COASTAL CONDITIONS:
Responding to the Partial Opening of the
Haringvliet Sluice

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INTRODUCTION
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DESIGNING WITH NATURAL PROCESSES

Landscape architects create spaces, places and forms. These spaces are mainly outdoor, where they are affected by natural processes such as decay and growth. The photo opposite shows the power of natural processes.

Landscape architects take different positions on their role in creating form. Should landscape architects ignore natural processes in their designs and design a form of outdoor architectural ‘sculpture’? Should landscape architects design outdoor spaces in the style of ‘gardens’, manipulating and maintaining forms in both vegetation and architectural materials to be an unchanging and proscribed scene, as much as possible, throughout time?

In The Trouble with Wilderness, author William Cronon notes that the only way to allow natural areas to continue and succeed is

“If we abandon the dualism that sees the tree in the garden as artificial—completely fallen and unnatural—and the tree in the wilderness as natural—completely pristine and wild.” (16)

A garden or courtyard then should not be entirely controlled and artificial. A farm should not be planned as disconnected from surrounding natural areas. A natural area should not be regarded as unchangeable. Landscape architects cannot continue to design by proscribing, and instead must design with natural processes in order to create responsible spaces that consider both how the site will change over time – and how the site will affect other sites around it.

INTENT
The intent of this paper is to demonstrate how to create responsible landscape architectural designs in coastal areas. In the next few paragraphs, the theory behind designing with nature will be explained. Next, the natural and cultural processes of coastal areas are introduced. To demonstrate how these processes can be used in a design, coastal landscape projects are analyzed. Finally, lessons from these projects are generalized to form design principles, and extrapolated to the specific design project of the author to demonstrate the applicability of the design principles.

The specific design project of the author is located in a coastal and fluvial area south of Rotterdam, in the Rijnmond area (Figure 3). The design question revolves around the opening of the Haringvliet dam, and the creation of an island that could resolve some of the storm impact and saltwater intrusion issues created by the opening of the sluice.
This island must respond to needs in an integrated manner: promoting the enjoyment and recreation of Dutch residents, the ecosystem needs of the area, and the pragmatic needs of people such as protection, economic strength, housing or energy extraction.

To begin designing the island, it is necessary to first understand the relevant theory of designing with nature.

**DESIGNING WITH NATURAL PROCESSES: THEORETICAL DIMENSIONS**

Ian McHarg, a well-known landscape architect, explains that the main form of the design can be derived from the natural processes on the site. McHarg wrote,

“Form and process are indivisible aspects of a single phenomenon. The ecological method allows one to understand form as an explicit point in evolutionary process. Again, Lou Kahn made clear to us the distinction between form and design. Cup is form and begins from the cupped hand. Design is the creation of the cup, transmuted by the artist, but never denying its formal origins. As a profession, landscape architecture has exploited a pliant earth, tractable and docile plants to make much that is arbitrary, capricious, and inconsequential. We could not see the cupped hand as giving form to the cup, the earth and its processes as giving form to our works. The ecological method is then also the perception of form, an insight to the given form, implication for the made form which is to say design, and this, for landscape architects, may be its greatest gift.” (218)

Within the design methodology, Hargreaves incorporated the natural processes by adopting an open-ended approach – letting natural processes also define form. Meyer continues,

“Hargreaves’s firm is working toward a design practice that might be understood as initiating process instead of imposing form. In an interview with Jane Brown Gillette, Hargreaves described the differences between establishing a set of principles that lead to a design thesis and imposing a set of fixed forms” (221).

By not only concerning themselves with surface forms, but also with the natural and cultural processes behind the forms, in the same way that landscape architecture forefather Lawrence Halprin studied both wind erosion and the sculptural forms created by erosion, landscape architects can responsibly design for a sustainable, integrated future landscape.

Where there are stronger natural processes; the processes must be considered even more deeply. Coastal areas have much stronger and more fluctuating natural variables than many sites in more sheltered areas. The chosen site is in a coastal area - therefore an inventory of the site-specific processes must be understood.

The park includes mounds and a terraced lawn beside a waterfront. Landscape critic Elizabeth K. Meyer notes,

“The shaping of the landforms and the primary spatial sequences around them refer to, and rely on, the site’s wind processes in varied ways: they channel and deflect the wind’s flow to create a rhythmic experience of calm and force, sound and silence, stillness and movement; they allude to other forms shaped by the wind, such as the aeolian dunes; and they create various microclimates that create diverse habitats of volunteer grasses and wildflowers to supplement those planted on the site.” (214)

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Where there are stronger natural processes; the processes must be considered even more deeply. Coastal areas have much stronger and more fluctuating natural variables than many sites in more sheltered areas. The chosen site is in a coastal area - therefore an inventory of the site-specific processes must be understood.
Many studies have been conducted on relevant natural and cultural processes. Generally, natural processes are studied by scientists and engineers, while cultural processes are studied by sociologists and urban planners. Both must be studied by landscape architects. Dr. Ronald Waterman, a preeminent engineer, creates designs in coastal areas that attempt to respond to and work with natural processes. He works mainly with materials of “loose mobile sand and silt; ranging from coarse to fine, and the forces and interactions to which they are exposed.” He notes that the forces and interactions consist of:

“Tidal action (ebb & flood), Wave action (specifically in the breaking zone) and swell action, Sea currents other than tidal currents, River outflow (as force and as supplier of freshwater and sediment), Gravity, Wind, Rain, Solar radiation, Interaction dunes - vegetation (root system vegetation keeps together sand/silt), Complex interaction marine organisms – sand/silt, [as well as] Existing Biogeomorphology & Geohydrology of Coast and Seabed” (Waterman, 12). These coastal natural processes should act as tools for coastal designers. (Waterman, 12)

These coastal natural processes should act as tools for coastal designers. Other examples of coastal natural processes include the complexities of sedimentation and erosion arising from the geometry of the coastline. Figure 4 on the upper left shows some of these principles: for example, a solid wall will reflect a wave, increasing its peak and trough and therefore having greater erosion of the coast. Understanding the diagrams will allow one to see how the shape of a coastline affects the processes, in order to minimize erosion. Figure 5 on the upper right, drawn by landscape architect Ian McHarg, shows some of the processes of vegetation growth and sand movement in relation to wind in coastal dune areas.

Additionally, cultural and human development forces and interactions should be considered. These pressures could be: residential, energy supply, food production, recreation, freshwater supply, commerce, industry, education, heritage conservation, religion, health care, transit, infrastructure, ecosystem stability and environmental conservation, etc.

Prof. Christopher Charles Benninger, an architect who taught at Harvard, believes that the ten principles of intelligent urbanism are: balance with nature, balance with tradition, appropriate technology, conviviality, efficiency, human scale, opportunity matrix, regional integration, balanced transportation movement, and institutional integrity. One could view these principles as the optimal state of cultural processes.

However, understanding and mapping the processes on a site is only the first step in understanding the effects of interventions. For example, to design in interaction with natural processes, Waterman specified that to add more sand to the coastline of Hook van Holland, the sand supply by dredging boats should only be gathered after 20 meters depth of seawater, ensuring that the slope of the coast stays intact and relatively undisturbed; preventing underwater erosion.

To give an example of how to intervene to affect cultural processes: in his book, Designing Cities, Leonhard Schenk notes that,

“Instead of beginning by assembling the smallest parts – the buildings – with urban design it is more sensible to start at a level higher with building lots, and for larger schemes, with districts and development sites.” (147)

Once the largest zones are framed, the smaller areas will grow logically and naturally. To give examples of strategic interventions that will work with cultural processes, Schenk notes that the city layout, in terms of zones and/or building lots, should be developed using principles of axis and symmetry, hierarchy, datum, and repetition, sequencing and rhythm, and grouping (Figure 6 and 7). Therefore it is important to not only understand the forces that affect an area, but also how one can design to interact with these processes in the desired manner. Projects that design by interacting with natural and cultural processes are analyzed in the following few pages.
A successful design, which works with cultural and natural processes in a sustainable manner, can glean design solutions from past coastal design projects. This method allows designers to, in the words of Isaac Newton, ‘see further by standing on the shoulders of giants.’

HOOK VAN HOLLAND

One coastal design example is the area north of Hook van Holland. This area was designed by Eng. Waterman, and constructed partially to his design (Figure 8).

Waterman designed the area by first analyzing the evidence of processes on the site. He noted the dune ridges and valleys through the plot angles in Den Haag, as well as the fact that the pond near houses of parliament was a remnant of the dune valley. He explained that inner dunes are different than outer dunes: the angle of inner dunes is based on wind, the angle of outer dunes is different because it is based on coastal waves. The linear dune ridges in the Den Haag area were once parabolic inner dune ridges in which the vegetation did not take hold.

Waterman analyzed the past and the formation of the contours because, as he notes, “Good plans have roots in the past and are pointing towards the future.” [Personal Communication, December 10, 2014]. By having roots in the past, one can understand how the natural processes in the area work: from geology, to vegetation, to wind. He also analyzed the groins on the coast and realized that they were not working. Each groin creates a rip current that carries sand away from the coast (Figure 9). He found that the best way to trap sand is to create a very large concave angle – as one can see on the coast of the Netherlands. He also notes that to place the sand there, dredging methods should be used that collect sand from far offshore, at 20 meters depth, to not undercut the coastline.

Waterman’s design project then consisted of a phased evolvement of sand additions to the Hook van Holland coastline, with dune valley pools that serve as south-facing recreational beaches. In the built design, the dune valleys were left to nature and the beachfront was used for recreation.

Design principles:
1. Parabolic dunes become linear dunes if the vegetation does not hold; Den Haag is an example of development over linear dunes, with the dune valleys becoming contained moats or channels. The new design was developed to integrate along the same patterns as both the dunes contours and the urban development.
2. Wind or another process can ensure a certain form, allowing phased development along this path.
3. Waterman creates zones that respond to natural processes. Less dynamic areas in terms of effects of natural processes are more appropriate for tourism and recreation, while more dynamic areas are more useful for ecosystems in terms of having more diversity of ecosystem niches. This is an interesting approach, but not necessarily true in terms of ecosystem diversity value at a regional scale. Therefore, the zones should respond to natural processes but also cultural and ecological balances.
4. To prevent scouring of sand, the coastline should function as a large concave angle.
5. Sand should be collected in an area that does not undercut the coastline.
BUCKTHORN CITY

The same Hook van Holland area was also designed (unbuilt) by landscape architecture firm West 8 (Figure 10). West 8’s proposal for Buckthorn City demonstrated a design for both nature and infrastructure growth over time (Figure 11). These two parts developed interdependently: first sand was placed and a dune landscape was created. Vegetation was used to stabilize land to allow building of housing and transportation. The built environment and harbors also helped fix into place the dune landscape. West 8 uses a time sequence plan and models to detail the growth of nature and infrastructure.

**Design principles:**
1. The zones between natural areas and cultural areas do not have to be highly defined. In a ‘dance with nature,’ built forms can adapt and change over time depending on the forms created by natural processes. They develop interdependently. This is demonstrated in the time sequence plan.
2. Buckthorn vegetation (a native species) was used to stabilize land.
3. The coastal dune was built up by wind and protected the land behind from the wind and waves.
4. Remnant of the past construction of the land is repurposed, adding cultural confrontation with the past and understanding of human construction to the landscape.
5. Residences and transportation routes are confronted with natural forms maintained in natural areas, which creates a healthy living environment as well as environmental awareness.
6. Connects clearly to the regional transportation and cultural pressures.

RECREATIONAL COMPLEX IN TRIESTE

The firm of Desvigne and Dalnoky created a design in a bay of an abandoned quarry in Sistiana, Trieste. The oceanfront ‘garden’ included tide pools that interacted with the rising tides (Figure 13). Paths for human visitors were designed according to principles of axis and symmetry, hierarchy, datum, and repetition, sequencing and rhythm, and grouping, and relation to existing contour (Figure 12). It was inspired by views of saltworks. The paths were layered with hierarchy, and would appear or disappear depending on the natural process of tidal movement. The innermost basin has water from a nearby freshwater stream, integrating both the coastal and fluvial processes, and allowing lagoon vegetation to develop in less saline water. The outline of the coast is also reworked so that it shelters the bay and garden. The ‘garden’ was coupled and contiguous with a more developed bay waterfront to the left, which included a port and recreation related to a building designed by Renzo Piano. Like the two previously mentioned projects, this project “uses the seaside environment as its primary material.” (Desvigne and Dalnoky, 31).

**Design Principles:**
1. A design language of straight lines can successfully interact with and highlight natural forms.
2. Natural materials are highlighted and adjusted, and used as a primary material in the design.
3. Paths and circulation are designed according to general design principles (as previously noted by Schenk).
4. Protection/Exposure to natural processes is used as a tool in design of natural spaces.
5. Fluvial processes are also harnessed in order to create an intended biotope.
DISCUSSION OF THE FINDINGS

As introduced previously, the intent of this paper is to demonstrate how to create responsible landscape architectural designs in coastal areas. Therefore, how can the design principles discussed in the previous pages be extrapolated and applied in a coastal design project?

**General Coastal Design Principles**

We can summarize the answer in these general principles that have been divided into three categories: contextual/site-derived in planning, temporal in design, and functional in use.

**Contextual and Site-specific**

1. The program should respond to the cultural and ecological needs of the area.
2. Next, the zoning should respond to the contours and natural processes in the specific site (Waterman Design Principle #3).

**Temporal**

3. The site should be built in a dynamic ‘dance with nature’ over time (West 8 #1).
4. The design should integrate with both urban and natural development of the processes on the site (Waterman #1, West 8 #6).
5. The natural processes, such as wind (in terms of dunes) and wave transport (in terms of coastline scouring) should ‘hold in place’ built elements instead of working to undo them as the design is constructed and after initial construction (Waterman #2, #4).
6. During construction, care should be taken to not trigger the heightening of unintended processes (Waterman #5, or West 8 #2’s use of native vegetation).
7. Protection/Exposure to natural processes is used as a tool in design of natural spaces (Waterman #3, West 8 #3, Desvigne and Dalnoky #4 #5).

**Functional**

8. Individuals should be confronted with both clearly naturally-formed spaces (West 8 #5, Desvigne and Dalnoky #2) and demonstrations how humans affect the seemingly ‘natural’ environment (West 8 #4, Desvigne and Dalnoky #1).
9. General design principles / planning layout principles should be used (Desvigne and Dalnoky #3).

**Extrapolated Coastal Design Principles**

These principles could be applied in the design project island creation of the author in the Rijnmond area, in one following way:

A. Analyze the cultural and ecological needs of the region, and decide on a general program that works with the site: for example, recreational housing, estuarine ecosystem rehabilitation, and energy creation (wind). (General Principles 1, 2).

B. Plan the island in an area that creates a lagoon ecosystem. (8).

C. Plan to spray sand to create the island using current dredging methods, making sure to take sand from an area that does not undercut the coast nor strongly impair the ecosystems in the area. (5).

D. Plan to spray sand to a height at which it is stable and does not wash away. (4).

E. Anchor the island with rip rap (rocks) on the area of most erosion, and a groin wall at the end area of sedimentation, to create a concave curve that prevents scouring (8).

F. Plan layout of housing and transportation development according to site conditions and urban planning principles (Schenk and Benninger) and developing interdependently and in parallel with the natural processes. (2, 3).

G. Plan the recreation areas and transportation paths to view natural forms and gradients, such as the estuarine mudflats (7).

H. Highlight the interaction between natural and artificial forms, as well as remnants of construction by placing recreation areas near the rip rap and groin wall, and creating a park that has a clearly defined gradient between saltwater and freshwater (from dune valley lake) ecosystems. (7).

I. Plan these areas not to have sharp boundaries – urban development should happen slowly, and every few years address if the natural processes have created new areas that were not predicted. These areas should then be redesigned to fit the current condition (3).

J. Finally, the master plan should be checked to see that it fully integrates with both urban and natural development of the processes on the site – allowing animal migration, and human migration, off and on the island (6).
DESIGN PROPOSAL
Problem Statement, Research Question, Models, Design Overview

This project was instigated by a fascination: how to harness and predict the effects of coastal forces in landscape design.

The Netherlands has always had a relationship with the sea, making it an apt place to explore this fascination.

Another engaging aspect of the site location includes revisiting the traditional Dutch techniques of coastal management.

Current tools such as GIS, modelling, and satellite data; as well as the current understandings they bring on coastal, urban, civil engineering, and ecological processes, allows one to partially predict and design with these processes, and conclude with a variety of solutions to the age-old issues of the Dutch coast.
In the Dutch DeltaWorks, which lasted from 1950-1970, various inlets to the sea were permanently closed, which pushed the saltwater line more and more towards the coast. Although these actions helped protect the inland against flooding, they also wreaked havoc on the ecological connection for Rhine River and estuarine flora and fauna, robbing them of the connection to the sea.

Under the EU Water Framework Directive, the Netherlands has adopted the opening of the Haringvliet sluices as a measure to attain the required good status of bodies of water.

The Netherlands promised to open the Haringvliet sluice because ecological integrity is dependant on the freshwater/saltwater estuarine system.

The project site and test area is located on the mouth of the Rhine to the sea: the Haringvliet. In this Rijnmond area, the river and sea connection is currently closed by a sluice that was built during the DeltaWorks, but will in the future be opened.

Proposed open Haringvliet Sluice

Saltwater incursion slowed by construction of the Deltaworks

test area

Above is shown the currently closed Haringvliet Sluice, a 56 meters wide complex of sluices with seventeen steel gates.
Many threats or opportunity points come from the opening, such as storms, saltwater influx, fluvial flooding, and high waveheights.

On the opposing page is shown four scenarios that were examined to demonstrate how the Dutch coast can respond to the opening of the sluice and try to address the challenges (2009 Adaptive Strategies Research Project, Delta Urbanism). Scenario 4 was chosen to detail as a designerly exercise.

The challenges are:

- storms from the coast
- saltwater influx disturbing the farming areas
- flooding from the river
- high inland wave heights

Graphics on this page by 2009 Adaptive Strategies Research Project, Delta Urbanism

8.5: Scenario 1: Degrading the role of Nieuwe Maas and Nieuwe Waterweg, locking all water entrances to the region, main discharge to the south of the region.

8.6: Scenario 2: Maintaining the role of Nieuwe Maas and Nieuwe Waterweg as main river channels, introduction of movable storm surge barriers at all water entrances.

8.7: Scenario 3: Maintaining the role of Nieuwe Maas and Nieuwe Waterweg as main river channels; improving existing dikes.

8.8: Scenario 4: Upgrading the role of Nieuwe Maas and Nieuwe Waterweg, combined with the introduction of controlled flood areas.
Design Proposal

Sedimentation and Erosion land/sea dynamics are important because designing with coastal natural processes in this project means supporting accretion and avoiding erosion.

Detailing the barrier island circled above (which is part of the coastal defense in Scenario 4) is the purpose of this thesis project.

Erosion and sedimentation principles (graphic on upper right) were studied to see how natural forces worked in this area. This understanding was used to know where to put sand or hard walls. For example, to understand reflective waves or where there will be sand accretion or washovers. These principles are applied to form the island.

From this challenge of the opening of the sluice and the detailing of the island from Scenario 4 comes the research question: How can we use the partial opening of the Haringvliet sluice to: Fulfill the estuarine ecological landscape potential, Protect the Dutch coast from excessive salt water intrusion and storms, Offer landscape architectural qualities for the region while utilizing the coastal natural processes?

**RESEARCH QUESTION**

*How can this thesis use the partial opening of the Haringvliet sluice to:*

- **Fulfill the estuarine ecological landscape potential**
- **Protect the Dutch coast from excessive salt water intrusion and storms**
- **Offer landscape architectural qualities for the region while utilizing the coastal natural processes?**
Various technical solutions for how to create the island were examined. Civil engineers were consulted (see sources).

The firm of Grontmij and consultants proposed a useful study for a barrier island in front of the opened Haringvliet sluice to prevent the saltwater influx into the channel. Their engineers used computer models to realize the optimal size and placement of sand to create the island. They named the island Balance Island. It determines through engineering models that this island (Balance Island) will stop saltwater incursion into the Haringvliet (the area of water behind the Haringvliet sluice), and it will reduce wave-topping heights.

These details add validity to the shape and form of the island (see details and a graphic below).

This thesis proposes that the solution to the challenges facing the opening to the Haringvliet can be more than just a sand mass, and more integrated than a simple technical solution.

It can change the entire region. It can promote a new lifestyle – living alongside nature, while respecting natural processes of ecology and coastal processes. This step will make the solution a landscape architecture assignment and demonstrate the landscape architecture relevance to the project.

So this thesis chooses to use the form and shape of Grontmij's Balance Island in order to meet the challenges of the opening of the sluice, but this thesis, as a landscape architecture assignment, will additionally offer enhanced landscape quality to the island and region.

In the next few pages it will be explained that other barrier islands also provide examples of various types of land use, and inspired by these case studies, various possible solutions of land use on the island were modelled. After combining them into one solution and refining it, the final design is exhibited (page 40).

The solution can be more than just a sand mass. It can change the entire region. It can promote a new lifestyle – living alongside nature, while respecting natural processes of ecology and coastal processes. Below are some examples of islands that have an identity that blends natural and urban processes.
To begin addressing the research question, case studies around the world were looked at to determine the useful program on the site, and analysed via relational scale, land use, and island identity.

Contextual research was also conducted, and is shown in the Appendix.
Programs inspired by these case studies were tested in various compositions, resulting in one composite model solution.

Model 0: No barrier

Model 1: Artificial Barrier Wall

Model 0 addressed the possibility of opening the Haringvliet sluice without placing any barrier to the saltwater incursion or storms. The negative aspects of this model outweighed the positive aspects.

Model 1 addressed the possibility of opening the Haringvliet sluice while placing an artificial barrier wall to stop saltwater incursion or storms.
Model 2 addressed the possibility of a fully nature park island. It explored how the Grontmij sand mass could transform naturally. It was a valuable design exercise to understand how the natural landscapes would grow. This step allowed the understanding of the development of the natural processes on the site, which are necessary to understand before interweaving the urban processes.

Example development over time: Natural processes

1 yr - Sluice opened more, estuary formed
1 yr - Rainbowing technique to place sand
1 yr - Rainbowing technique to place sand
2 yr - Sand moves, mud flats form, plants develop, vegetation grows over Voor-delta dunes
5 yr - Islands become fully colonized by species, sediment continues to move, creating deep channels and shallow areas
Model 3 addressed the possibility of using the island for a rich program of commercial and research uses.

Model 4 addressed the possibility of opening the Haringvliet sluice and using the island for a combination of seasonal housing and energy acquisition.
Finally, the resolution of the optimal balance of these programmatic models was reached in a composite model.

This composite model solution was detailed in a time series. This step was very useful in understanding how the human program and the natural program would interplay, although this is not the final layout of the design.
The composite model demonstrates the optimal location for many programs. The diagram on the right highlights why these programs are suitable for their positions on the island.
FINAL DESIGN
Here is shown the final design on a contextual regional level. In the next few pages an overview of how the design grows over time will be presented, and then the many aspects in which it addresses the research question will be exposed.
Time 0

A plan and section of how the test area looks currently.

1 m intervals height
20 m intervals width

SHALLOW SAND
Next, a concrete barrier, or ‘spine’ of the future island, is placed in the ground. The Haringvliet sluice is then opened.

This barrier was a human intervention placed on the site to change the siting of the erosion and sedimentation processes.
Time 3

Coastal sedimentation and erosion

Natural processes of sedimentation processes gather sand around the barrier.

These accretion processes were estimated to have an optimal time of seven years, although most of the sand accretion should occur in the first two to three years.
Time 10  Human Intervention - Sand Addition and Bridge

Additional sand is placed around the barrier using current dredging methods, making sure to take sand from an area that does not undercut the coast nor strongly impair the ecosystems in the area.

A bridge is built between the two islands.
Dunegrass is planted to stabilize the sand. The dunegrass will then quickly spread along the dunes, which helps stop the sand from moving.

A second bridge is built to the mainland and a harbor and ferry line is established to allow further access to the island. These are built by human intervention.

Natural reeds propagation (rhizome based)

Time 15

human addition of sand and fixing of sand from erosion with native dune plantings

marshlands/fluvial deposition

permanently flooded

low intertidal

high intertidal
Finally, lighthouses, housing, a ferry terminal and other facilities are established on the island.

The island was created with a combination of human intervention and natural processes.

**Time 25  Human Intervention - Facilities**

- CONCRETE SPINE
- SAND ACCRETION
- BUILT BRIDGE
- SAND ADDITION OR ADJUSTMENT
- SECOND BRIDGE BUILT
- STABILIZING DUNEGRASS
- HARBOR + FERRY LINE
- HOUSING + FACILITIES

**Finally, housing and facilities built on the stabilized island.**

**marshlands/fluvial deposition**

**dunes**

**high intertidal**

**low intertidal**

**permanently flooded**
The development of the region is shown here as a time lapse.
DECONSTRUCTION
Of the design project by thematic analysis

To exhibit the layers of the design, they will be deconstructed using these five general aspects: structure, process, program, accessibility and resiliency; as well as a zoom-in on design details.

Underlying Structure - Constructing a barrier wall to form the backbone of a new barrier island

Program - Industry, agriculture, and housing developments and their benefits.

Accessibility - Transportations options on-island and mainland access by water, bridges, or ferries

Design Details - Zooming in and explaining the island North to South

Resiliency and Multiuse - How the island and the surrounding area is both resilient and able to accommodate a variety of activities
The spine is highlighted as the keystone of change in the underlying structure.

Below is a graphic that shows how the spine develops. The materials shown above would work as the spine but concrete was chosen because it is more reliable over time as a securing mechanism. The spine stops saltwater intrusion and provides some habitat for a few organisms.

Design Principles from examples: Curvature from Grontmij study, wall details from Dutch dam precedents such as the Haringvliet sluice, and wooden pilings for sedimentation from RAAF.

The spine (highlighted in red), geomorphological processes, and plant propagation will determine the underlying topography. These topics will be discussed in this ‘Underlying Structure’ section.
Barrier island results in wave height protection

Sand accretion theories are accurate (Sand motor example)

The barrier island results in wave height decrease.

Plantings result in dune formation and sand accretion theories work. Planting anchors and allows buildup of dune sand. Human intervention through planting regimes and sand deposition can speed up the process.

These are ways one can speed up the natural processes. They are used in the design.

Mass.gov, Stormsmart coasts, Coastal Landscaping, 2014

These techniques are used in the design.
Sand flats, marshes, estuaries, dunes, and nature reserves (highlighted in red) will be altered both by the natural processes and human interventions proposed. These landscapes will be discussed in this ‘Process’ section.
Why will the sand flats be in this formation in the future?

The blue arrows, which show the main channel flow, show that now the flow is very directed, but in the future most of this flow will be directed towards the north since it hits the island, allowing more space for the sand flats to grow.
The development of the marsh areas are similar to the aforementioned sand banks - they depend on the water channels.

The marsh areas differ from the sand banks because they are less likely to move, they usually establish in more sheltered areas and they do not develop where there are minor currents.

Before the intervention there are small sheltered edges of marshland because of the major water channels.

After the water is redirected the areas of marshland grow since they are sheltered by the island.

The design will create important habitat and recreational landscapes.
In terms of dune areas, most of the island in the future will consist of dune vegetation because of the strong coastal winds and waves.

The dunes behind the island will continue to be dunescapes but develop 3rd generation dune species.

Dune area’s atmospheric inspiration:

Beach dunes in Ystad, Sweden

Dunes in Hook Van Holland, Netherlands

The natural forces and designated urban area that determine where there will be dunes.
For these endangered species, there is currently a barrier to their migration, but in the future, these barriers will be opened, allowing full migration.

These migration areas will therefore have areas of high or medium importance nature reserves.

The marshland and oceanfront areas are currently protected NATURA 2000 habitat, and a continuation of the protection increases lifetime development of ecosystems. Furthermore, tidal height and diversity results in habitat richness.

Why should these areas be high or medium priority nature reserves?

1. Currently valuable NATURA 2000 area of the Voordelta - a continuation

2. Tidal height and diversity results in high habitat richness
Endangered species around the world need the site to move though. The Netherlands is actually one of the most important areas in Europe for marine species as you can see with the dark blue, but has some of the highest nitrogen and phosphorus loading in it's waterways, which ruin ecosystems. By connecting the river and the sea and using aquaculture, you flush out the extra nutrients from the waterways, as well as provide habitat for native species. Native shellfish farming also helps reduce the nutrient overload.

Using native species will protect the region's ecological integrity.

Why must all plantings on island use native variety of a species?
1. They will grow well in that climate
2. As an alternative to an exotic species.
3. Invasive species create monocultures of habitat areas - that leave no space for the other species in the chain and destroying the habitat gradient or ecosystem
4. Regional effects. Where you plant is effectively a 'breeding zone, where the seeds of your plantings will spread along bird, wind, or water corridors.
On this spread is shown the native dune and salt marsh species in the ridges, slacks, scrub, valleys, and grasslands. On the opposite page one can see how the swale, which is in a more urban area, can still be planted using these native dune and salt marsh varieties.
The layers of natural landscapes are used by many endangered species (shown above in their optimal feeding tidal cycle). Here are all the endangered fauna species that use site (the Rijnmond area / mouth of the Haringvliet), and where in the tidal cycle is their most important feeding times.

Species richness is the number of species present in an area – on the opposing page are 3 site photos of low, medium, and high species richness, demonstrating as according to research, foliage height diversity results in high species richness.

“Species richness is simply the number of species present ... it is one component of the concept of species diversity, which also incorporates species evenness, that is, the relative abundance of species.”
- Mark McGinley, eoeart.org

Foliage height diversity and bird species diversity
MacArthur and MacArthur 1961, sky.scnu.edu.cn

The text reads:

- Black scoter (Melanitta nigra)
- Grey plover (Pluvialis squatarola)
- Curlew (Numenius arquata)
- Common teal (Anas crecca)
- Common tern (Sterna hirundo)
- Common redshank (Tringa totanus)
- Scaup (Aythya marila)
- Turnstone (Arenaria interpres)
- Eurasian wigeon (Mareca penelope)
- Northern shoveler (Anas clypeata)
- Oystercatcher (Haematopus ostralegus)
- Bar-tailed godwit (Limosa lapponioca)
- Red-throated diver (Gavia stellata)
- Northern pintail (Anas acuta)
- Red-breasted merganser (Mergus serrator)
- Common spoonbill (Platalea leucorodia)
- Gadwall (Anas strepera)
- Avocet (Recurvirostra avosetta)
- Sandwich tern (Sterna sandvicensis)
- Greylag goose (Anser anser)
- Great crested grebe (Podiceps cristatus)
- Eider (Somateria mollissima)
- Little gull (Larus minutus)
- Sanderling (Calidris alba)
- Common goldeneye (Bucephala clangula)
- Red-backed sandpiper (Calidris alpina)
- Shelduck (Tadorna tadorna)
- Cormorant (Phalacrocorax carbo)
- Sea lamprey (Petromyzon marinus)
- River lamprey (Lampetra /f_luviatilis)
- Twait shad (Alosa fallax)
- Allis shad (Alosa alosa)
- Grey seal (Halichoerus grypus)
- Harbour seal (Phoca vitulina)
- Cormorant (Phalacrocorax carbo)

This list includes many bird species known for their feeding habits in different tidal cycles and environments.
Native marsh plantings
Section Perspective with tidal, salinity, and habitat information for the test area location
Here is an overview of the programmatic layers in this section: industry, agriculture, and housing, and their current patterns.
These graphics show the industry areas before and after the barrier island construction. New industry areas are shown as the new harbour because of the shipping routes and the local fishing area established offshore.

The graphic on the right shows the agricultural areas before the intervention.
The saltwater influx will mean that some areas behind the sluice will have to change from agriculture to perhaps aquaculture.

Aquaculture could be a good option for this area because it uses nutrients from upstream, which are currently overloading the system, but seasonally flooded agriculture or recreation areas are other options.
Exploration of Regional Housing Types near the Haringvliet sluice. Regional housing types include historic buildings, holiday houses, and marsh cottages. A feasibility study of regional housing typology was outside the scope of this research.

Later in this thesis the housing aspect is further developed.

Regional Housing Types
A. High capacity, historic style. Visible from afar.
B. Holiday beach housing. Summer and weekend housing.
C. Historic style cottages that border the forest and marsh. More secluded housing close to nature.

Housing areas - Before Intervention
The fourth aspect is accessibility. The layers include shipping, water activities, island access, and more.
The shipping route related to the harbors.

To allow ferry and boat access to the island, it is advisable to add a marina to two existing marinas, as well as place it in a sheltered area along the shipping route.
The shipping route as well as the coastline results in the addition of three lighthouses.
The final piece of water accessibility is the zones for other human uses. It was discovered that based on depth of water, wind degree, and proximity to land, one could predict which zones would be suitable for a variety of activities.

**Water Activity Zones**

- A Close Proximity to land, Shallow, Windy/Salty water
- B Close, Deep, Windy/Salty
- C Far, Shallow, Windy/Salty
- D Far, Deep, Windy/Salty
- E Close, Shallow, Not Windy/Brackish water
- F Close, Deep, Not Windy/Brackish
- G Far, Shallow, Not Windy/Brackish
- H Far, Deep, Not Windy/Brackish

Potential activities corresponding to Water Zones:
- A Swimming, recreational beach, clamming, surfing
- B Sailing, catamaran cruises, scuba/snorkeling,
- C Saltworks, clamming, wadlopen
- D Fish Farming, lobster boats, fishing boats
- E Birdwatching, motorboats, kayaking,
- F Kayaking, ferry lanes, fishing, motorboat
- G Sea farms to clean water, wadlopen, endangered species
- H Shipping, container boats, trade routes
A major point to resolve was the accessibility of the island. Should there be a bridge?

Bridge:
- many Zeeland islands are accessible by bridge
- expensive to build and maintain
- cheaper goods at the market
- year round use
- attract young people

No bridge:
- no coastal Zeeland island only accessible by ferry
- relaxing journey
- small scale
- isolated
- dead in winter/ peaceful
- long travel from maasvlakte harbor

Transport to Island
The resolution was a compromise – a narrow bridge and a large nature reserve, where the bridge served only emergency vehicles, periodic delivery and public transportation during high season.

less boat traffic disrupting ecosystem
ferry use
year round suburban housing and use
secluded vacation spot
adaptable
connection with Maasvlakte
commuter residences
‘living alongside nature’

Maasvlakte bridge in high season only for periodic deliveries, public transportation and emergency vehicles
The graphic below is a section of the first bridge from the Maasvlakte to the first small island. The bridge must be very long, but it lithely connects the two sites while allowing space for boats and fauna to pass under.
The second bridge from the small island to the main island has a stronger form and serves as a landmark from afar. It also adds community identity and has an experiential contrast with the first bridge.
What is the journey to the island? In pink is shown the automobile routes and in yellow the views. The perspectives on the right show the views when travelling to the island by automobile, as most residents would do.
Views from the mainland

The views of the island from the mainland were also considered.

The graphic on the right shows the major viewpoints.

The text below shows what could be seen after the intervention.
Although the research project was deconstructed through four aspects; structure, process, program, and accessibility, as well as greater depth on urban planning and ecological principles, it is still necessary to briefly address the resilience and year-round use of the research project.

On the right are examples of coastal areas that did not design in accordance with coastal natural processes – for example, on the upper right the FEMA photo shows that the deck was designed to the state of Florida coastal construction (CCCL) requirements, and the house, which pre-dated the requirements, was not.

The photo on the lower right shows Oostvorne beach, where after a storm the railroad was destroyed, leaving a staircase leading into the air.

Source: Coastal Construction Manual, FEMA, 2014

Oostvorne beach, 1916
The project is both resilient and multiuse. The areas shown on the lower graphic of the opposite page (town in red, harbor in blue, and nature park in green) result in a multitude of activities and uses. The activities also depend on the season (see graphic below), and change year round.

Every few years adjustments to the design should be made to fit the evolving naturescape as the boundaries of the dynamic natural areas shift.

- sailing and motorboats
- windsurfing, surfing
- biking
- swimming, beach activities

Wadlopen. Walkable areas (depending on seasons and tides)

Multiuse Activities: Three Areas: Town (Red), Harbor (Blue), Nature (green)
These activities reflect the stability of the island in different places.
The graphics on the right and opposite page exhibit in plan and atmospheric perspective the estimations of how the design would respond to a flooded situation and how it would look after the storm.

**Flooded situation**
Map shows that vital facilities are above storm surge and overtopping wave heights

**After storm situation**
Map shows potential sand movement
The top section shows the current regional situation.

The middle section shows the island with a harbor in 2030.

The final section on the bottom shows the island in 2100 with sea level rise, where the island stays dry at maximum high tide even after climate change.
SITE SCALE
Site plan, experience of human scale and design details

Here is shown the final design on a site plan level. In the next few pages an overview of the details of the design will be exhibited.
The plans on the previous 4 pages were developed in conjunction with this zoning diagram and nature accessibility diagram that exhibit the districts of the island.
On the opposite page is shown the paths, the landmarks and nodes of the site plan.

The project’s atmospheric inspiration:

Low and High tide differences Inspiration, Schermonnikoog, Netherlands

Nestled in Dunes Inspiration, Ystad, Sweden
25 yrs

The graphics on the following pages show the development of the housing areas over time.

On the opposite page is shown the plan of the housing area at 25 years.
35 yrs

On the opposite page is shown the plan of the housing area at 35 years. Note the increase of both the medium and low density housing blocks.
On the opposite page is shown the plan of the housing area at 35 years. The maximum housing in the area has been established that allows the housing to stay within the ‘footprint’ of urban development while experiencing the surrounding atmosphere of dunes and/or marsh.
This section shows the typology of beach houses, dune houses, and marsh houses, and the public/private gradient, as well as the pedestrian-only walkways.
Low Density Dune and Beach Neighborhoods

This section highlights the housing area. Note the boardwalk, which is seasonally flooded, coastal houses on stilts, a swale to absorb stormwater or road runoff, a road with areas for pedestrians and biking, the concrete spine, the dunescape in between, houses with wet flooding basements that can absorb water, and finally the marsh edge. The underground details refer to FEMA regulations for coastal building in hurricane areas.
Urban Planning factors implemented within the project:

The advantage of a **street network with small blocks**
Not just functional but relationships

**Legible orientation**
Systems of reference
Three scales – co-dependant – **roads for movement distributions**
Plot subdivisions of public and private

**Buildings that contain different activities**
Differentiation of areas through district grids
morphological treatment of squares with taller buildings
Use of center of block for playing areas
Row of homes with grouping inside
Strict and legible hierarchy of roads
Nice façades, corner treatments and development of internal spaces
Thought of ends of street views

**Public green belts, transition barriers**
Social function
Architectural function
Information design that empowers the user
Density and form
Project size

**Children safe from cars**
Space hierarchy
Community identity
Social homogeneity

**Ground floor households**
Locally acceptable materials
Transitional filters
Neighbourly surveillance
Playground
Sidewalks
A public common space
Supervised play area

**Casual meeting areas**
Day care center
Microclimate trees to provide wind shelter
Footpath systems
Buffer zones

**Clearly delineated public space, private space and community space**
(examples in blue are explained)

Literature Sources:
Town hall, Facilities and Shops

Above is a perspective of the market square at the entrance to the island.

On the left the yellow beam denotes the view in the graphic above and its orientation.
Above is a perspective of the community park next to Balance Island Library. On the opposite page the yellow beam denotes the view in the graphic above and where the section is located. Below is a section with the houses near the marsh.
Beach Detail of walkway partially flooded during high tide, allowing pedestrian but not bicycle access.

The plan on left shows the area from above.
Perspective of Commercial Shellfish Warehouse, Ferry Terminal, Harbor shops, Harbor and campsites

The plan on left shows the area from above.
Zoom-in plan of dune harbor camping area
Location of the section below is shown in the graphic above.
In a zoom-in on the section one can see how they incorporate three kinds of edges – ecological, harbour, and the combination edge, which uses underwater riprap to keep the harbour wall in place while not increasing wave heights and allowing a gradient of biotypes.
The details of the boardwalks show how the boardwalks must be 1 m above the dune, and 2.8 m minimum below the possible scour lines of the dune.

This is because although normally a concrete T-shape is sufficient in places without erosion, in places with erosion the T-shape will shift in the sand and fall over. Therefore a very long pier as you saw in the previous sections is necessary.

concrete pier
maximum depth of erosion and scour
concrete pier
maximum depth of erosion and scour
steel or wood
maximum depth of erosion and scour
These final graphics show how beautiful the lighthouse will look in the dunes, and how the end of the island dune looks with the combination of the hard concrete spine poking out.
REFLECTION on the Resolution of the Research Question

This project resolved the research question of using the partial opening of the Haringvliet sluice to fulfill the estuarine ecological landscape potential, protect the Dutch coast from excessive salt water intrusion and storms, and offer landscape architectural qualities for the region while utilizing the coastal natural processes in a site-specific design.

By combining the aspects of structure, process, program, and accessibility, a resilient and multiuse design was developed. It also addressed the goal of living together with nature, designing with natural processes, reinstating the flow of ecology networks and social networks.

In the introduction of this paper, the design principles learned from research were introduced and extrapolated to this research project; however, more design principles were discovered during the development of the research project.

Design Principles learned from Project Development:
- Compact man-made (cut out, flat lower, walled off) contrasts vast open nature
- Urban and natural processes interrelate and develop over time
- Site specific experience of the landscape
- Animals and natural processes are important to be connected as urban processes
- Seasonal changes – island strength rests on a diversity of island uses – harbour, industry (cleaning water)
- Consistent application of principles from small to large scale
- Small connected blocks for safety, but also space for private use
- A gradient of public/private use
- A thoughtful delineation of the upper and lower layers of public infrastructure, interior and exterior of public infrastructure.

To review the method of the interdependence of urban and natural processes, an overview of the design steps is exhibited on the following page.

Design Project Overview:
0. Open the sluice to reconnect the ecological cycles
1. Intervene with spine (placement should be informed by hydrology models)
2. Natural Processes gather sand around the spine (accretion)
3. Add enough sand (through sustainable dredging methods) to allow the island to stay dry even with 100 years of climate change
4. Fix the dunes with optimally-placed native plantings, which will establish and spread
5. Create access to the island and place facilities, zoning, commercial, industry, and housing areas on the island. The optimal placement of these should be informed by design research, contextual research and testing.
6. The urban forms on the island should be placed to help fix the sheltered marsh area, establish the shipping channel, use shellfish to ameliorate the nutrient loading, drain the street stormwater in swales, (i.e. work with the natural processes) and develop in density over time while retaining a site-specific natural atmosphere and maximum endangered species habitat.
7. These urban forms should also reflect necessary elements of the urban tissue (such as community spaces, landmarks, pedestrian paths, etc. ) and prove resilient against coastal storms and fluvial flooding.
THE DESIGN PROJECT AS A DEMONSTRATION OF THE FINDINGS IN THE INTRODUCTION

The design project: “Coastal Conditions: Responding to the Partial opening of the Haringvliet Sluice” successfully demonstrates the findings of the research exhibited in the Introduction. The general principles were used and applied in the manner detailed in the preceding pages.

The diagrams on the right show the design language of artificial and natural form interplay, and the channels of accessibility for both social and ecological networks. The diagrams on the following page demonstrate the site development using natural processes over time.

Further diagrams, plans, sections and details that fully explain the application of the extrapolated coastal design principles from A.-J. are located in the previous pages.

Diagram of reconnected habitat paths

Diagram of accessibility networks

Diagram of human activity alongside ecological corridors

Section of housing on island including details of water channels that channel floods, and housing structures derived from FEMA regulations that provide stability in storm seasons.
A timeline in plan and section for how the entire region will develop. The text shows if the major action is being done by the natural forces or by human intervention.

Cross sections of the island showing the width and depth of the island from 0-25 years.

1 m interval height
20 m interval width
Did the project answer the research question? Yes. In terms of product, it resolved the research question into a functioning and resilient design that fits the preconditions of the site and research question, yet also has the ability to inform coastal design methodology worldwide. The design demonstrates architectonic significance in the layout of the urban forms in relation to the site-specific biotypes and natural processes and development over time, as well as social significance in terms of the design methodology. The formal product is this research report.

In terms of process, the author gained valuable insight into coastal geomorphological processes, design theory, land use planning and urban logistical processes. In terms of planning, the final design is a strong design because it was based on a reoccurring cycle of creating, choosing and testing various designs. The method of interdependence of urban and natural materials and forms over time strongly reflected the argumentation of designing with natural and urban processes over time.

Points in the project to develop further include working with the major community stakeholders, shaping further details, fundraising, working with the Dutch water bureau, and doing a regional housing study. These points were beyond the scope of the project. To realize the project would require the consultation and support of many stakeholders and experts.

However, the method developed in this project of designing with coastal natural processes for both coastal safety and landscape quality, with an interdependence of natural and urban processes over time, can serve as an example for other coastal areas worldwide.

Too often designers base their work on personal aesthetics, personal processes or commercial values. While the method presented in this paper has the flexibility to be integrated within the design personal aesthetics, personal processes and commercial values of the designer, it also prioritizes the natural and urban processes within the design, ensuring that the design will not serve only one factor and will successfully address the site and context. The use of this method in the design project: “Coastal Conditions: Responding to the Partial opening of the Haringvliet Sluice” resulted in a strong and holistic design project that worked with natural processes both in construction and change over time of the project.

Further research could include expanding this methodology to form an overview of riverfront processes, alpine/valley processes, desert processes, tropical landscape processes, and other environmental area types. This overview could aid landscape architects in designing feasible, thoughtful, and successful projects.

The role (and future) of landscape architects is to not only to ‘design gardens,’ but to design and plan spaces as educated stewards of our landscape’s future. Therefore landscape architects must answer not only to their aesthetic preferences and the designs’ economic investors, but also to regional human and environmental pressures. These regional pressures are connected to worldwide pressures, and cultural and natural processes. This method demonstrates that uncovering the status of these processes on the site and in context, as well as understanding how design interventions affect these processes, allows landscape architects to design responsibly.
APPENDIX
Contextual Research

First time-lapse sketch of island developing over time in accordance with natural processes

First time-lapse sketch of island growth in regional context

Potential activities regional map

General storm patterns hitting the Dutch coast

Sketches of Regional sections

Identity of beaches on the coast + water turbidity

Regional analysis of forest, grass and urban areas

Natural forms inspiration

Exploration of highlighting biotypes through architecture

Closer analysis of urban areas in relation to site

How the region changed over time based on historical expert estimation

The lowest points - channels (blue) contrasted with the highest points - dikes and dunes (green)

Topography heights inland (dark red is lowest points)

Rough sketch of estimation of the biotypes

Rough sketch of necessary dikes to be raised

Road, train, and ferry regional networks

dune, grassland, and forested regional areas

Regional analysis of forest, grass and urban areas
Most likely, each of these edges will be used in a different place on the Island, as the Island gains sand.

Water Design Principles: Details

• • • • • •

250 m
+5.3 m MHW
+13.7 m
-17.5 m

Hard edge harbor edge ecological edge combination edge - underwater riprap keeps island in place, while the long gradual slope allows a variety of biotypes

Ecological areas for fauna

Permanently flooded
Low intertidal
High intertidal
Dunes

Fascination

Biotypes South Coast: Haringvliet Sluice, Havenhoofd + Melissant
Biotypes North Coast: Maasvlake and Oostvorne

Ecology Analysis: Regional Biotopes and Site Photos

• • • • • •

Areas with lack of connected covered wetland / forest corridor dunes fields forests

Regional biotypes (in plan) and site photos with their locations

Gradient of biotypes highlighted in site photos

Ecology analysis

Water forest wetland

Sandy dune marsh grassland

Mud flats field grasslands

Coastal shrub forests

Beach disturbed site (weeds)

Dunes coastal forest

Built structures

Mudflats shrubland grass tidal system ocean steep rock beach
P2 overview demonstrating the methodology of research question, geomorphological processes understanding, exploring regional possibilities, utilization of the Grontmij study, research on other islands worldwide, and the 4 models that resulted in a composite model.

The layers of the analysis and interventions demonstrate the layered approach of the design research.
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LITERATURE SOURCES


ADDITIONAL PHOTO SOURCES FROM THE INTRODUCTION:


Coastal Construction Manual , FEMA, 2014


Google maps. Rijnmond area, Netherlands. Google.com


