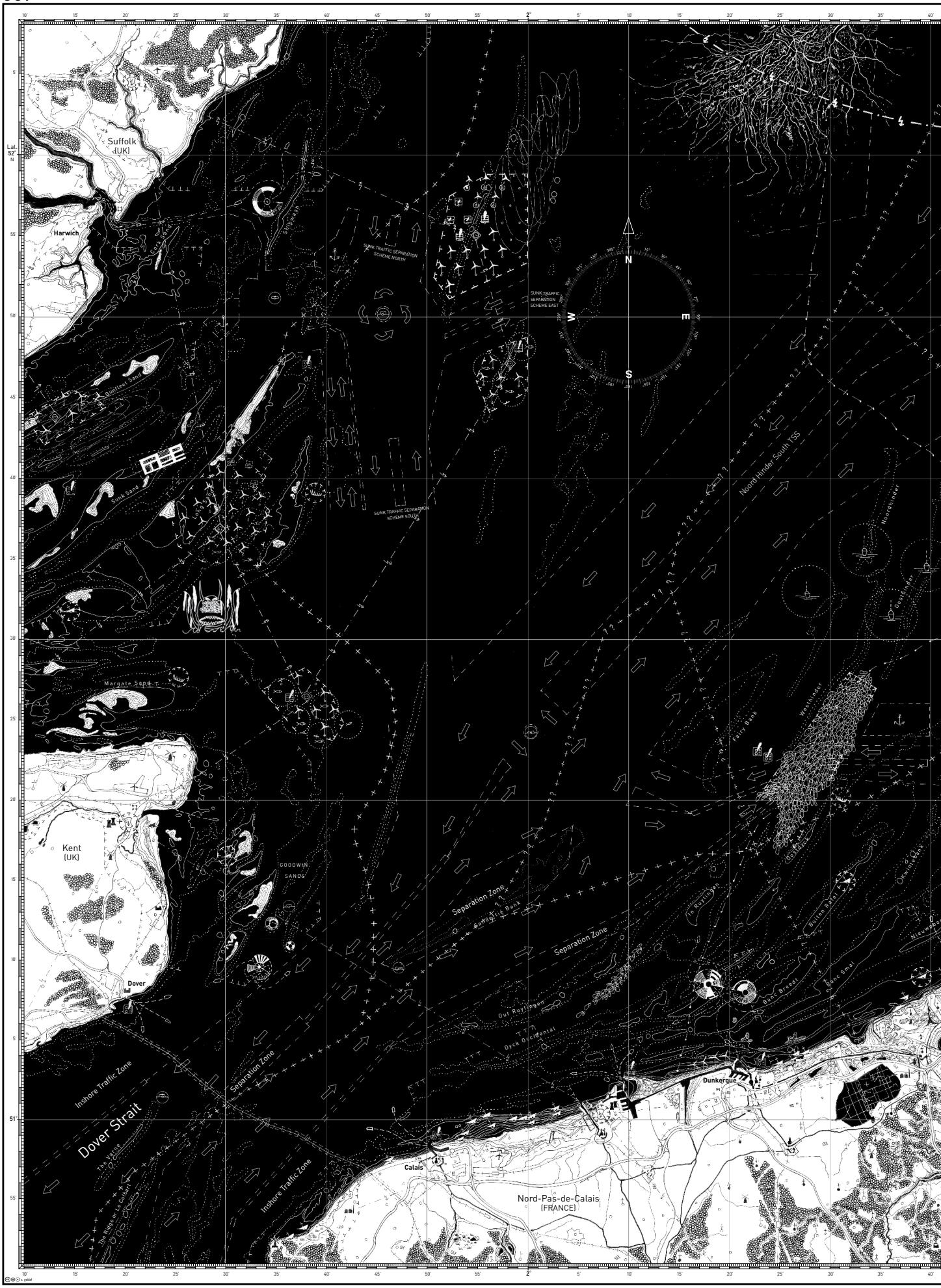
- Community commons: the infrastructures required to monitor these ecosystems are part of the commons. Navigation support infrastructure, sludge processing installations and clusters for generating renewable energy, which also harbor some forms of marine-culture and other functions, are commons. The Channel Tunnel, floating educational leisure activities, a sand motor and other large scale infrastructure works for coastal protection are elements of common interest. Energy networks are partially privatised but as they are essential for transportation from the clustered renewable energy production units to the coast, they also are a part of the commons; the government also invests in them. The cloud symbolizes those future elements required for the functioning of society in 2070 which can only be established at sea or on a sea floor level.

- Cultural commons: just like seascapes, underwater archaeological sites and shipwrecks are part of the commons. The sea monster symbolizes the unknown and the immaterial. It also stands for the new values that will be important on a cultural level to society in 2070. It is likely that in the future more marine cultural commons will be discovered.

This map is a first, tentative attempt at developing a critical vision, introducing the commons as leading principle for maritime spatial planning in this part of the Southern North Sea, the coastal area and the polders.

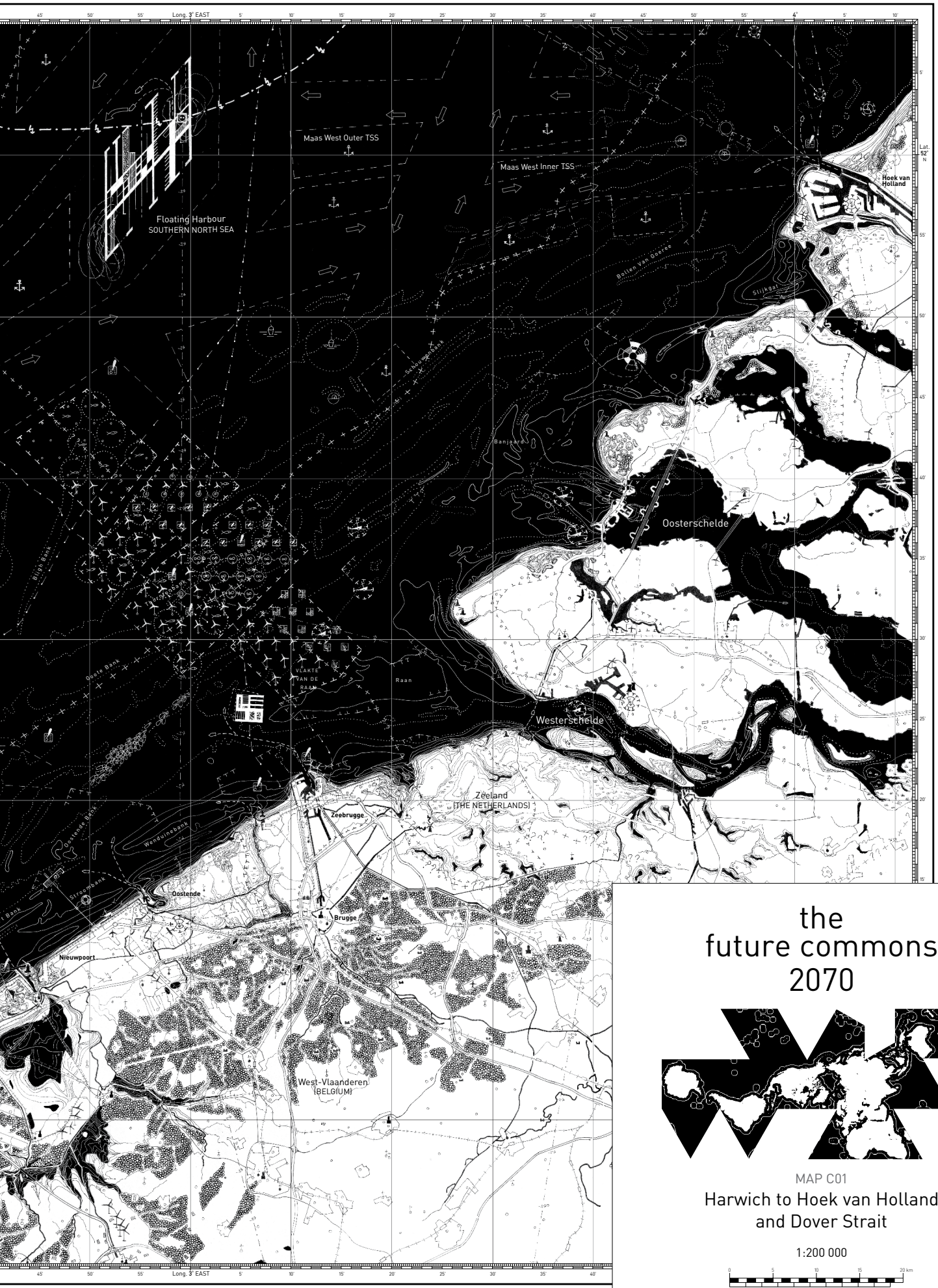
Design research by Charlotte Geldof -Magnificent Surroundings.org office, Ester Goris, Dagmar Pelger, Nel janssens.

C01



Printed in October 2011 and updated up until December 2010

This product has been derived in part from material obtained from the IMRAY map C30
Harwich to Hoek van Holland and Dover Strait, WGS 84



the future commons 2070

MAP C01

Harwich to Hoek van Holland and Dover Strait

1:200 000

0 5 10 15 20 km

0 1 3 5 7 9 10 nm

Printed and published by **magnificentsurroundings.org**, Tentoonstellingslaan 143, 9000 Gent, Belgium.
Supported by the Belgian Vocation Foundation. Edited June 2011

"To live close to the sea and with the sea is to be aware of the biological origins of life. It is also to be aware of rythms and patterns - tidal systoles and diastoles, wave-shapes and wave-movements, currents and winds, a changing meteorology, the multiple variations of a coastline -, and, with all that, to have a pervasive sense of chaos and cosmos, chaosmos." (Kenneth White 2006)

1.2.2.10 LAND & ZEE 2070
2012-2013>2070

1.2.2.10.1 The secondary dwelling cities,. A One-Way Experience:

"…From the high-way we change to the Koninklijke Bann, then haeds into the underground parking and then with bag and baggage rashly into in the elevator up till the apartment, and well…finally the view of the sea." (Land & Zee 2070)

That's how the summer starts for mostly of the inhabitants of the coast. The Koninklijk Bann is the high-way which goes through the polders parallel to the sea and serves the different coastal towns. It's the main connection and the infrastructural limit of the polders. From the high way few secondary roads branch off to the towns. Each town has its own connection, like a channel which goas straight to the water and flows in a conurbation of delta shape. The settlements rise gradually in density and width, starting from spread

"… conglomerate of an office, an industrial and a house with garden,…the result of successive
investments of a family business,...,today version of the ancient Flemish farmstead, symbol of the private initiative and the Flemish entrepreneurial spirit"; (ESTEE — architecten de vylder vinck taillieu)

to the bungalows, the tents and the caravans organized in vast camping areas next to the road and behind the dunes, caravans which look like pretty much fixed to the ground, enriched by some pup up volume, where the wheels are just an excuse to respect the regulations. Then you can already see the High rise "apartment blocks wall', but still you need to cross the towns: the middle density apartment blocks, the single family houses, the reconstruction of British colonial villages, the commercial streets, the restaurants, to reach at last the waterfront.
The waterfront is the compromise of the Belgium coast: a dyke 10-30 m large per 2-6m high between the towns and the beach, equipped by bicycle path, restaurants, shops, fast foods, parking, public toilets, tram line, chalets , ice cream and waffle parlours, highly popular an differently arranged according to the coastal towns. It's the gold edge of the coast, the concentration of the entertainments and activities: . It's also the limit of the urban settlements and the private property.
The dyke is the compromise with the horizon, with the perpendicular view from the coast to the sea:

"Merry stroll in the shade of the Atlantic Wall, the long parking on one side and cabins, playgrounds and beaches on the other side; as the beach bars: wood floors, designer furniture and popular music. The Belgian coast today is nothing more than an accumulation of "props" that doesn't have anything to do with the landscape. The constellation of props determines the current coastal experience. The coast without scen-

ery, without magnificent surrounding." (Land & Zee 2070)

the one-way experience of the Belgium coast. Experience that is complete in the moment you can actually buy one of the expensive apartments on the dyke and reach then the Flemish dream.
Actually on the coast it's possible to find any kind of residential option, measured by size, view and location. From the costly apartment on the dyke to the small British charming cottage.

1.2.2.10.2 The Exibition

The exhibition “Land & Zee 2070” is an assignment from the International Kustcampus De Singel in Antwerpen. This spatial and artistic initiative presented a possible future organization of the Belgian coastal area for the year 2070.

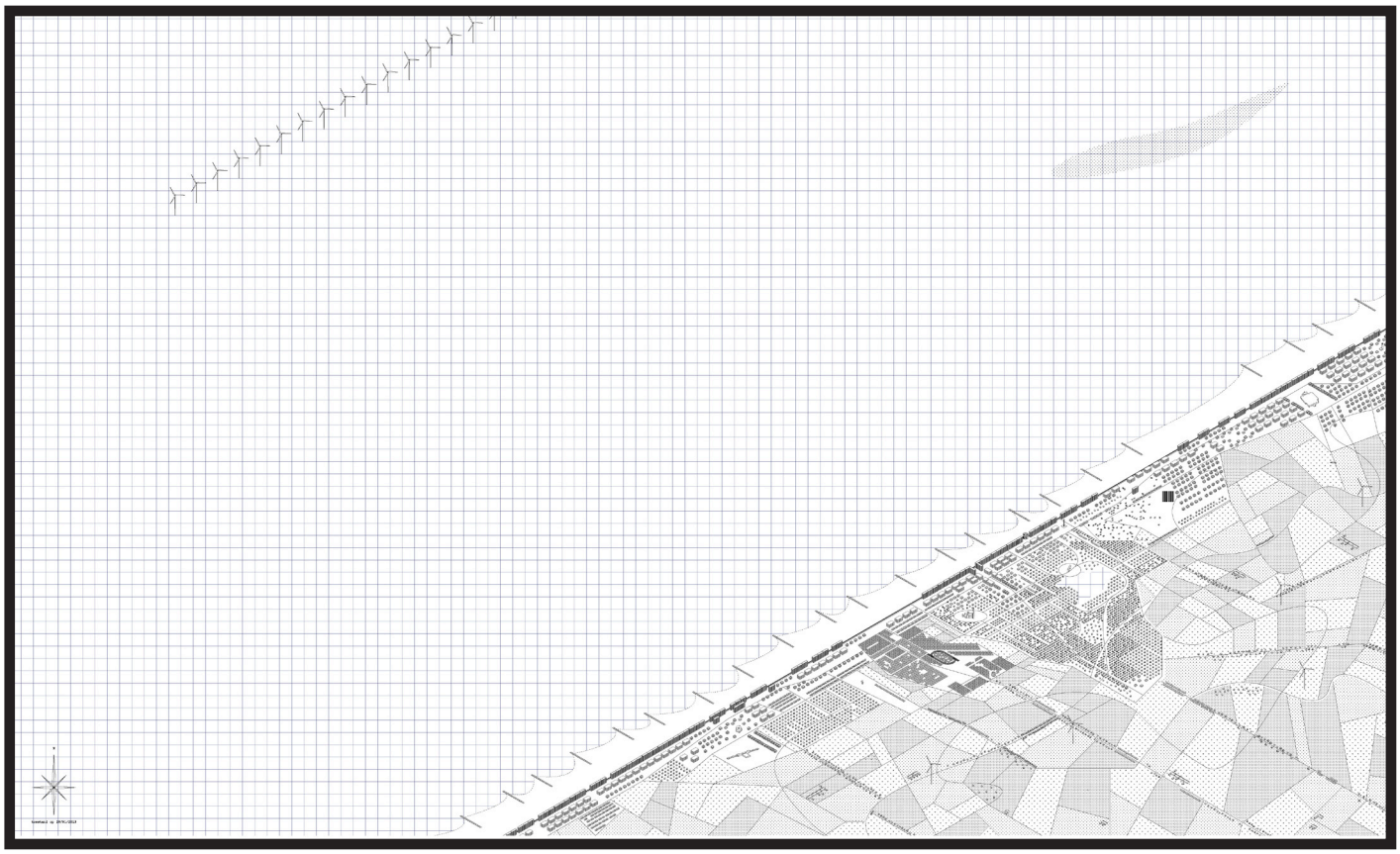
The exhibition is based on a personal interpretation of the coast. An interpretation trained by several meetings with the researcher Charlotte Geldof, co-author of a study carried out recently about the Belgian coast: “The Future Commons 2070” and planner at the Minestry of Flemish Government in the design research “Metropolitan Coastal Landscape”. With the collaboration of the curators of the exhibition Christoph Grafe and Katrien Vandermarliere (coordinators of the Flemish Architectural Institute V.A.I) and the architects Bart Melort, Frederic Vandoninck and Wouter Willems.

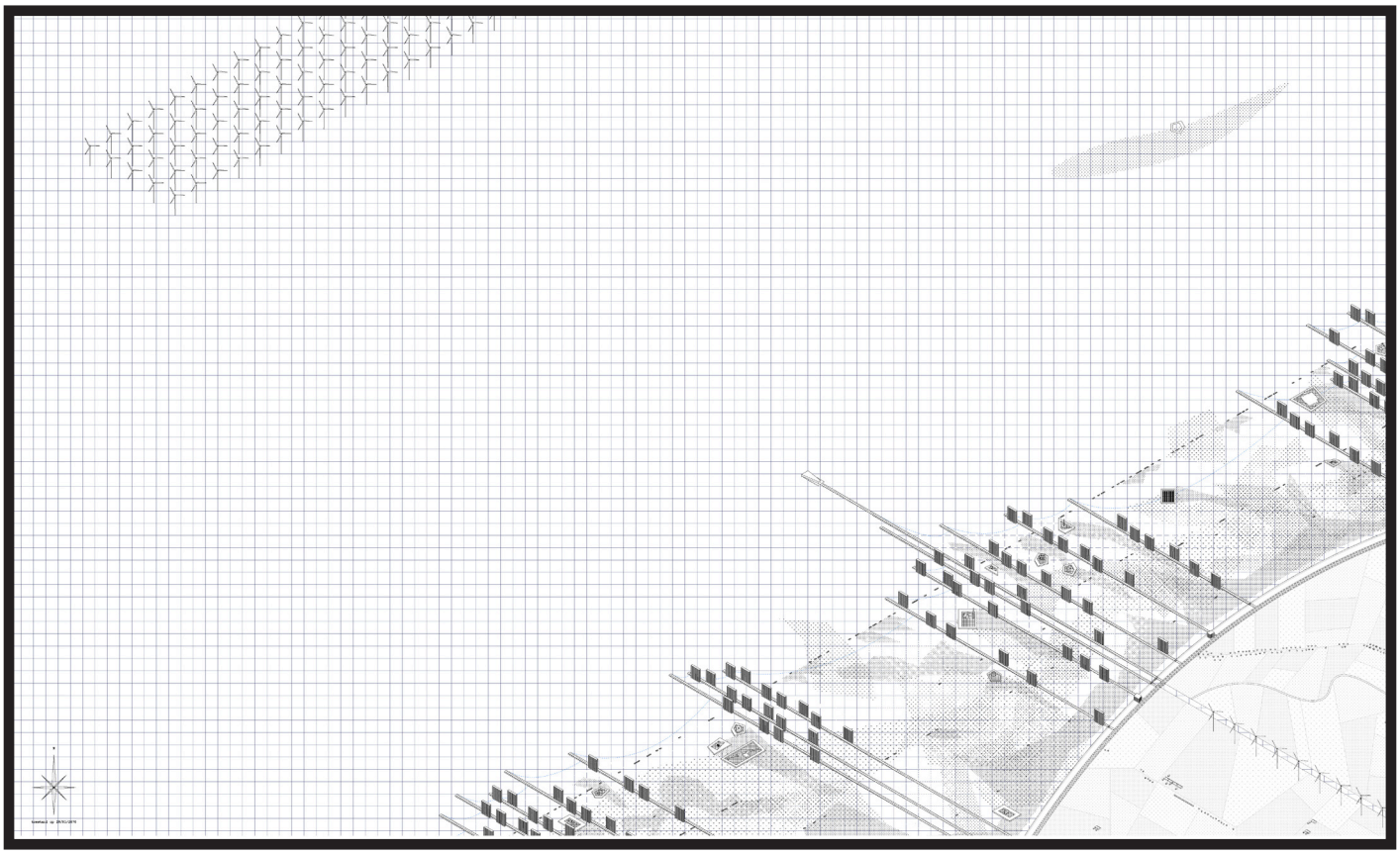
According to the path I’ve undertaken during the exhibition, there is the possibility that the coast may not be exclusively an edge from France to Holand, but rather a zone which includes a portion of territory much bigger, from the sand banks to the polders area behind. A zone which may be consider as a “surface in transition” instead of a “barrier”. In this zone the settlements are designed perpendicular to the coast, through the landscape in direct connection with the land. The dyke is fragmented, eroded by the constant transition of the tides. The Building are arranged on piers which provide both protection against the wave and connection to the in-land. The piers are spaced out differently according to the necessity, from 200m distant, like in the entrances of the harbour, to several kilometers. Between the settlements the attention is led by the landscape of the coast. Whole portions of land would be left under the action of the sea. A landscape that is rich of species, migrant birds, lagoons of salt and sweet water mixed together, that is attached and living into the piers. A landscape that is not sporadic like the nowadays survivor portions of dunes and lagoons of Bredene, the Zwin or Koksijd.
In the vastness of these places just certain buildings could remain intact. Thanks to the design of a new dyke may be possible to realize protected places.
Differently from now the dyke will protect exclusively what hold a symbolic value, historical, social: as much as its importance, to guaranty its protection.
In order to visit this collection of “forts” it will be necessary to walk through the tidal landscape, or sometime by crossing footbridges between the “forts”and the piers when the they get closer.
The “relics” in the “forts” may work as guidance elements, restoring the relation between “res publica” and “res economica”. A dynamic relation between what makes the city describable, and what makes it in real.

Making big format collages we meant to make the visitors be able “to feel” the materials, the ambience, the views of the coast through a evocative presentation, made by characters away from now, sited in a future which is actually not that far.

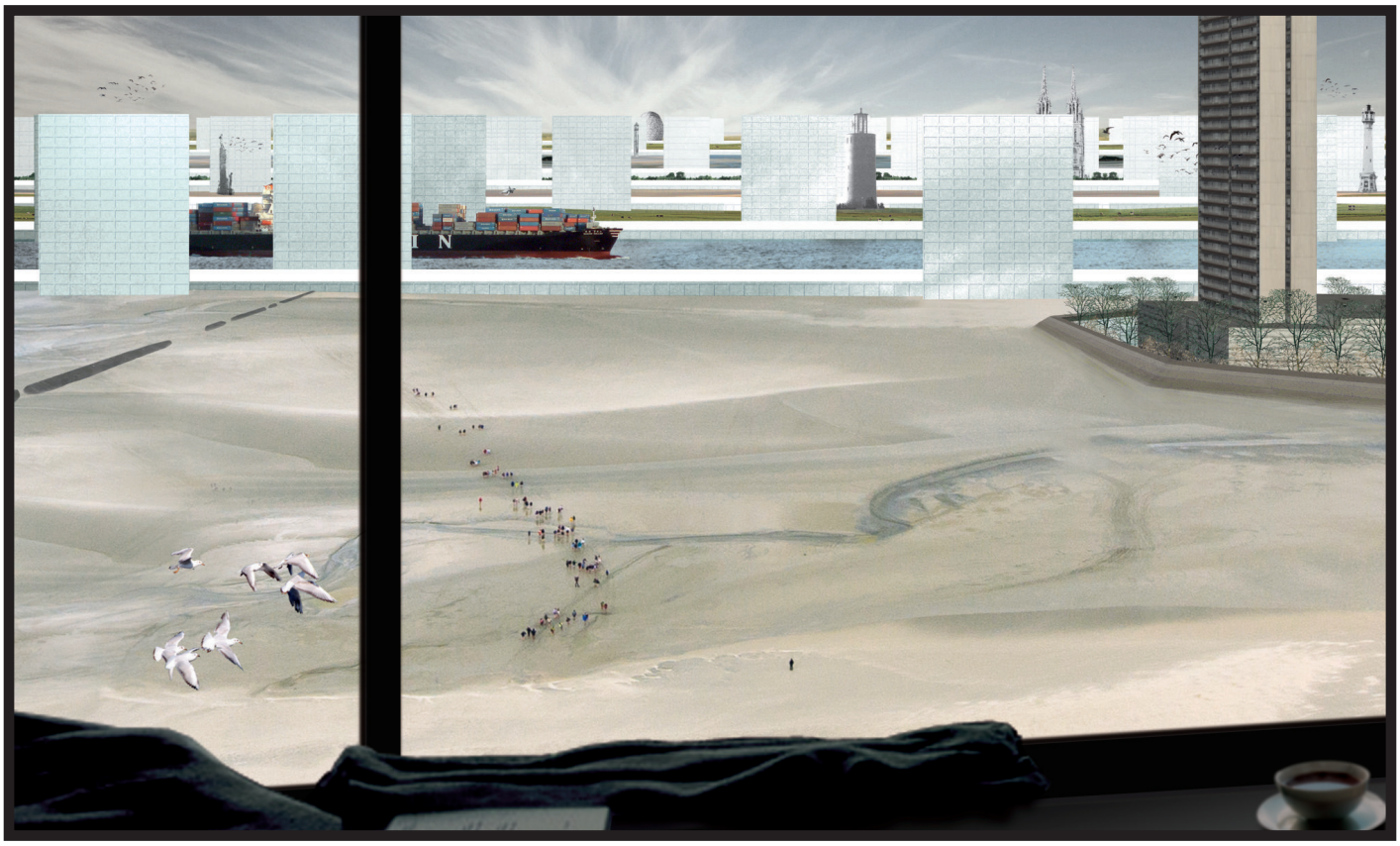
Being at the conclusion of the exhibition I believe that the potential of this statement could be inspiring for the present condition. I find that today is essential to promote projects that interact with the processes of modification of the coast especially with the dykes, integrating the infrastructures maintenance with the design of the public space.

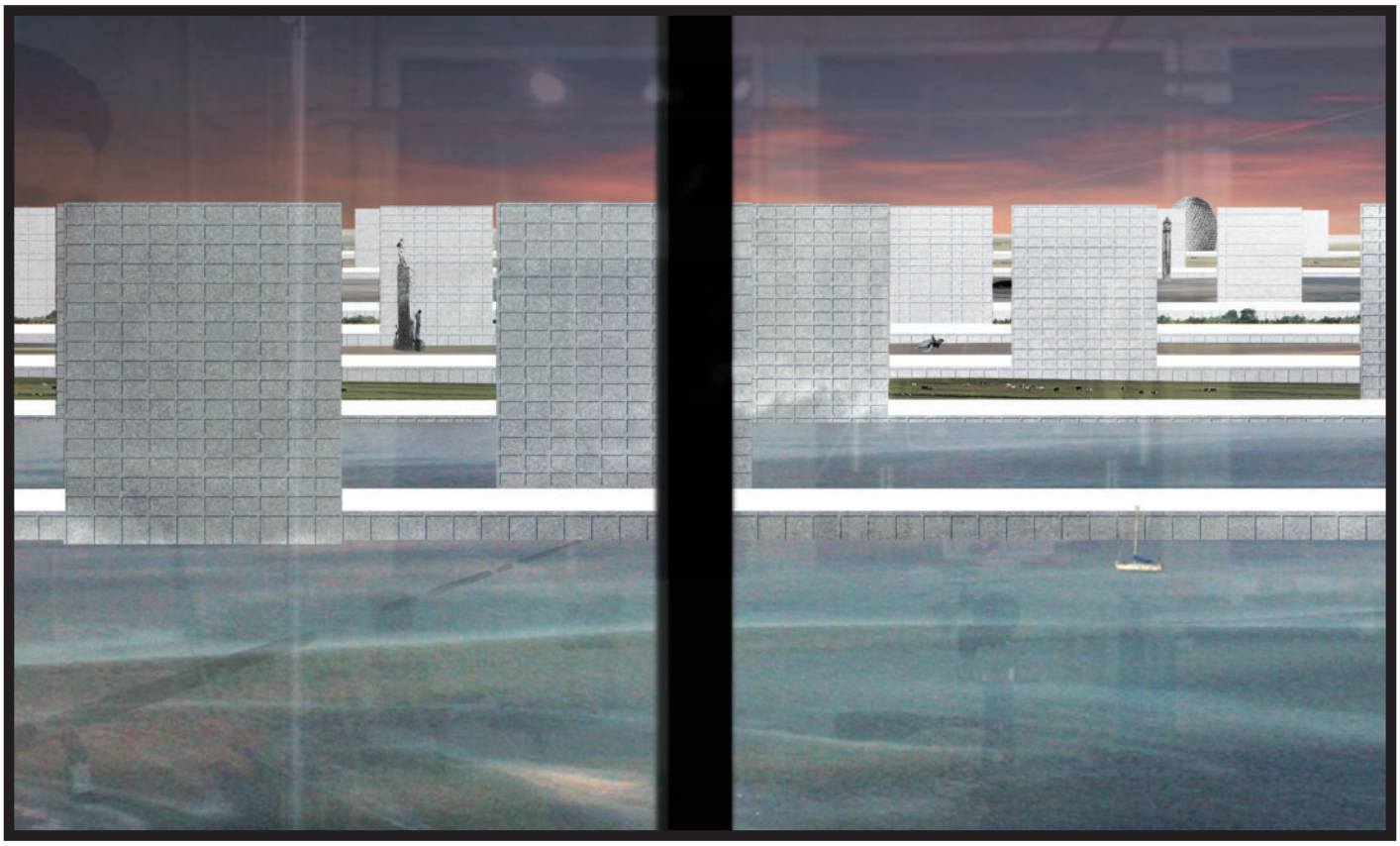
LAND & ZEE 2070 EXIBITION MATERIALS





Enea Facoetti, **Moments Before The Sand. De Belgische Kust.**





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Enea Facoetti, **Moments Before The Sand. De Belgische Kust.**

1.2.3 Moments before the sand.

1.2.3.1 INTRO

Right know diggers and bulldozers are moving, shaping, scratching and transporting thousands of m3 of sand.
The maintenance of the coast is a usual process, but this time it's different. The amount of sand it's meant to be the new coastal defense infrastructure.

According to the MER rapport the only nourishments are the couse of negative costs. One third of the costs which could be reduced by the implementation of specific groynes, in a long term strategy. The negative costs are caused by the frequent maintenance of the nourishments erosion, due to the tides, the winter storms, the raising of the sea level and to the lack of protection of the groynes. The sand is going to cover the groynes in different quantities according to the warning zone.

The cities with an higher need of hard coastal defense will need an upper profile of sand to respect the level of safety for the coast, like Oostende, Blankeberge and Knokke.

I've chosen to focus on one of these cases to apply the "Alternative 6" of the M.E.R. or rather, the sand-nourishments with groynes supplementation.

In the case of Knokke the groynes are vary important. The presence of the existing groynes in Knokke-Heist guaranties 'de Appelzak' away from the coast and they keep the sand in front of the dike as well. The current beach has already a steep profile, also under the low tide waterline.

The so called "Appelzak" is a pit in front of the groynes at the east side of Knokke beach. The hollow is due to the the clash of the currents from east, caused by the Zwin deltas, and the currents fro west, coming from The Channel.
The erosion takes away more than 10cm of send per year. In the '70, '80 and '90 have already been done important nourishments. At the end of the winter the erosion in significantly visible.

The sand, in order to provide the safety level, would be nourished according to the beach profile of the steep sand, more or less the same slope as the current profile, but it will be situated more in the direction of the sea.
Since the outlines move in the direction of the sea, because of the sand nourishment, the groynes require to be extended towards the sea as well.
A groyne of 350m length and 10m width would be raised with 2m in order to stick out of the sand and withstand the waves. According to the M.E.R in Knokke-Heist could be necessary the enlargement and rise of the existing 11 groynes numbered: 10-1-2-3-4-5-6-7-8-9-11, from the section 233 to the section 242.
With 2m of extra layer the stone quantity would be of 7000m3 per groyne, totally 80.000m3 for Knokke-Heist.

1.2.3.2 STRATEGY

The thesis is aimed to design a possible extention of a groyne in the beach of Konkke Heist, starting from the assumption that:

"Protection against the sea cannot be seen as separated from the other tasks in the coastal zone: natural development, economic development, the development of a coast that is attractive to tourists and residents and the development of sustainable energy are the basic principles of an integrated formulation of each project for the coastal area.
...a design in which the functional aspect – incre¬asing coastal security – is linked to an upgrade of the public space, considering the importance of this zone to tourism and recreation, and the character of the public space."

Vlaams Bouwmeester. OO2404 Open Oproep.

The beach is the common ground of the inhabitants of the coast and being usable only by temporary settlements, it lends itself to be naturally the "main square" of the coast. It's a strip of sand constantly washed by the tides, a sort of gigantic waterline, unstable ground, not suitable for privatization.

According to the Environmental Assessments the sand supplying with groynes creates additional recreational opportunities, food source for wader birds, less maintenance of the beach, but also involves risks for activities such as swimming on surfing and increase barrier for beach walkers.

This are actually positive and negative aspects which could be enhance and solve at the design scale, working with the volume and the materiality of the groyne supplementation, trying to find a compromise between the form of the infrastructure and the proportion of the human scale.

But how to design the addiction, how to make it both a coastal defense, an intermediate structure to guaranty a safe used and part of the tidal landscape in the foreshore. The thickness of the addiction could be use to reaffirm the groyne as a place, extension of the facilities of the dyke and of the higher beach.

During the last century these coastal defenses where used by the bathers thanks to chairs, carts or beach cabines. I think that nowadays is necessary to interpret those tools according with the present needs.
If in the last century the bathers were trying to find a compromise with these hard coastal defense, nowadays the perception of the sea is with distance.
The cabins, the chalets are settle on the higher beach instead of to colonize the water line. The view of the horizon became the main attraction, and the space between the view and the landscape has been turned to a distance which can't be measured.

Nevertheless the summer on the coast is a moment of strong modification. A vast amount of temporary facilities is built all over the higher beach. Chalets, cabins, pals, wind proof towels, pup up hotels are assembled, in order to supply at the bathers needs and provide entertainments. The coast is completed by the addiction of those several props.

I say it's completed because there is a part of them which is already there, that allow the colonization of the props and work as a infrastructural element for both the temporary settlements and for the defense of the coast.

The dyke is actually the "Res Publica" of the coast, it the compromise between the population of

the coast and the landscape. Which gives order and condensation of the rituals and the activities of the Belgian coast.
The dyke is also the sharp edge between the privatized ground of the apartments blocks, the fashion brands, the restaurants and the public beach of the temporary chalet, the windscreens and the sport activities.

"New coastal defense structures should be in accordance with other uses in particular with tourism and recreation. They should also ideally act as an extension of existing soft and hard coastal defense structures."

Gaufre

As well as the dyke, the groynes gather the same potential of and condensation of the rituals and the activities.
But differently from the dyke are connecting the public and the privatize ground. The groyne are path through the sea, the tidal landscape of the forshore, the higher beach and the dyke. They are the extension of the civilization and the walkways of the sea.

Thus in my opinion the groynes are valuable specific urban structures as well as the dyke, even more. I believe that could a specific urban instrument to raise awareness of both the use of the hard coastal defense infrastructures and the potential of a tidal landscape. The tidal landscape meant like a zone which may be consider as a "surface in transition" instead of a "barrier".

The groyne could be the extension of some of the functions compressed on the dyke, decreasing the preassure from the line to a zone.

" Where hyper-individualism and the economy of experience intersect, that's where Mare Nostrum becomes Mare Meum. The pressure imposed on this ribbon city and the landscape behind it by exclusive housing, (mass) tourism, leisure and recreation continues to increase. "

MUD.

The sand is temporary, to be replaced, constantly in movement: it's a soft component of the shore. The dyke is permanent, do not require much maintenance, it's a stable heavy loads in the sand: it's the rigid components of the shore.
The groynes gather both components into a gradual desified massive structure which lays and adapt on the sandy bottom.

The way the groynes are built is in my opinion interesting to explain the way hard coastal defense are interfered by the tidal landscape the privatized land become the common ground.

Starting from the dry shore the groyne is liked by large slabs of reinforced concrete to the dyke, which are usually under the sand, the core consists of rubble stones of 2-300kg which is lying on a layer of compacted sand, separated by a geo-textile. The surface of the volume is more rigid and built by Blue Ashlarstone or concrete blocks of 1-3 t, jointed by mortar. The following part has a different finishment: the section is changing at the bottom by an additional layer under the rubble stones, a "mattress" in plastic tissue with weapon rack in wicker, meant to get stuck in the sand. Then the surface is out of the same stones of before but without mortar, so it is made to adapt to the strengths of wave, and keep the sand. The "mattress" continues under the next part which is complete different from the previews: it's realized by stereometric rocks of 25t, cubes of 1,5m large, arranged on several layers of the same plastic tissue with weapon rack in wicker,

finished by a layer of rubble stone. The rocks define a perimeter, and work as wave breker, eroded by the water and the species.
The infrastructure works as a rigid component keeping the sand and as soft component adapting to the sand bottom and the wave breaking.

The way the groynes are colonized is vary interested as well to way the habitas and the micro-environments are interfered by the tidal landscape and the simple platform became a rubble stone garden.

The groynse are also the condensation of several micro habitats: The groynes are made out of stones in different size and finishing. The constant transition of the tides caused processes of erosion which have changed the aspects of these infrastructures. Whether the groynes are artificial hard coastal defenses on the other side have been totally integrated by the processes of erosion, making them the habitat of several species. The heads of the groynes are nowadays the attraction of many inhabitants of the coast, displaying also a vast amount of micro environments and becoming platform for the amateur fishermen. In general, the ecological value on the groynes increases with the length, the height and the number of microhabitats.
These species are living in symbiosis, the mussels and the oysters are the "fertile ground " of sea weed and anphipods.
Follow a list of the main species which lives in the crowns of the groynes and between the high and low tide zone. Mussels "semibalanus balanoides" and "mytilus edulis"; oysters "oyster ostrea edulis", "japanese oyster", "crassostrea gigas"; shore crab "carcinus maenas"; sea stars; shrimps gobies; alga "purple seaweed", sea sponges, sea spiders, octopus.

In the framework of coastal defense several artificial hard substrates have been built. In total 127 groynes and 33 beach groynes.

"The degree of exposure in relation to the waves, the building material (concrete or Belgian blue stone Arduin, wood and asphalt), the length and height of the groynes that also influences the degree of exposure, the shape (the presence-absence of a dump of stones, loose-fixed blocks) and the degree of silting are strongly correlated with the presence of diversity of habitat".

GAUFRE

1.2.3.3 DESIGN

1.2.3.3.4 The Walkway Description

I've been making a proposal for the groyne n^ 3, in front the secondary street of Marie Josestraat, next to the Lichttoren-plein square and the Bunnenplein square. One of the most visible coming from the Lippenslaan, wich is the main street of the city of Knokke Heis, arriving from the train station or the highway.
The existing groyne is 370 m long and 8-10 m large. It goas from 3+m T.A.W to -2m T.A.W., the average slope is 1.4%. One third of the groyne is laying under the sand for about 100m from the dyke, that guaranty a higher beach from +8m T.A.W to +3m T.A.W., 2-3 m lower than the dyke and 3-4m higher than the groyne.

The groyne n^ 3 is going to guaranty phenomena of deposit and slowing down erosion on the west side of the infrastruc-ture, section 235. While on the est side ther will be phenom-ena of erosion due to the waves from the Zwin delta and the pit of the Appelzak.
According to the nourishments, in order to have a constant slope shore profile, will be added a layer of sand from 1 to 2 m higher of the existing profile.
The existing groyne will be raised by 2m, sticking out of 0.5-1m from the nourishment profile.

The design is meant to arrange some public facilities on the groyne, organized in rigid and soft components, interpreting the construction components as a design tool.

1.2.3.3.5 The Costruction Techniques

From the dyke to the high tide waterline the the terraces steps are realized in concrete slabs, carried by lateral structural boxes in concrete, partially pre casted and partly thrown in connection to the underlying platform.

From the waterline to the crown, the pools are framed in rigid L shape edges, out of pre-casted concrete caissons, placed on the side of the existing groyne and partially thrown in connection to the underlying platform.
The edges of the frames are opened in the center of the groyne, the infrastructure can therefore slightly adapt to the asymmetrical strengths of the transversal waves impacts.

The concrete pre-casted blocks are stuck in the massive blocks and intertwined at the bottom by a rebar net, wich is meant to allow the adjustment of the blocks and to keep them as well stuck under the weight of the oter massive block over the net.

The rocks of the crown have different sizes, the edges are in massive blocks, following the existing crown perimeter.
In the frames there will be added new rubble stones and rocks of a smaller size to up-grade the weight and the height of the crown. The blocks and the stones supported without being joined.

1.2.3.3.6 Costs Strategy

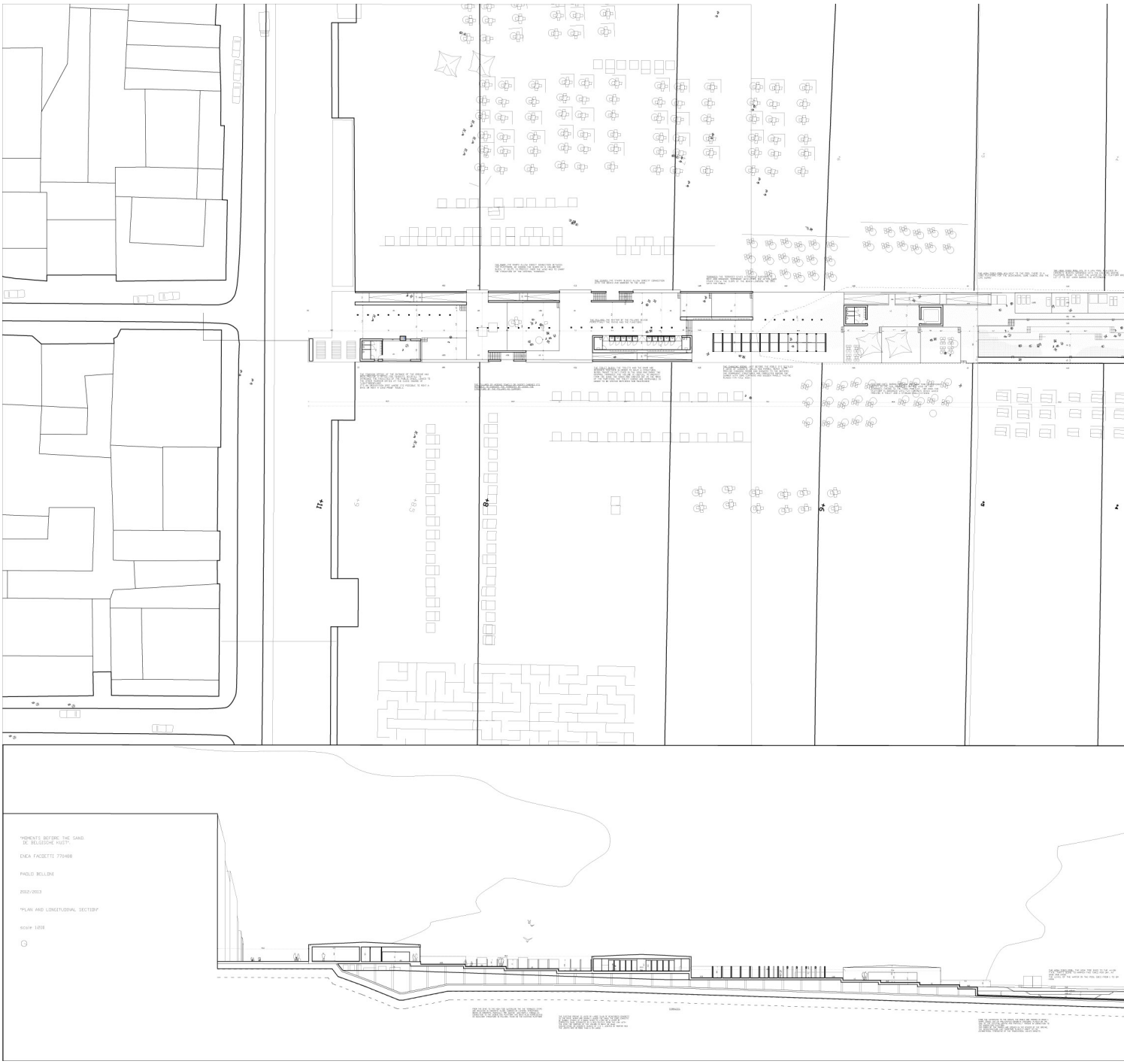
The sand nourishments according to the Master plan Kustveiligheidsplan will cost 300’000’000€.
200’000’000€ is the cost of the actual sand nourishments .
The total is due to the costs of the sand of 15€/m3 for the total amount of sand, 20’000’000 m3.
The other 100’000’000€ are the costs of maintenance, considering a renovation of the sand each 5-10 years.

To provide the sand nourishments for 200m of beach in fort of the Lichttorenplein square costs 180’000€.
To keep the same 200m of beach by a complete new groyne 600m long costruction will costs 1’544’000€.
The difference is that the nourishments need to be maintained each 7 years, while the groyne can resist till 75 years.
Besides the groyne I’ve chosen for the design is 350m long.
The nourishments will raise to 1’260’000€ versus 1’000’000€ of the groyne maintenance, in a long term strategy of 75 years.
Moreover the costs of the intervention are going to be an investment for the future.
The design will ensure that the infrastructure will become a source of income. Thanks to the facilities.

The costs have been taken from the GAUFRE research and the Afdeling kust RDS workshop .

URBAN SCALE REDRAW AND ANALYASIS TAV.01

MASTERPLAN TAV.02



PLAN AND LONGITUDINAL SECTION TAV.03

COLLAGE TAV.04

2 BIBLIOGRAPHY
2.1 Books

"GAUFRE a flood of space.Towards a spatial structure plan for the Belgian part of the North Sea" Project lead: Frank Maes, Jan Schreijvers, De Windroos, 2005, Beernem.

Ccaspar, "I don't believe In global worming", Climate change and changes in spatial structures research project, publisherDate, place

John Pauwels, ir. Tina Mertens, P. DeWolf, T. Verwaest, K. Trouw, L. De Nocker, K. Couderé, "Masterplan Kustveiligheid", Afdelig kust,Waterbouwkundig Laboratorium, Universiteit Gent, Afdeling Kust, VITO, IMDC, TRITEL, CIBE, Pantarein publishing, 2007-2011.

Carl the Keyser, "Moments before the flood", Lannoo, 16/08/2012*place

Peter Swinnen, Stefan Devoldere, Tania Hertveld, Joachim Declerck, Roeland Dudal, Joeri De Bruyn, "The ambition of the territory. Vlaanderen als ontwerp", VAI, Biennale di Venezia & Tentostelling De SIngel, 25.11.2012,Bruxelles.

2.2 Articles / Essay

Benjamin Pors, “Van Glorie tot Banaliteit” , A+ 236 magazine, pag.30, Juni- July 2012, Brux-elles.

Van Lancker V, Du Four I, Degraer S,…,QUEST4D, “Final Report Phase 1, Quantification of Erosion/Sedimentation patterns to Trace the natural versus anthropogenic sediment dynamic”, 2009, Bruxelles.

D. Van Den Eynde, L. De Smet, R. De Sutter,…, SSD,“Evaluation of climate change impacts and adaptation responses for marine activities”, Belgian Science Policy, 2009, Bruxelles.

Koen Couderé, Kristin Bluekens, Iris Catteeuw, Koen Trouw,“Plan/Voor het Geintegreert Kustveiligheidsplan. Kennisgeving”, Agentschap Maritieme dienstverlening en Afdeling Kust, 26/06/2009

Afdeling kust, “Nieuwsbrief van de afdeling kust. NB 01-02-03-04” , 2008-2010, Oostende.

John Pauwels, ir. Tina Mertens, P. DeWolf, T. Verwaest, K. Trouw, L. De Nocker, K. Couderé,“An integrated master plan for flanders future coastal safety”, Afdelig kust,Waterbouwkundig Laboratorium, Universiteit Gent, Afdeling Kust, VITO, IMDC, TRITEL, CIBE, Pantarein publishing, 2007-2011.

Ccaspar, “Compartimentimentering van de kust” A+ 236 magazine,pag.40, Juni- July 2012, Bruxelles.

Ccaspar, “Superstormen”. Ccaspar, Climate change and changes in spatial structures research project. Congress kustbescherming, 13/10/2011, Oostende.

Ccaspar, “Coastal flooding risk calculations for the Belgian coast”, at the 31st International Con-ference on Coastal Engineering 2008 from the August - September 2008 in Hamburg.

Jeroen de Waegemaeker, “Climate responsive spatial adaptation, research by design on the Flemish coast”, Gent University, 17-18/12/2012, Gent.

“Key stone species, MPA-s and the ecosystem approach”, Marijn Rabaut, Ulrike Braekman, Uiversiteit Gent, 22/03/2011, Leuven.

Pieter Foré, “Ontwerpend onderzoek aan de kust: De Westhoek“, Ccaspar.

Caroline Goossens, Charlotte Geldof, “Zee in zicht” A+ 236 magazine, pag.46, Juni-July 2012, Bruxelles.

Charlotte Geldof, “The future commons 2070”, magnificent surroundings.org, , CcASPAR, 18/12/2012, Ghent.

Charlotte Geldof, Nel Janssen, “Maritieme Ruimtelijk Planning, Kritische visievorming en het belang van de commons”, Ruimte & Maatschappij magazine, pag. 20, 2010.

Charlotte Geldof, “Ruimtelijke planning op zee !?? met de zee mee? over het hoe en waarom”, March 2009.

Caroline Goossens, “Beeld van Mare Meum”,Tweede Internationale Architectuurbiënnale van

Rotterdam, 2005, Rotterdam.

Ministerle Vlaamse Gemeenschap, “Ontwerp van en natuurtechnisch Strandhoofd te bouwen in Lombardsijd. Verslag van de studie”, Haecon (Harbour & Engineering Consultants), 29/04/1998, Drongen.

Francis Maertens,“Bepaling van een ontwerpfactor voor strandhoofden in LITPACK m.b.v. 2D XBeach model resultaten”, Promotor: prof. dr. ir. Peter Troch, Begeleider: Annelies Bolle, Master in de ingenieurswetenschappen: bouwkunde, July 2012, Ghent.

“Strandhoofden als studieobjecten van ingenieurs en biologen”, …vado a vedere sul sito estratto VLIZ

J. G. L. Jorissen, “Strandhoofden Gemodellerdin Delft 3d Ram. Strandhoofde3n Als instrument voor het regelenvan het langstransport”, TU Delft, prof. dr. ir. M. J. F. Steve, December 2001, Delft.

Elaine Pearce, Mark Searles, Kerrie Curtis, “Old bar beach san replenishment Group In.”, OBBS,EAP, 29/04/2009, Wallabi Point.

Ing. G.W. Dekker, “Gemeente Den Haag”, Brandweer Veiligheidsregio Haaglanden, 09/09/2012, Den Haag.

Alexander Vandenbohede, Carolien Courtens, Luc Lebbe, William De Breuck, “Fresh-salt water distribution in the central Belgian coastal plain: an update”, Geologica Belgica, 2010, Ghent.

Luc denys, Cecil Baetemans, “Holocene evolution or relative sea level and local mean high water spring tides in Belgium. A first assessment”, R.U.C.A., International Journal of Marine Geology, 10/10/1994, Bruxelles.

Maurice Hoffmann, “Beheerplan VNR De IJzermonding”, , Agentschap voor natur en bos, Universiteit Gent, October 2006.

Baron W.F. Van Asbeck, “Bitumen In Coastal Engineering”, M.I.G.B., The Shell Petroleum Company Limited, London.

Ir Bernard Malherbe, “Sand: a natural resource for coastal protection”, Jan De Nul Group, 1990.

ADVIES, “Verwijderen Strandhoofden 51 en 01 te Duinbergen. Memo van resultaten”, . Flanders hydraulics research, October 2005.

Koen Trouw, “Als een paal boven het water van palen tot strandhoofden”, Fides Engineering, 2011.

Bart Deronde, “The sediment dynamics along the Belgian shoreline, studied with airborne imaging spectroscopy and LIDAR”, Promotor Prof. Dr. Jean-Pierre Henriet, 2007, Ghent.

H. O’Keeffe & A. Bartels, “Report for Busselton Groynes and Seawall Preliminary Options Assessment”, GHD Pty Ltd, Department for Planning and Infrastructure, 12/09/2007,Perth.

W.D. Meinema, B.V. Uitgave Waltman, “Handboek zandsupplementie”, Ministerie van verkeer en waterstaat, Rijkswaterstaat, 04/03/1988, Gravenhage.

“A guide to coastal erosion management practices in Europe”, National Institute of Coastal and Marine Management of the Netherlands, Eurosion, January 2004.

Prof. dr. ir. P. Verdonck, “Stabiliteit en transmissie van een laagkruinige golfbreker deel i: tekst”, Promotor: Prof. dr. ir. J. de Rouck, 2006, Ghent.

Agentschap voor Maritieme Dienstverlening en Kust , “Afdeling kust”, November 2010, Oostende.

P. De wolf, D. Fransaert, J van Sieleghem, “Morphological trends of the Belgium coast shownd by ten years of remote/sensing based surveying”, 1989.

RSD workshopzeewering en zoveel meer, “Waarde van 1m³ zand voor kustveiligheid”, Maritieme Dienstverlening en kust, januari 2010.

Ir. A. Pape, “Constructie van golfbrekers en geleidedamnen”,1970, Delft.

Fabiana Maccarini & Massimo Grisoglia, “Cedimenti di opere di difesa a mare di tipo verticale su alti fondali”, Diprtimento Ingenieria Strutturale e Geotecnica, Università degli studi di Roma, IARG 2005, 29/06/2005, Ancona.

Annemie Volckaert, Henry Engledow, Olivier Beck, Steven Degraer, Magda Vincx, Eric Coppejane en Maurice Hoffmann, “Onderzoek van de ecologische interacties van macroalgen, macrofauna en vogels geassocieerd met intertidale harde constructies langsheen de Vlaamse kust.”,
Instituut voor
natuurbehoud , June 2004, Ghent.

Jose Pedro Osuna Ca~nedo, “On the high{resolution simulation of the dynamic interaction between current and waves in coastal waters: an application to the Southern North Sea”, Promotoren: Prof. dr. ir. J. Monbaliu Proefschrift , Prof. dr. N. Vandenberghe, Katholieke Universiteit Leuven Faculteit Wetenschappen, May 2002, Leuven.

Leão Rodrigues, “Wave power conversion systems for electrical energy production”, Department of Electrical Engineering Faculty of Science and Technology Nova University of Lisbon,2008, Caparica.

2.3 Links

http://www.vliz.be
http://www.kustveiligheid.be
www.afdelingkust.be
http://www.agentschapmdk.be
http://www.maritiemetoegang.be
www.ccaspar.ugent.be
http://www.ilvo.vlaanderen.be
http://www.kustatlas.be
http://www.imdc.be
http://www.watlab.be

http://gluedideas.com/Encyclopedia-Britannica-Volume-5-Part-2-Cast-I
http://www.innovatielocaties.nl/veiligheid/rijke_dijk
http://archive.nrc-cnrc.gc.ca/fra/idp/chc/cotes/ouvrages.html
http://www.fonti-rinnovabili.it/index.php?c=news_dett&id=5388

http://www.west8.nl/projects/happy_isles
http://www.vlaamsebaaien.com

3 INDEX IMAGES

4 INDEX CHARTS AND GRAPHS

5 ATTACHEMENTS

5.1 Binder Office: “Zeestad 2070. 058-VAI. MVV. 1.”

5.2 Binder material review: “Working process ”

5.3 Sketch books: tot n° 4

5.4 Urban scale redraw and analyasis tav.01

5.5 Masterplan tav.02

5.6 Plan and Longitudinal section tav.03

5.7 Collage tav.04

RESEARCH BASED ON:

Master Plan *Kustveiligheid* / M.E.R. *Milieu Effect Rapportage* / GAUFRE / Happy Isles (West 8 & Svasek) / Vlaamse Baaien 2100 / CCASPAR *Climate Change and Changes in Climate Structures Research Project* / The Road Map 2050 (OMA) / M.U.D. *Multi User Domain* / The Future Commons 2070 (C. Geldhof) / Land & Zee 2070 (MikeViktorViktor) // Moments before the sand (own research) //