LET THE WATER FLOW

RESEARCH DOCUMENT

BREGJE WALKTE - GRADUATION PROJECT

FORM, STRUCTURE & AESTETHICS

Table of Contents

Personal note

As a child, I grew up in Zuidhorn, a small village in the province of Groningen. I remember walking through the snow in overalls because the layer of snow came up to my waist. With my sister I rolled a snowman and on icy days we were allowed to go to school by sledge.

It pains me to see in the data from this study that future children will hardly experience days like this. The ice and snow will be replaced by lots of water and rain. This research can therefore be seen as a thought experiment. A possibility to design the future in a liveable way for both humans and nature.

A solution for a livable future does not take away from the fact that we all must do everything we can to limit climate change. So that even in 100 years, children can still enjoy sledding through the snow.

family picture, around 2005

INTRODUCTION

PAST

PRESENT

RESEARCH QUESTION

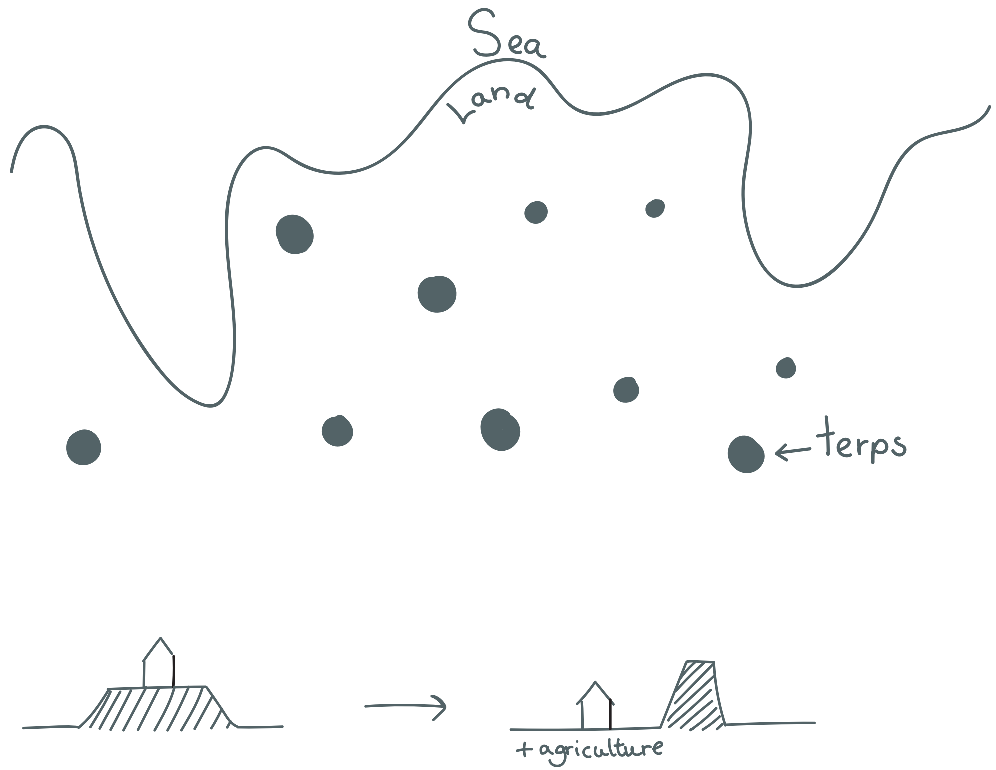
METHODOLOGY

History of terps en dikes in Frisian-Groningen

The Netherlands has been fighting a battle against water for hundreds of years, especially in the coastal areas. When the first inhabitants settled in the Frisian-Groningen salt marsh area in the sixth century BC, they built their entire built environment on mounds. They called these mounds a 'terp', the Frisian word for village.

The soil that the terpen were built with proved to be very fertile so it was increasingly used for field cultivation in the lower-lying areas. Naturally, the inhabitants wanted to protect their fields, so dykes were built in 1200 CE to protect the fertile land. The inhabitants also created new land through rice dams. With the arrival of the dykes, the creation op terps also ended, as the built-up area was now protected from the water even in the lower parts of the province.

Since the terp soil was proven to be very fertile, many terps were excavated. Currently, over 1,300 mounds and wierden are still known in the Netherlands, of which 326 have archaeological national monument status.



own work, 2023

INTRODUCTION

PAST

PRESENT

RESEARCH QUESTION

METHODOLOGY

For a long time, these dykes protected us from sea water. Due to man's handling of the climate over the past two centuries, sea levels have continued to rise. And it will continue to rise further according to various climate predictions (Rifkin, 2004). Currently, the salt marsh area in Groningen is struggling with several problems due to the effects of climate change, especially the ever-rising sea level. The area suffers from a lot of flooding from both rainfall and the flooding of rivers and lakes. Some areas have even become impassable due to the water. As the land is often inundated with salt water, the agricultural sector faces the problem of salinisation in the area.

It is clear that the Groningen salt marsh area is running up against the limits of functioning under the current conditions.

Flooded parking lot (own photo, 2023)

Flooded grass field (own photo, 2023)

Movement analysis

To get a better understanding of the impact of climate change in the area, a field trip was conducted in northern Groningen. We drove around the area and I captured images along the way of its infrastructure. I was particularly interested in how people currently move through the wet landscape. After the excursion, I organised the footage into three categories: movement by foot, movement by car and transition from land to water.

movement by foot

movement by car

transition land to water

own work, 2023

Conclusions

There is a wide variety of footpaths, from paved to unpaved. Motorways are all paved and usually placed higher up on embankments.

Not all paved motorways were passable due to privacy restrictions or waterlogging. Many highways and low-lying footpaths have become impassable due to waterlogging.

There are areas that have adapted to the water through dykes, tall building structures and houseboats. Various riser building typologies can be found in the area.

Re-organising imagery

During the excursion, we drove a route from the south, under the Reitdiep, up to the north to arrive at the Wadden Sea. During this route, we passed both higher and lower elevations, seeing a range of wet and dry nature.

I tried to visualise how nature in Groningen reacts to the arrival of water. From left to right, you can see the Groningen landscape transitioning from dry to wet. I can use this gauge to estimate my future scenario. Which picture represents a possible water scenario for 2100?

flat to rural area

own work, 2023

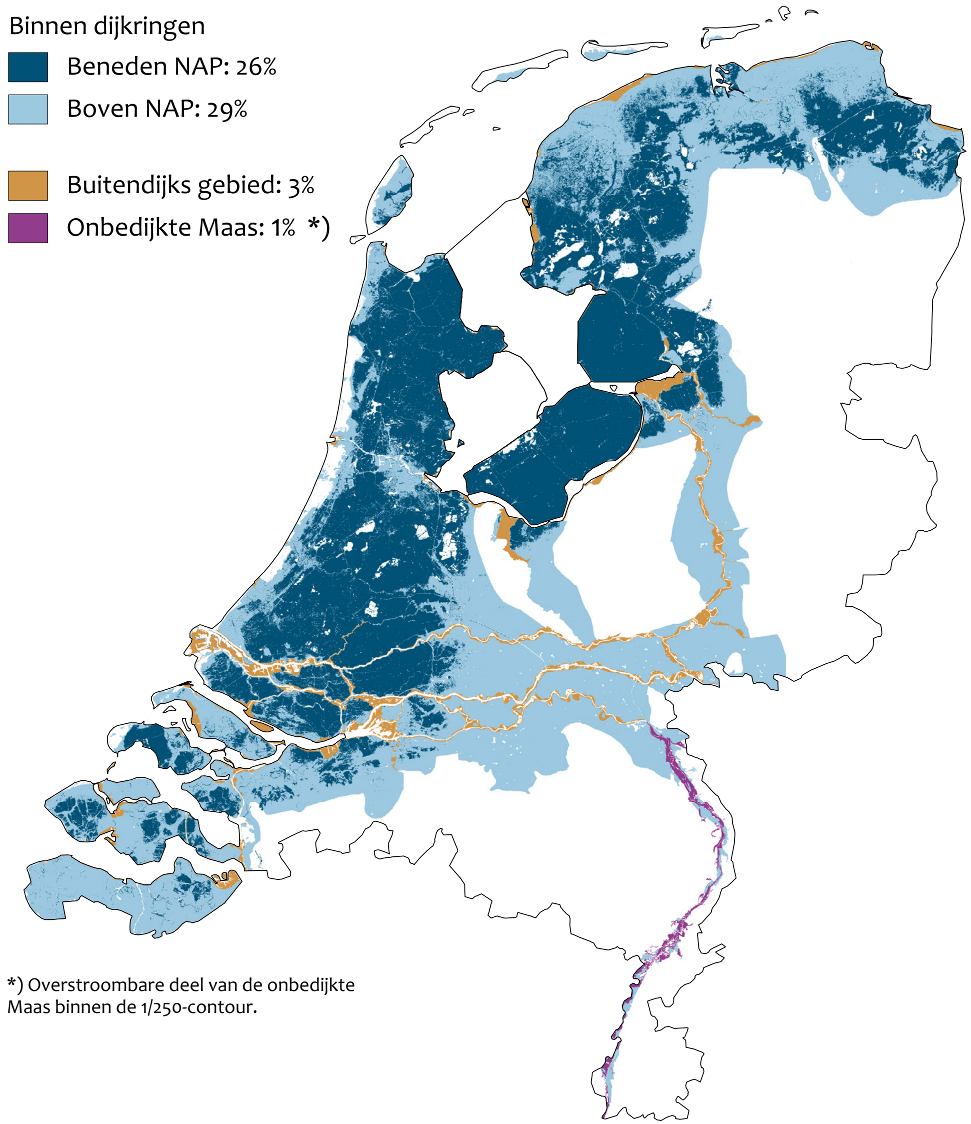
dry to wet landscape

own work, 2023

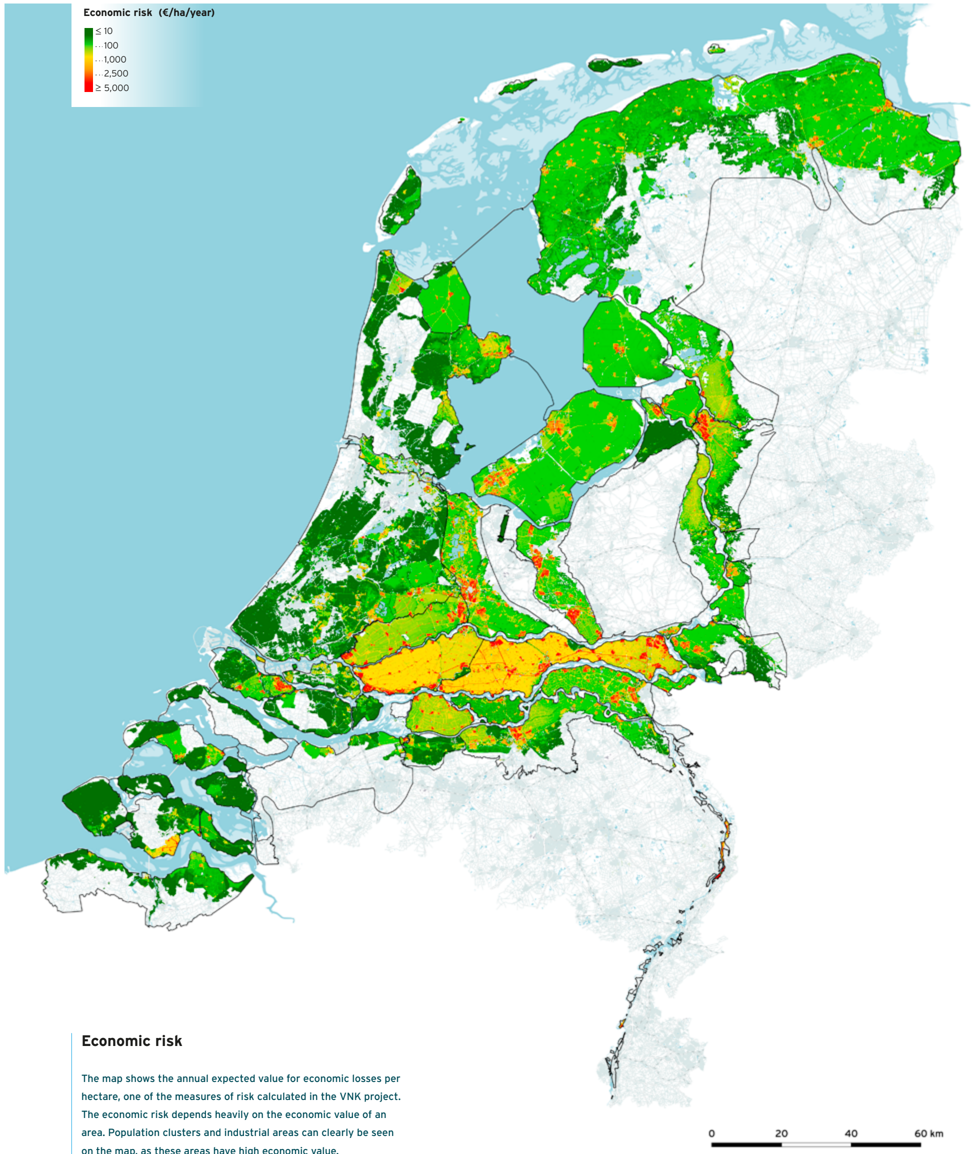
Risk of flooding

The degree of flooding observed during the field trip corresponds to several maps showing flood risk in the Netherlands.

The Netherlands Environmental Assessment Agency mapped the flood-prone areas of the Netherlands .
(Planbureau voor de Leefomgeving, 2013). They concluded that 59% of the Netherlands' land area (excluding Wadden Sea, IJsselmeer and other open waters) is vulnerable to flooding.



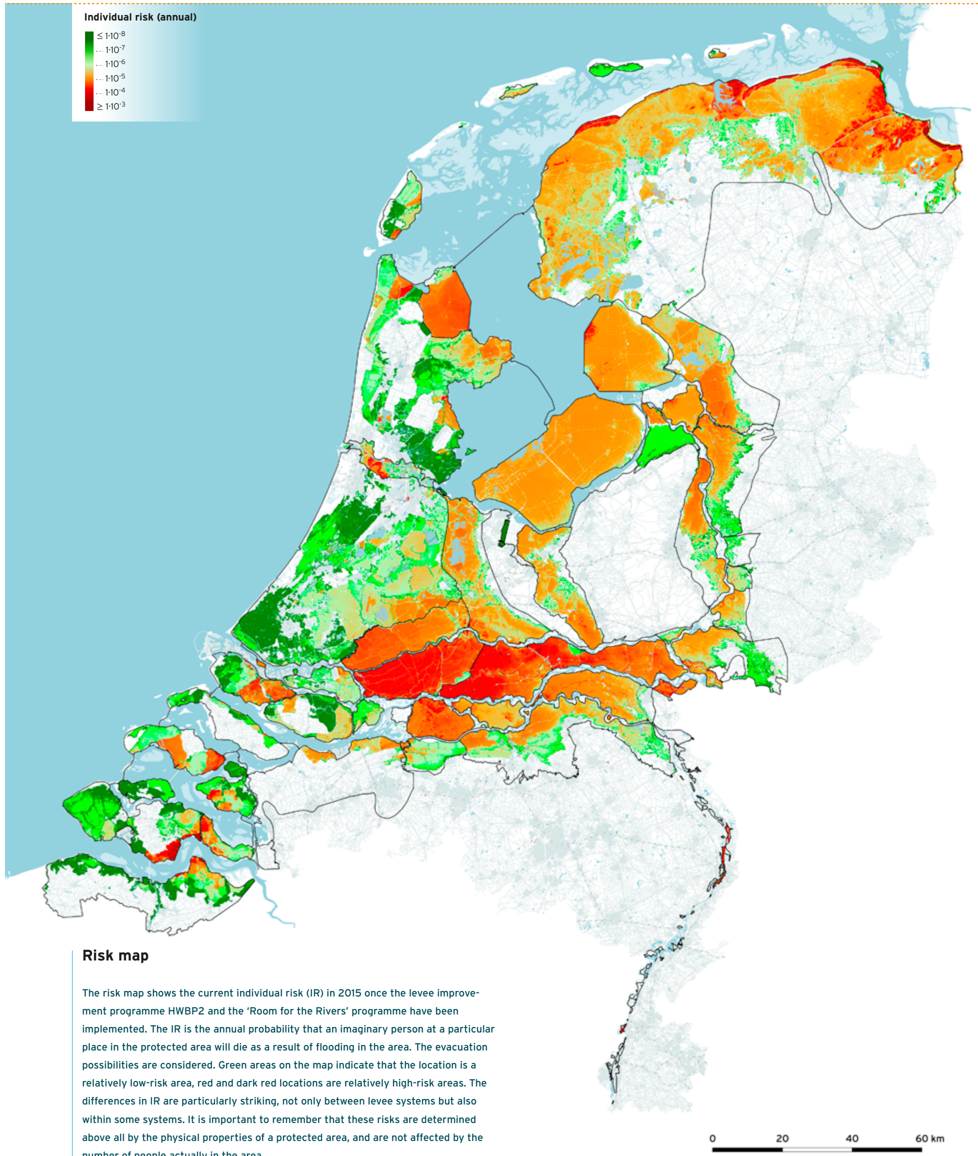
(Planbureau voor de Leefomgeving, 2013)



Economic risk

The map shows the annual expected value for economic losses per hectare, one of the measures of risk calculated in the VNK project. The economic risk depends heavily on the economic value of an area. Population clusters and industrial areas can clearly be seen on the map, as these areas have high economic value.

Flood risk analysis (Jongejan et al., 2013)



Risk map

The risk map shows the current individual risk (IR) in 2015 once the levee improvement programme HWBP2 and the 'Room for the Rivers' programme have been implemented. The IR is the annual probability that an imaginary person at a particular place in the protected area will die as a result of flooding in the area. The evacuation possibilities are considered. Green areas on the map indicate that the location is a relatively low-risk area, red and dark red locations are relatively high-risk areas. The differences in IR are particularly striking, not only between levee systems but also within some systems. It is important to remember that these risks are determined above all by the physical properties of a protected area, and are not affected by the number of people actually in the area.

Flood risk analysis (Jongejan et al., 2013)

How to adapt?

According to Rifkin (2004), the rising temperature and sea level will result in multiple urgencies: First of all, energy must be produced in a way that minimises the effect on global warming. Secondly, man has to adapt to the effects of climate change (Stern 2006).

Contemporary planning approaches only show little adjustments, while big adjustments are required to deal with the turbulence of climate change and energy supply. New planning approaches will have emerge in reaction to new demands and developments (Roggema, 2013).

What does the future described by Rifkin (2004), Stern (2006) and Roggema (2013) look like? How would the area of Groningen, its built environment and the daily lives of its residents change in 100 years? Is it perhaps time to stop fighting the water and allow the water back into the country as we did before? How would this affect the built environment?

own work, 2023

INTRODUCTION

Research goal

The essence of this research is to design a building that will be located in Groningen a 100 years from now. Nature and its climate will perform an essential role for the building's energy supply. The design of the energy supply will look at possibilities for energy generation, as energy storage and use. To grasp the magnitude of this design task within a future scenario, this research has been divided into four scales: urban, local, building and details. Each scale level raises its own set of design questions.

URBAN

What kind of urban development interventions are needed for a village based in North Groningen a 100 years from now to adapt to the rising sea level?

- How does the climate of North Groningen look like a 100 years from now?
- What adaption strategies can be used to adapt to this climate?
- What energy systems could be implemented in the landscape in a future scenario?
- What kind of urban planning interventions are needed for a village to function 100 years from now?
- What does the infrastructure look like?

LOCAL

Within this future scenario, how would a village function while adapted to the future climate?

- What energy systems could be implemented on a local level?

BUILDING

- How can a building be adapted to withstand future floodings?
- how can you make use of this new climate to improve a building its energy efficiency?
    - Passive (water, wind, heat)
    - Active (solar energy)
- What consequences would this have for the building typology and its aesthetics?

DETAIL

In terms of ... what inspiration can be drawn from the surrounding climate and how can this be used to improve the energy efficiency of a building in the future scenario?

- In terms of form
- In terms of colour
- In terms of materialisation

What consequences would this have for the building typology and its aesthetics?

INTRODUCTION

PAST

PRESENT

RESEARCH QUESTION

METHODOLOGY

The aim of this P2 research is to form building principles that can be used during the design phase. The main focus will be on optimising the building its energy use. Through the different scales, guidelines will be established from which the design phase can start.

URBAN

The **Urban** chapter will outline a future scenario for Groningen 100 years from now. Adaptation strategies will be discussed and some aspects of the adaptation strategies will be tested for feasibility.

Based on the future scenario data, 3 sketch designs will be made on an Urban scale. The potential use of energy systems within this scale for energy generation and storage will also be considered. At the end of this chapter, guidelines will be drawn up that can be used in the design phase.

LOCAL

In the **Local** chapter, there will be explored how a future Groningen village can adapt to the climate in 100 years. The problems currently facing the area will be taken into account. Can these be solved? The sketch designs will be based on those previously drawn for the Urban scale.

It will also look at how energy systems can be used within this scale for energy generation and storage. At the end of this chapter, the sketch designs will be compared.

BUILDING

The **Building** chapter will look first and foremost at how a building can cope with the climate in Groningen in the future. Especially in terms of flooding. What consequences does this have for the building typology? It will also examine to what extent the building can make use of the future climate for energy supply.

First, the possibilities of passively designing the building to reduce energy consumption will be examined. The possibility of generating energy through solar power will also be investigated. How does optimising the building for solar energy affect the building typology? At the end of the chapter, guidelines will be drawn up for a building typology focused on energy supply in the Groningen climate in 100 years' time. These guidelines can be further applied in the design phase.

DETAIL

In the **Detail** section, the aspects of form, material and colour will be addressed. The aim is to examine how each aspect can contribute to the energy supply of a building. Here, inspiration will be taken from the Groningen area.

Can statements be made about form, material and colour use in order to create a design that has a relationship with both the environment and energy use in the future?

TRANSLATION TO DESIGN

The final chapter **Translation to Design** aims to combine the outcomes of the research in all four scales and summarise them into requirements that can be used in the design phase.

First, the future scenario will be concluded. What will the landscape look like on an Urban and Local scale? Then, a building typology for a building design within this future scenario will be further discussed. Then, a programme of requirements will be drawn which will reflect the design challenges for the building to be designed.

"How does the climate of North Groningen look like a 100 years from now?"

URBAN

FUTURE SCENARIO

ADAPTION STRATEGIES

ENERGY

DESIGN SKETCH

GUIDELINES

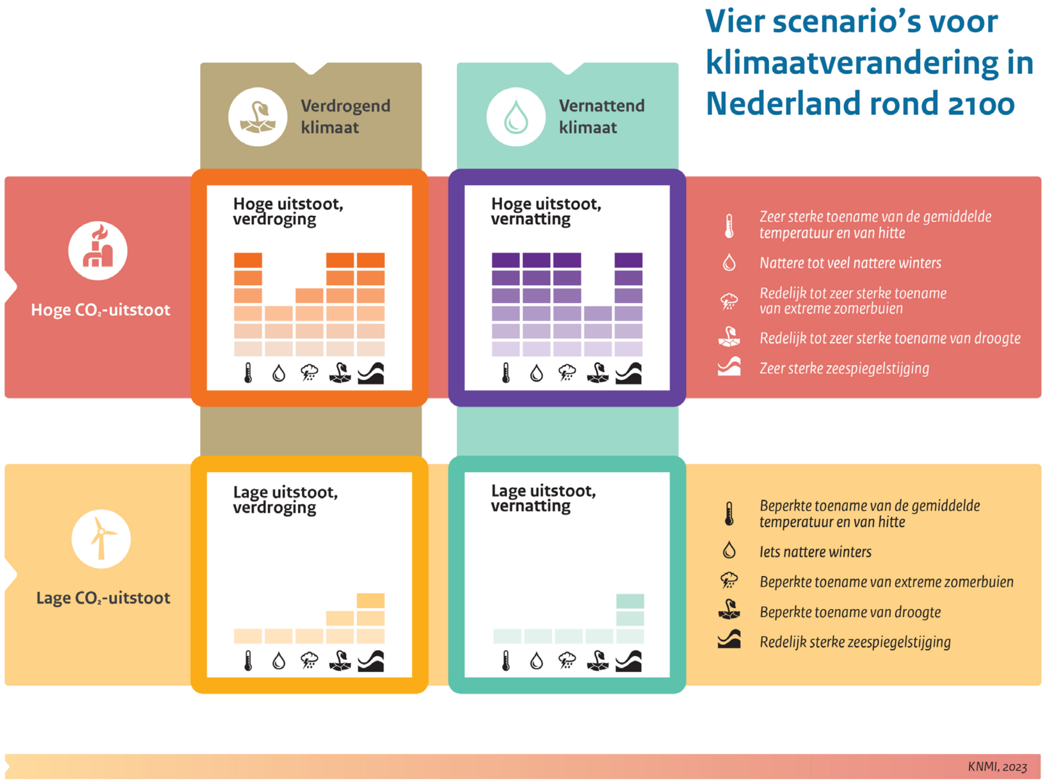
Climate predications

To make a future resilient design, it is important to look at the predictions for how the climate will behave in 100 years. This is of course difficult to predict, so rough assumptions will be made.

First, the current state of the climate was determined in the province of Groningen. The amount of precipitation, sunshine hours, average temperatures throughout the year, wind force and wind direction were considered (Meteoblue, 2023).

The same aspects were then visualised, but for a future scenario 100 years from now using climate data from the KNMI. Using climate models, KNMI (2023) calculated the effects of human greenhouse gas emissions on the future climate. The KNMI'23 climate scenarios consist of four paths describing a possible future climate in the Netherlands: around 2050, 2100 and 2150. The scenarios are based on the amount of greenhouse gas emissions (and thus global warming) and the degree of precipitation change in the Netherlands.

For this reasearch the scenario is assumed to be Hn in 2100. This means a wet climate with a high Co2 emmision. This would be the worst climate scenario for Groningen and therfore it is important to investigate design possibilities in it.



KNMI'23-KlimaatScenario's (2023)

Seizoen	Variabele	Indicator	Klimaat 1991-2020 = referentie-periode	2050 (2036-2065)				2100 (2086-2115)			
				Ld	Ln	Hd	Hn	Ld	Ln	Hd	Hn
	Wereldwijde temperatuurstijging ten opzichte van 1991-2020			+0,8°C	+0,8°C	+1,5°C	+1,5°C	+0,8°C	+0,8°C	+4,0°C	+4,0°C
	Wereldwijde temperatuurstijging ten opzichte van 1850-1900			+1,7°C	+1,7°C	+2,4°C	+2,4°C	+1,7°C	+1,7°C	+4,9°C	+4,9°C
Jaar	Zeespiegel bij Nederlandse kust	gemiddelde niveau	0 cm [1]	+24 (16 tot 34) cm	+24 (16 tot 34) cm	+27 (19 tot 38) cm	+27 (19 tot 38) cm	+44 (26 tot 73) cm	+44 (26 tot 73) cm	+82 (59 tot 124) cm	+82 (59 tot 124) cm
		tempo van verandering	3 mm/jaar [1]	+3 (1 tot 6) mm/jaar	+3 (1 tot 6) mm/jaar	+5 (4 tot 8) mm/jaar	+5 (4 tot 8) mm/jaar	-1 (-4 tot 4) mm/jaar	-1 (-4 tot 4) mm/jaar	+11 (6 tot 23) mm/jaar	+11 (6 tot 23) mm/jaar
	Temperatuur	gemiddelde	10,5°C	+0,9°C	+0,9°C	+1,6°C	+1,5°C	+0,9°C	+0,9°C	+4,4°C	+4,1°C
	Neerslag	hoeveelheid	851 mm	0%	+3%	-2%	+3%	0%	+3%	-3%	+8%
	Zonnestraling	gemiddelde	120 W/m²	+5,8 W/m²	+4,8 W/m²	+5,4 W/m²	+2,5 W/m²	+5,8 W/m²	+4,8 W/m²	+7,1 W/m²	+1,3 W/m²
	Vochtigheid	gemiddelde relatieve vochtigheid [2]	82%	-1%	-1%	-1%	0%	-1%	-1%	-1%	+1%
	Verdamping	potentiële verdamping (Makkink)	603 mm	+7%	+6%	+9%	+6%	+7%	+6%	+17%	+11%
	Wind	gemiddelde windsnelheid	4,8 m/s	-0,1 m/s	-0,1 m/s	0,0 m/s	0,0 m/s	-0,1 m/s	-0,1 m/s	-0,1 m/s	-0,1 m/s

KNMI Klimaatscenario Nederland (KNMI, 2023)

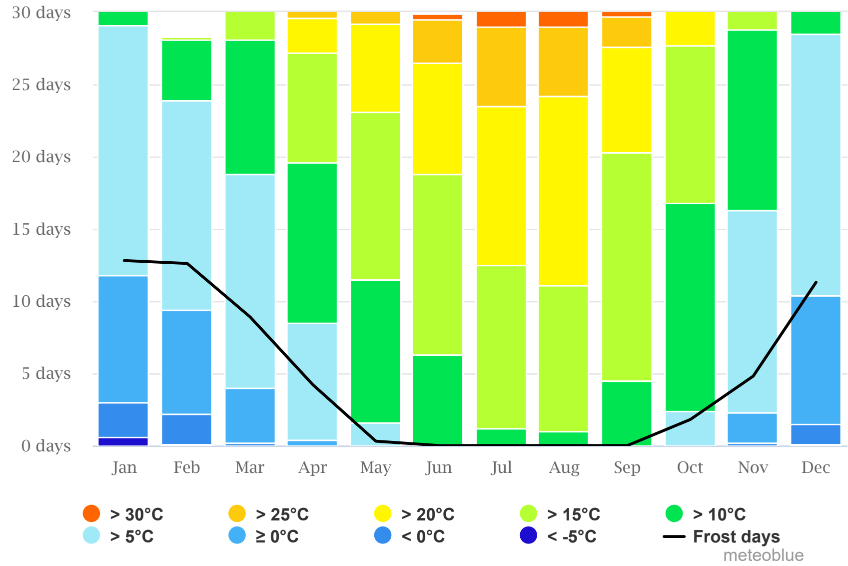
Seizoen	Variabele	Indicator	Klimatologie 1991-2020	2100 Ld	2100 Ln	2100 Hd	2100 Hn
Wereldwijde temperatuurstijging ten opzichte van 1991-2020				0,8°C	0,8°C	4,0°C	4,0°C
Wereldwijde temperatuurstijging ten opzichte van 1850-1900				1,7°C	1,7°C	4,9°C	4,9°C
Jaar	Temperatuur	aantal ijsdagen (max temp < 0°C)	9,2 dagen	-3,8 dagen	-3,9 dagen	-7,9 dagen	-8,3 dagen
		aantal tropische dagen (max temp ≥ 30 °C)	5,1 dagen	+5,2 dagen	+5,2 dagen	+27 dagen	+18 dagen
		aantal vorstdagen (min temp < 0°C)	63 dagen	-14 dagen	-14 dagen	-48 dagen	-48 dagen
		aantal zomerse dagen (max temp ≥ 25 °C)	24 dagen	+14 dagen	+14 dagen	+57 dagen	+48 dagen

KNMI Klimaatscenario Groningen (KNMI, 2023)

Maximum temperatures 2024

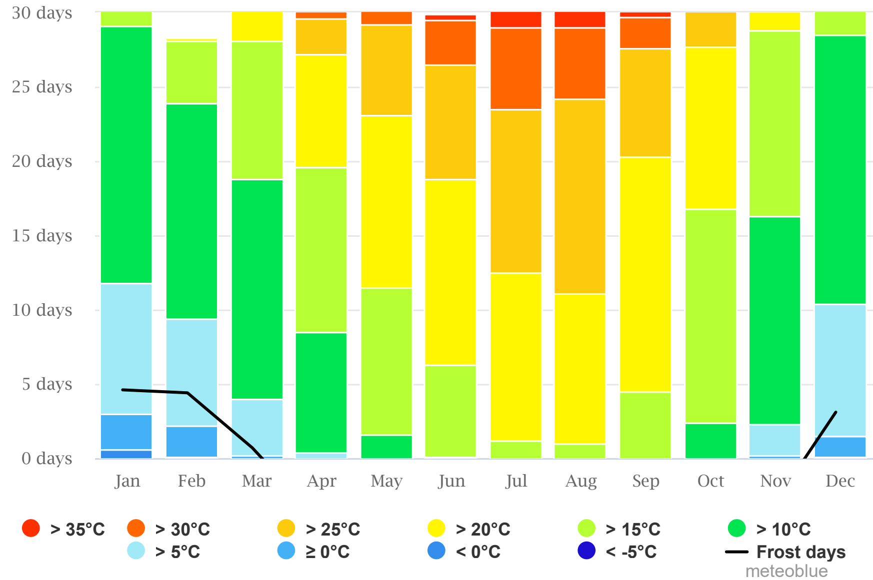
The data of the KNMI is linked to current climate situation in Groningen, mapped out by Meteoblue. Their climate diagrams are based on 30 years of hourly weather model simulations and available for every place on Earth. They give indications of typical climate patterns and expected conditions (temperature, precipitation, sunshine and wind).

The maximum temperature diagram for Groningen displays how many days per month reach certain temperatures.



Maximum temperatures 2100

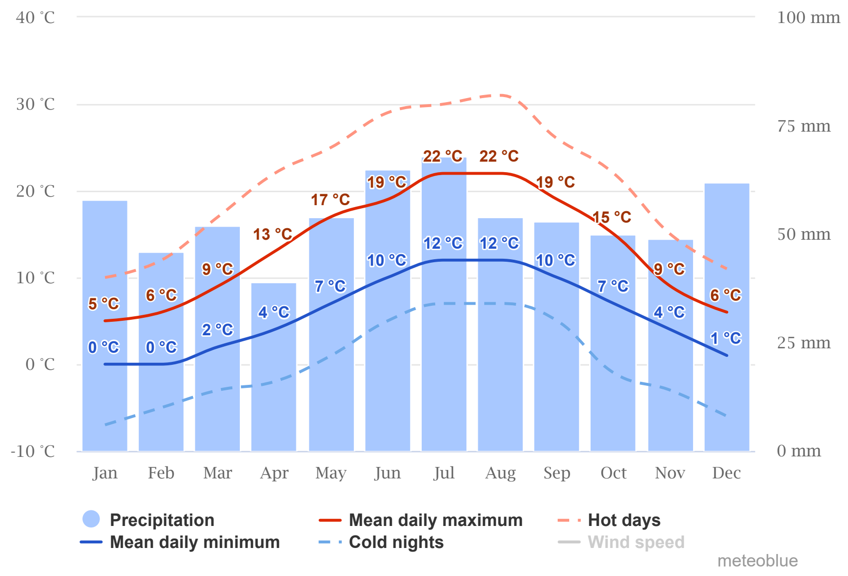
Climate forecast 2100 in Groningen. Temperature is risen by 5 degrees. During summer there will be +48 days with temperatures above 35 degrees. Limited frost days and extreme heat days in summer.



Michaelaschloegl. (2023). Simulated historical climate & weather data for Groningen. Meteoblue.
https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/groningen_the-netherlands_2755251

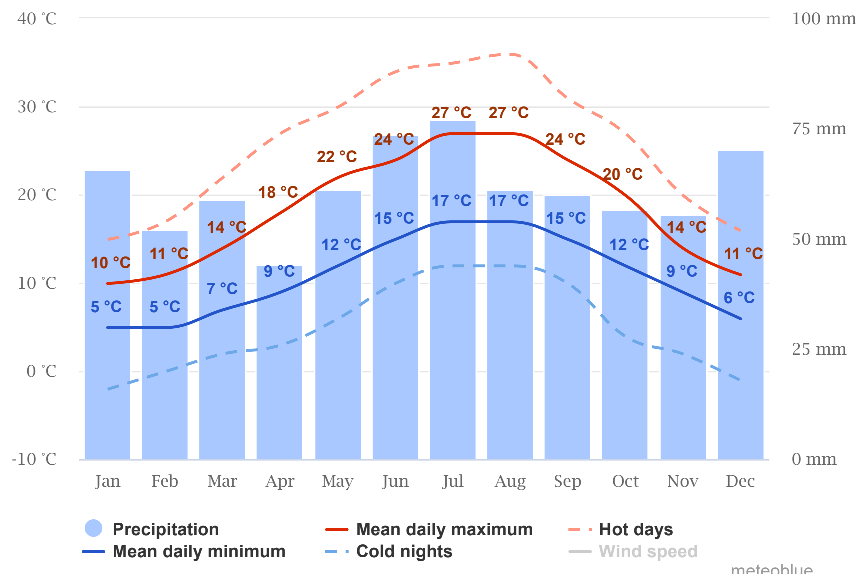
Current average temperatures

The “mean daily maximum” (solid red line) shows the maximum temperature of an average day for every month for Groningen. Likewise, “mean daily minimum” (solid blue line) shows the average minimum temperature. Hot days and cold nights (dashed red and blue lines) show the average of the hottest day and coldest night of each month of the last 30 years.



Average temperatures 2100

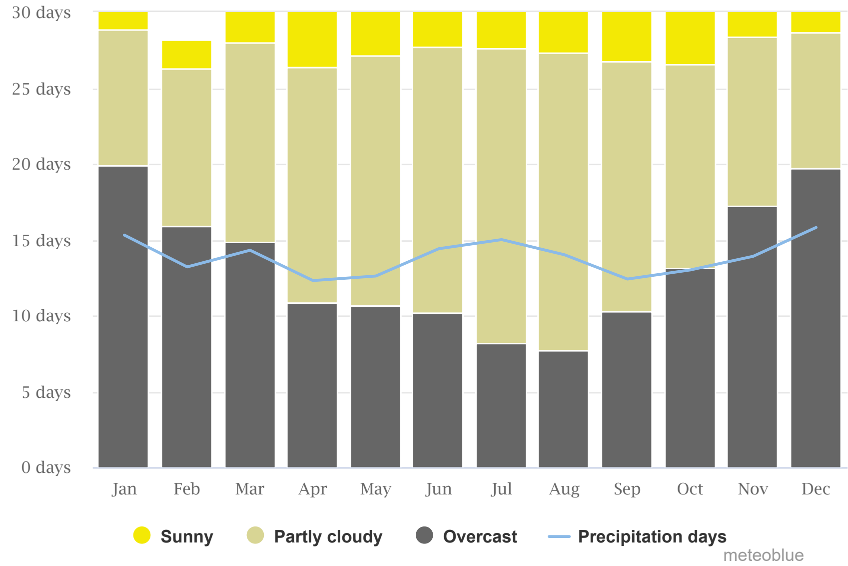
Temperature is risen by 5 degrees. Precipation amount is risen by 8%.



Michaelaschloegl. (2023). Simulated historical climate & weather data for Groningen. Meteoblue.
https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/groningen_the-netherlands_2755251

Current cloudy, sunny, and precipitation days

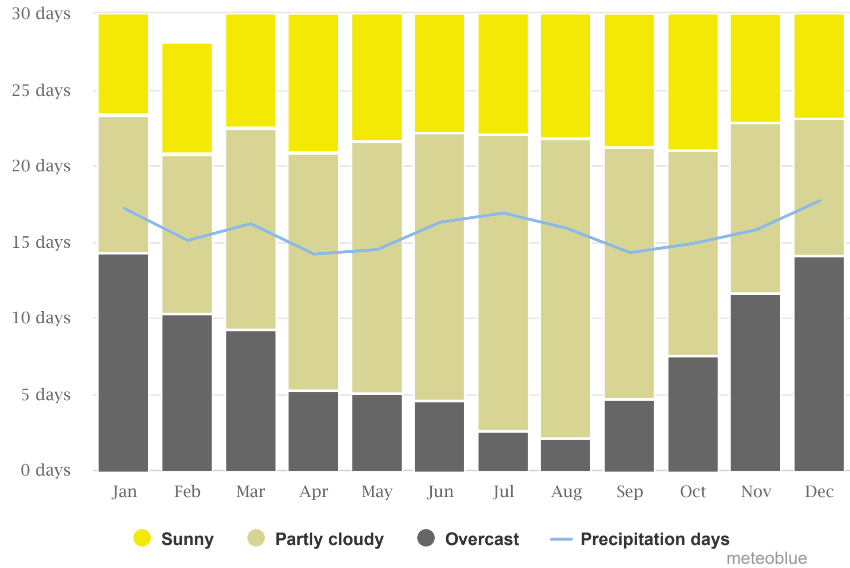
The graph shows the monthly number of sunny, partly cloudy, overcast and precipitation days. Days with less than 20% cloud cover are considered as sunny, with 20-80% cloud cover as partly cloudy and with more than 80% as overcast.



Cloudy, sunny, and precipitation days 2100

Precipitation days are risen by 8%. The KNMI models (2023) show that the amount of sunny days will increase, but they make no predications about the amount of sunny days. It will also depend on how clean the air is in 100 years. With a clean air fog, smog and low clouds are less likely to occur.

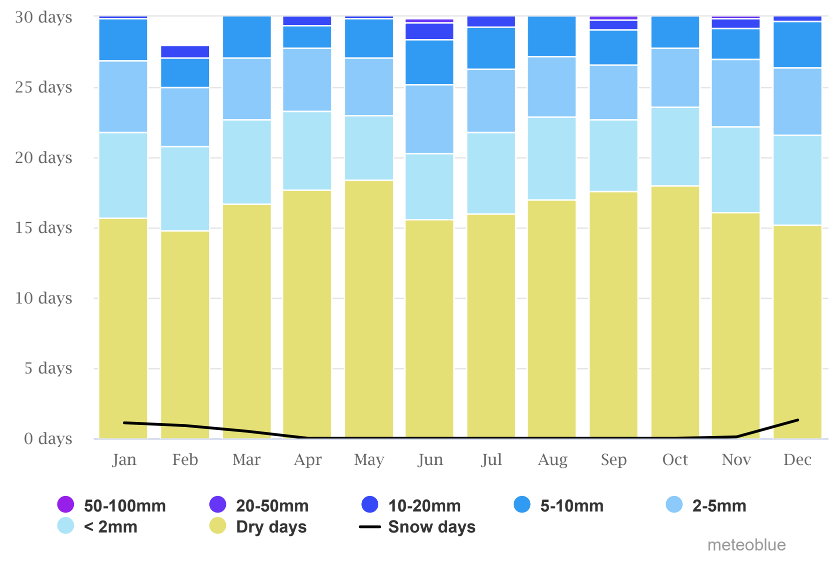
For this prediction I looked at the data from weer.nl (2024. They described that in the last 10 years, 1 extra week of sunshine hours was added in the Netherlands. Building on this trend, a rough predication can be estimated that in 100 years, 10 extra weeks of sunshine hours will be added, amounting to 70 sunny days extra.



Michaelaschloegl. (2023). Simulated historical climate & weather data for Groningen. Meteoblue. https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/groningen_the-netherlands_2755251

Current precipitation amounts

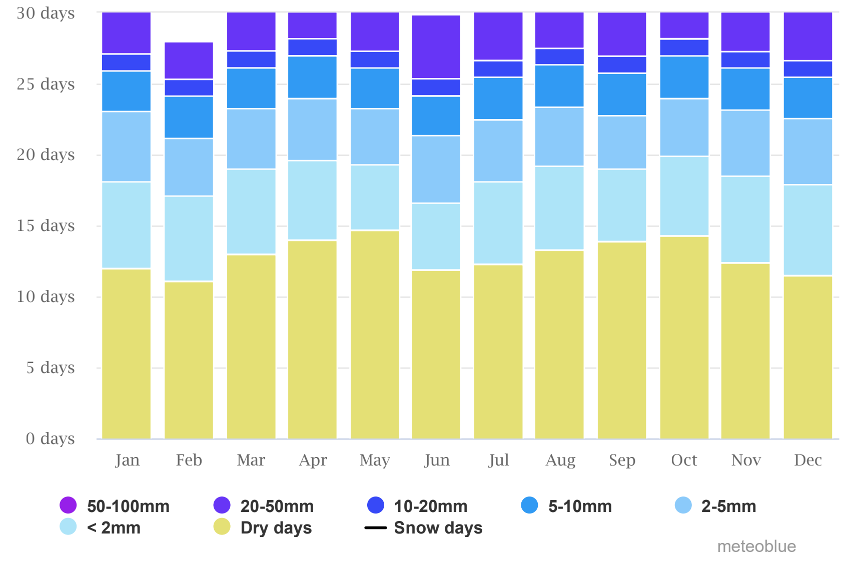
The precipitation diagram for Groningen shows on how many days per month, certain precipitation amounts are reached.



Precipitation amounts 2100

Again, 8 per cent was added to the mount of rainfall, resulting in +3 days of rainfall added per month. The rainfall will also be more extreme, especially in summer with precipation amounts of 50-100 mm. The intensity of the precipation will depend on the timeperiod the precipation amount is reached. The KNMI (2023) predicts that the maximum hourly precipitation per summer will increase by 7 to 25 per cent around 2050.

The building design will need to withstand a heavy amount of rainfall in short periods of time. The building structure will need to be adapted and excess water must be drained on all scales.

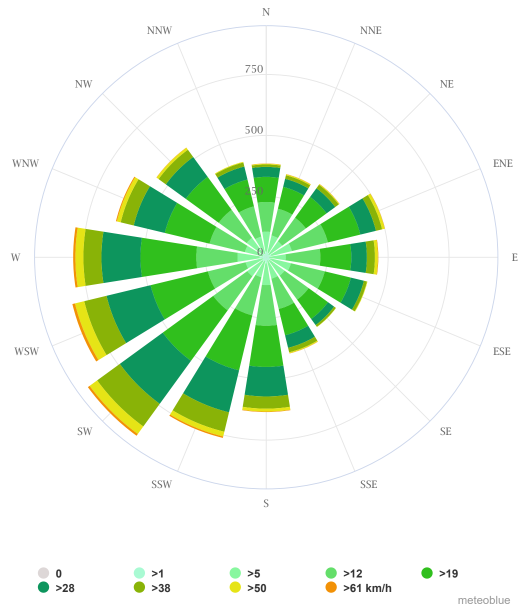


Michaelaschloegl. (2023). Simulated historical climate & weather data for Groningen. Meteoblue. https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/groningen_the-netherlands_2755251

Current wind rose and speed

The diagram for Groningen shows the days per month, during which the wind reaches a certain speed.

The wind rose for Groningen shows how many hours per year the wind blows from the indicated direction.

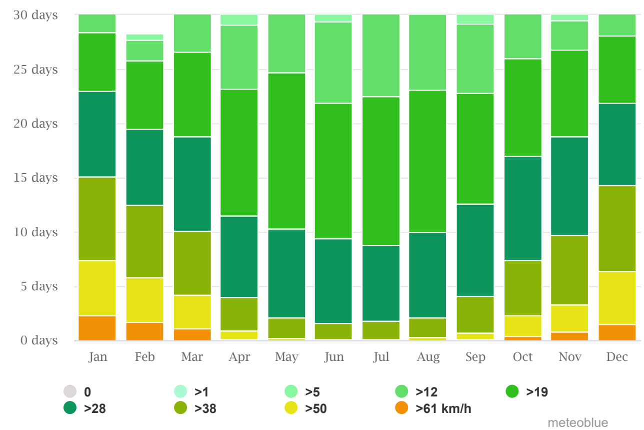


Wind rose - current avarage

Wind rose and speed 2100

The KNMI (2023) data shows that the wind speed will hardly increase by -0,1 m/s. This change is considered negligible for this study. No predictions could be found about a possible change of wind direction in a future scenario.

Therefore, the same tables will be maintained for 2100 as in 2024.



Wind speed - current avarage

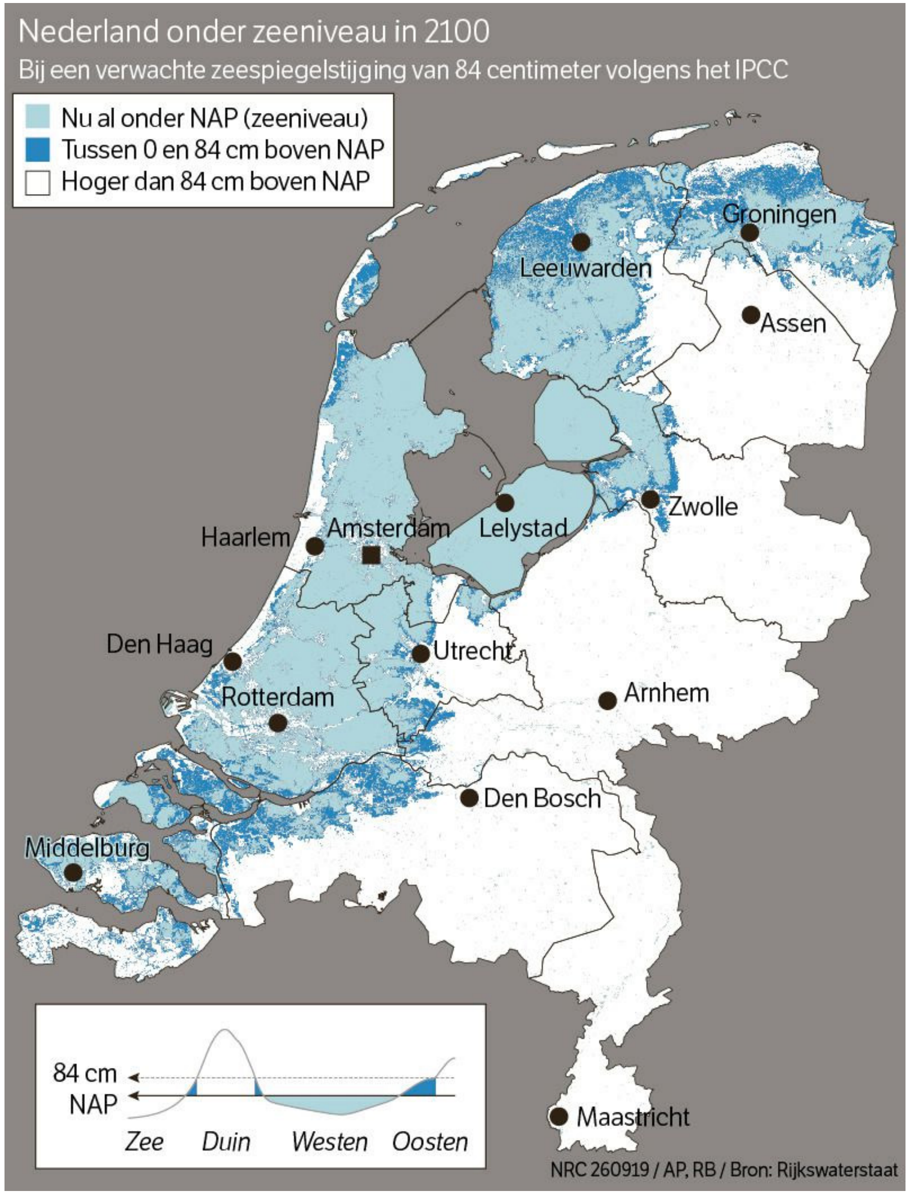
Michaelaschloegl. (2023). Simulated historical climate & weather data for Groningen. Meteoblue.
https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/groningen_the-netherlands_2755251

Rising sea level

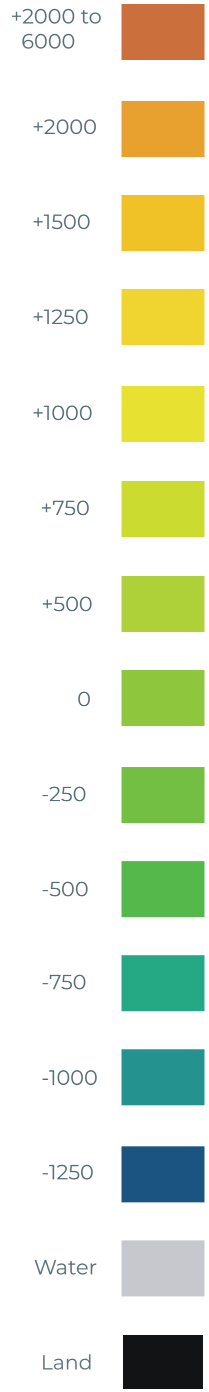
The Intergovernmental Panel on Climate Change (IPCC, 2019) shows which parts of the Netherlands will be under sea level in 2100 if the sea level has risen 84 cm by then.

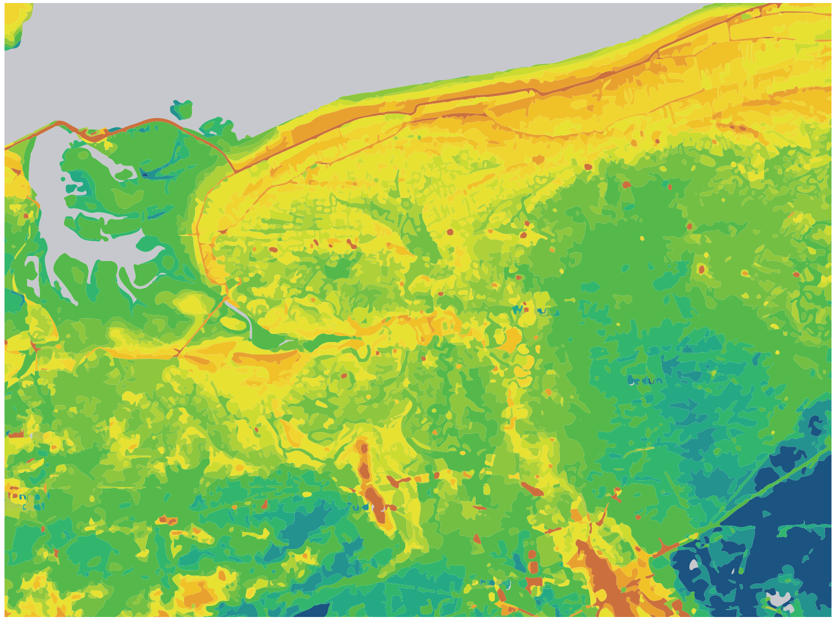
The IPCC only shows a map on national level, but for this research it is also useful to know which areas of the salt marsh landscape in Groningen would be flooded in 2100.

Therefore, I linked KNMI's predictions for the sea level in 2100 to an elevation map of Groningen province (Actueel Hoogtebestand Nederland, 2023). For three different sea level rise predictions of the KNMI, I indicated which parts of the province could potentially be flooded because they are lower than the new risen sea level. The maps show which higher areas can be used in a future design as a safe base that will not flood.

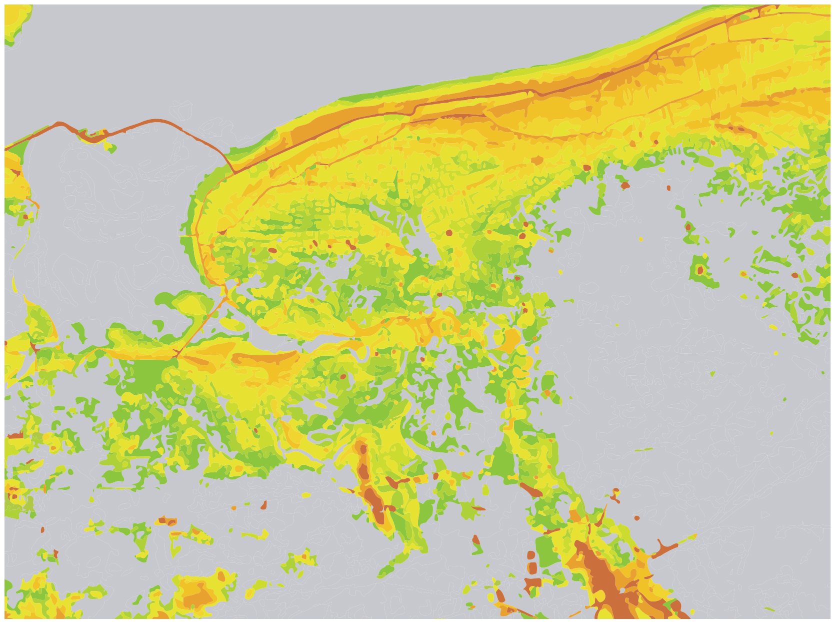


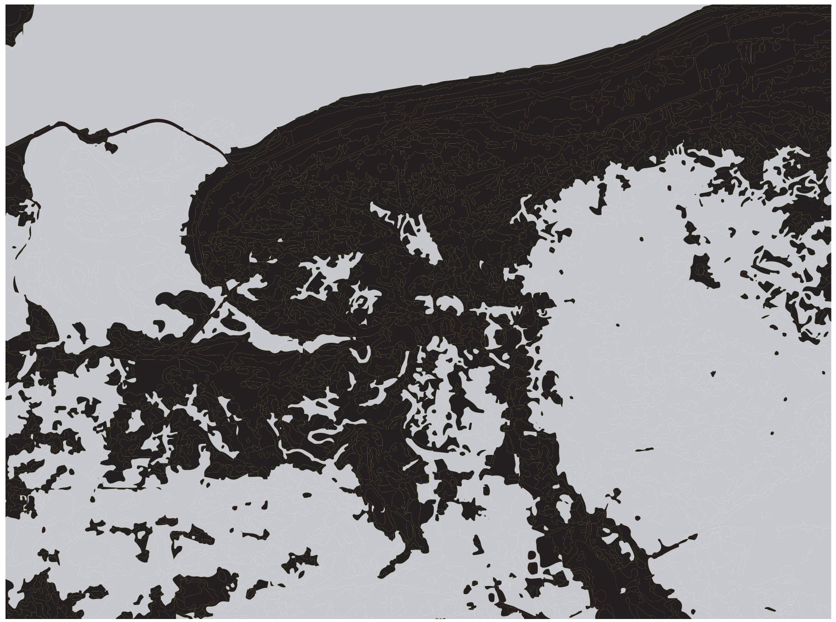
Intergovernmental Panel on Climate Change , 2019



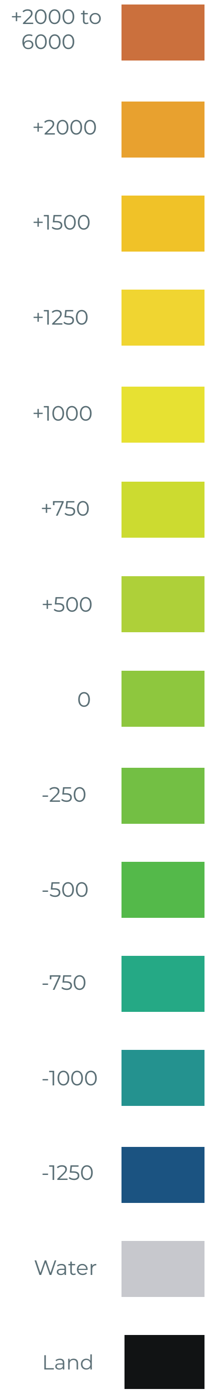


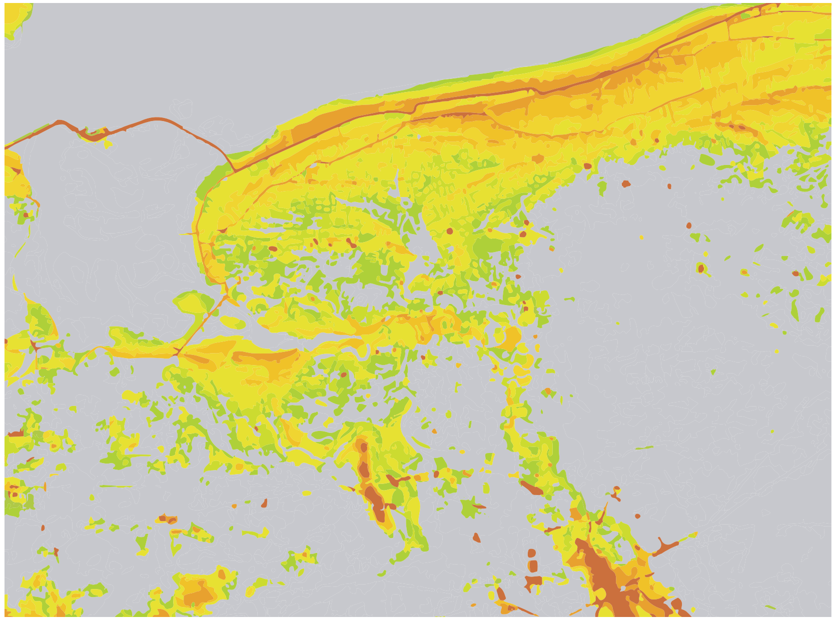
Groningen area - current status - sea level 0
based on Actueel Hoogtebestand Nederland

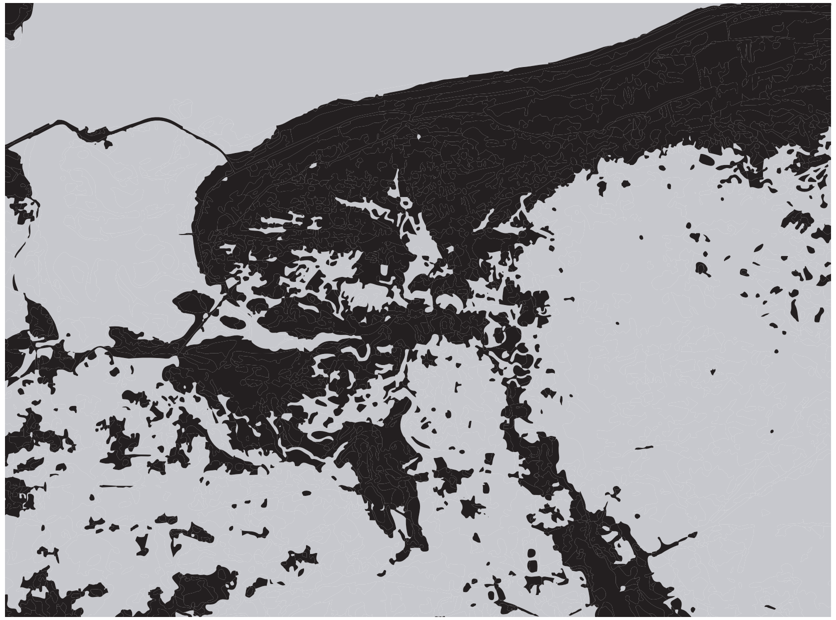




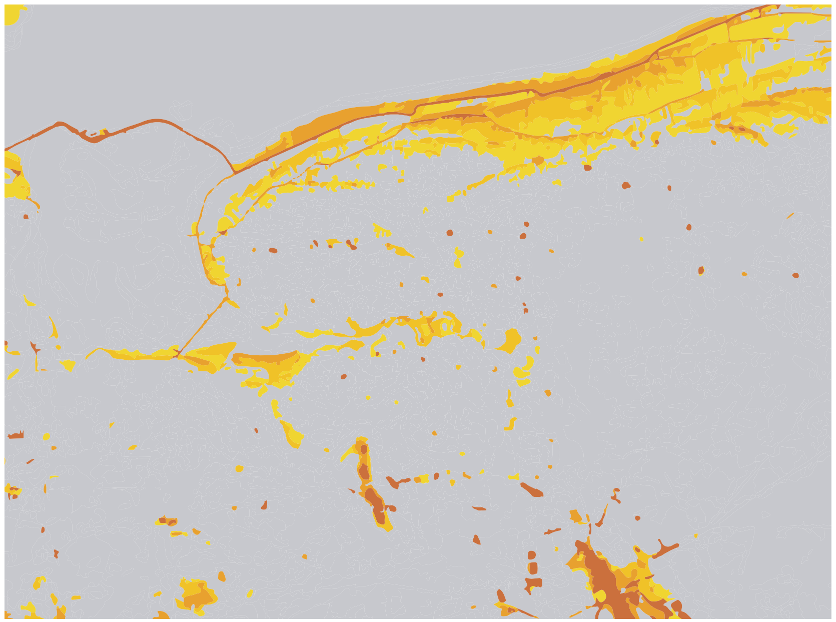
Groningen area - 250 mm sea level rise
based on Actueel Hoogtebestand Nederland

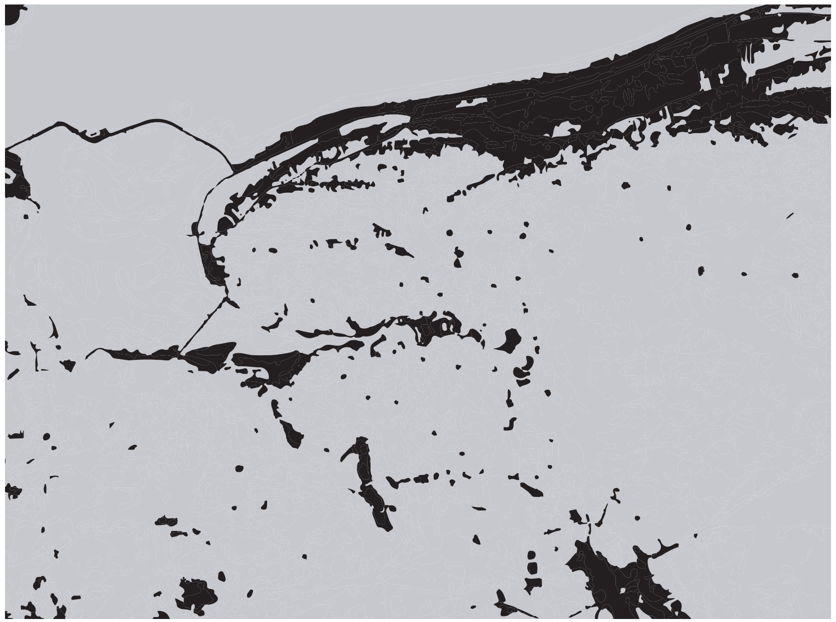






Groningen area - 500 mm sea level rise
based on Actueel Hoogtebestand Nederland





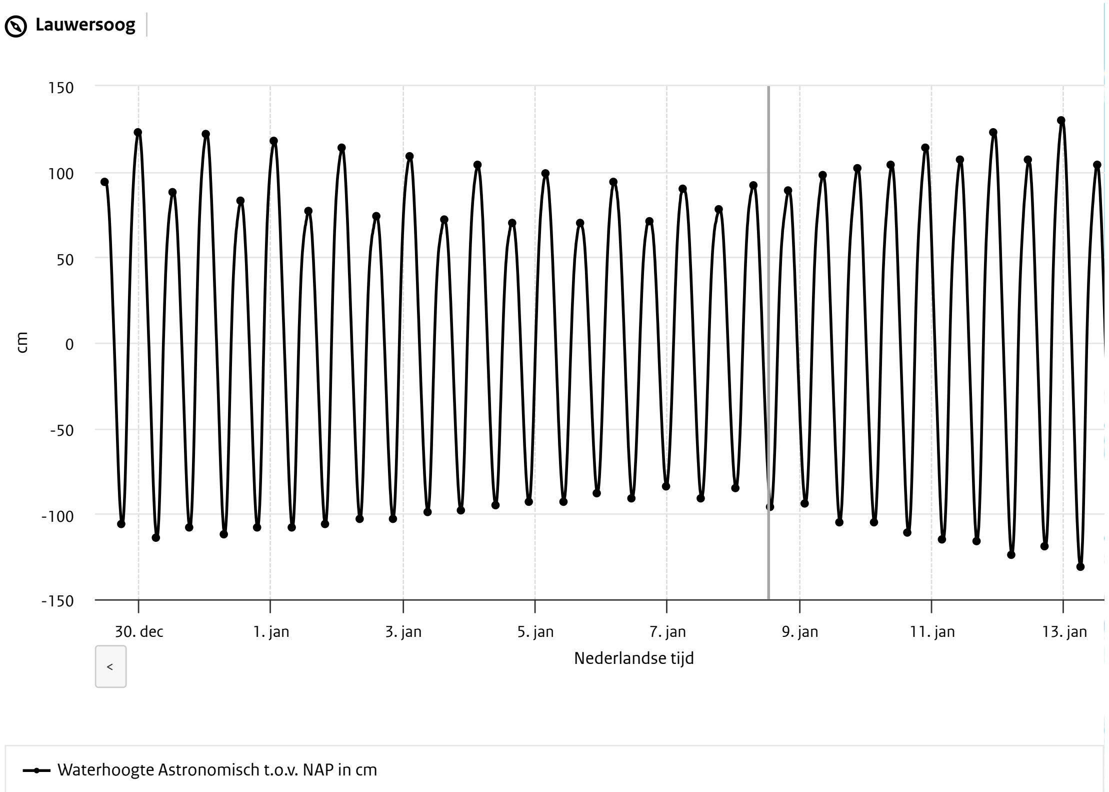
Groningen area - 1250 mm sea level rise
based on Actueel Hoogtebestand Nederland

How often will floodings occur?

Besides rising sea levels, tidal flooding will also have to be taken into account. In the Netherlands, there are two high and low tides in each day. One tidal cycle lasts 12 hours and 25 minutes (Ministry of Infrastructure and Water Management, 2023). Twice in each lunar month a 'spring tide' will occur, causing high tides to be higher and low tides to be lower. Between three and four times a year a perigean (or proxigean) spring tide will occur, when the Moon's orbit passes its closest point to the Earth at the same time as a spring tide (Barsley, 2020).

Rijkswaterstaat has recorded astronomical water levels relative to NAP. In northern Groningen, there is one measurement point at Lauwersoog. Within one lunar cycle in Lauwersoog, the amplitude of the water level is between 60 and 150 cm. Within the design task, these water height differences will have to be taken into account.

Besides rising sea levels and tidal flooding, the Netherlands may also experience other types of flooding such as surface water flooding, river flooding and groundwater flooding. One type of flooding can also cause another, which makes it difficult to predict the water levels and occurrences. This research will mainly focus on designing with rising sea levels and tidal floods to constrain the scale of the study.



Astronomical water level compared to NAP (Ministerie van Infrastructuur en Waterstaat, 2023)

"What adaption strategies can be used to adapt to this future climate?"

URBAN

FUTURE SCENARIO

ADAPTION STRATEGIES

ENERGY

DESIGN SKETCH

GUIDELINES

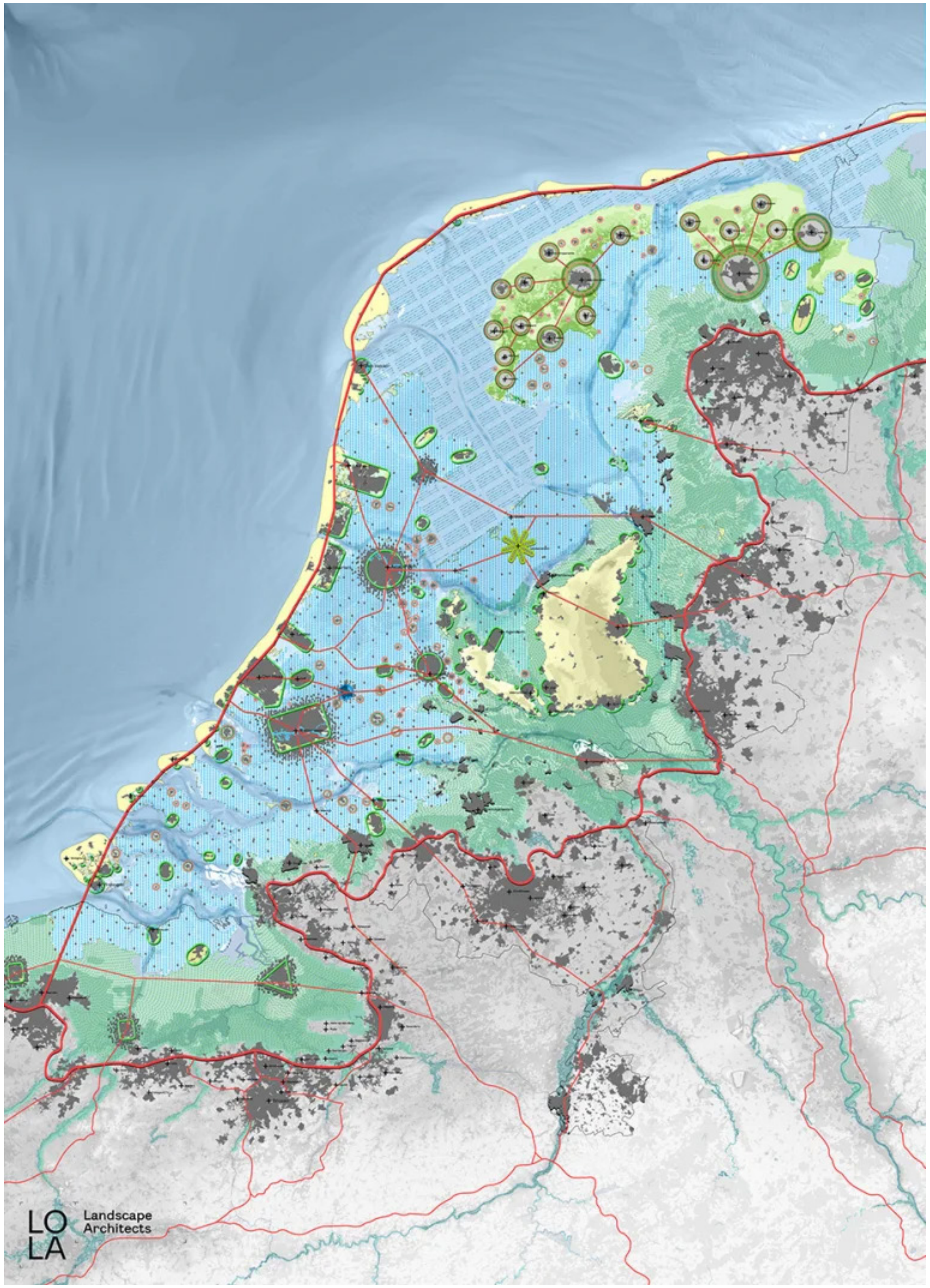
Plan B NL2200

How can we adapt to the climate as stated in the previous chapter? To gain knowledge of possible interventions that can be made to future-proof the landscape, several adaptation strategies have been set out that show a vision for both the Netherlands and the province of Groningen. Some aspects from these adaptation strategies have been further investigated and tested for feasibility, such as wet and salt farming.

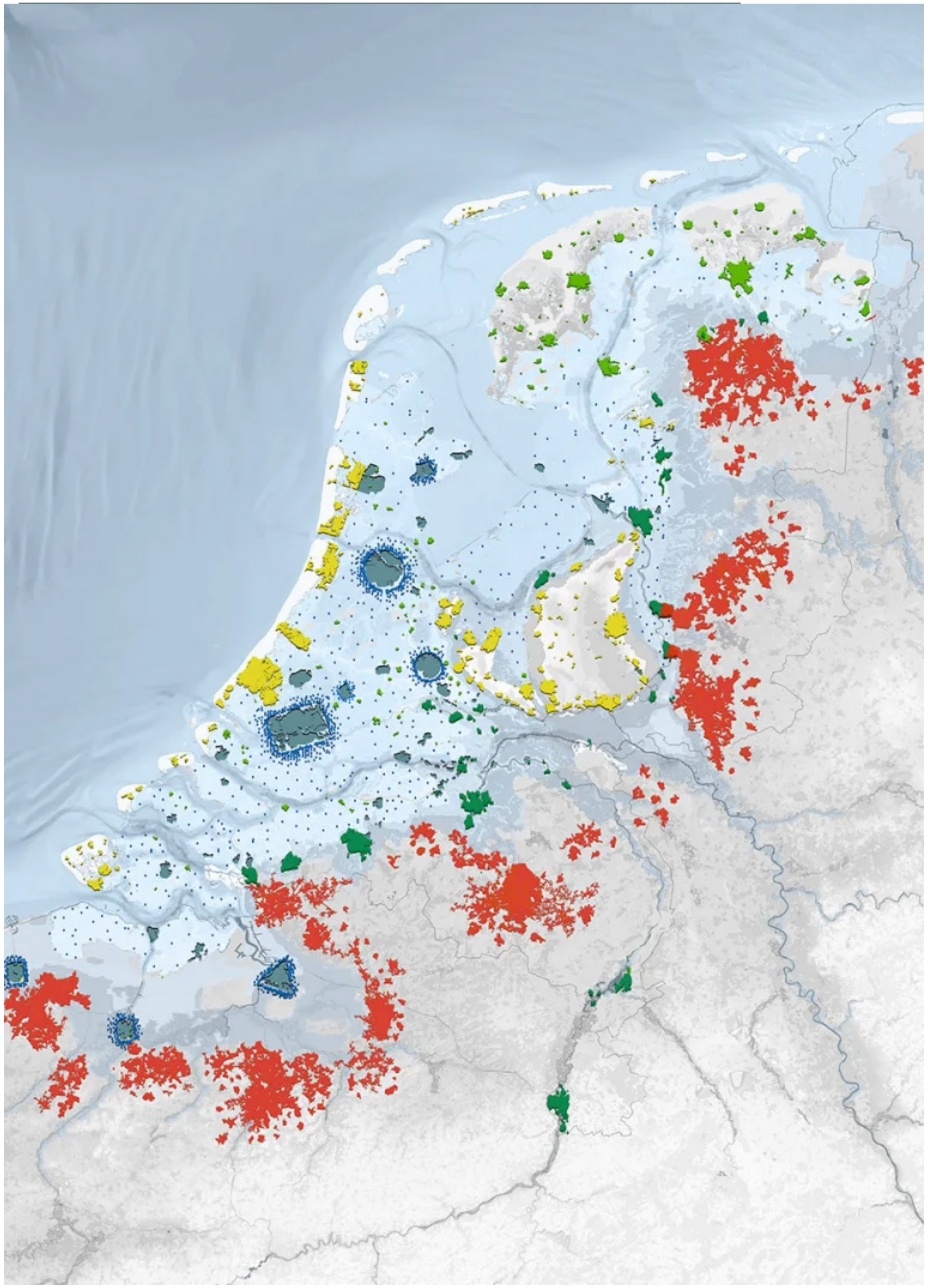
LOLA Architects have experimented with the solution of letting the water flow into the Netherlands and protect the land by creating big terps called 'megaterpen' (LOLA, 2020). Plan B NL2200 by LOLA is a first exploration of a strategy to adapt to a higher sea level of +3 meter in 2100. The plan envisions a country without dikes that uses the accelerated sea level rise to leverage the rebuilding of a new Netherlands.

The coastline is shifted to the east of the Netherlands, where the economic heart of the country (Randstad) will be reconstructed. Inhabitants of the lower parts of the country will have to move to the east or to terpen.

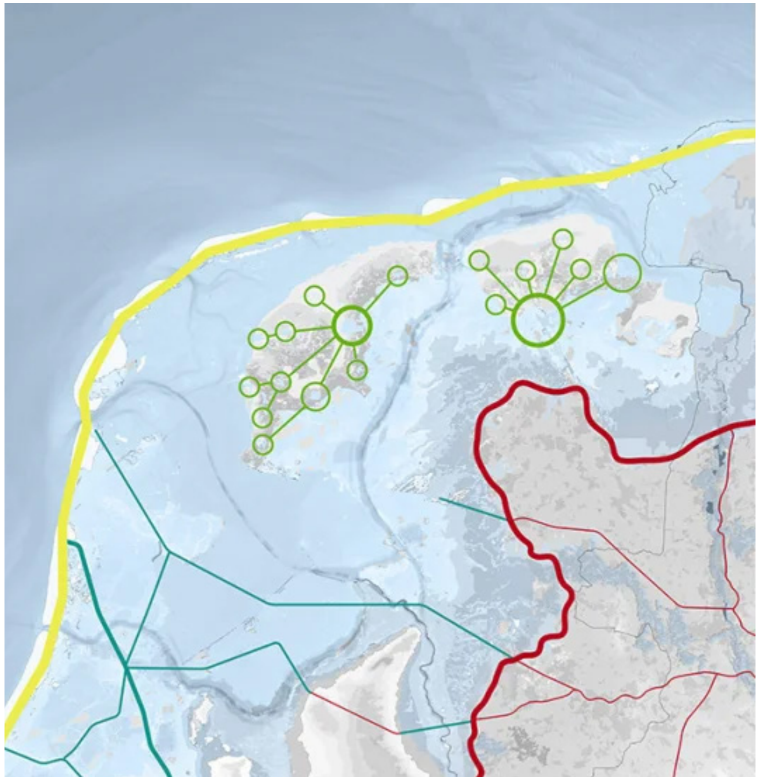
The remainders of the west coast will be maintained and strengthened to develop a marine lagoon that will be developed for residential areas, fisheries, aquaculture, recreation, nature and energy.



(LOLA - Plan B: NL2200, 2020)



(LOLA - Plan B: NL2200, 2020)



It would be interesting to investigate futher how a plan like this could be implemented in the Privince of Groningen? Could the creation of the ‘megaterpen’ be feasible?

Deltares has designed several adaptation strategies that give direction to the tasks ahead for urban planning in the Netherlands. This research will further focus on the strategy of 'Meebewegen' to explore the possibilities of co-existing with the water instead of fighting against it.

This strategy reduces vulnerability to the effects of higher sea level rise through water- or salt-tolerant land use, raising land by mounds and spatial planning.

In all strategies it is advised to change the agriculture in the coastal zones to more salt-tolerant crops.

Tabel 4. Samenvatting van de betekenis van de oplossingsrichtingen voor de indicatoren.

Strategie	Maatregel	Mate van zeespiegelstijging en overig doelbereik	Technische haalbaarheid	Maatschappelijke haalbaarheid	Adaptiviteit
Meebewegen	**Palen of terpen**	Beperkt		- Lokaal, bij nieuwe bebouwing mogelijk - Alleen bij tijdelijke overstroming	Beperkt
	Drijvend of megaterpen	- Beperkt en lokaal met natuurlijke landspiegelstijging - Kunstmatige ophoging enkele meters - Veel bij drijvend	Ruimte nodig om tijdelijk heen te gaan terwijl gebieden worden opgehoogd.	Ruimtegebruik gaat ten koste van andere functies	- Beperkt, zodra er gebouwen etc op staan kun je niet eenvoudig verder ophogen - Rotatie om grote gebieden op te hogen
	Migreren	Veel	- Beschikbare ruimte in NL of over de grens - Verplaatsbaarheid vastgoed	- Grote uitdaging, vooral als water- bewustzijn laag is. - Kan bespoedigd worden door een overstroming, gebrek aan vertrouwen in de overheid, verandering investeringsklimaat. - Migratie kost veel tijd, kan autonoom gebeuren	- Transitie vraagt veel tijd - Kan gefaseerd worden uitgevoerd.

'Meebewegen' direction to adapt to a higher sea level (Haasnoot et al., 2019)

Future farming

Deltares mentiones changing arable farming to saline and wet agriculture as adaptation strategy. What impact would this have in terms of spatial planning for the built environment? And could the cultivated products be used within a building design?

To investigate this futher, I examined different crop product lists and marked the crops that could be useful in the built environment. I carried this out for both saline and wet crops. The lists are documented in the appendix.

In the design phase, the building possibilities with some crops could be further developed, like bamboo. This crop can grow well in both wet and saline areas and has strong structural properties.

Paludicultural plants and utilisation options (selection)

GREIFSWALD MIRE CENTRE

	English name	Latin name	Most promising uses	Other uses
Uptake of cultivation very likely	Peat moss	*Sphagnum* spp.	• Founder material for restoration and Sphagnum farming • Orchid cultivation • Horticultural growing media replacing peat • substrates for carnivorous plants, for vivaria with amphibians, reptiles and spiders, • substrate for hanging baskets, wreathes and vegetation walls	• Insulation and packaging material • Food preservation • Medical dressings, diapers, and sanitary towels • *Sphagnum* extracts as source of natural sunscreen
	Sundew	*Drosera rotundifolia*	• Medicinal uses	• Vegetarian rennet for cheese making
	Cattail, Bulrush	*Typha angustifolia, Typha latifolia*	• Insulation material • Filling material (seed hairs) • Construction material • Packaging and disposable tableware • Horticultural growing media replacing peat • Fodder • Pollen for feeding predatory mites (pest control in glasshouses)	• Combustion • Biogas • Extraction of proteins
	Reed	*Phragmites australis*	• Thatching material • Insulation material • Construction material • Packaging and disposable tableware • Fodder • Combustion	• Paper • Biogas • Liquid fuels • Extraction of proteins • Silicon from reed leaves for high-performance energy storage devices
	Giant cane	*Arundo donax*	• Combustion	• Biogas
	Reed Manna Grass	*Glyceria maxima*	• Fodder	• Biogas • Extraction of proteins
	Reed canary grass	*Phalaris arundinacea*	• Packaging and disposable tableware • Panels • Fodder • Bedding • Combustion	• Paper • Biogas • Liquid fuels • Extraction of proteins
	Sedges	*Carex* spp.	• Packaging and disposable tableware • Panels • Fodder • Bedding • Combustion	• Paper • Biogas • Liquid fuels • Extraction of proteins
	Alder	*Alnus glutinosa*	• Timber for carpentry, interior fittings, furniture • Veneer • Combustion	
	Willow	*Salix* spp.	• Fodder • Weaving material (e.g. baskets)	
	Bog Myrtle	*Myrica gale*	• insect repellent • flavour (e.g. beer) • medicinal uses, cosmetics	
	Cranberry	*Vaccinium oxycoccos*	• Food (e.g. berries, juice)	
	Black Chokeberry	*Aronia melanocarpa*	• Food (e.g. berries, juice)	Medicinal uses
Further promising plants for paludiculture	Wild rice	*Zizania aquatica, Z. palustris*	Cereal	
	Japanese Millet	*Echinochloa esculenta*	• Food • fodder	
	Celery	*Apium graveolens*	Vegetable	
	Water Pepper	*Persicaria hydropiper*	Spicy leaf vegetable	
	Holy Grass	*Hierochloe odorata*	Flavour (e. g. for drinks)	
	Calamus	*Acorus calamus*	Flavour (e.g. for drinks), cosmetics	
	Water mint	*Mentha aquatica*	• Flavour, tea • Perfumery	
	• Cloudberry • Blueberry	• *Rubus chamaemorus* • *Vaccinium myrtillus*	• Food (e.g. jam, juice)	
	• Bogbean, buckbean • Meadowsweet • Valerian • Butterbur • Garden Angelica • Alder Buckthorn • Gypsywort • Water Dropwort	• *Menyanthes trifoliata* • *Filipendula ulmaria* • *Valeriana officinale* • *Petasites hybridus* • *Angelica archangelica* • *Frangula alnus* • *Lycopus europaeus* • *Oenanthe aquatica*	Medicinal plants (e.g. pharmaceuticals, cosmetics)	
	Duckweed fern	*Azolla filiculoides*	• Fodder • Fertiliser (N-fixation)	• Food • Protein extraction
	Duckweed	*Lemna* spp.	• Fodder	• Protein extraction

Abel, S. & Kallweit, T. (2022)

"WHAT ENERGY SYSTEMS COULD BE IMPLEMENTED IN THE LANDSCAPE IN A FUTURE SCENARIO?"

URBAN

FUTURE SCENARIO

ADAPTION STRATEGIES

ENERGY

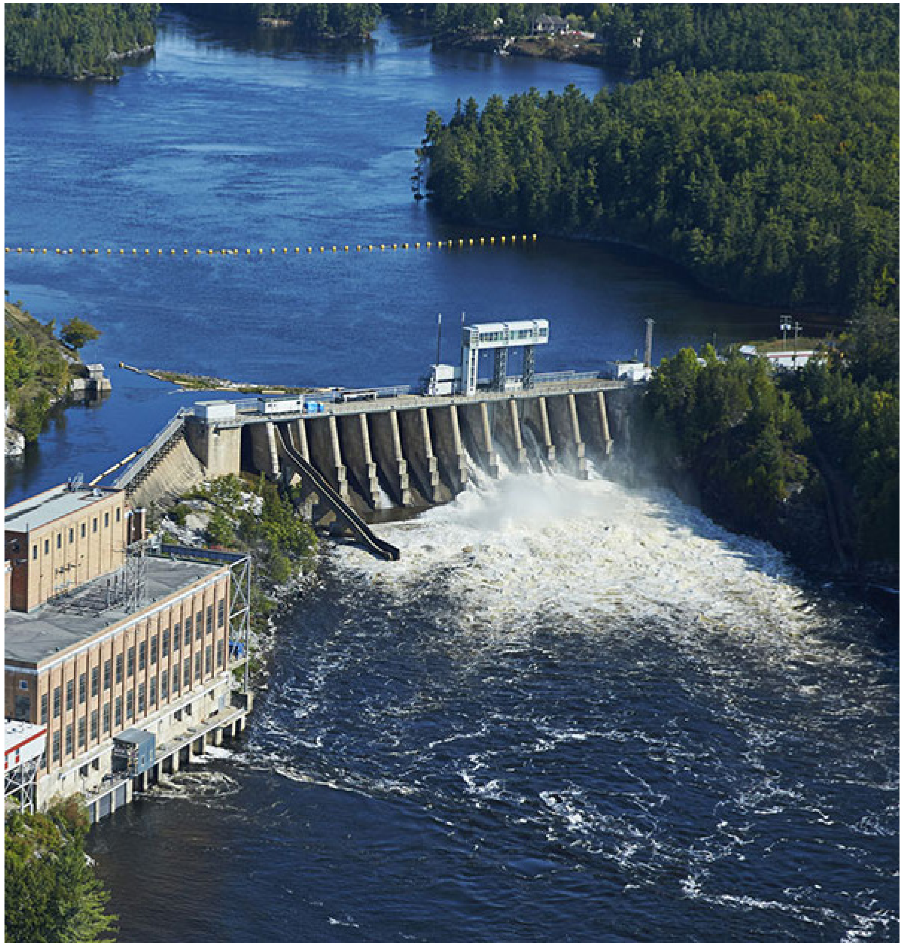
DESIGN SKETCH

GUIDELINES

Make use of the water

Is there a way of using the water on an urban scale for energy regulation? Energy could be generated by making use of the water tides, like the water works in Zeeland. Hightened areas of land could also be used for water storage and function as a watter battery as is done in Canada (Waterpower Canada, 2023). They make use of hydropower, which is convertsing kinetic energy in falling or flowing water, into mechanical energy, and then into electrical energy (or so called hydroelectricity).

Water is stored in a reservoir behind a dam. The potential energy of this water is converted to kinetic energy when it flows upon release from the reservoir into the penstock.
Pumped storage is another type of hydropower which also stores water in a reservoir. At pumped storage facilities, water is pumped up to an elevated reservoir for storage. When electricity generation is required, the water is released into the penstock.



(Waterpower Canada, 2023).

"What urban planning interventions will be necessary to ensure the functionality of a future village?"

"What would the infrastructure look like?"

URBAN

FUTURE SCENARIO

ADAPTION STRATEGIES

ENERGY

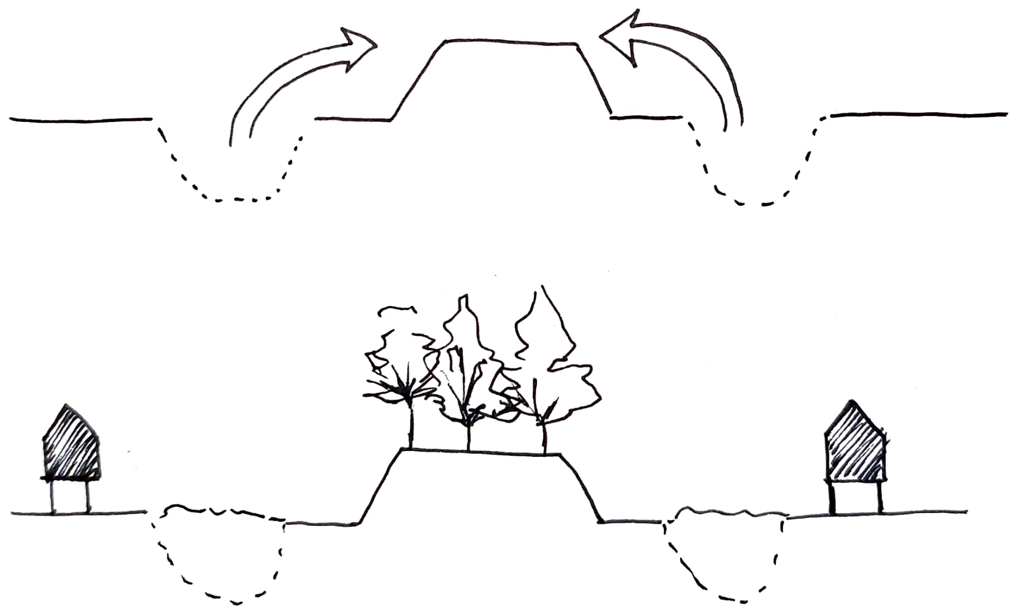
DESIGN SKETCH

GUIDELINES

Design inspiration

Based on the previous research on what the climate situation will look like in 100 years, a brainstorm session was held on possible design ideas in Groningen's landscape. Doing so, inspiration was drawn from the lecture by landscape architect and founder of 'Landscape Collided' Lieke de Jong (lecture, October 2023). She talked about her graduation project in which she had designed freshwater estates by excavating parts of Groningen's fertile soil for water storage and using the earth as access material.

I would like to further explore this principle and investigate whether the created yards could be applied on a larger scale and could function as mounds to protect buildings from higher sea levels. I have further developed this idea into three scenario designs for the urban scale. In the next chapter, these three scenarios will be further elaborated on the local scale.



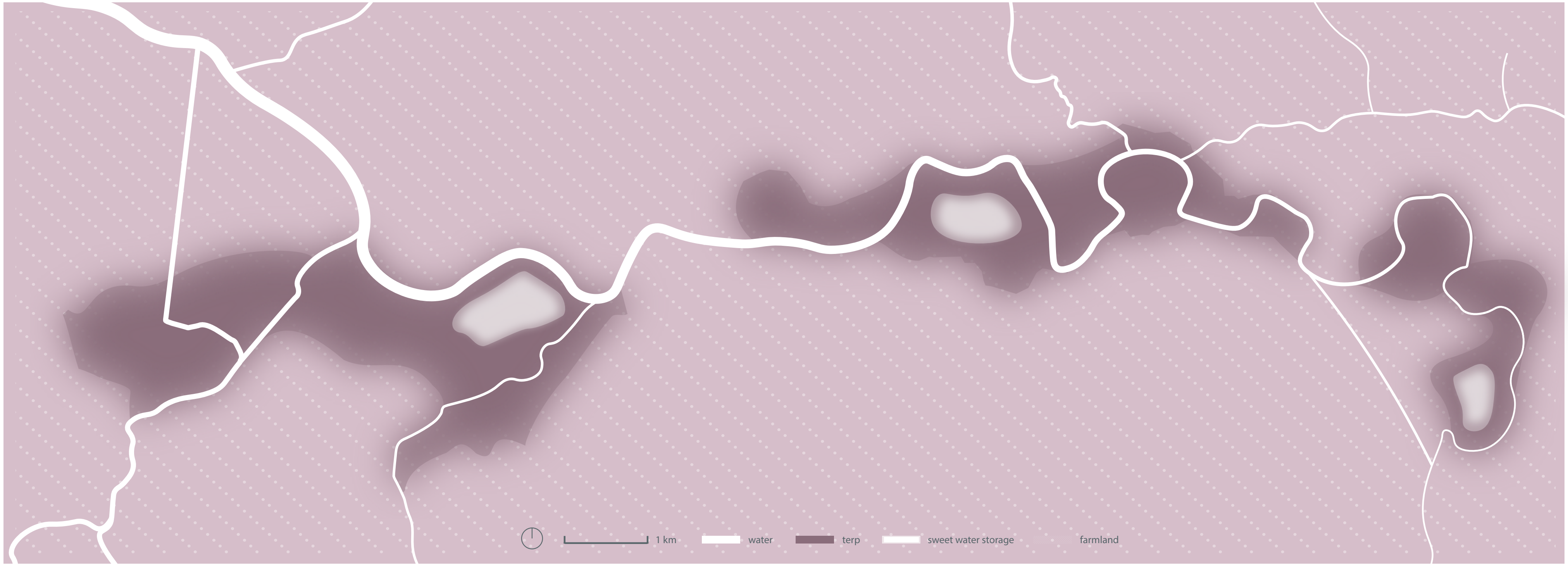
Own work (2023) inspired by the lecture of Lieke de Jong (october, 2023)

Scenario 1 - Living on terps

Buildings
The built environment will be concentrated on terps. At the core of each terp there will be a freshwater spring according to de Jong's concept (2021).

Farming
Arable farming will take place in the wetlands with saline and wetland cultivation.

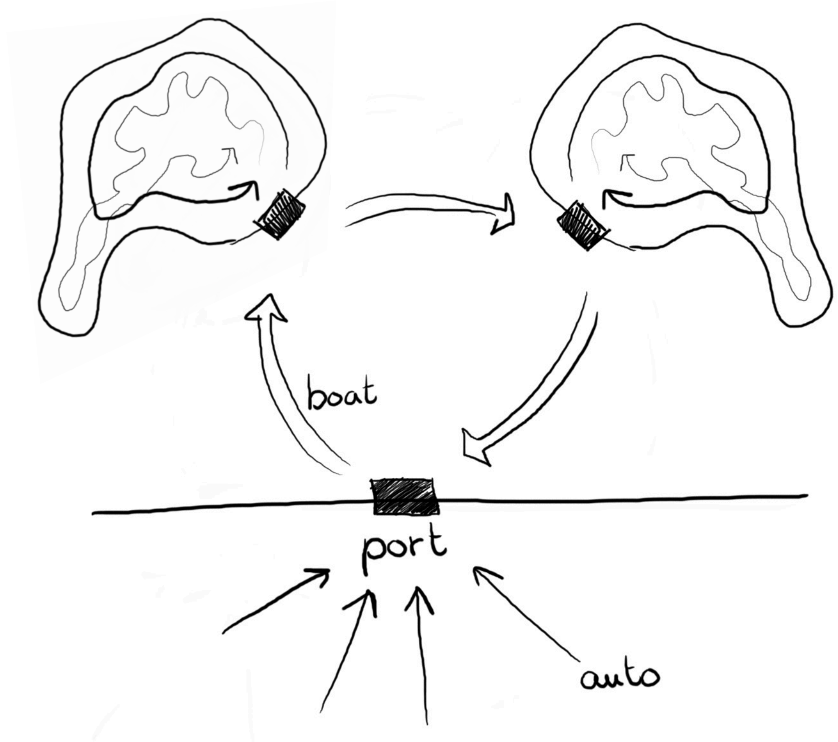
Infrastructure
Main infrastructure via waterways. Existing canals are excavated to allow boat traffic. The excavated earth will be used to raise the terps.



Scenario 1 impression (own work, 2024)

Movement by boat or car?

In this scenario, people will mainly travel by water. Like the islands in the Wadden Sea, a boat will sail regularly to take travellers from the mainland to the terps. On the terps, residents can move on by car, bicycle or on foot.



Own work, 2023

Scenario 2 - It's all about farming

Buildings
In this scenario, the built environment will be placed in the wetlands. Floodproofing methods (see building chapter) will be used to protect the buildings from water.

Farming
This scenario revolves around maintaining the current arable products. By placing arable farming on terps with fresh water sources, the current crop products can still be grown a hundred years from now.

Infrastructure
Here, too, people will move by water. As the housing development is more spread out in this scenario, there will be more of a canal structure here through which households will travel by their own boat.

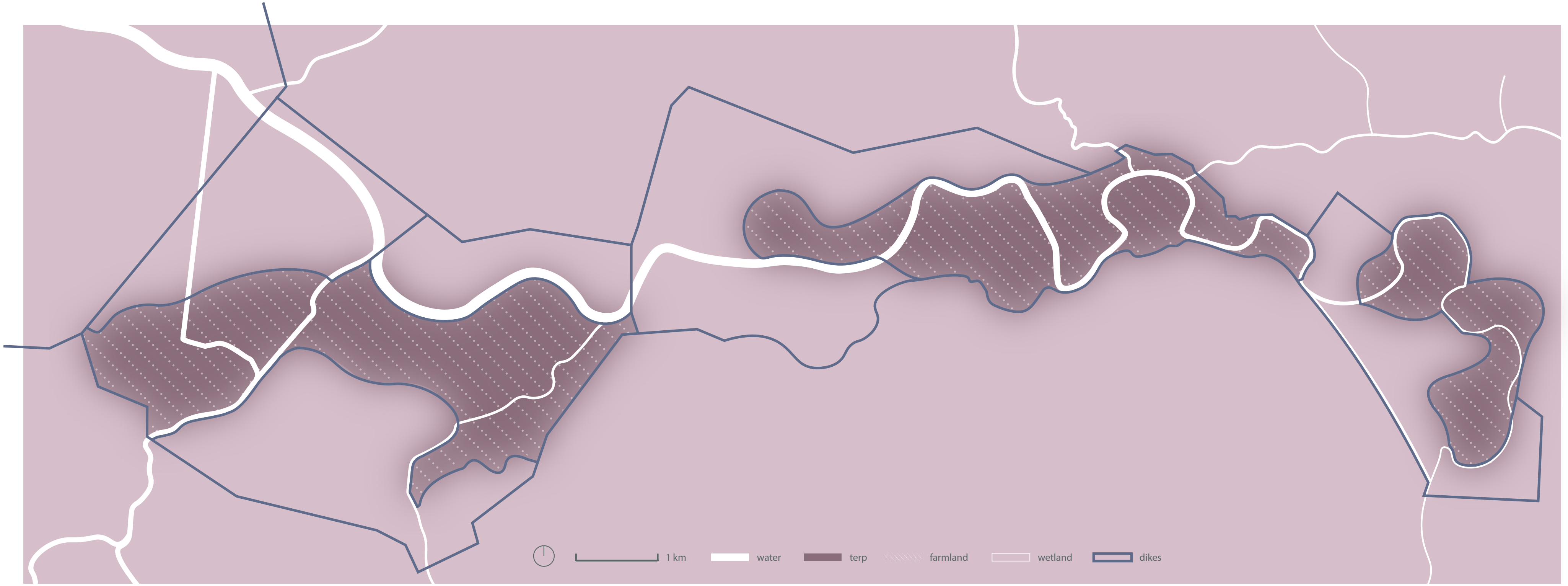
Scenario 2 impression (own work, 2024)

Scenario 3 - Dike landscape

Buildings
The built environment follows the same principle as scenario 2. Buildings will be distributed over the area in wetlands with wet floodproofing methods. These are needed because the 'tussendijkse' areas between the dykes will sometimes flood with water in a controlled manner.

Farming
A mix of low arable and high arable farming. This creates variety in the landscape and regional products.

Infrastructure
The dykes will function as the main infrastructure. They will be created on different heights, resulting in a variety of floodplains when flooding occurs. When water flows over a dike, energy can be generated there. Some intermediate dike areas are also used as water and/or energy storage.



Scenario 2 impression (own work, 2024)

“What conclusions can be drawn on a building scale that can be taken into consideration during the design phase?”

URBAN

FUTURE SCENARIO

ADAPTION STRATEGIES

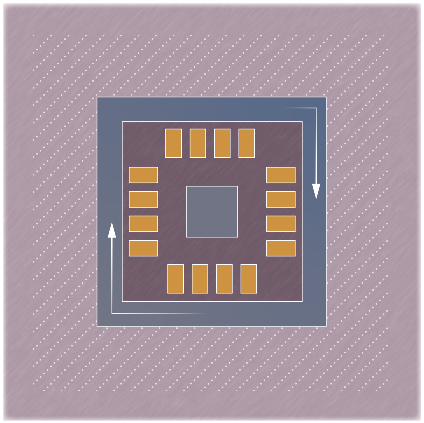
ENERGY

DESIGN SKETCH

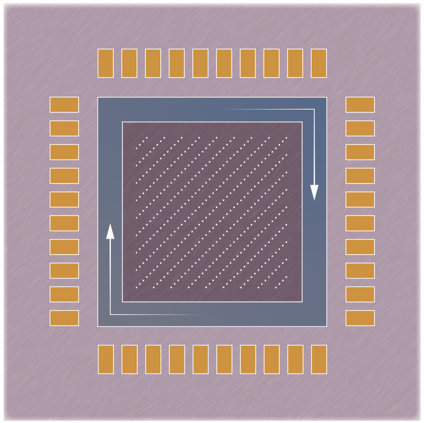
GUIDELINES

Urban landscape concept

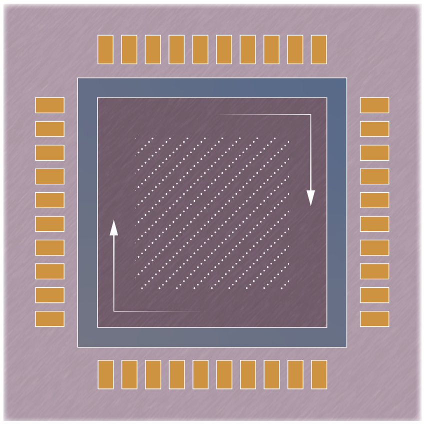
The three urban scenario sketches are converted and simplified into concepts. These will be further developed on a smaller scale in the following chapter.



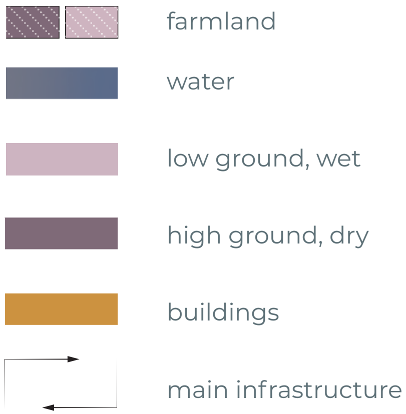
1. Living on terps



2.It's all about farming



3. Dike landscape



"WITHIN THIS FUTURE SCENARIO, HOW WOULD A VILLAGE FUNCTION WHILE ADAPTED TO THE FUTURE CLIMATE?"

LOCAL

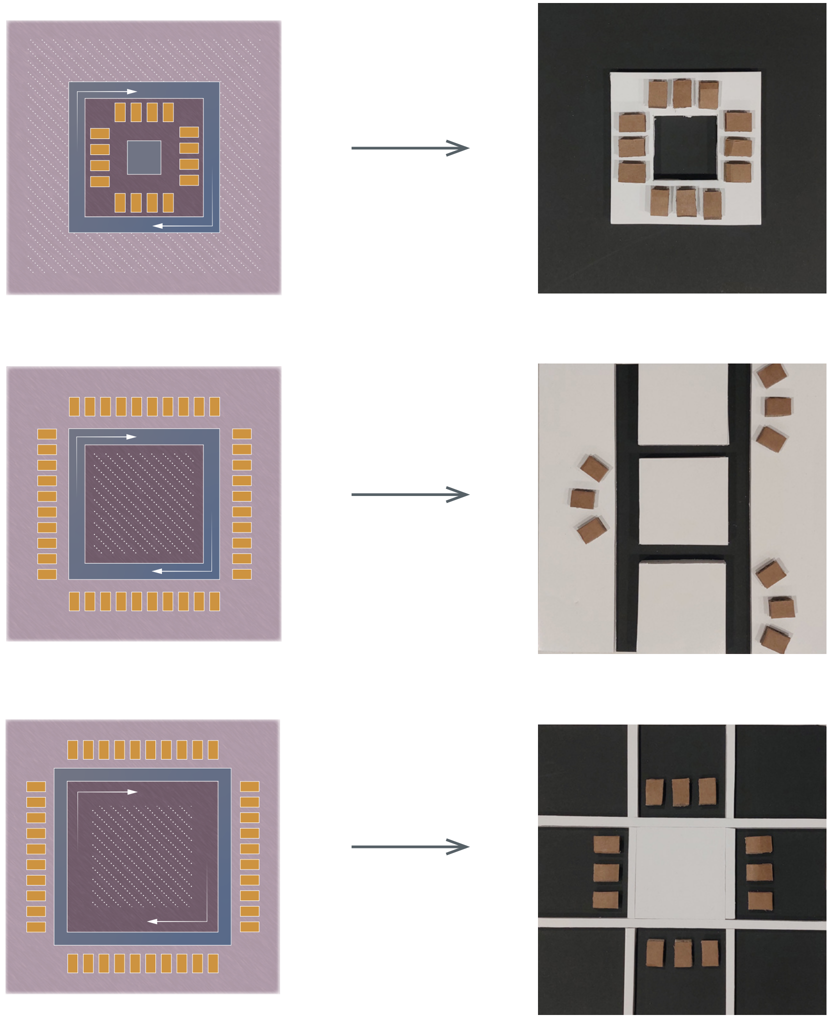
DESIGN SKETCH

ENERGY

COMPARATIVE ANALYSIS

Translation urban to local

To get a grip on the concept sketches from the urban chapter, physical models were created at 1:1000 scale and cross-sectional hand sketches 1:500.



own work, 2023

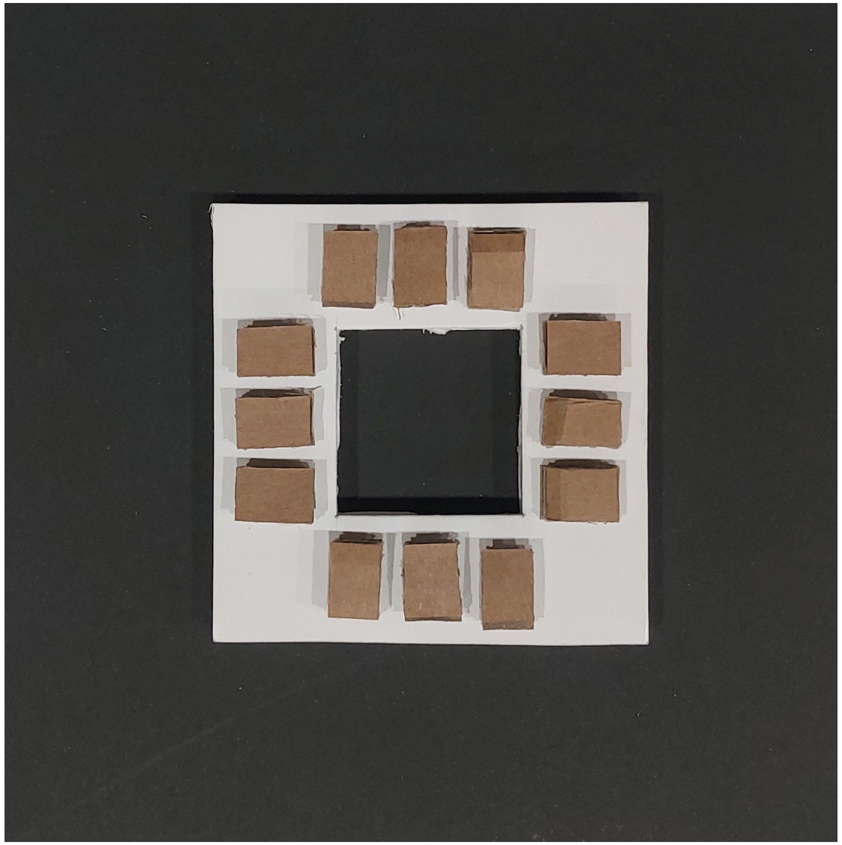
Scenario 1 - Living on terps

Dwelling on terps

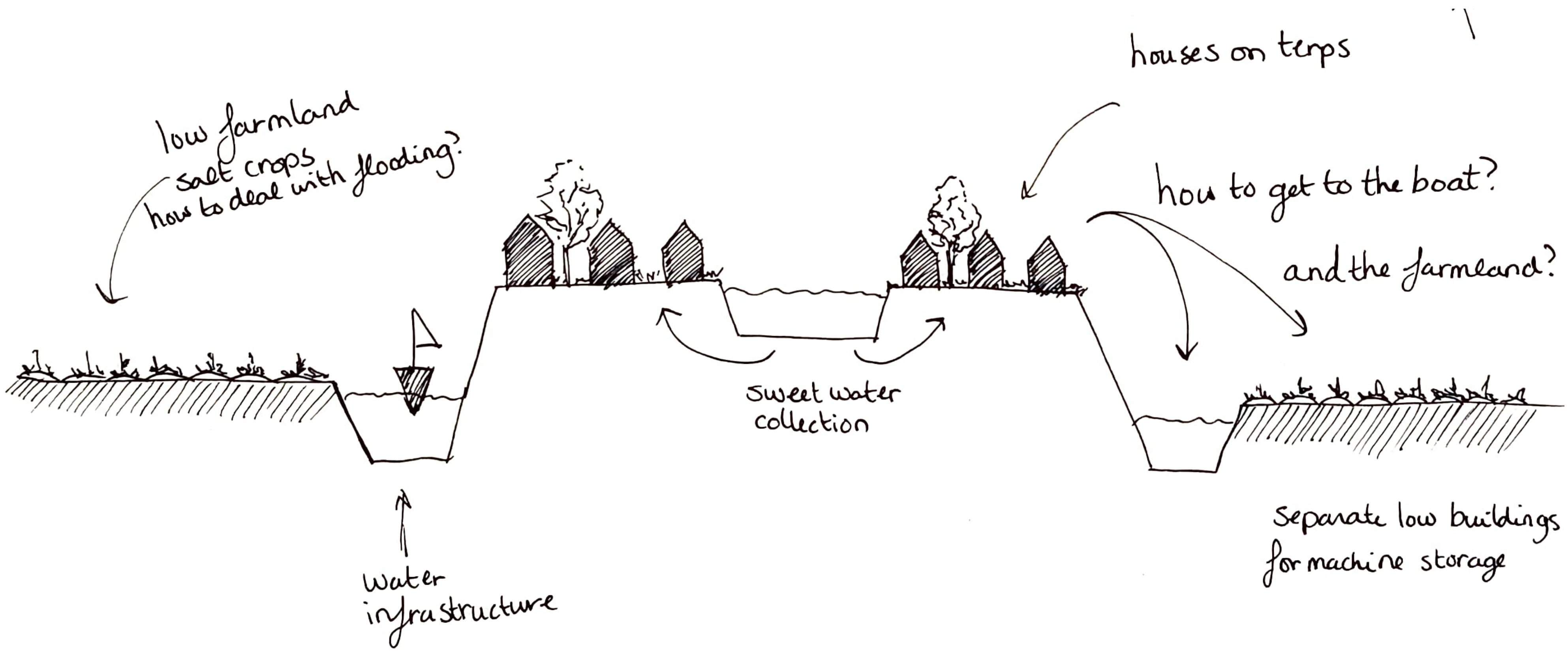
Sweet water storage centered in the terps

Farms on lower land - wet and salty

Water infrastructure like Waddensea



own work, 2023



Intersection of future scenario ‘ terpen water landscape’ , own work, 2023

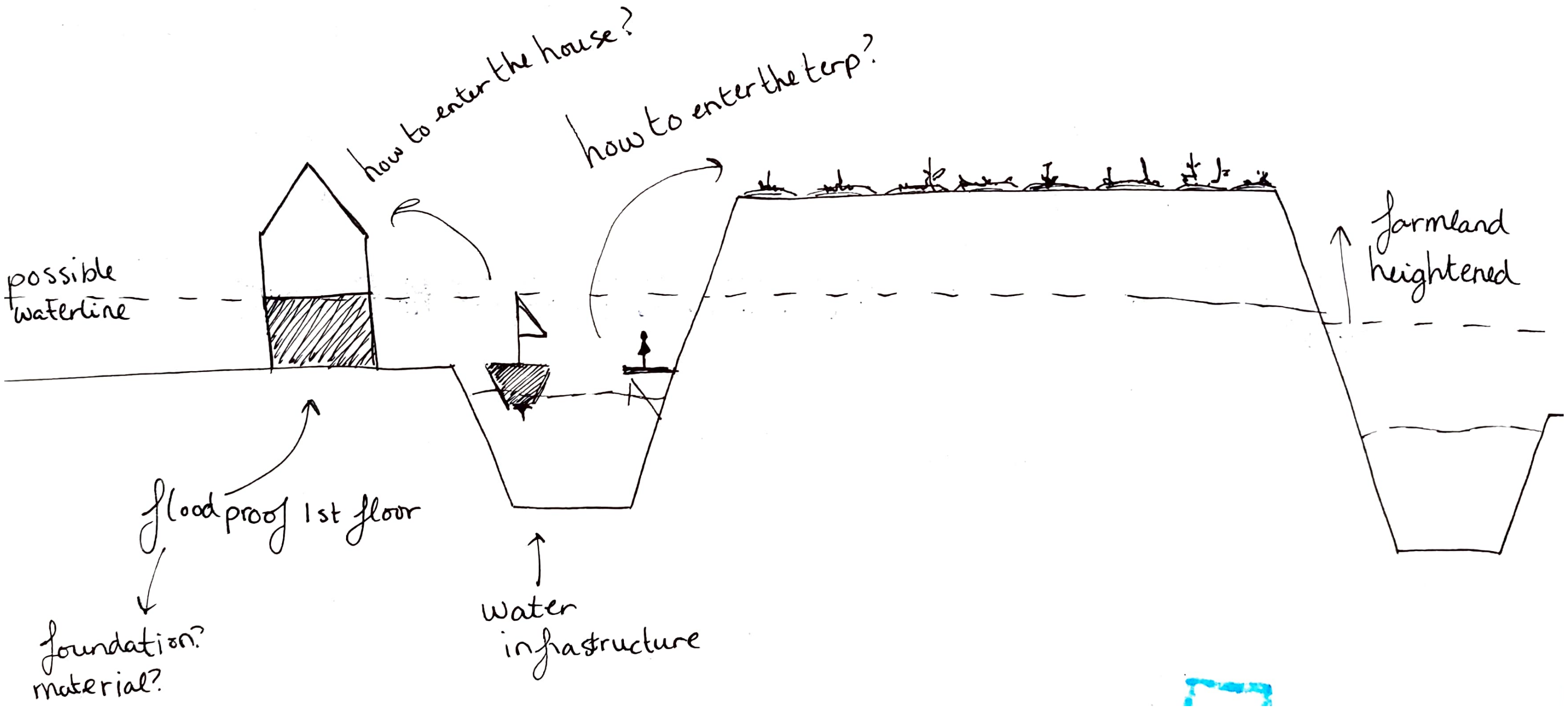
Scenario 2 - It’s all about farming

Dwelling on lower land - wet floodproofing

Farms on terpen - dry and sweet

Water infrastructure via canals

own work, 2023



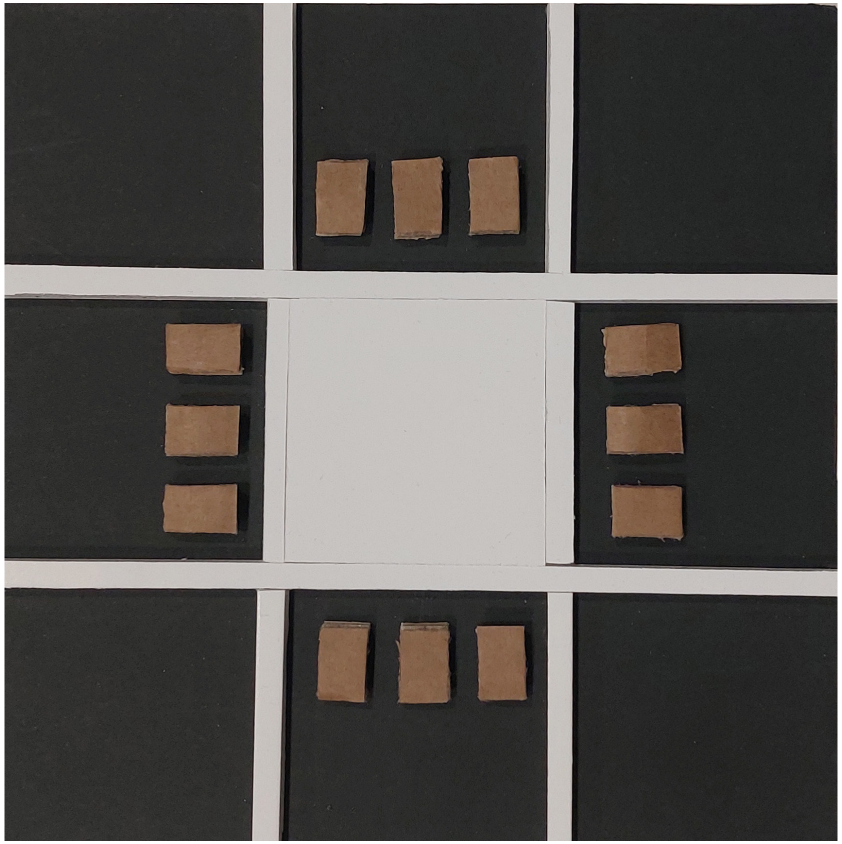
Intersection of future scenario 'farm water landscape' , own work, 2023

Scenario 3 - Dike landscape

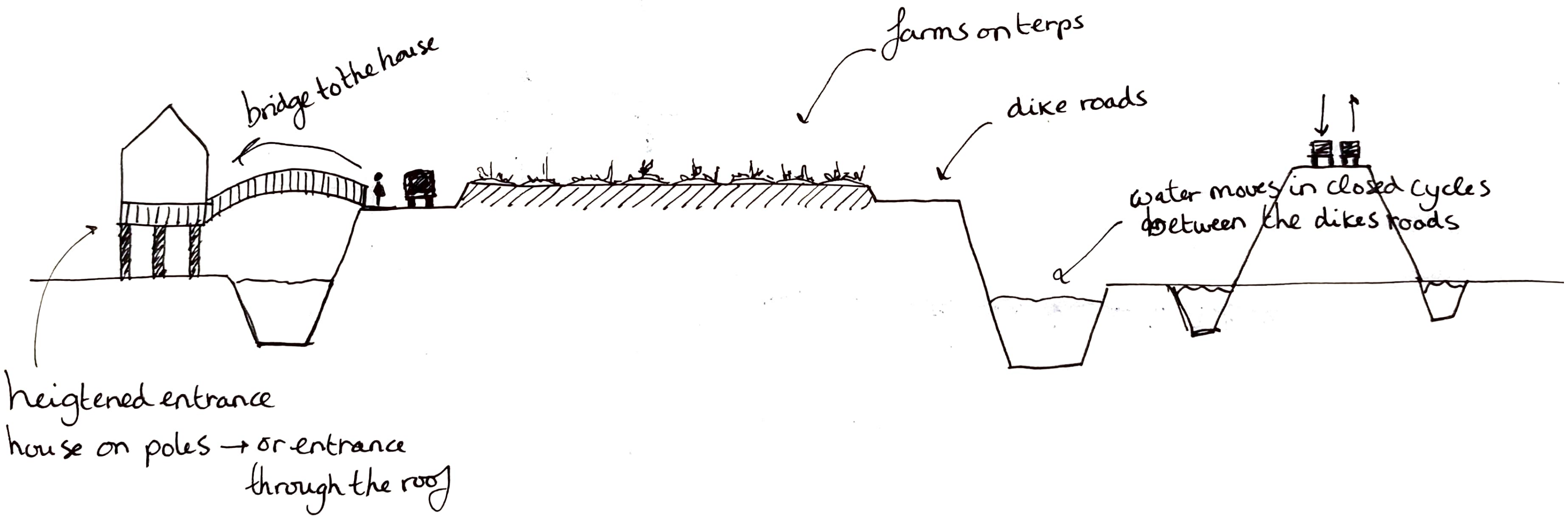
Dwelling on lower land - wet floodproofing

Farms on terpen or wetlands - mix of cultivation products

Dike infrastructure



own work, 2023



Intersection of future scenario 'farm dike landscape' , own work, 2023

"What energy systems could be implemented on a local level?"

LOCAL

DESIGN SKETCH

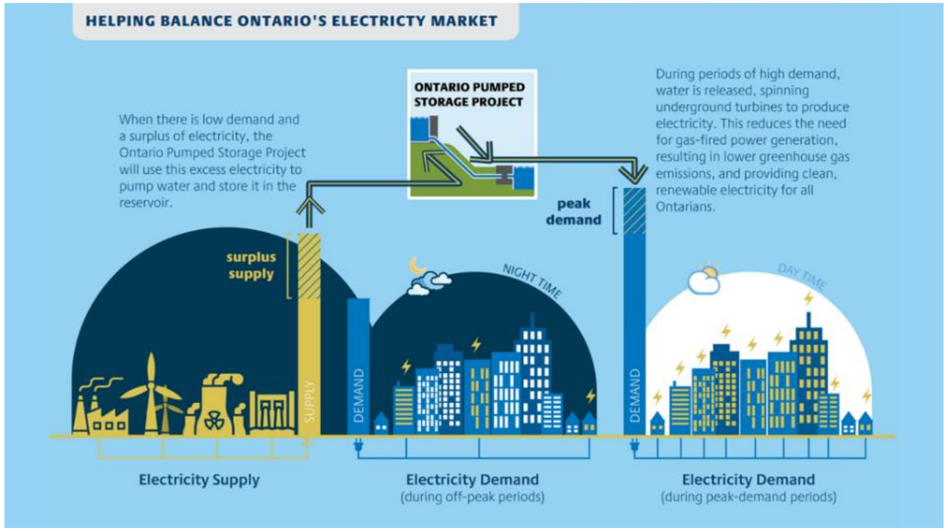
ENERGY

COMPARATIVE ANALYSIS

Energy design ideas

Water
Within a terp, an elevated water source could be used as a battery. The water can run downhill when you need energy. This concept is already widely used in Norway and Canada (Waterpower Canada, 2023).
Furthermore, buildings on the edges of the terps could be placed partly in the water to function as water mills.

Wind
Utility buildings can be used to generate energy outside visitor hours when the building does not need to be heated. Large halls within the building could function as wind turbines if air is sent through the building via negative pressure.
The energy systems of the buildings on a terp could be linked together. In this way, the utility buildings could heat the residential buildings in the evening and at night.



Pumped Storage Project (Waterpower Canada, 2023)

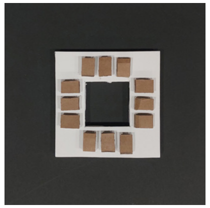
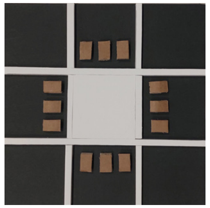
"WHAT CONCLUSIONS CAN BE DRAWN ON A LOCAL SCALE THAT CAN BE TAKEN INTO CONSIDERATION DURING THE DESIGN PHASE?"

LOCAL

DESIGN SKETCH

ENERGY

COMPARATIVE ANALYSIS

			
Housing	high - dry	low - wet	low - wet
Farmland	salty and wet	sweet and dry	mixed
infrastructure	water	water	dikes

Housing

Low: wet, change of floodings, accessibility to the building can be lost in case of floodings. A new form of entrances is needed so that buildings are always accessible via the rooftop.

High: clustered villages, well protected from the water. You can only built on terps, so your whole built environment will be clustered.

Farmland

Salty and wet: creating of a new agriculture. Difficult to control the level of salt. Future resilient considering the rising sea level.

Sweet and dry: no chances need to be made in the exiting farming principles. Export of products and family businesses will stay intact.

Infrastructure

Water: infrastructure via canals or open water if the sea level rises high. Investment in electrical boats.

Dikes: all dikes need to be levelled up. A network of new dikes needs to be developed. Solution for parking spaces needs to be found on the dikes.

"How can a building be adapted to withstand future floodings?"

"Can the water be used as an advantage for the energy regulation of a building?"

BUILDING

DESIGN WITH WATER

PASSIVE ENERGY GUIDELINES

How to deal with floodings?

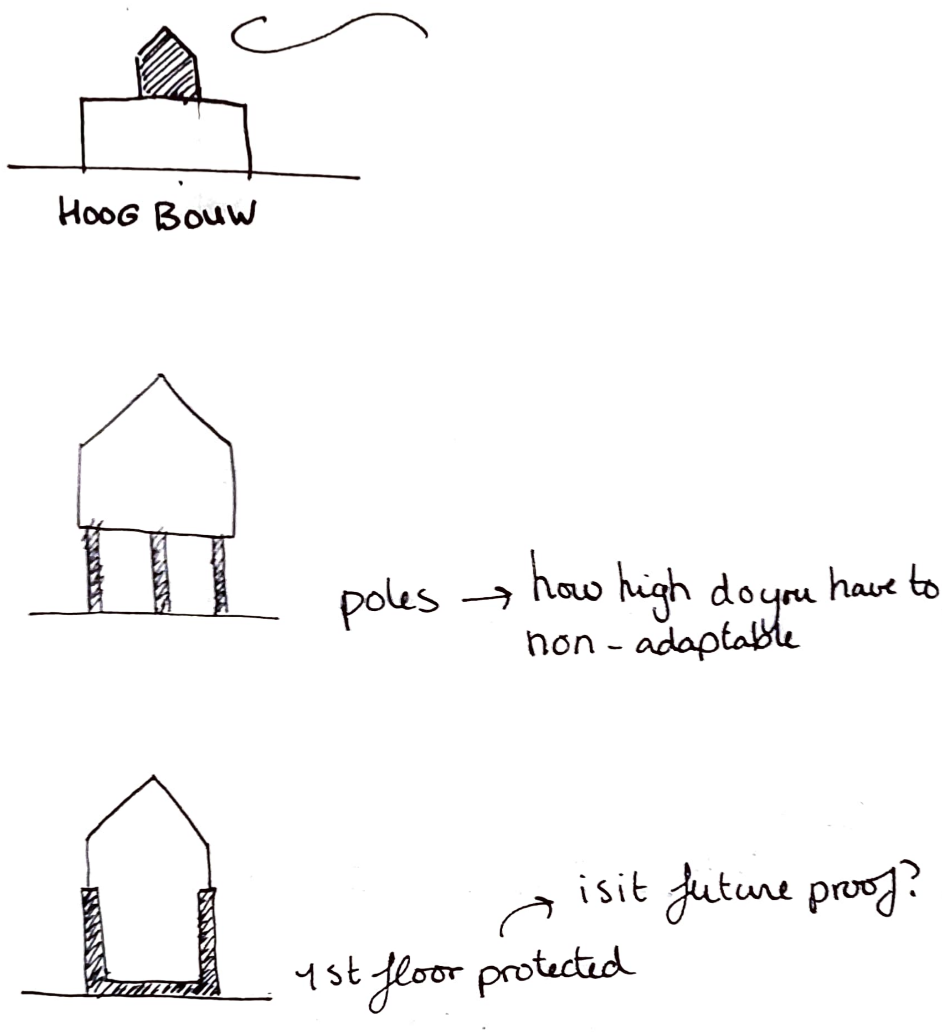
To look at the design challenge at the building level, the first step will be to look at a major challenge arising from the study of a future scenario: dealing with an overflow of water in the landscape. At the urban and local level, we have already looked at large-scale interventions that can be made to gain more control of the water and use it as an advantage for the energy supply. At the building level, this chapter will look at measures that can be taken to flood-proof buildings. What ways are there to deal with high water?

According to Barsley (2020), there are four main principles that can be applied to protect buildings from higher water levels:

Dry floodproofing:
- Placing the building on raised ground on mounds
- Raised construction by placing piles under the building
- Protect your building with a watertight 1fst floor

Wet floodproofing:
- Let the water into your building in a way it doesn't harm the building and its inhabitants.

Dry floodproofing methods avoid contact with water, whereas wet floodproofing allows water to enter the building in a controlled way. I'm interested to see if there's a possibility of combining these wet floodproofing methods together with energy systems that generate energy from water. This chapter will therefore look further into the method of wet floodproofing.



Water protecting principles (own work, 2023)

Wet floodproofing - design consequences

Edward Barsley, specialist in environmental design in architecture, discusses in his book 'Retrofitting for flood resilience: A Guide to Building & Community Design' different strategies for creating a flood resistant building. He describes how a building can be made 'recoverable' by making the inside of the building more water compatible. This strategy is also known as wet floodproofing. Recoverable measures can be used for any depth of flood water, but can be limited in effectiveness in depths of over 1500 mm.

Barsley divides the different recoverable strategies into three subjects: positioning, material use and devices.

Positioning - elevate or adjust the position of materials, services and objects to reduce their exposure to water; include elements that can be easily moved out of harm's way.

Materials - use materials with low water penetration rates, which do not deform when in contact with flood water; use materials that can be easily recovered after a flood; use sacrificial elements,
designed for redundancy

Devices - use products that can help to remove flood water (e.g. sump and pump system); design in the capacity to allow water entry so loading on the walls of the building can be reduced and rebalanced.

Barsley (2020) has detailed an approach for each strategy. In addition, he shows all the challenges that can occur. This chapter explains some of the strategies, but Barsley's (2020) work as a whole will be a useful resource during the design phase. Barsley has also created a materials list showing which building materials are useful to design a water-resistant building (see appendix).

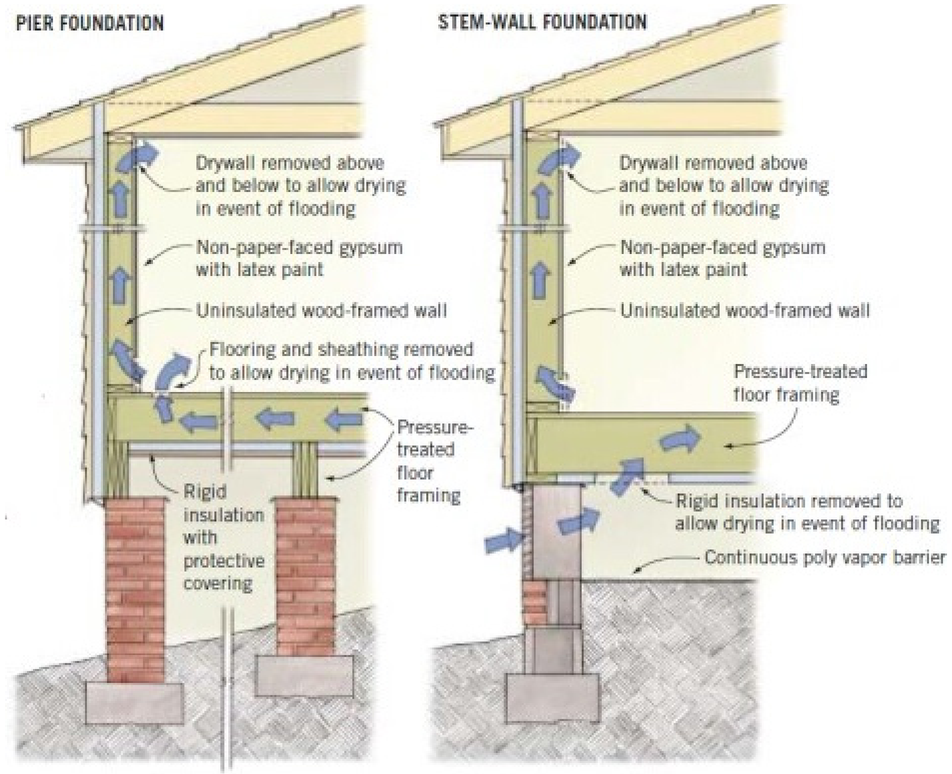
from a vulnerable to a water resilient city of Yalding in the UK (Barsley, 2020)

Wet floodproofing - building structure

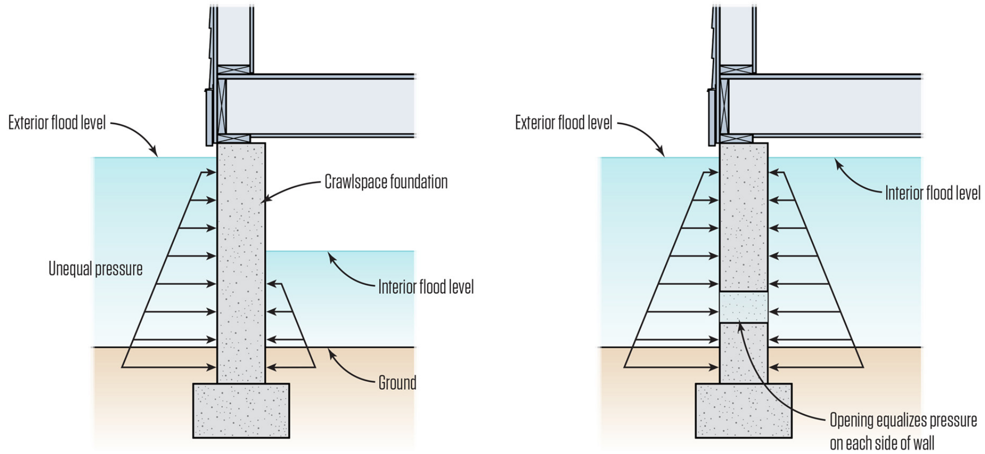
Solid walls are one of the simplest wall build-ups for flood-resilient construction, as there is no cavity within which to trap moisture or sediment. Brick could be a good structural building material, but the moltar joints can be a weak point through which flood water could move (Barsley, 2020). The structural building material needs to provide structural support, partitions, storage areas, entryways, and easy exterior excess to convert floodable space into functional areas.

When designing a space where water can flow in, hydrostatic pressure will have to be taken into account. By creating small openings in the wall, the indoor water level will rise to the same height as the exterior water level. This will equalize the pressure on each side of the wall, stabilizing the building structure.

All interior structural materials must be designed to withstand the hydrostatic pressure of rising waters. The materials also need to be cleaned after the floodwaters recede. The ventilation system can be designed in such a way, it will help the drying process of the wet materials after a flooding has occurred.



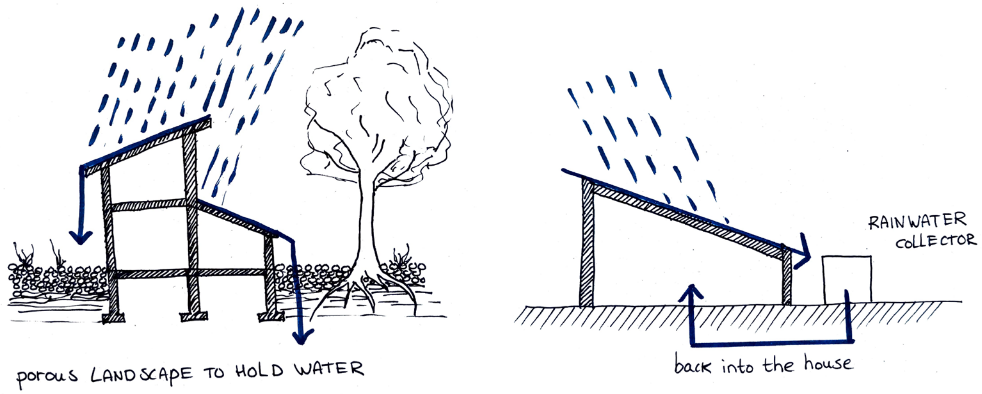
foundation floor assemblies for drying after a flood, (Cushman, 2006)



controlling hydrostatic pressure, (Staff, 2022)

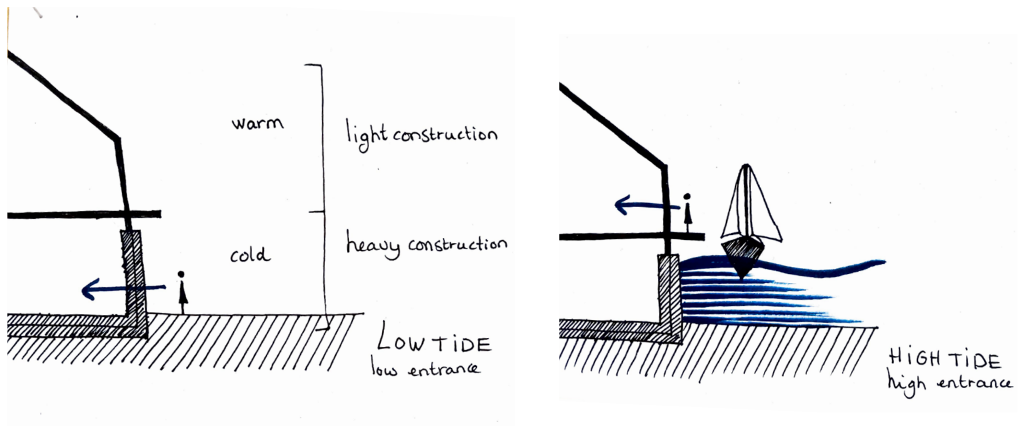
water regulation

Besides the afore mentioned wet flood proofing methods, it is also important to look at the possibilities in regulating water around the building. A porous landscape can absorb water and keep the ground from drying out during hot days. Rainwater can be collected and used for indoor water systems.



Building flooding entrance

If a building is designed to resist flodding, it is also important to exlore the impact this will have on the building typology. A high alternative entrance can be incorporated into the design to allow access to the building in the event of a flooding.



Water regulation principles (own work, 2023)

"TO WHAT EXTENT CAN YOU PASSIVELY MAKE USE OF THE FUTURE CLIMATE TO IMPROVE A BUILDING ITS ENERGY EFFICIENCY?"

BUILDING

DESIGN WITH WATER

PASSIVE ENERGY

GUIDELINES

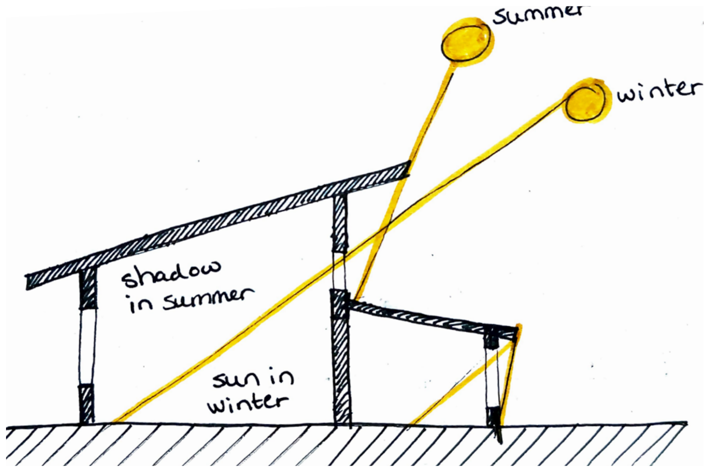
Avert warmth through building typology

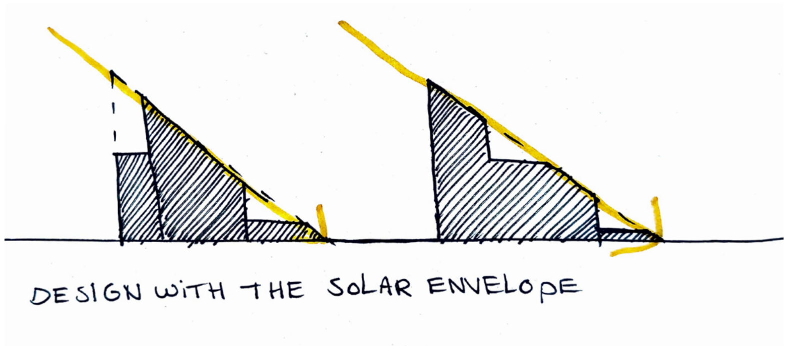
According to the climate scenario set out in the 'Urban' chapter, it has become clear that by the year 2100, the Groningen area will experience much warmer days. According to KNMI (2023), the average temperature will increase by 5 degrees and there will be around 48 additional summer days with temperatures above 25 degrees Celsius.

To avoid a large energy demand for cooling in a building 100 years from now, this chapter will look at the possibilities of passive solar design in order to cool the building.

First, this chapter will look at methods that keep sunlight out in summer to prevent the building from heating up too much. Then, ventilation principles for cooling will be outlined.

The effect of solar energy on the building typology has also been sought out as a seperate research (see appendix: research plan).



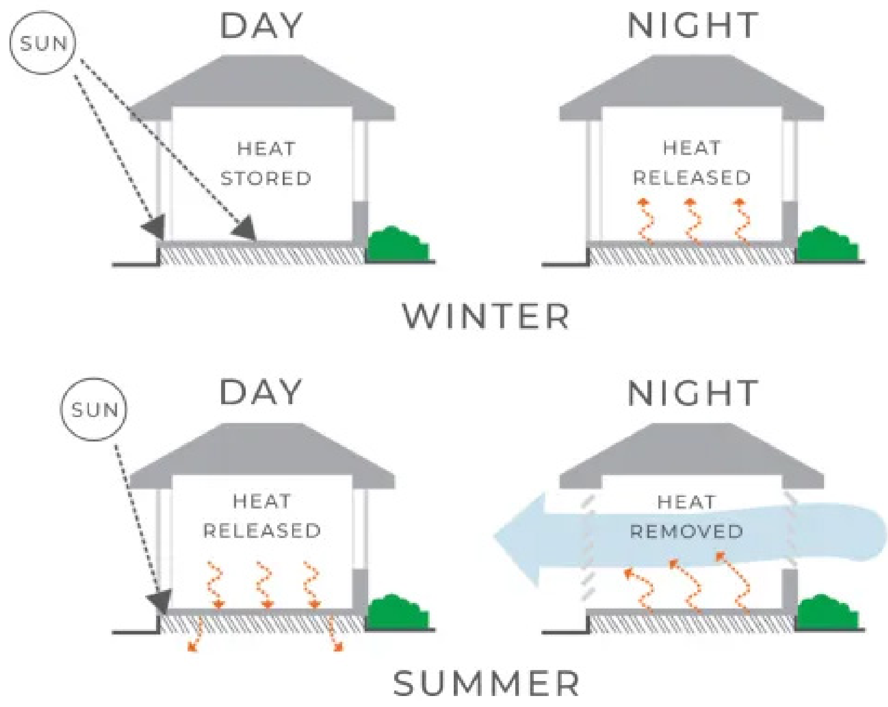


Passive energy regulation principles (own work, 2023)

Avertion of sunlight

To prevent the building from heating up too much from sunlight entry during summer, the building typology can be adapted to the sun's trajectory. The south façade can be arranged in such a way that a roof overhang blocks the summer sun while allowing the winter sunlight. This will prevent the building from cooling down too much during the winter.

Light materials with a fast heat release can also be used for the façade. Heavy materials with a slow heat release, such as brick and concrete, can be used as a thermal mass for the floor or as an interior elements (Hamakareem, 2022). In this way, combined with ventilation, the heat regulation can be regulated. The 'Materials' appendix provides a list of materials suitable for use as a thermal mass.

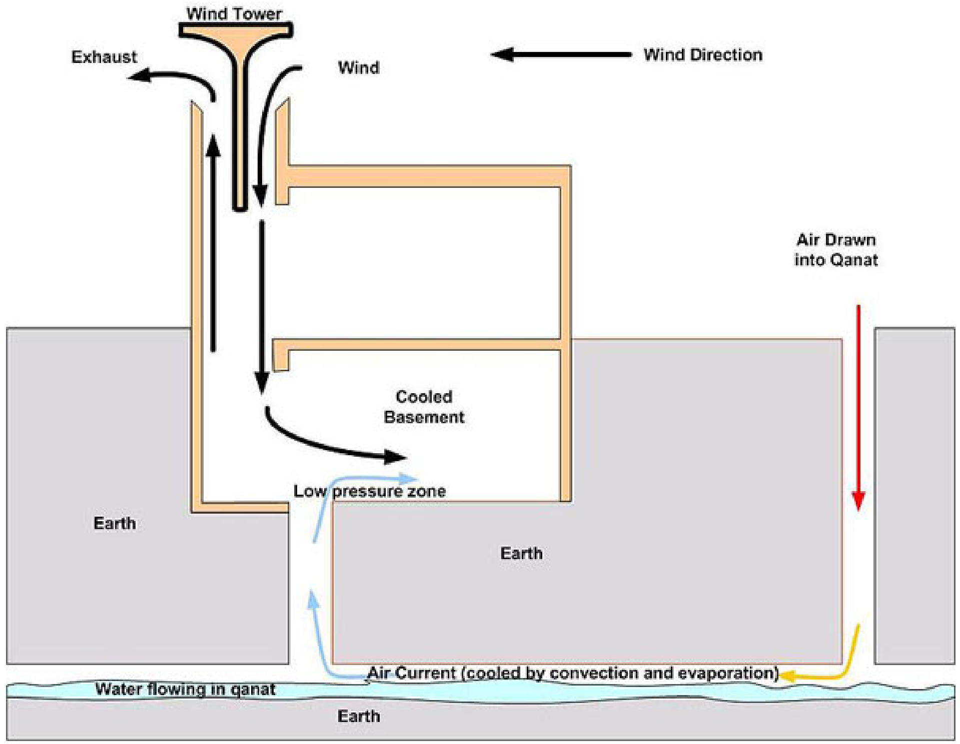


Thermal mass and solar regulation (Hamakareem, 2022)

Wind for passive cooling

As the Netherlands faces an increasingly hotter climate, inspiration for passive cooling can be drawn from building typologies in countries that already experience hot climates. In the Middle East for example, the Persians traditionally built wind towers (burj al hawwa) that functioned as ventilation systems. Ahmadikia et al (2012) describe in their study on the functioning of these wind towers, how this type of system works. The airflow is generated by either the wind, or a temperature difference between the building interior and exterior. In cities where the wind blows from a specific direction, the air trap is open to one direction and closed to the other three directions. The cooling system of the Dolatabad Garden wind-catcher cools the building interior through air displacement and evaporation; the air flows inside the building, passes over a small rocky pool through the water jet, and is channelled to other rooms.

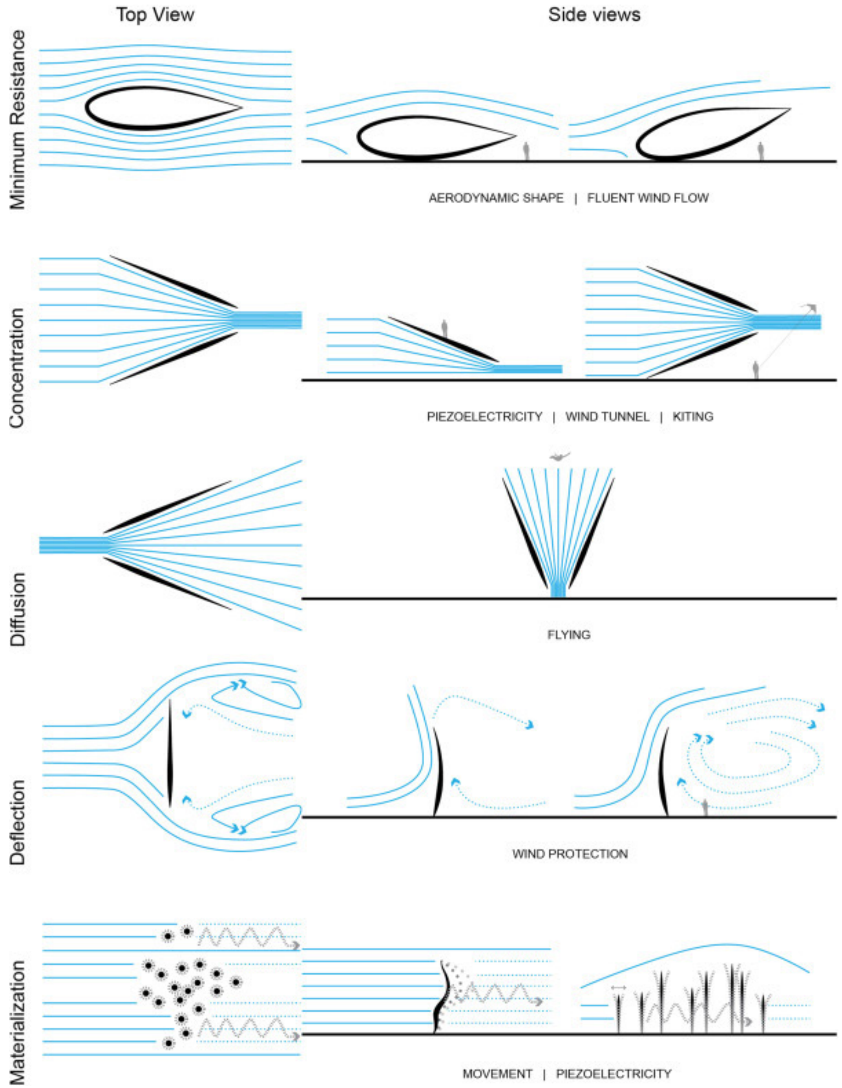
It would be interesting to see if a system like the Persian wind catchers could work in the future climate of Groningen. The conditions would be suitable for it: warm climate, wind and water nearby.



Persian wind tower principle (Hamakareem, 2022)

Catch the wind for cooling and energy production

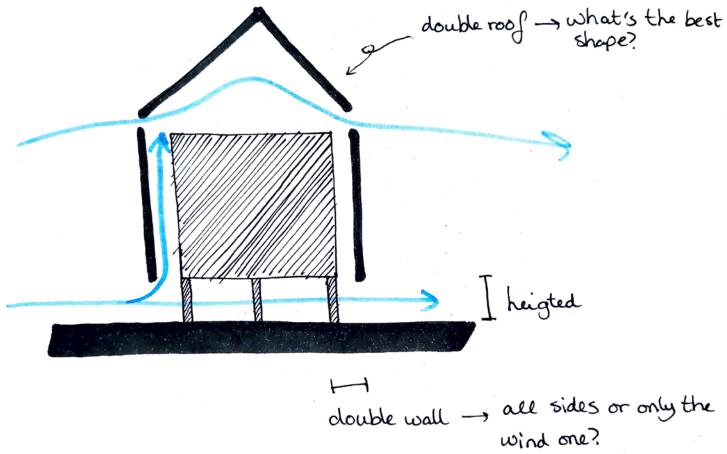
Besides ventilating the interior, the exterior can also be cooled by using the current of the wind. Applying a double facade through which wind can ventilate can help cool the building. When designing the shape of the building in the design phase, aerodynamic principles and studies on the behaviour of wind can be considered, such as the study by Kormaníková et al. (2018) on parametric design principles.

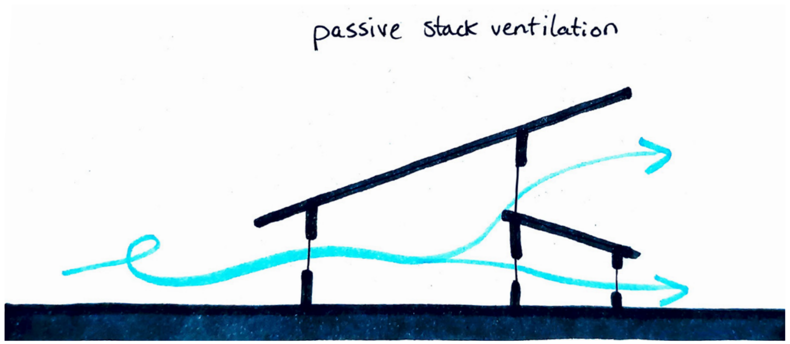


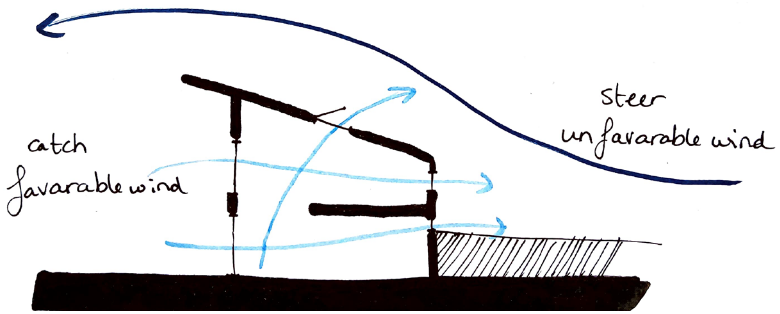
Parametric wind design (Kormaníková et al., 2018)

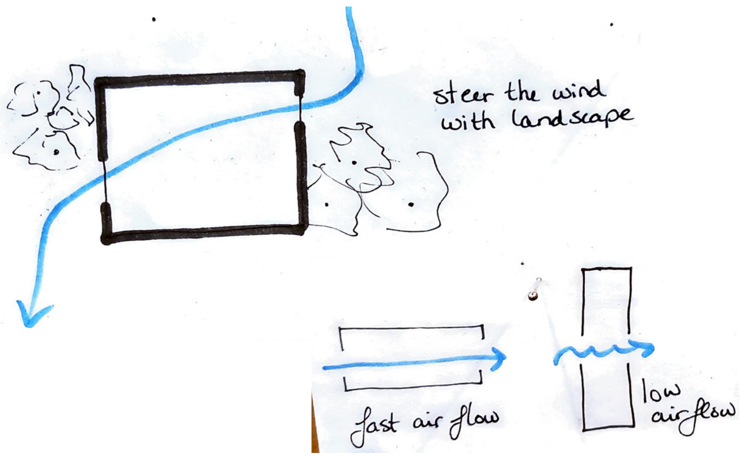
Wind principles

Visualised principles for using wind as a passive cooling system. (own work, 2023).









"WHAT CONCLUSIONS CAN BE DRAWN ON A BUILDING SCALE THAT CAN BE TAKEN INTO CONSIDERATION DURING THE DESIGN PHASE?"

BUILDING

DESIGN WITH WATER

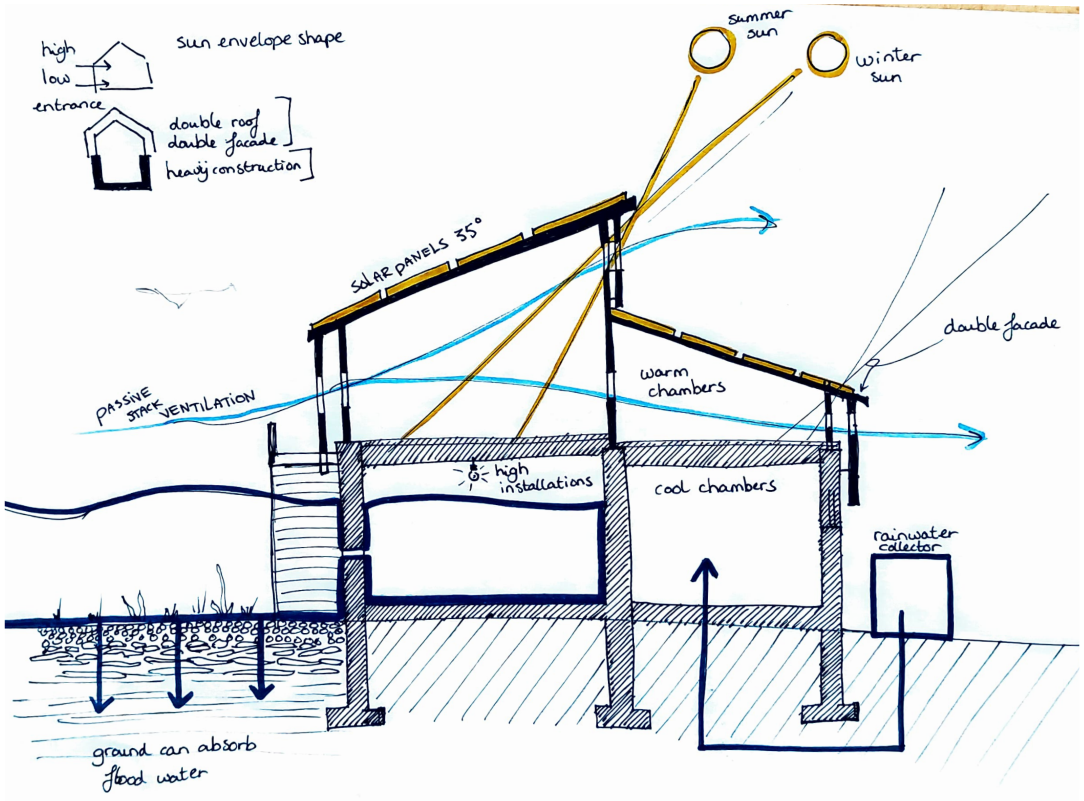
PASSIVE ENERGY

GUIDELINES

The most future-resilient design would incorporate multiple flood proofing methods. This combination of principles will be used for buildings with functions wherein no connection to the water is desired.

For buildings where the function can tolerate the admission of water, a cooperation of the building and the surrounding water for the energy management of the building can be considered. Here, part of the building will be able to admit water to generate energy.

All buildings will require multipe solar energy principles for their energy regulation.



Passive energy regulation combined principles (own work, 2023)

"In terms of **FORM**, what inspiration can be drawn from the surrounding climate and how can this be used to improve the energy efficiency of a building in the future scenario?

DETAIL

FORM

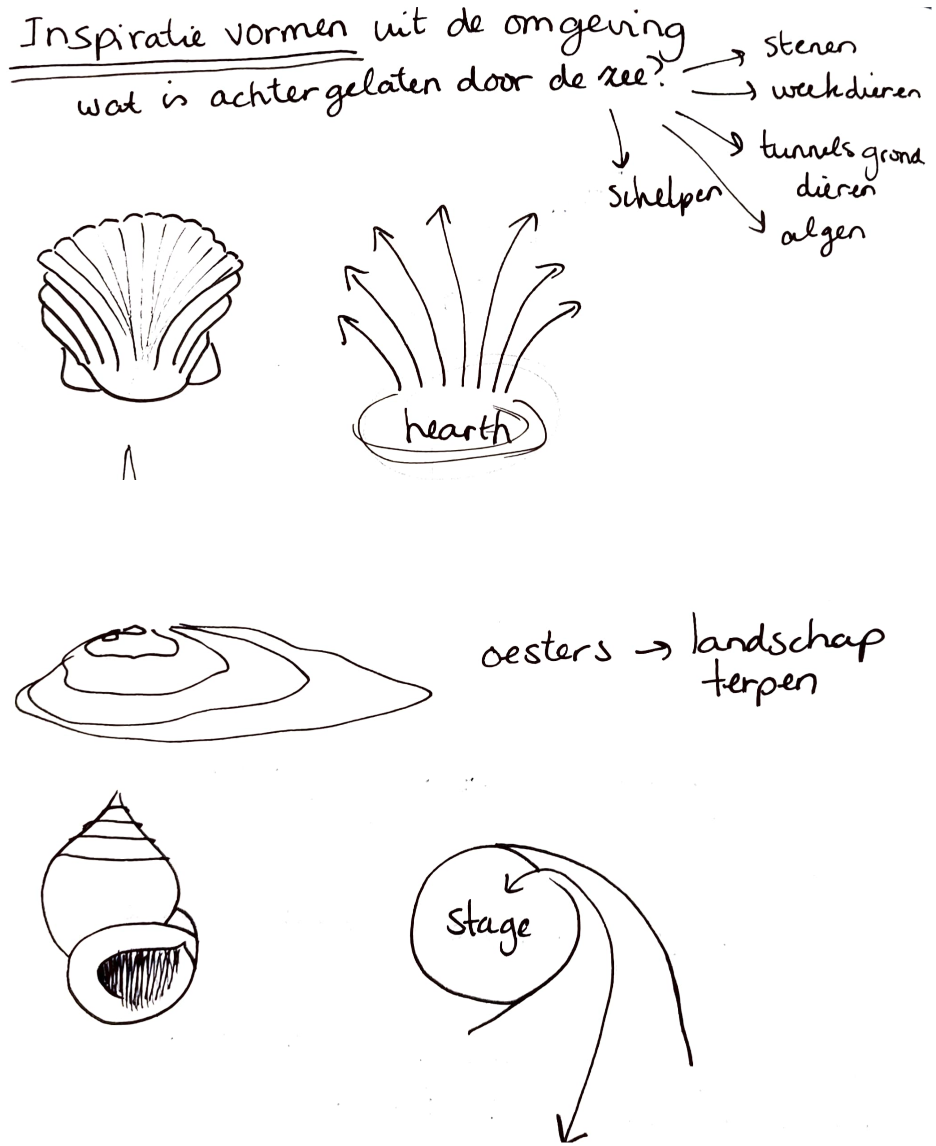
MATERIAL

COLOUR

GUIDELINES

Water as inspirational guide

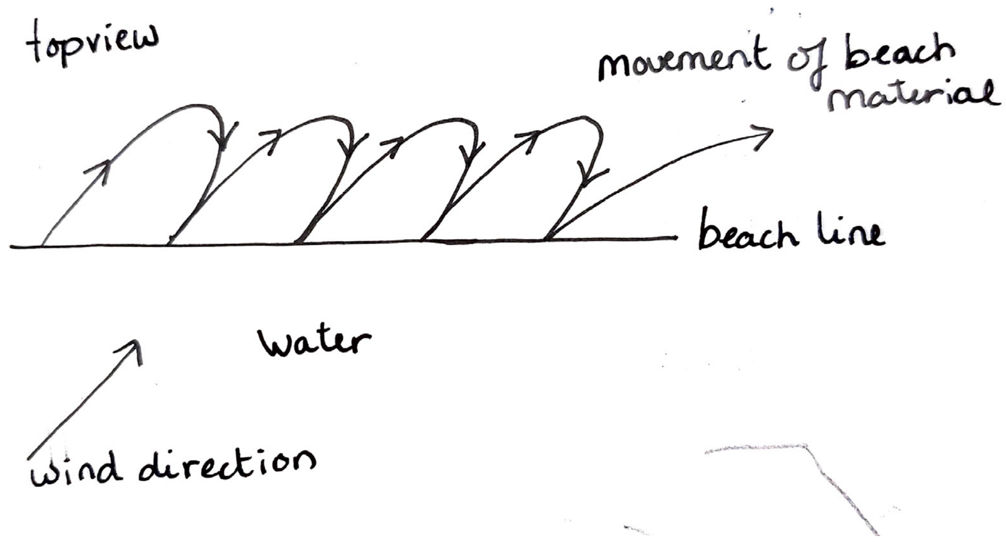
In terms of form, inspiration can be drawn from the shapes and structures that water leaves behind during low tide. These forms connect strongly to the seawater. The structure of shells serves the living organism inside it. What energy principles can be inspired by these shell structures and efficient shapes? This will be further developed during the design phase.



Own work, 2023

Water as inspirational guide

On a larger scale inspiration can be drawn from the movement of the sea. You can see the flowing motion of the sea in the pattern of the sand, created by tidal waves. Will the waterlandscape in the future mimic these motions?



Own work, 2023

Ecomare Texel, 2023

"In terms of **material**, what inspiration can be drawn from the surrounding climate and how can this be used to improve the energy efficiency of a building in the future scenario?

DETAIL

FORM

MATERIAL

COLOUR

GUIDELINES

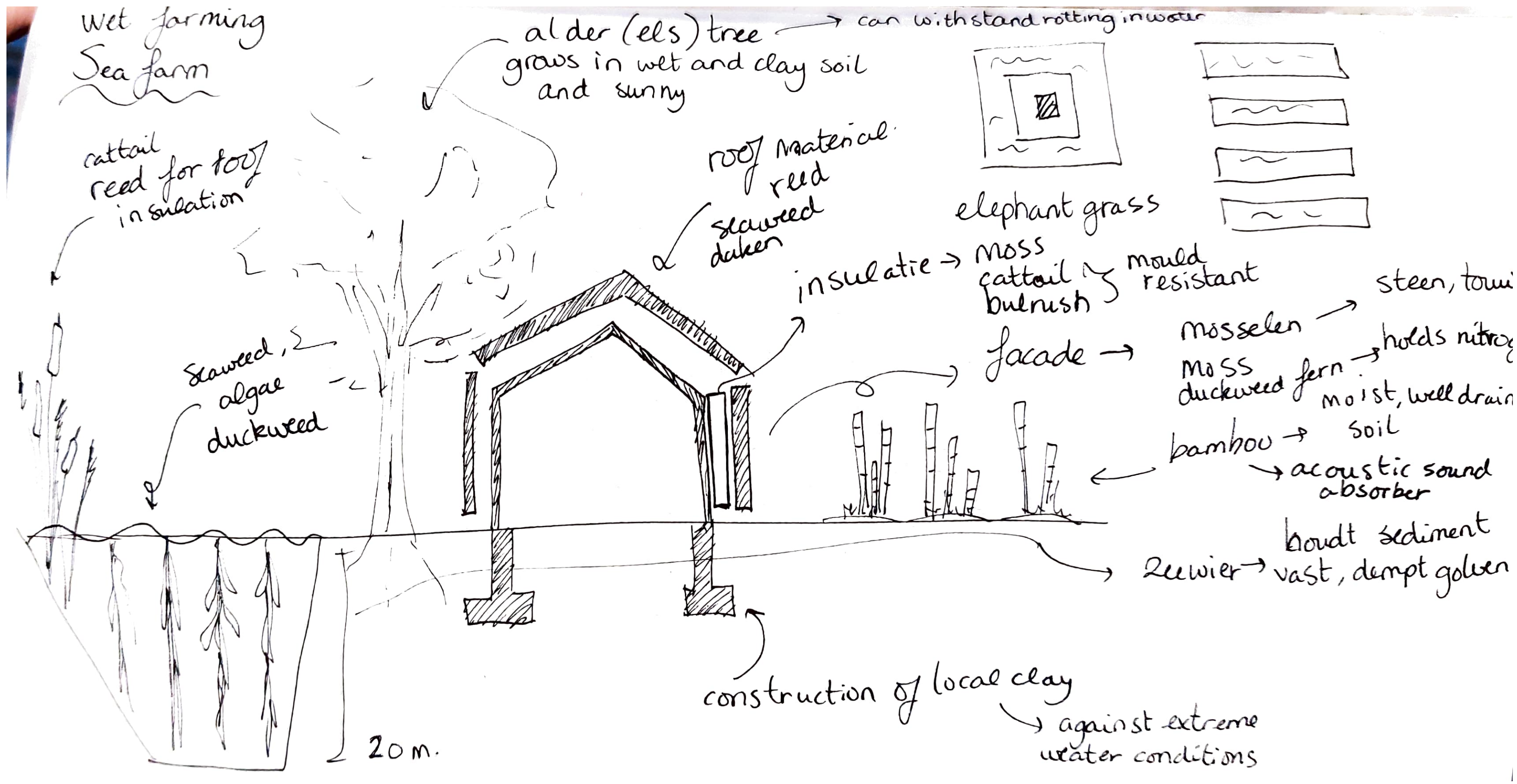
What can be harvested?

The future scenario with wet and saline cultivation involves agricultural products that can be used as building materials (see materials list addendum).

Furthermore, building materials for ground and basement floors will have to be suitable for the wet floodproofing method (see materials list addendum).

Thermal mass can be used for internal energy regulation. This also entails certain material choices (see materials list addendum).

For energy efficiency, lightweight materials will have to be used, since peak visitor hours call for the building to heat up quickly. With heavy materials, it will take a long time and cost a lot of energy to warm up the theatre hall every day.



Harvested material inspiration, own work (2023)

"In terms of **colour**, what inspiration can be drawn from the surrounding climate and how can this be used to improve the energy efficiency of a building in the future scenario?

DETAIL

FORM

MATERIAL

COLOUR

GUIDELINES

Colourscape of Groningen

For the use of colour in the design, inspiration was taken from the colour palette of the Groningen landscape.

Nature:

Pathways:

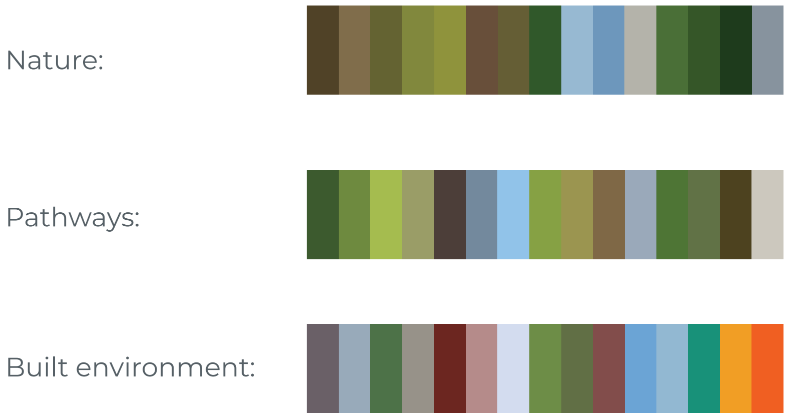
Built environment:

own work, 2023

Application

For 3 themes, colours were extracted from the landscape based on photos from the field trip. This results in a colour palette for each theme.

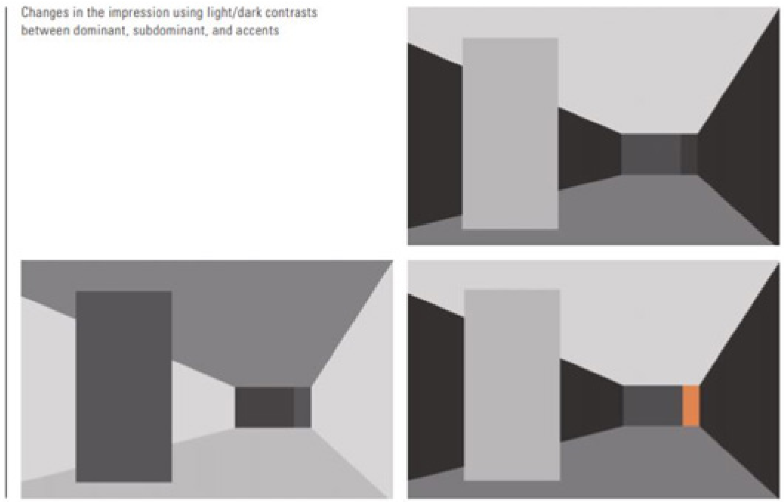
These colour palettes can be taken along into design decisions. The exterior colours of the design can respond to the colours in the landscape by blending or creating contrast.



Landscape colour palets, own work (2023)

Orientation

A smart application of interior colours can contribute to orientation within the building (Meerwein, G., & Rodeck, B., 2007). In a theatre building, this is particularly important to direct visitors to their correct route through the building.



colour giving direction through contrast (Meerwein, G., & Rodeck, B., 2007)

Effect colour on energy efficiency

Are there colours that can have an effect on a building's energy use?

For the exterior colour choices, buildings that experience all four seasons will benefit from a balanced colour scheme. Neutral colours will reflect the sun, while darker accents absorb enough heat to save energy throughout the winter.

For the interior colour choices, Cheng et al. (2005) have revealed in their study that the use of a lighter surface colour and thermal mass can dramatically reduce maximum indoor temperatures. . Integrating warm or cool colours in indoor spaces can optimize thermal perception against occupants' actual thermal condition, which has positive significance for energy saving in building environment.

Winter interior colours

yellow and red

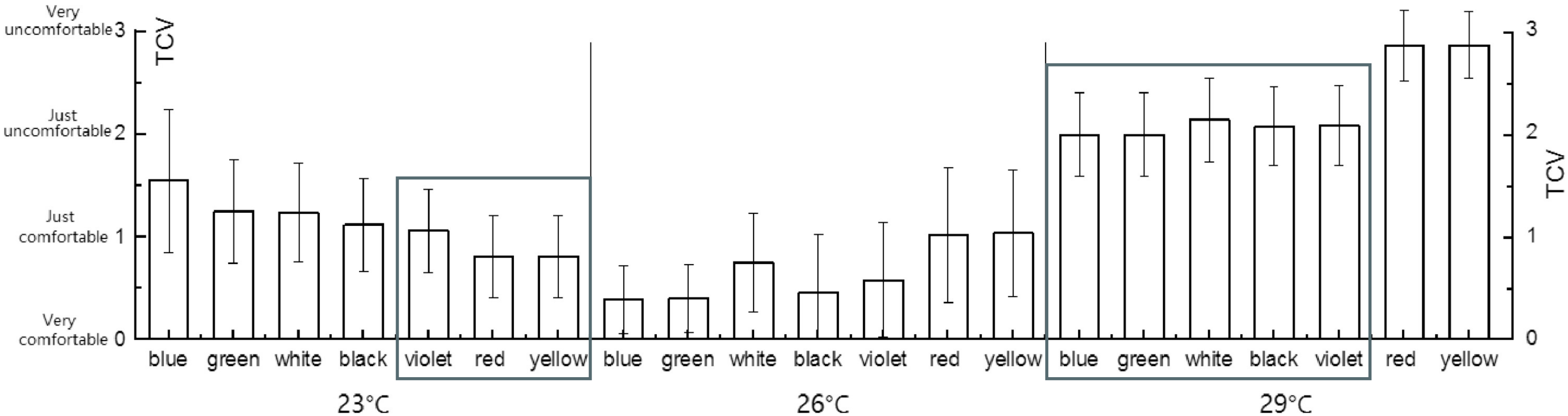
violet

Summer interior colours:

blues and violet

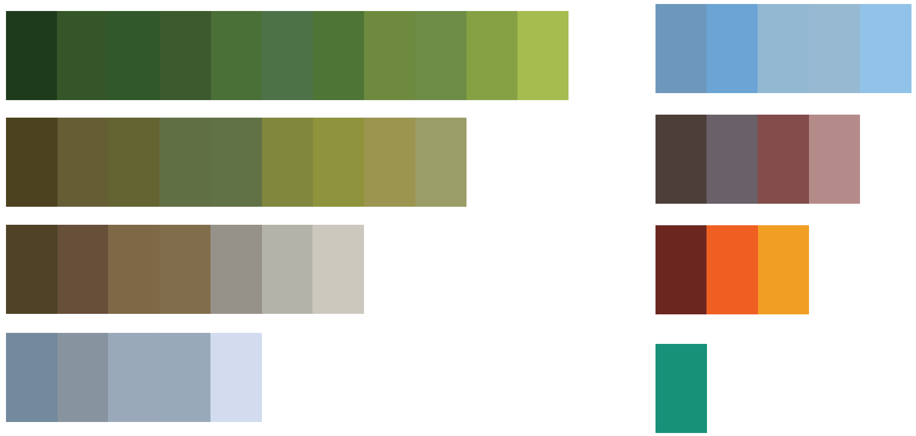
greens

greys



comfortability of coloured environment (Cheng et al., 2005)

Sorted from dark to light:



Effect colour on energy efficiency

To link these two concepts to the area of Groningen, I combined the previously created colour palettes and sorted them from light to dark. Using this new palette, colours can be selected that refer to the Groningen landscape.

Colours of Groningen from dark to light, own work (2023)

"What conclusions can drawn for a possible future scenario?"

TRANSLATION TO DESIGN

CONCLUSION FUTURE SCENARIO

BUILDING TYPOLOGY

DESIGN PRINCIPLES

Infrastructuur

Does the infrastructure run over dykes with cars or over water with boats? If you assume electric transport, the electric capacities of boats and cars are quite similar. Looking at mileage, a car will always cover a greater distance within a given time than a boat. Therefore, the choice of infrastructure is made on the basis of sustainability: building a road network over dykes is not future-resilient, since with higher sea levels, you will have to keep raising them. The infrastructure via canals with electric boats can continue to be used if sea levels rise further. You make a one-off investment to excavate canals that you will then be able to use for a long period of time.

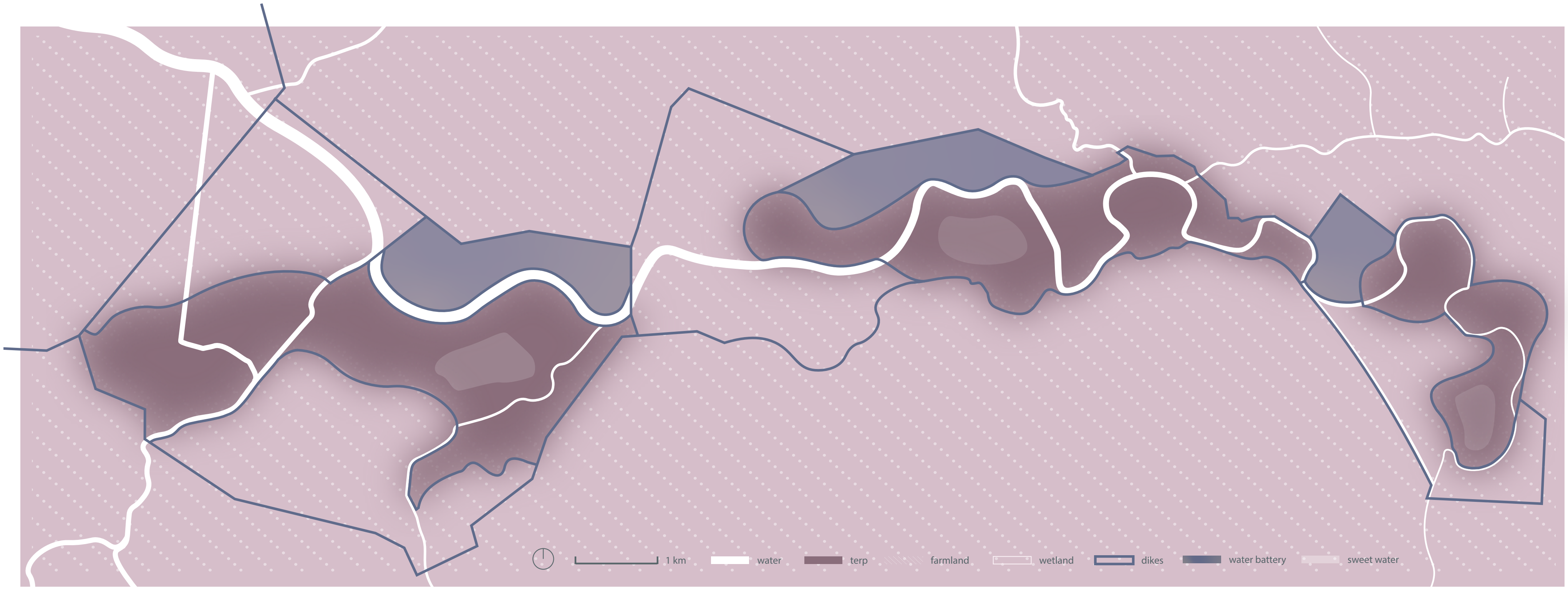
Energy

Energy concepts of scenarios 2 and 3 can still be examined and incorporated within scenario 1.

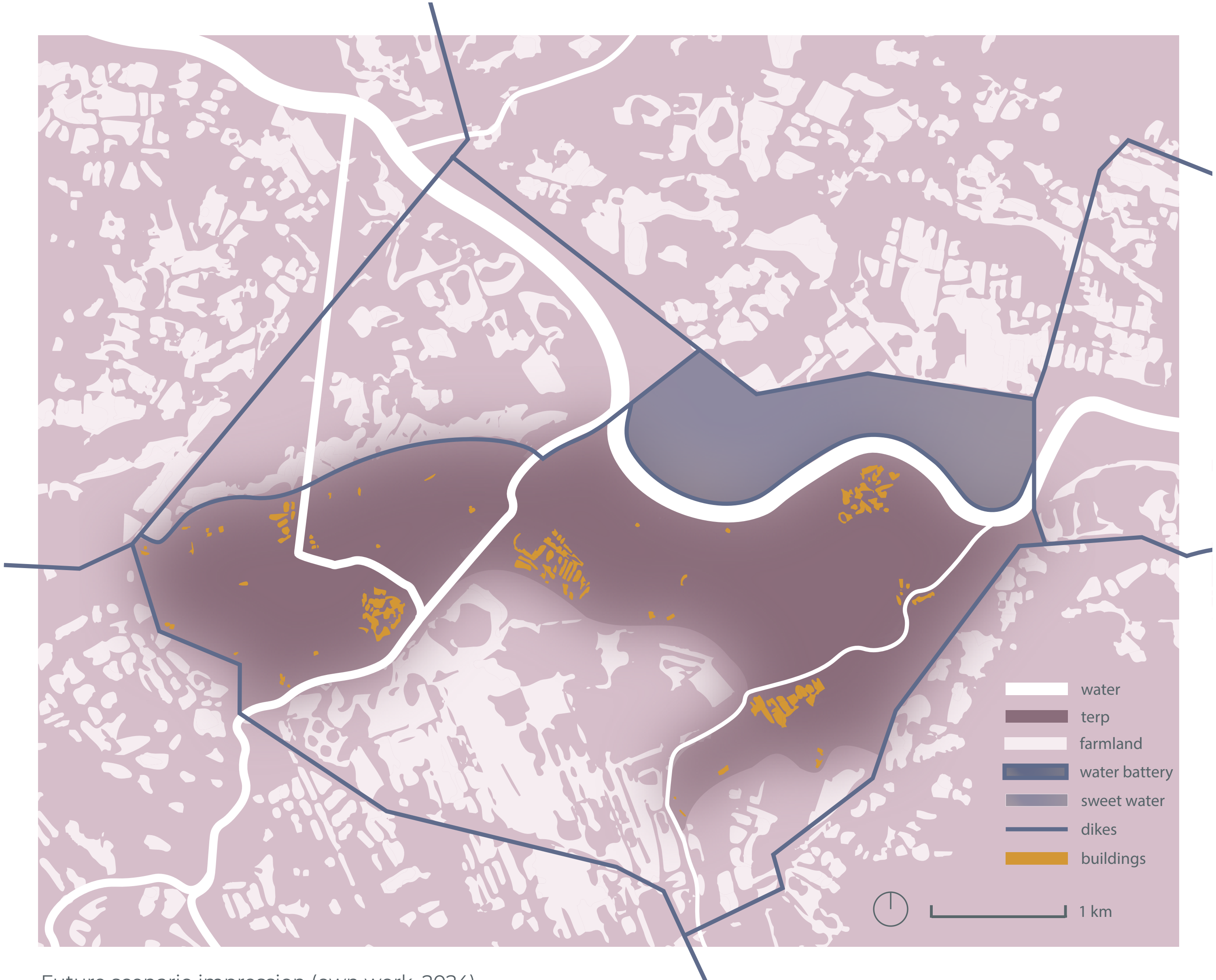
Landbouw

The infrastructure choice would drop scenario 3 ‘dike landscape’ as a future scenario. Then, a choice has to be made about the arable type. Again, this choice is taken on behalf of the future-resiliency. When the agriculture switches to saline and wet agriculture, water no longer forms a danger to crops and instead will cooperate with the farmland.

This decision would drop scenario 2 as well, making scenario 1 the most future-resilient spatial plan.



Future scenario urban masterplan Reitdiep (own work, 2024)



Future scenario impression (own work, 2024)

“What building typology will be implemented in the future scenario?”

TRANSLATION TO DESIGN

CONCLUSION FUTURE SCENARIO

BUILDING TYPOLOGY

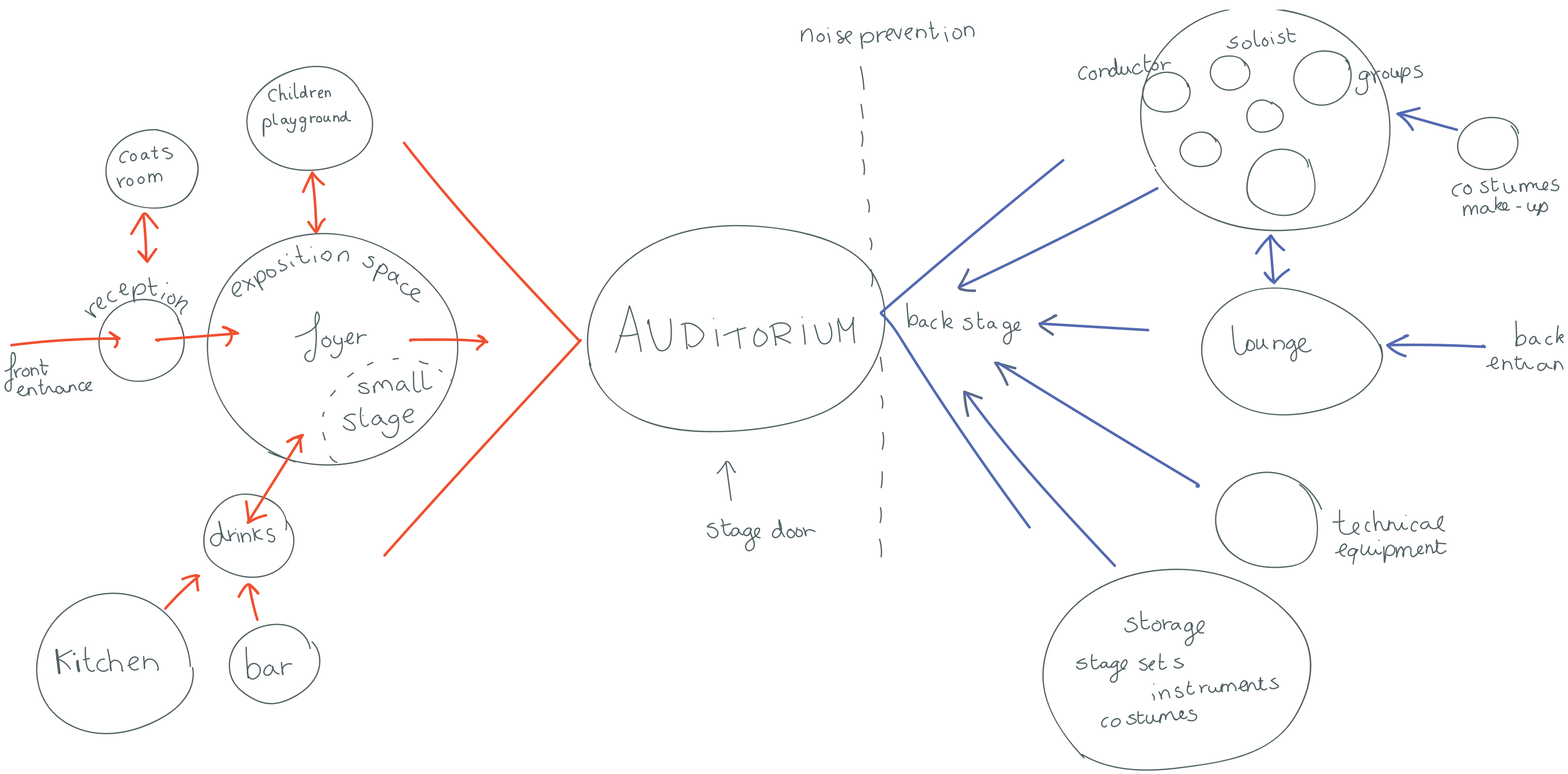
DESIGN PRINCIPLES

Program - Cultural Centre

For the design phase, the focus wil lie on the design of a cultural centre, within a new created terp village in the area of North Groningen. The main part of the building will be the theatre stage hall, that will facilitate various kinds of concert types. The centre will create interaction between the villagers of all ages. The design will also encourage this interaction and function as a cultural meeting point.

Program - Theater mapping

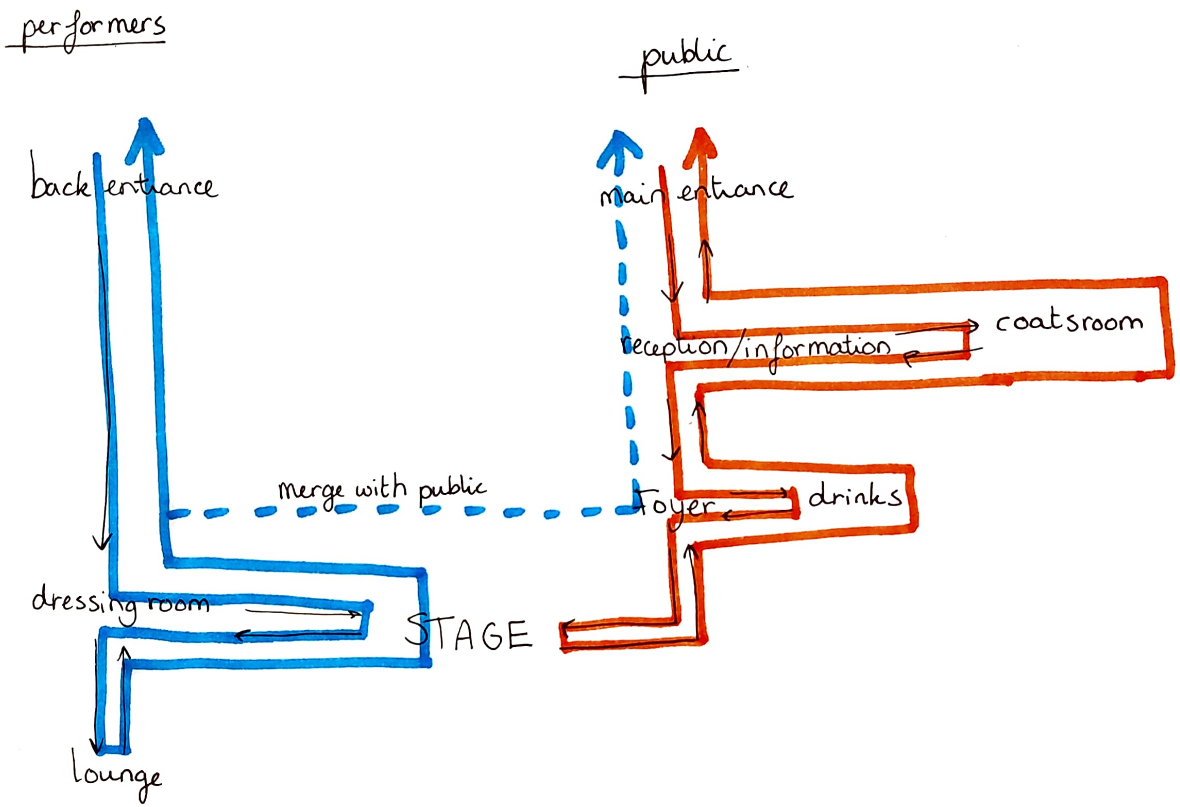
First, an overview of the required spaces of a cultural center are created, based on the work of Strong (2010). The main elements are visualised in a diagram where the interrelationships between the programme elements becomes clear.



Theatre mapping, own work (2023) based on the work of Strong (2010)

Routing

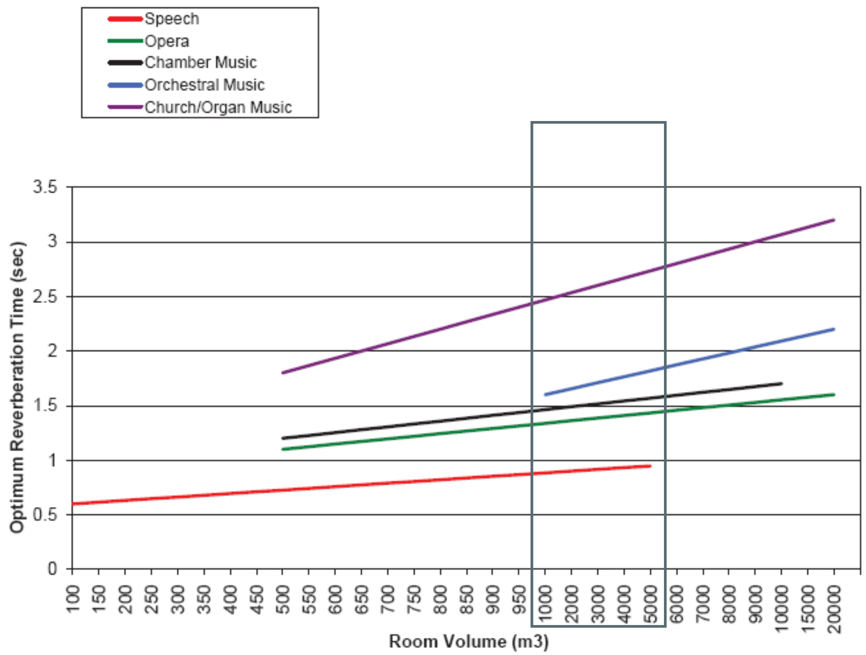
Based on the programme, a routing map is visualised that shows how people will move through the building. Visitors will walk a different route than the performers, creating an interesting routing scheme. The stage will function as the core of the building where the separation between performer and visitor will fade away.



Theatre routing, own work (2023) based on the work of Strong (2010)

Acoustics

The size for the stage is based on the acoustic properties the stage should meet. Strong (2010) shows that the stage hall should be 1000 to 5000 m3 in order to obtain the optimal reverbaration time for as many different types of performances as possible. This is desirable for the building to give fine acoustics for different performances.

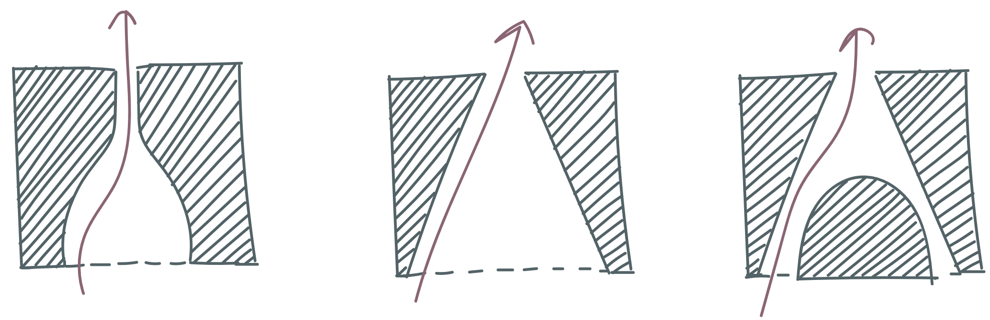


Relation volumes and reverberation times (Strong, 2010)

Ventilation

The greatest demand for cooling in summer and heating in winter occurs during peak hours when visitors enter the building for a concert or village activity. In order to quickly heat and cool the building, a lightweight structure is needed that stores little heat.

The theatre hall could be used as wind turbines outside visitor hours. Wind could be flown through the space by the use of negative pressure, which will generate energy. This will also quickly cool the building during the summer.



Culture center impression, own work (2023)

"FOLLOWING THIS RESEARCH, WHAT DESIGN PRINCIPLES WILL NEED TO BE TAKEN ALONG IN AN ARCHITECTURAL DESIGN?"

TRANSLATION TO DESIGN

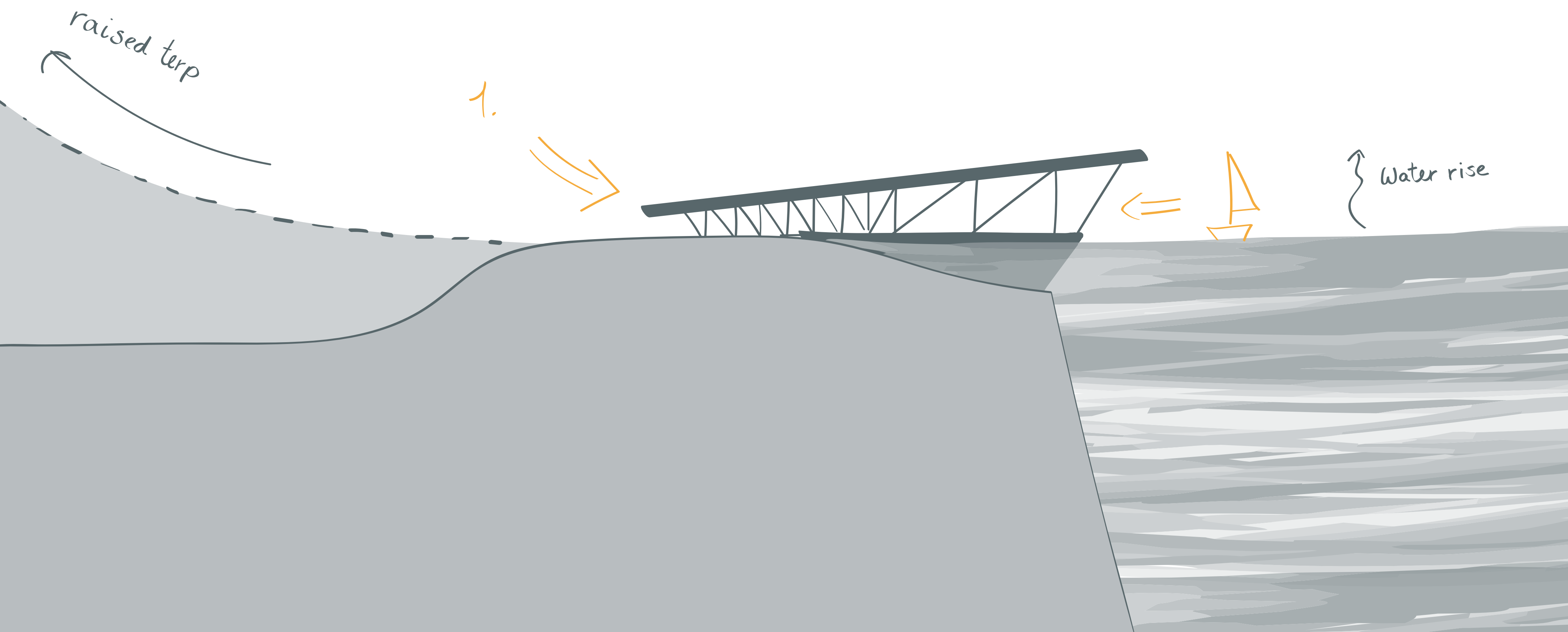
CONCLUSION FUTURE SCENARIO

BUILDING TYPOLOGY

DESIGN PRINCIPLES

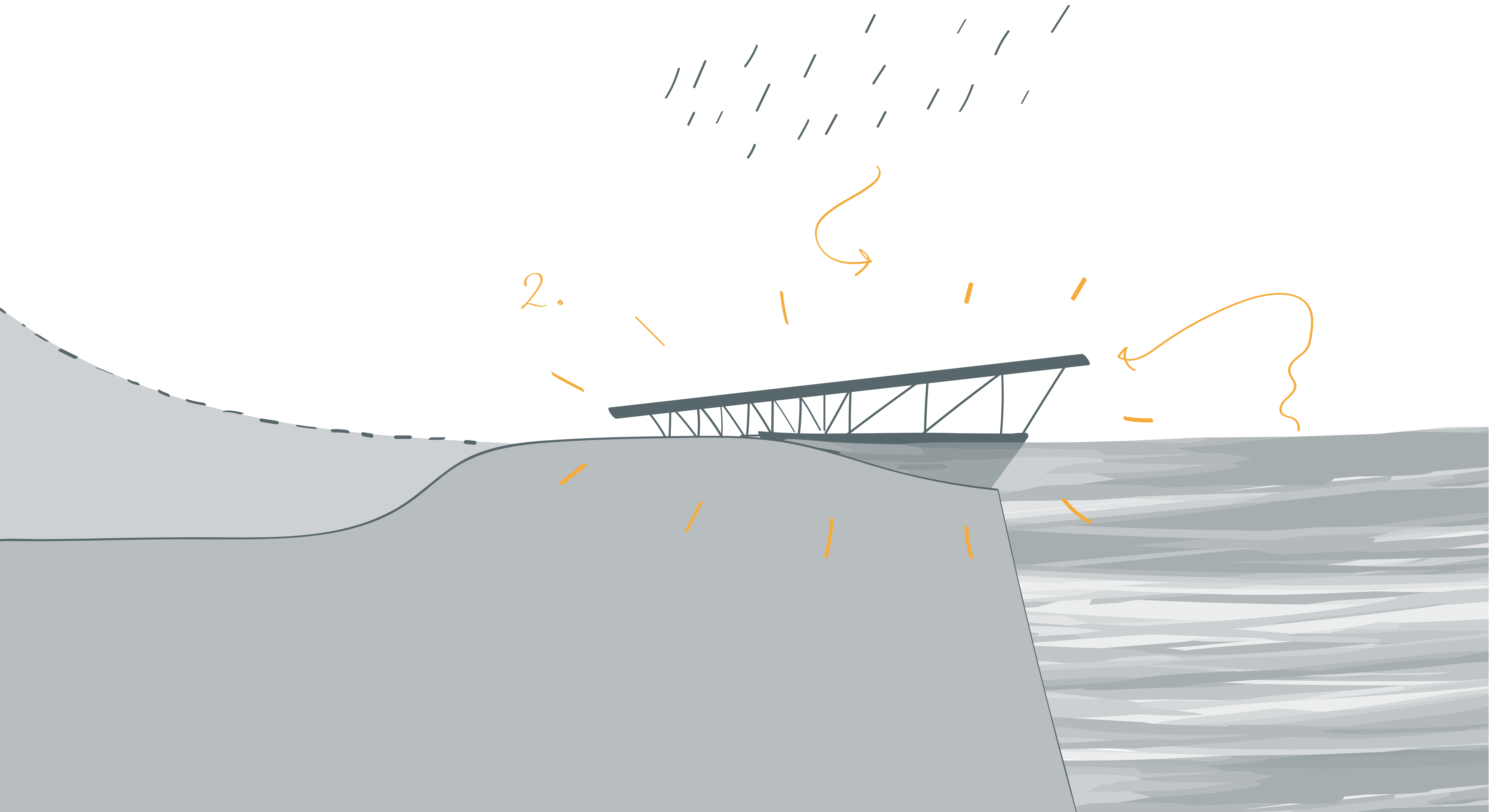
1. Accesibility

With the rising sea level and the heigtening of the land, accesibility should be taken into account.



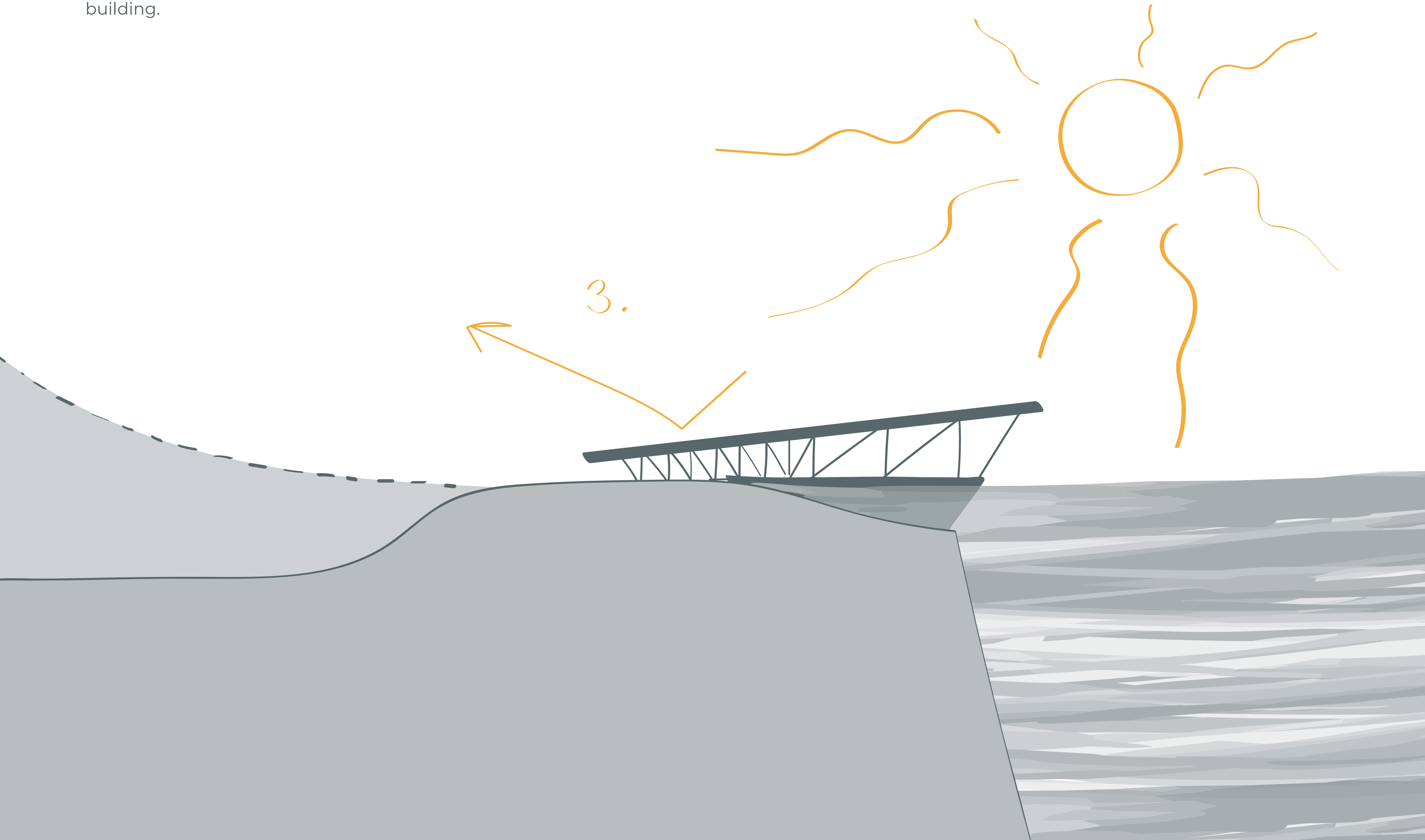
2. Use water as a benifit

The sea level rise and predicted precipitations amounts will cause the area to become a wetland. To what extend can this water be used to the benifit of the building and its surroundings?



3. Protection against heat

The climate will change to a warmer climate. The indoor climate of the building should stay comfortable and measures can be taken to actively and passively cool the building.



EPILOGUE

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EPILOGUE

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Paludicultural plants and utilisation options (selection)

	English name	Latin name	Most promising uses	Other uses
Uptake of cultivation very likely	Peat moss	*Sphagnum* spp.	• Founder material for restoration and Sphagnum farming • Orchid cultivation • Horticultural growing media replacing peat • substrates for carnivorous plants, for vivaria with amphibians, reptiles and spiders, • substrate for hanging baskets, wreathes and vegetation walls	• Insulation and packaging material • Food preservation • Medical dressings, diapers, and sanitary towels • *Sphagnum* extracts as source of natural sunscreen
	Sundew	*Drosera rotundifolia*	• Medicinal uses	• Vegetarian rennet for cheese making
	Cattail, Bulrush	*Typha angustifolia, Typha latifolia*	• Insulation material • Filling material (seed hairs) • Construction material • Packaging and disposable tableware • Horticultural growing media replacing peat • Fodder • Pollen for feeding predatory mites (pest control in glasshouses)	• Combustion • Biogas • Extraction of proteins
	Reed	*Phragmites australis*	• Thatching material • Insulation material • Construction material • Packaging and disposable tableware • Fodder • Combustion	• Paper • Biogas • Liquid fuels • Extraction of proteins • Silicon from reed leaves for high-performance energy storage devices
	Giant cane	*Arundo donax*	• Combustion	• Biogas
	Reed Manna Grass	*Glyceria maxima*	• Fodder	• Biogas • Extraction of proteins
	Reed canary grass	*Phalaris arundinacea*	• Packaging and disposable tableware • Panels • Fodder • Bedding • Combustion	• Paper • Biogas • Liquid fuels • Extraction of proteins
	Sedges	*Carex* spp.	• Packaging and disposable tableware • Panels	• Paper • Biogas

		• Fodder • Bedding • Combustion	• Liquid fuels • Extraction of proteins
	Alder	*Alnus glutinosa*	• Timber for carpentry, interior fittings, furniture • Veneer • Combustion	
	Willow	*Salix* spp.	• Fodder • Weaving material (e.g. baskets)	
	Bog Myrtle	*Myrica gale*	• insect repellent • flavour (e.g. beer) • medicinal uses, cosmetics	
	Cranberry	*Vaccinium oxycoccos*	• Food (e.g. berries, juice)	
	Black Chokeberry	*Aronia melanocarpa*	• Food (e.g. berries, juice)	Medicinal uses
Further promising plants for paludiculture	Wild rice	*Zizania aquatica,* *Z. palustris*	Cereal	
	Japanese Millet	*Echinochloa esculenta*	• Food • fodder	
	Celery	*Apium graveolens*	Vegetable	
	Water Pepper	*Persicaria hydropiper*	Spicy leaf vegetable	
	Holy Grass	*Hierochloe odorata*	Flavour (e. g. for drinks)	
	Calamus	*Acorus calamus*	Flavour (e.g. for drinks), cosmetics	
	Water mint	*Mentha aquatica*	• Flavour, tea • Perfumery	
	• Cloudberry • Blueberry	• *Rubus chamaemorus* • *Vaccinium myrtillus*	• Food (e.g. jam, juice)	
	• Bogbean, buckbean • Meadowsweet • Valerian • Butterbur • Garden Angelica • Alder Buckthorn • Gypsywort • Water Dropwort	• *Menyanthes trifoliata* • *Filipendula ulmaria* • *Valeriana officinale* • *Petasites hybridus* • *Angelica archangelica* • *Frangula alnus* • *Lycopus europaeus* • *Oenanthe aquatica*	} Medicinal plants (e.g. pharmaceuticals, cosmetics)	
	Duckweed fern	*Azolla filiculoides*	• Fodder • Fertiliser (N-fixation)	• Food • Protein extraction
	Duckweed	*Lemna* spp.	• Fodder	• Protein extraction

PLANTS AND SALT WATER IRRIGATION

- Plants are arranged in approximate order of salt tolerance in each column with the least tolerant at the top.
- The difference between two or three plants near one another in each column is small and possibly not significant.
- The plant and water groupings are not rigid, merely a general guide. Soil texture and drainage could be over-riding factors.
- Plants listed as suitable for salty waters will nevertheless grow better with less salty water.

Water Group	Precautions for Irrigation Use (*See Important Footnote)	Suggested Plants: Pastures and Fodders	Fruit	Vegetables	Ornamentals
A **0-500 mg/l‡** (0–35 gpg‡ or 0–800 EC‡)	1. Avoid wetting leaves on hot dry days	Ladino clover Red clover Alsike clover White Dutch clover Subterranean clover	Persimmon Loquat Passionfruit Strawberry Avocado Almond Apricot Peach Plum Lemon Grapefruit Orange Grape	Parsnips Green beans Celery Radish Cucumber Squash Peas Onion Carrot Potatoes Sweet Corn Lettuce	African violet Primula Gardenia Begonia Azalia Camelia Magnolia Fuchsia
B **500-1,500 mg/l** (35–105 gpg or 800–2,300 EC)	1. Avoid wetting leaves during daytime 2. Avoid light frequent waterings 3. Water quickly and use continuous-wetting sprinklers if wetting the leaves	Cocksfoot Perennial ryegrass	Mulberry Apple Pear	Cauliflower Bell pepper Cabbage Broccoli Tomato	Geranium Gladiolus Bauhinia Zinnia Rose Aster Poinsettia Musa Podocarpus
C **1,500-3,500 mg/l** (105–245 gpg or 2,300–5,500 EC)	1. Avoid wetting leaves of most plants where possible 2. Adequate leaching necessary	Oats (hay) Wheat (hay) Rye (hay) Lucerne Sudan grass Paspalum dilatatum Strawberry clover Sweet clovers Millet Wimmera ryegrass Rhodes grass Couch grass Barley Birdsfoot trefoil	Olive Fig Pomegranate	Spinach Asparagus Kale Garden beets	Stock Chrysanthemum Carnation Hibiscus Oleander Bougainvillea Vinca Aus. Hop Bush (*Dodonea attenuata*) Coprosma (green and variegated) Japanese Pepper (*Schinus terbinthifolius*) *Ficus* spp. in general *Ficus hillii* False acacia (*Robinia pseudoacacia*) Queensland Pyramid Tree (*Lagunaria patersonii*) N.Z. Christmas bush (*Metrosideros tomentosa*) False mahogany (*Eucalyptus botryoides*) Rottnest ti-tree (*Melaleuca pubescens*) *C. cuppressiformis* Rottnest cyprus (*Callitris robusta*) *Acacia longifolia* Buffalo grass Kikuyu grass Portulaca Mesembryanthemum Boobyalla (*Myoporum acuminatum*) Morrel (*E. oleosa*) Swamp yate (*E. occidentalis*) York gum (*E. loxophloeba*) Couch grass Bamboo Kondinin blackbutt (*E. Kondininensis*) Native pine (*Actinostrobus pyramidalis*)
D **3,500-13,000 mg/l** (245–910 gpg or 5,500–20,300 EC)	1. Do not wet leaves where possible 2. Excellent drainage and leaching essential	Seashore paspalum (*Paspalum vaginatum*) *Puccinella ciliata* Salt water couch (*Sporobolus virginicus*)	Date palm		Canary Palm (*Phoenix canariensis*) *Paspalum vaginatum* (lawns) Salt sheoaks (*Casuarina cristata*) Salt sheoaks (*Casuarina glauca*) Salt river gum (*Eucaluptus sargentii*) Tamarisks (evergreen and deciduous) Saltbushes
E **More than 13,000 mg/l** (910 gpg or 20,300 EC)	Too salty for irrigation				

* Under average conditions the precautions listed should enable satisfactory growth of the suggested plants. Yield of virtually all plants would be progressively reduced as saltier waters are used.

‡ All figures are for total soluble salts ; mg/l = milligrams per litre ; gpg = grains per gallon ; EC = electrical conductivity in micromhos per centimetre at 25° C.

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(Malcolm & Smith, 1971)

(Schaap et al., 2009)

Bijlage III.

Verzilting en zouttolerantie gewassen

Tabel IIII.1. *[1] T= Tolerant MT= Matig Tolerant, MG= Matig Gevoelig, G= Gevoelig*
[2] Verondersteld wordt dat winterpeen dezelfde drempelwaarde heeft als bospeen

Gewastype	Mg Cl/l bodemvocht (ref 1)	Mg Cl/l gietwater (ref 1)	Categorie gevoeligheid [1]	Referentie
Zonnebloem	circa 45		MT	2
Lelie (broei)	196	80	MT	1
Artisjok	circa 280		MT	2
Zoete kers		250	G	1
Winterpeen		101 [2]	G	1
Zaaiui	378	101	G	1
Tomaat	686	288	T	1
Pootaardappel	756	202	MG	1
Consumptieaardappel			MG	1
Druif	2.124		MT	1
Gras	3.606	963	MT	1
Wintertarwe	3.947	1.053	T	1
Suikerbiet	4.831	1.288	MT	1
Koolzaad	8.733	2.329	T	1
Riet			T	3

N.B. De gevoeligheidscategorie waarin het gewas wordt ingedeeld, is niet in alle gevallen consequent gerelateerd aan de drempelwaarde die voor het gewas wordt opgegeven (zie bijvoorbeeld bij de tomaat). Ook worden er in de literatuur wel verschillen in mate van gevoeligheid opgegeven voor eenzelfde gewastype. In deze tabel is zoveel mogelijk van eenzelfde bron uitgegaan t.b.v. de eenduidigheid in interpretatie.

Referenties
1. Dam, 2007
2. Westerdijk and Visser, 2003
3. Timothy D. Colmer, 2008

MATERIAL TYPE

STRUCTURAL MATERIALS (FLOOR SLABS, BEAMS, SUB-FLOORS, FRAMING, AND INTERIOR/EXTERIOR SHEATHING)	USES OF BUILDING MATERIALS: FLOORS	USES OF BUILDING MATERIALS: WALLS/ CEILINGS	CLASS OF BUILDING MATERIALS	NOTES
Brick				
Face or glazed		■	5	
Common (clay)		■	4	
Cast stone (in waterproof mortar)		■	5	
Cement board/fibre-cement board		■	5	
Cement/latex, formed-in-place	■		4	
Clay tile, structural glazed		■	5	
Concrete, precast or cast-in-place	■	■	5	
Concrete block		■	5	*
Gypsum products				
Paper-faced gypsum board		■	3	
Non-paper-faced gypsum board		■	4	
Greenboard		■	2	
Keene's cement or plaster		■	3	
Plaster, otherwise, including acoustic		■	2	
Sheathing panels, exterior grade		■	3	
Water-resistant, fibre-reinforced gypsum ext. sheathing		■	4	
Hardboard (high-density fibreboard)				
Tempered, enamel or plastic coated		■	2	
All other types		■	1	
Mineral fibreboard		■	1	
Oriented-strand board (OSB)				
Exterior grade	■	■	2	
Edge swell-resistant OSB	■	■	2	
All other types	■	■	1	
Particle board	■		1	
Plywood				
Marine grade	■	■	5	
Preservative-treated, alkaline copper quaternary (ACQ) or copper azole (C-A)	■	■	4	
Preservative-treated, borate	■	■	5	^
Exterior grade/exposure (WBP – weather and boil-proof)	■	■	4	
All other types	■	■	1	
Recycled plastic lumber (RPL)				
Commingled, with 80–90% polyethylene (PE)	■		5	
Fibre-reinforced, with glass fibre strands	■		5	
High-density polyethylene (HDPE), up to 95%	■		5	
Wood-filled, with 50% sawdust or wood fibre	■		3	
Stone				
Natural or artificial non-absorbent solid or veneer, waterproof grout	■	■	5	
All other applications		■	2	
Structural building components				
Floor trusses, wood, solid (2x4s), decay-resistant or preservative-treated	■	■	4	
Floor trusses, steel	■		5	±
Headers and beams, solid (2x4s) or plywood, exterior grade or preservative-treated		■	4	
Headers and beams, OSB, exterior grade or edge-swell resistant		■	2	
Headers and beams, steel		■	5	±
I-joists	■		2	
Wall panels, plywood, exterior grade or preservative-treated		■	5	
Wall panels, OSB, exterior grade or edge-swell resistant		■	2	
Wall panels, steel		■	5	±
Wood				
Solid, standard, structural (2x4s)		■	4	
Solid, standard, finish/trim		■	3	
Solid, decay-resistant	■	■	5	~
Solid, preservative-treated, ACQ or C-An		■	4	
Solid, preservative-treated, borate		■	4	^

	CLASS	CLASS DESCRIPTIONS OF MATERIALS
ACCEPTABLE	5	Highly resistant to flood water damage, including damage caused by moving water
ACCEPTABLE	4	Resistant to flood water damage from wetting and drying, less durable when exposed to moving water
UNACCEPTABLE	3	Resistant to clean water damage, but not flood water damage
UNACCEPTABLE	2	Not resistant to clean water damage
UNACCEPTABLE	1	Not resistant to clean water damage or moisture damage

* Unfilled concrete block cells can create a reservoir that can hold water following a flood, which can make the blocks difficult or impossible to clean if the flood waters are contaminated.
^ Borate preservative-treated wood meets the NFIP requirements for flood damage resistance; however, the borate can leach out of the wood if the material is continuously exposed to standing or moving water.
± Not recommended in areas subject to salt-water flooding.
~ Examples of decay-resistant lumber include heart wood of redwood, cedar and black locust.
O Using normally specified suspended flooring (i.e., above-grade) adhesives, including sulphite liquor (lignin or 'linoleum paste'), rubber/asphaltic dispersions, or 'alcohol' type resinous adhesives (culmar, oleoresin).
/ Examples include epoxy-polyamide adhesives or latex-hydraulic cement

Adapted from the FEMA document: Flood Damage-Resistant Materials Requirements for Buildings Located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program - Technical Bulletin 2 / August 2008 https://www.fema.gov/media-library-data/20130726-1502-20490-4764/fema_tb_2_rev1.pdf

(Barsley, 2020)

MATERIAL TYPE **FINISH MATERIALS** (FLOOR COVERINGS, WALL AND CEILING FINISHES, INSULATION, CABINETS, DOORS, PARTITIONS AND WINDOWS)	USES OF BUILDING MATERIALS: FLOORS	USES OF BUILDING MATERIALS: WALLS/ CEILINGS	CLASS OF BUILDING MATERIALS	NOTES
Asphalt tile				o
With asphaltic adhesives	■		[yellow]	
All other types	■		[red]	
Cabinets, built-in				
Wood		■	[orange]	
Particle board		■	[red]	
Metal		■	[light green]	±
Carpeting	■		[red]	
Ceramic and porcelain tile				
With mortar set	■	■	[light green]	
With organic adhesives	■	■	[orange]	
Concrete tile, with mortar set	■		[dark green]	
Corkboard		■	[orange]	
Doors				
Wood, hollow		■	[orange]	
Wood, lightweight panel construction		■	[orange]	
Wood, solid		■	[orange]	
Metal, hollow		■	[light green]	±
Metal, wood core		■	[light green]	±
Metal, foam-filled core		■	[light green]	±
Fibreglass, wood core		■	[light green]	
Epoxy, formed-in-place	■		[dark green]	
Glass (sheets, coloured tiles, panels)		■	[light green]	
Glass blocks		■	[dark green]	
Insulation				
Sprayed polyurethane foam (SPUF) or closed-cell plastic foams	■	■	[dark green]	
Inorganic – fibreglass, mineral wool: batts, blankets or blown	■	■	[yellow]	
All other types (cellulose, cotton, open-cell plastic foams, etc.)	■	■	[orange]	
Linoleum	■		[red]	
Magnesite (magnesium oxychloride)	■		[red]	
Mastic felt-base floor covering	■		[red]	
Mastic flooring, formed-in-place	■		[dark green]	
Metals, non-ferrous (aluminium, copper or zinc tiles)		■	[yellow]	
Metals				
Non-ferrous (aluminium, copper or zinc tiles)		■	[yellow]	
Metals, ferrous		■	[light green]	±
Paint				
Polyester-epoxy and other oil-based waterproof types		■	[light green]	
Latex		■	[light green]	
Partitions, folding				
Wood		■	[orange]	
Metal		■	[light green]	±
Fabric-covered		■	[red]	
Partitions, stationary (freestanding)				
Wood frame		■	[light green]	
Metal		■	[light green]	±
Glass, unreinforced		■	[light green]	
Glass, reinforced		■	[light green]	
Gypsum, solid or block		■	[red]	
Polyurethane, formed-in-place	■		[dark green]	
Polyvinyl acetate (PVA) emulsion cement	■		[red]	
Rubber				
Mouldings and trim with epoxy polyamide adhesive		■	[light green]	
All other applications		■	[red]	
Rubber sheets or tiles				o
With chemical-set adhesives	■		[dark green]	/
All other applications	■		[red]	
Silicone floor, formed-in-place	■		[dark green]	
Steel (panels, trim, tile)				
With waterproof adhesives		■	[dark green]	±
With non-waterproof adhesives		■	[orange]	
Terrazo	■		[light green]	
Vinyl asbestos tile (semi-flexible vinyl)				o
With asphaltic adhesives	■		[dark green]	
All other applications	■		[red]	
Vinyl sheets or tiles (coated on cork or wood product backings)	■		[red]	
Vinyl sheets or tiles (homogeneous)				o
With chemical-set adhesives	■		[light green]	/
All other applications	■		[red]	
Wall coverings				
Paper, burlap, cloth types		■	[red]	
Vinyl, plastic, wallpaper		■	[red]	
Wood floor coverings				
Wood (solid)	■		[red]	
Engineered wood flooring	■		[orange]	
Plastic laminate flooring	■		[orange]	
Wood composition blocks, laid in cement mortar	■		[orange]	
Wood composition blocks, dipped and laid in hot pitch or bitumen	■		[orange]	

(Barsley, 2020)

Table 1: Thermal Mass Construction Material

Thermal mass material	Specific heat capacity	Thermal conductivity	Density	Effectiveness
Water	4200	0.60	1000	high
Stone	1000	1.8	2300	high
Brick	800	0.73	1700	high
Concrete	1000	1.13	2000	high
Unfired clay bricks	1000	0.21	700	high
Dense concrete block	1000	1.63	2300	high
Gypsum plaster	1000	0.5	1300	high
Aircrete block	1000	0.15	600	medium
Steel	480	45	7800	low
Timber	1200	0.14	650	low
Mineral fibre insulation	1000	0.035	25	low

Thermal mass materials (Hamakareem, 2022)

EPILOGUE

BIBLIOGRAPHY

APPENDIX

REFLECTION

Throughout my design process, I tried to design through the scales as much as possible. Making variations of ideas in each scale each time made it clear what choices needed to be made. It also helped me to work more loosely and creatively because I could let go of my perfectionism. I used to get stuck in design projects because I wanted to draw an idea perfectly the first time. By making variations, my work didn't have to be perfect in 1 go. I also wanted to make my sometimes chaotic thoughts visible, so that it became clear what I was struggling with and what my thought flow was. By looking at all my sketches together with a teacher, new ideas emerged or a quality was seen in a sketch that I had already stopped paying attention to.

The downside of making variations is that at some point you have a variation on everything and you have to cut knots. This was also advised in the feedback after P2. I could sometimes feel lost among all the ideas and possibilities. After P2, I established guidelines for my design with the topics that appealed to me the most. The P3 moment also helped me in my decision-making. During P3, I wanted to present a complete plan, with as little variations as possible. This cleared my project and also gave the space to work further and go into detail on the design. P4 is another one of those moments that allows me to really connect the dots.

Towards P5, I want to work on the visualisation and atmospheric images of my project. I have never made a render or a collage atmospheric image before and this seems like a valuable skill to have and explore. Further, I plan to materialise and elaborate the maquette in 1:50 scale. I also had an idea to make material fragments of my building in 1:1 scale. Like a material library where the colour, expression and texture becomes clear of the different materials.

I would like to set up my P5 presentation as an exhibition where all my models and my design process are visible. If I can, I would like to spend time decorating the space and the way of exhibiting (on stands, hanging or on partition walls).

1. What is the relation between your graduation project topic, your master track (A, U, BT, LA, MBE), and your master programme (MSc AUBS)?

The studio topic explores different future possibilities for living in the wetlands of Groningen. My topic explores the possibilities, takes one and develops it further on an architectural scale. A scenario is created wherein an architectural design can be positioned. To be able to design for the future and all the challenges that this brings is also in line with the master programme as the description of the Master's programme says it explores innovative ways to create more sustainable development. Which is exactly what I'll be doing with my project.

2. How did your research influence your design/ recommendations and how did the design/recommendations influence your research?

I approached my research quite instinctively. I sensed which scale or design aspect was still the least clear to me and then went on to investigate that point further through sketches, models or literature. Sometimes I made an intuitive maquette, looking afterwards to see exactly what the shapes could mean. At other times, I first looked up information about the subject, which gave me ideas I could elaborate on. This alternation provided a fine balance between creativity and freedom on the one hand and structure and data on the other.

3. How do you assess the value of your way of working (your approach, your used methods, used methodology)?

I am learning more and more which design method works for me and what blocks me. I really enjoy sketching and creating a lot by hand instead of using the computer. This brings spontaneity to my work and also makes me more creative. Alternating between different media also lets me explore design in a very diverse way. I hope I can find a job with an architectural firm which appreciates the value of handwork just as strongly.

4. How do you assess the academic and societal value, scope and implication of your graduation project, including ethical aspects?

As I also mentioned in my research, there is a great lack of designers looking at climate change from a solution-oriented and creative point of view. I think it is hugely important that we as a community explore solutions to problems that could possibly occur over the next 100 years due to climate change, such as rising sea levels. It is important that we find solutions that not only benefit humans so that we can continue to live in the same place, but also provide a nice living environment for flora and fauna.

5. How do you assess the value of the transferability of your project results?

My solution may be a bit extreme, but it does prompt thought about how we might live in the future and what innovations are still needed to get there. Through thought experiments like this, it becomes clear what challenges remain and what technology or social developments are needed. Living on as we do now is not a possibility in the Groningen area, so adjustments and major interventions in the landscape will have to be made to keep the area liveable.
own questions:

6. Is there anything that you would've done differently?

At the beginning of the year, I was very focused on what was expected of me. Above all, I didn't want to fail. Throughout the process, I increasingly understood how to put my own spin on the research. Ideally, I would have done this from the beginning and taken more time to research my own interests. I also noticed that the research I did for the Research Plan was not implemented much in my design, probably because of this.

7. What is you advise for the next student that starts their graduation process?

Think well about what you enjoy doing and where your interests lie in architecture. If you do something you like, the energy to work on it will come naturally. Also make sure you have a good balance between work and free time. By distancing myself from my design from time to time, I looked at my project very differently and saw the priorities more clearly.