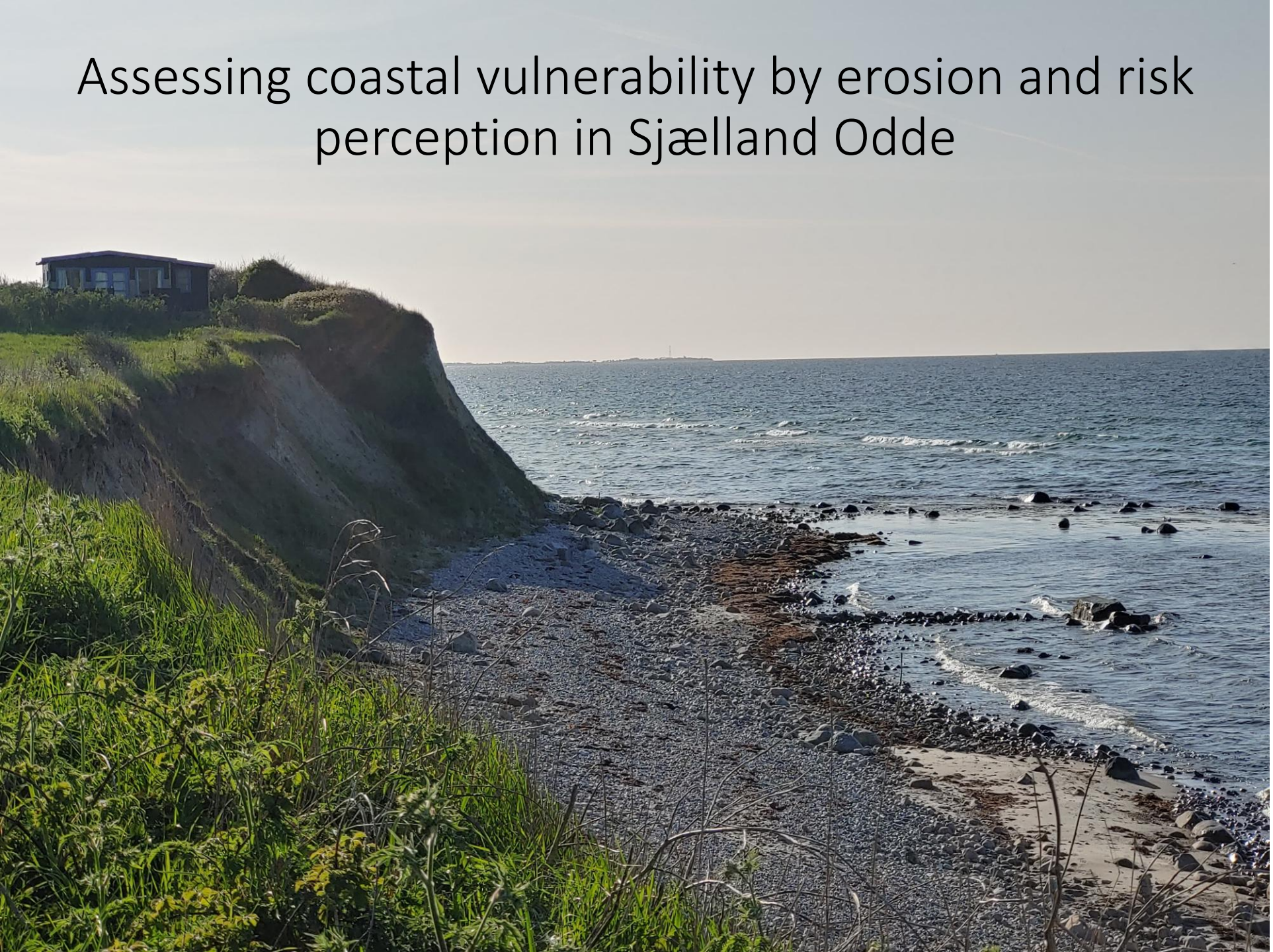
Assessing coastal vulnerability by erosion and risk perception in Sjælland Odde



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Problem statement

- Vulnerability of coastline
- Erosion
- Protection of coastline can be valuable

Problem statement

- Risk perception
- Support for protective measures
- Socio-economic and spatial differences
- Understanding awareness

Research questions

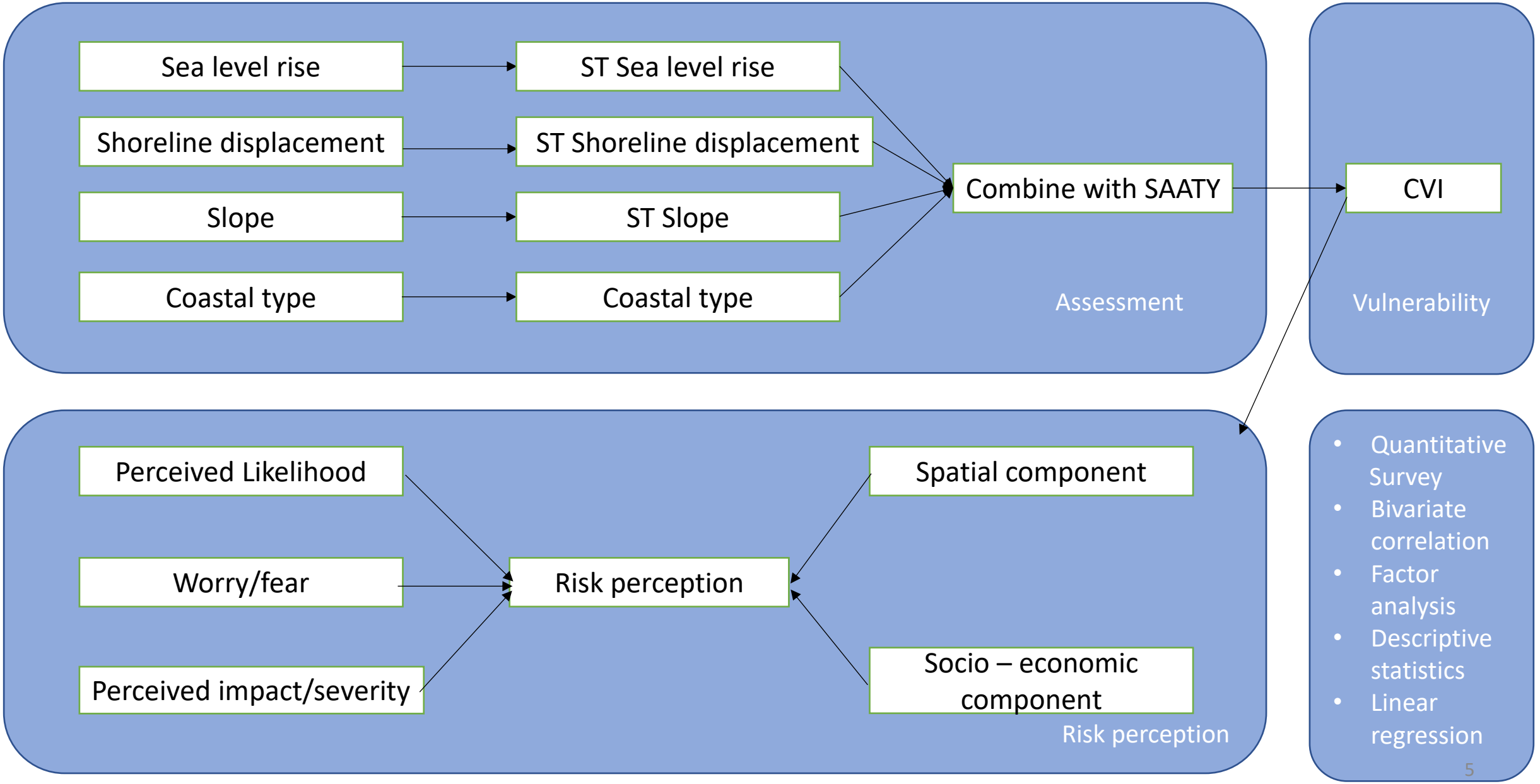
(1) What is the risk of coastal erosion?

(2) Are the inhabitants aware of the causes of the erosion to Sjællands Odde?

(3) Is there a difference in risk perception based on the location of the property of the respondent?

(4) Is there a link between willingness-to-pay and risk perception?

Method


Sea level rise
ST Sea level rise
Shoreline displacement
ST Shoreline displacement
Slope
ST Slope
Coastal type
Coastal type
Combine with SAATY
Assessment
CVI
Vulnerability
Perceived Likelihood
Worry/fear
Perceived impact/severity
Risk perception
Spatial component
Socio – economic component
Risk perception
• Quantitative Survey
• Bivariate correlation
• Factor analysis
• Descriptive statistics
• Linear regression

Weighted combination: SAATY and CVI

Factors

- F1: coastal types
- F2: slope
- F3: Shoreline displacement
- F4: Relative sea level rise

Coastal vulnerability index :

$$CVI = \sqrt{\frac{a * b * c * d}{4}}$$

Ranking matrix

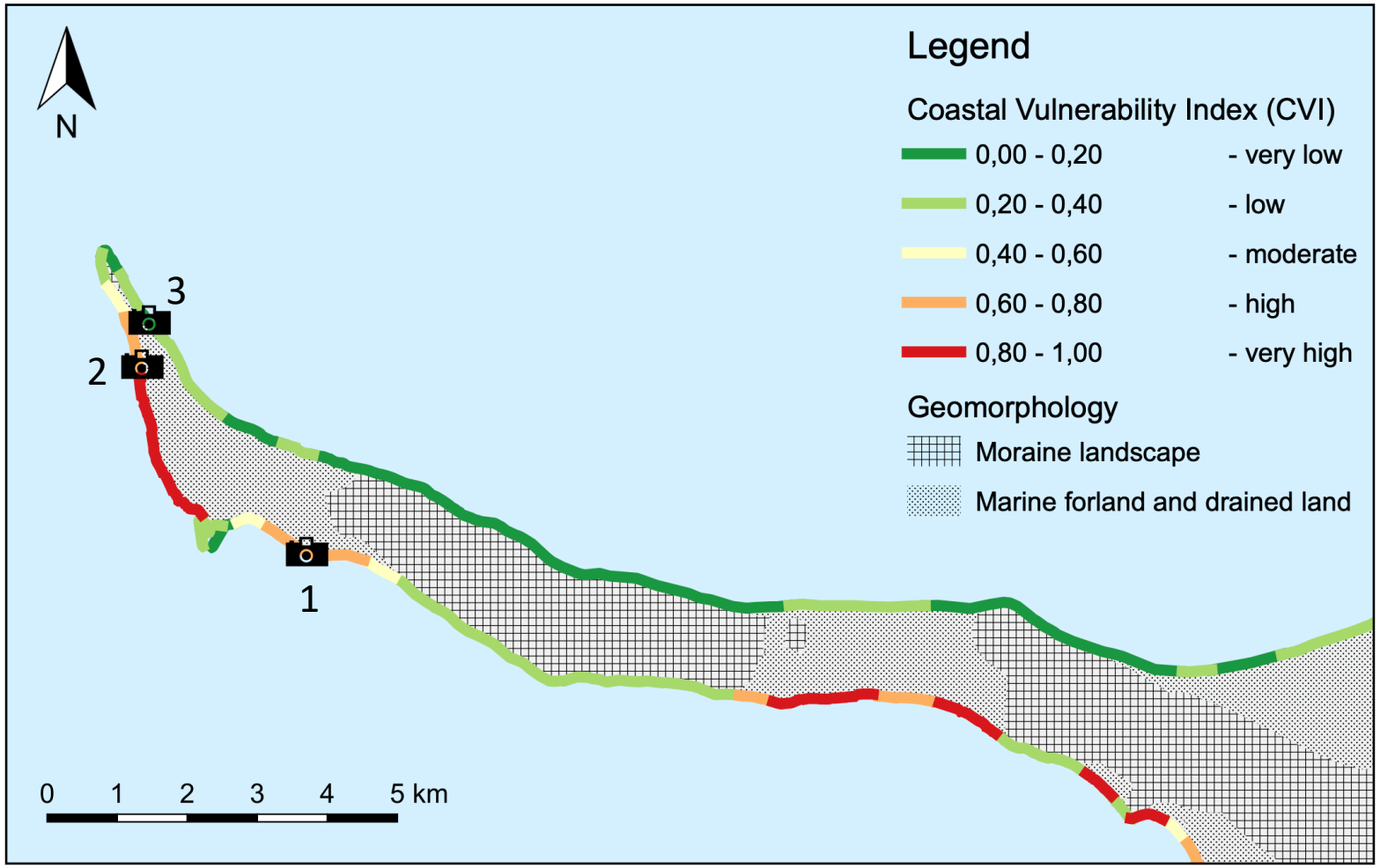
	F1	F2	F3	F4	∑
F1	1.00	3.00	0.20	3.00	7.2
F2	0.33	1.00	0.33	2.00	3.666666667
F3	5.00	3.00	1.00	3.00	12
F4	0.33	0.50	0.33	1.00	2.166666667
∑	6.666667	7.5	1.866667	9	

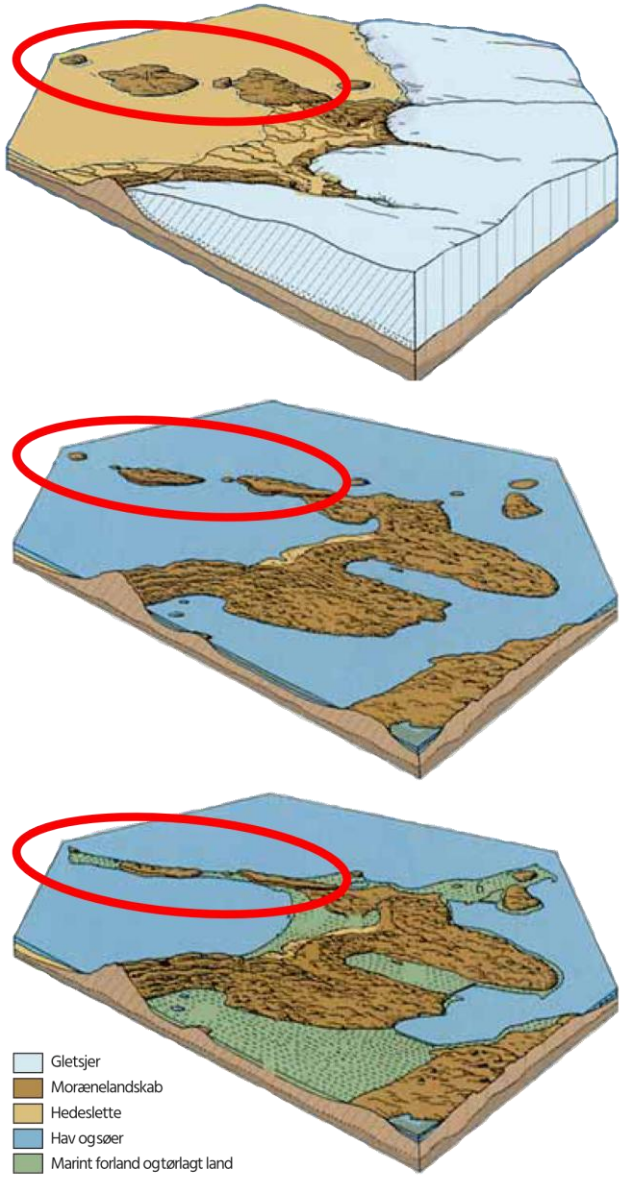
Weight matrix

					Average
F1	0.15	0.4	0.107143	0.333333	**0.247619048**
F2	0.05	0.133333	0.178571	0.222222	**0.146031746**
F3	0.75	0.4	0.535714	0.333333	**0.504761905**
F4	0.05	0.066667	0.178571	0.111111	**0.101587302**
					1

Results: Coastal Vulnerability

Association CVI - geomorphology





Results: Coastal Vulnerability

1

2

3

Method: survey

Question	Indicator	Knowledge (awareness in general)	Focus of the question
How likely do you think that this type of erosion will happen to your area	Perceived likelihood	Awareness of probability Cause-knowledge	Probability
When I think about erosion, I feel worried for the coastline closest to where I'm staying/living	worry	Awareness of consequences/impact emotion/feeling	Worry/fear/feeling
When I think about erosion, I feel worried for the area surrounding the house where I'm staying/living	worry	Awareness of consequences/impact, emotion/feeling	Worry/fear/feeling
To what extent would the property where you stay/live be affected by the erosion processes	Perceived impact/ severity	Question implies awareness about the severity of possible negative consequences	Impact/severity

Survey: Data exploration

- 66 surveys => 53 surveys used

What is your gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	26	49,1	49,1	49,1
	2	27	50,9	50,9	100,0
	Total	53	100,0	100,0	

What is your age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	3	5,7	5,7	5,7
	2	7	13,2	13,2	18,9
	3	10	18,9	18,9	37,7
	4	33	62,3	62,3	100,0
	Total	53	100,0	100,0	

What is your household approximate annueal income, including wages, tips, investment income, public assistance and income from retirement plans? would you say it is....

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	4	7,5	7,5	7,5
	2	16	30,2	30,2	37,7
	3	33	62,3	62,3	100,0
	Total	53	100,0	100,0	

What is your education level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	14	26,4	26,4	26,4
	2	6	11,3	11,3	37,7
	3	13	24,5	24,5	62,3
	4	20	37,7	37,7	100,0
	Total	53	100,0	100,0	

Do you have children?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	45	84,9	84,9	84,9
	2	8	15,1	15,1	100,0
	Total	53	100,0	100,0	

Survey: Data exploration

Bivariate correlation + KMO

Factor analysis

Correlation Matrix

		perceived_likelihood	worry_coastline	worry_property	impact
Correlation	perceived_likelihood	1,000	,373	,358	,394
	worry_coastline	,373	1,000	,473	,490
	worry_property	,358	,473	1,000	,658
	impact	,394	,490	,658	1,000
Sig. (1-tailed)	perceived_likelihood		,001	,002	,001
	worry_coastline	,001		,000	,000
	worry_property	,002	,000		,000
	impact	,001	,000	,000	

Component Matrix[a]

	Component 1	Component 2
perceived_likelihood	,654	,739
worry_coastline	,754	-,025
worry_property	,825	-,316
impact	,843	-,242

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Survey: Data exploration

Search for significant coefficients

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	,455	2,300		,198	,844
	elevation house	,088	,027	,776	3,237	,002
	distance to coastline	-,003	,001	-,483	-2,689	,010
	1. Where do you live?	-,091	,206	-,112	-,442	,661
	3. Are you owner of the property or tenant?	-,251	,614	-,084	-,409	,685
	5. If no, how frequently do you visit Sjaelland Odde?	,012	,176	,015	,066	,947
	6. How long is your average stay?	-,166	,153	-,234	-1,087	,284
	7. How important is Sjaelland odde to you?	,149	,135	,194	1,105	,276
	What is your gender	-,175	,312	-,086	-,561	,578
	What is your age	,044	,225	,040	,198	,844
	What is your education level	,146	,140	,174	1,042	,304
	What is your marital status?	-,175	,215	-,153	-,815	,420
	Do you have children?	-,194	,533	-,068	-,364	,718
	What is your household approximate annueal income, including wages, tips, investment income, public assistance and income from retirement plans? would you say it is....	-,170	,316	-,105	-,537	,594

a. Dependent Variable: REGR factor score 2 for analysis 2

Requirements Linear Regression

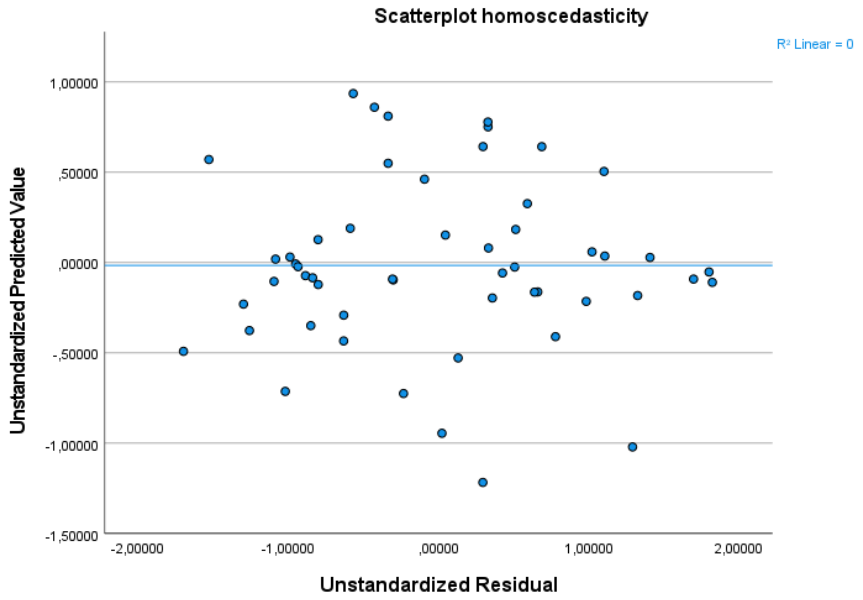
- Linearity
- Normal distribution of residuals
- No multicollinearity
- Homoscedasticity

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Unstandardized Residual	,093	53	,200*	,971	53	,218

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction



Linear Regression

- Dependent variable: Factor 2;
  high perceived probability but lower perceived impact
- Independent variables:
  - Elevation of the property
  - Distance to the coast
- Statistically significant on the 95% significance level
- But explains only a small amount of the total variance

Lineair Regression – linear correlation

Regression

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	elevation house, distance to coastline[b]	.	Enter

a. Dependent Variable: REGR factor score 2 for analysis 2

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,460[a]	,211	,180	,92951728

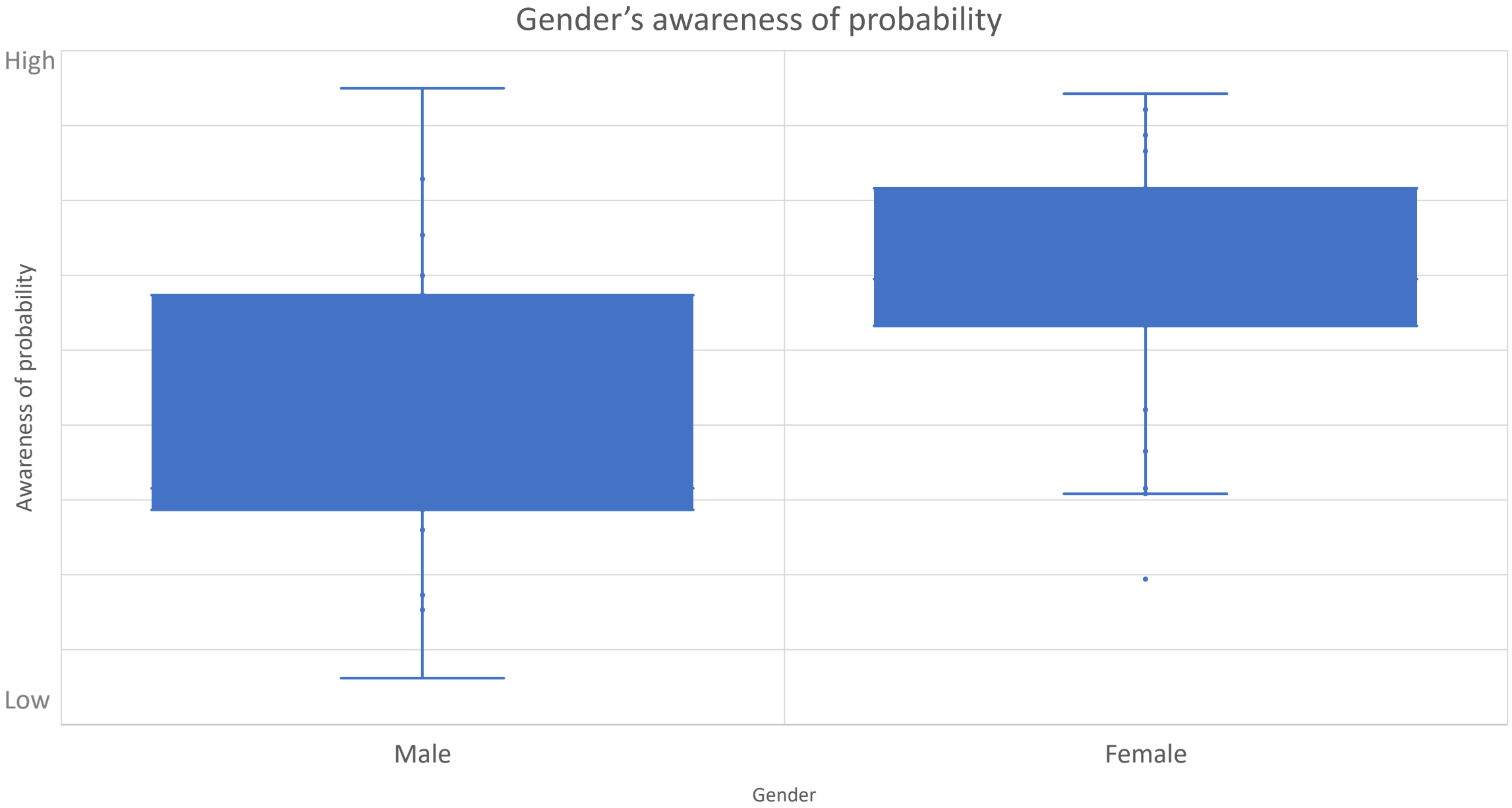
a. Predictors: (Constant), elevation house, distance to coastline

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11,564	2	5,782	6,692	,003[b]
	Residual	43,200	50	,864		
	Total	54,765	52			

a. Dependent Variable: REGR factor score 2 for analysis 2

b. Predictors: (Constant), elevation house, distance to coastline


Gender’s awareness of probability
High
Low
Awareness of probability
Male
Female
Gender

Lineair Regression – No lineair correlation

- Willingness to pay and risk perception
- Older people have a high perceived probability but a low perceived impact
- Places where the perception is of high perceived probability and a high perceived impact are more willing to pay

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	willingness_to_pay_property[b]	.	Enter

a. Dependent Variable: REGR factor score 1 for analysis 2

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,155[a]	,024	,004	1,02491952

a. Predictors: (Constant), willingness_to_pay_property

ANOVA[a]

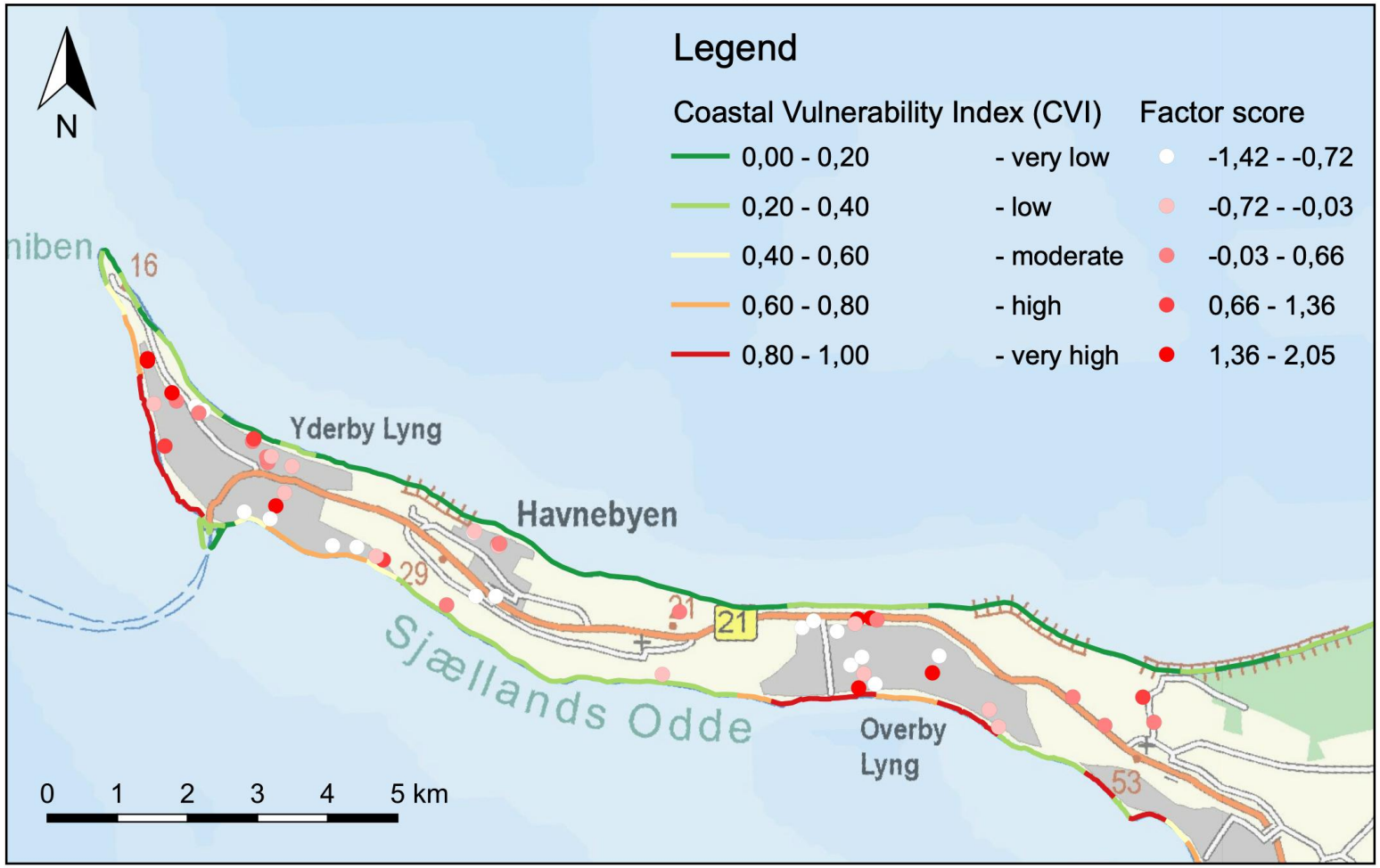
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1,288	1	1,288	1,227	,273[b]
	Residual	52,523	50	1,050		
	Total	53,811	51			

a. Dependent Variable: REGR factor score 1 for analysis 2

b. Predictors: (Constant), willingness_to_pay_property

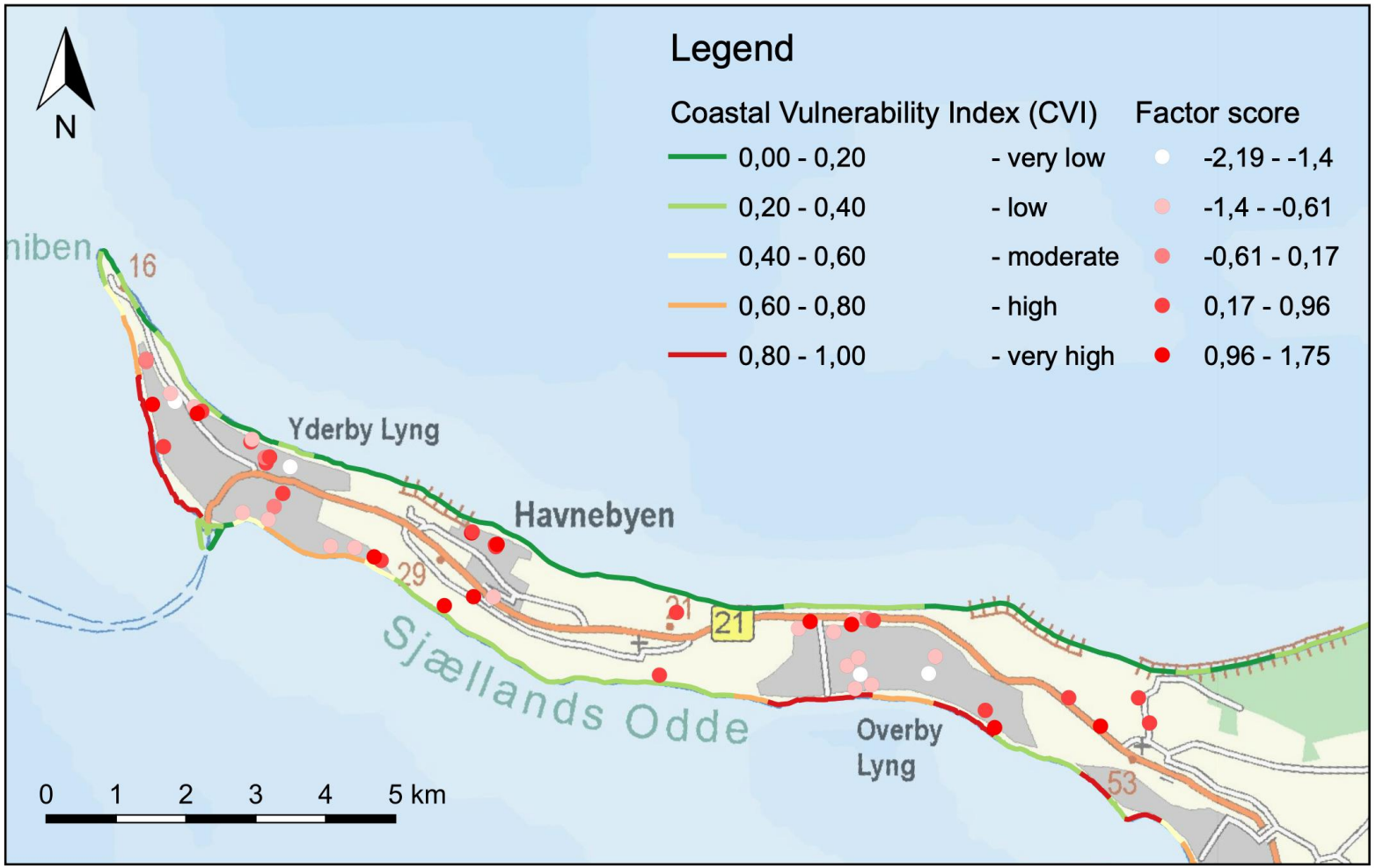
No spatial pattern in risk perception to CVI

Factor score: high probability - high impact



No spatial pattern in risk perception to CVI

Factor score: high probability - low impact



Qualitative findings

- *“Already made adaptations with the community”*
- *“It’s a natural process”*
- *“As long the ferry is located here, we are safe”*
- *“Erosion is mostly the result of the ferry”*
- *“Other side island, risk is higher”*

Discussion

- Optimistic bias
- Limitations
- Rejected hypotheses

Conclusion

- Aware of the causes
- Distance of coastline
- No link between willingness to pay and risk perception

Future research:

- Other period: low number respondents
- More extensive erosion analysis: include storms
- Other areas in Denmark, different types