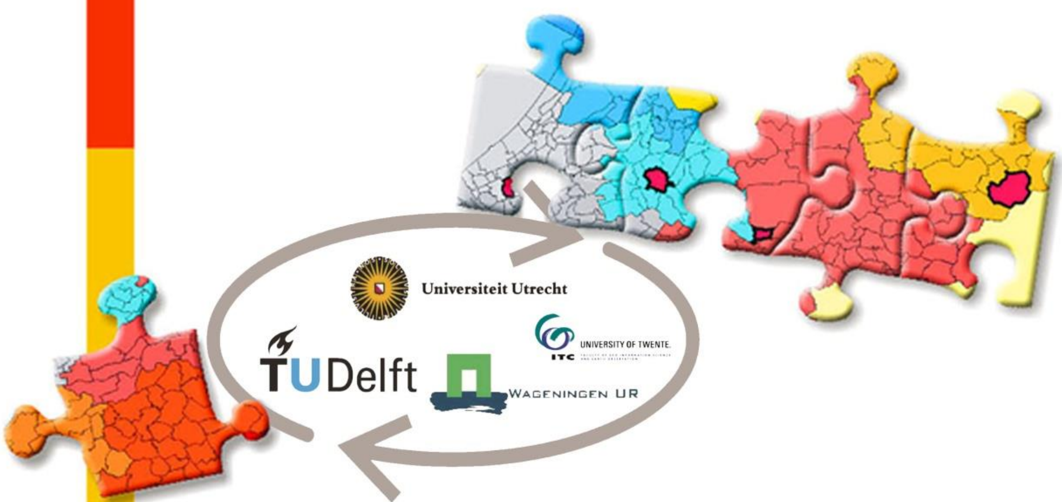
GIMA

Geographical Information Management and Applications

Evaluation of PROMETHEE for spatial vision development on Dutch coastal marina planning

Jelle Gulmans

2013



Evaluation of PROMETHEE for spatial vision development

GIMA MSc. Thesis

Jelle Gulmans

jgulmans@gmail.com

Professor:	Arnold Bregt (WUR)
Supervisors:	Arend Ligtenberg (WUR)
	John Stuiver (WUR)
	Marianne Walgreen (Province Noord-Holland)
Reviewer:	
Coordinator:	Sisi Zlatanova (TUD)

Geographical Information Management & Applications (GIMA)

May 2013

University of Wageningen

The Netherlands

Summary

This study deals with an evaluation of the Preference Ranking Organization METHods for Enrichment Evaluation (PROMETHEE). In this study, an enhancement is made with the Analytical Hierarchy Process (AHP) for criteria weighting.

The evaluation is projected on a case study on finding new possible locations for marinas along the Dutch coast. By using different spatial criteria, and having several alternatives for possible locations along the Dutch coast, the enhanced PROMETHEE method is evaluated on usability for governmental vision development. The study uses a broad view, considering a large part of the Dutch coast.

This study has two main objectives: 1. Creating a ranking on possible alternatives for new marinas, and 2. Evaluating the PROMETHEE method in a context for vision development.

When looking at the Dutch coast, two gaps can be identified in which no marinas are present. To fill these gaps, different alternatives of new marinas are possible. These alternatives are ranked via a multi-criteria analysis.

The AHP method is used to weight the criteria used in this study. It uses pairwise comparison for giving weights to the criteria that were selected by different stakeholders involved in marina(s) (planning). The weights are inserted in the PROMETHEE model for further analysis.

The results show a ranking of the different alternatives with their strengths and weaknesses. These results will be used for the National Vision Coast which will be presented in September 2013 by Deltaprogramme Coast. The results are a starting point for a discussion on whether new marinas are needed and what the final location should be.

The second objective is an evaluation of strengths and weaknesses of the PROMETHEE method, enhanced with AHP in the light of vision development. These strengths and weaknesses are discussed and explained.

As for objective one, two locations are clearly the best alternatives for new marina development: Katwijk aan Zee and Egmond aan Zee. These locations are favoured in the analysis by the presence of good basic marina facilities and good natural conditions. However, the other alternatives may be considered as well when looking at for instance nearby facilities. An extensive evaluation is given in this study.

For the second objective it is concluded that AHP/PROMETHEE is a suitable method for vision development, as it can deal with a broad view scope, and can create a starting point for the vision. However, in modern times it should be considered that opinions, lobby and discussion is getting more important, making the AHP/PROMETHEE method not the final answer to the problem.

Preface

In front of you lies the thesis for me becoming Master of Science (MSc) for the study Geographical Information Management and Applications (GIMA). During the period of a year of internship at Deltaprogramma Kust (Deltaprogramme Coast, DPC), the topic for this thesis was created. During the internship, I gained a lot of experience in working in the governmental organisation on coastal vision development. After choosing a few topics, DPC and I made a proposal for this study to the GIMA coordinators, and it was accepted.

Within a year time, I gained a lot of knowledge on marinas, planning, governmental structures, governmental cooperation and working with different levels of government. All in all, it has been a great experience.

I am very proud to present this thesis, and would like to thank all people that made this thesis possible. Marianne Walgreen, I would like to thank you for your feedback and guidance during the internship. Furthermore, I would like to thank Emmy Bolsius for the opportunities that where given to me during my internship. Without you I would not be presenting this thesis after all! Next, I would like to thank Arend Ligtenberg and John Stuiver for the supervision from Wageningen University. Thank you for the feedback rounds. Then, I would like to thank all colleagues of DPC. You have been very patient! I hope this thesis can serve a good basis for the part of marinas in the National Vision Coast.

Of course I would also like to thank all respondents and people I was able to interview during this thesis project. Thank you for your help, feedback and input for this thesis.

Finally I would like to thank my parents. Vincent, thank you for the great help, keeping me up track and helping me in difficult times. Without you no thesis, and you know that! Marian, thank you for making it easy on me to finish this thesis, and helped me look for the positivity!

Table of contents

1. Introduction

The Dutch coast is changing. This change is due to many aspects, but a very important one is climate change. Safety issues occur when thinking about the current situation of the Dutch dikes, dunes and water works, and the future sea level rise. Are the current standards on water safety enough to keep the Netherlands safe for the future? This is one of the questions which is researched within the Deltaprogramme.

The Deltaprogramme is an inter-governmental organization of ministries, provinces, water boards and municipalities. Since February 2010 the Deltaprogramme is working towards solutions on water safety and prospective trickle-down effects (Deltaprogramma Kust, 2013).

The Deltaprogramme consists of nine different sub-programs. One of these is the coastal program (Deltaprogramme Coast or DPC), that deals with the Dutch coast, from Cadzand-Bad to the Wadden island Rottumeroog. For the Wadden Islands, only the area that touches the North Sea is considered.

As stated before, the most important question for the Deltaprogramme, as is for the DPC, is how to keep the Netherlands safe from water in the future. However, because the Netherlands is also changing in economics, demographics, spatial planning and morphology, it would not be effective to only look at the safety issues: possibilities of restructuring in combination with safety issues occur along the coast in the upcoming hundred years. In this perspective, a National Vision Coast (NVC) is created by DPC. In this vision, the safety issues are combined with economic studies on the coast, morphology, demographic changes and with changes in spatial planning (including restructuring of the coastal villages and towns) (Deltaprogramma Kust, 2013).

The combination of safety with economic issues of the coast, brought the need for information on the Dutch coastal marinas. Many individual studies have been conducted on the potential of new marinas. However, to have a complete overview in the vision, an overall study must be conducted on the need of new coastal marinas. This is what this research will be dealing with.

Currently, there are twelve locations of marinas at the Dutch coast, and one planned marina, to be built in the next years (figure 1.1). Seven of these locations are situated on the North Sea coast. The others are situated in the Wadden Sea area. Some of these marinas have an open connection with the North Sea, and some of them are behind sluices. However, because of their proximity, these marinas will be considered as well.

In the case of Den Helder, multiple marinas are present, varying from small docks to larger full-service marinas. When talking about the marina Den Helder, all these marinas are considered as one.

Many different users of marinas can be identified. Figure 1.2 gives an overview of these users. All other user groups, not mentioned in this overview, are considered to be harbour users. The difference between a harbour and marina lies in the usage: marinas are for recreational purposes, while harbours are for professional use.

Source: Gulmans, 2013

Figure 1.1: Current (and planned) marina's at the Dutch coast

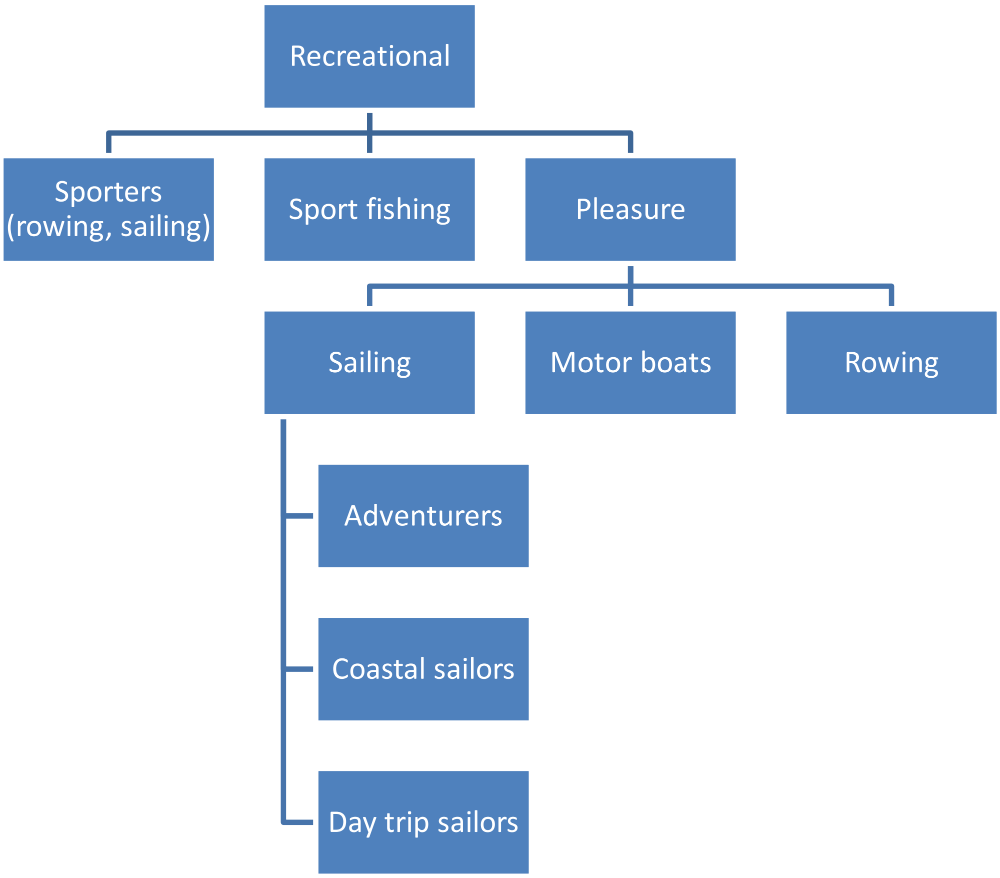


Figure 1.2: Marina users. Source: Deltaprogramme Coast, 2012.

The question posed by DPC is whether it is necessary to have more marinas at the Dutch coast, in order to have a complete network of marinas for sailors along the coast. A guideline here is that an average coastal sailor is willing to sail for four to five hours before reaching the next port (guideline: Deltaprogramme Coast, 2012, Watersportverbond, 2012). Furthermore, the sailors can be divided into three different categories (as given by the DPC):

- Adventurers: sailing from country to country. These sailors need only one or two stops in the Netherlands, and will mainly use the full-service marinas
- Coastal sailors: sailing from port to port along the coast for a period longer than two days.
- Day trip sailors: sailing within an area for one or two days, mostly returning to the same port that they left from.

When looking at the map, two gaps can be found in the network of marinas: between Scheveningen and IJmuiden, and between IJmuiden and Den Helder. Both gaps are situated in the Hollandse Boog, the area between Hoek van Holland and Den Helder. These gaps are based on the maximal sailing time between ports, which are exceeding the 5 hours.

1.1 Problem statement

The Dutch coast is approximately 350 kilometres long, with various landscapes. Most of the natural landscapes are part of the national protected areas. Furthermore, the Dutch coast consists roughly out of three different parts (Deltaprogramma Kust, 2011):

- The South-Western Delta: consisting of Zeeland and the Southern part of South-Holland. The Delta has got peninsulas with closed or open waters.
- The Hollandse Boog (Holland Arch): consisting of a (nearly) closed coastal line between the Harbour of Rotterdam and Den Helder.
- The Wadden Sea: Consisting of the Wadden Islands and their water inlets.

In various studies (Waterrecreatieadvies & Oranjewoud, 2010) (Waddenhaven Vlieland, 2012) (Waddenhaven Texel, 2012) (Waddenhaven Ameland, 2012) (Jachthaven Terschelling, 2012) (Jachthaven Schiermonnikoog, 2012) (Gemeente Den Helder, 2006) (Den Helder Willemsoord, 2012), it was noted that in the Wadden Sea area, the network sailors are using is mostly consisting within the Wadden Sea. It is stated that only a small amount of sailors tend to go to the North Sea. Most of the sailors stay within the distance of the Wadden marinas on the islands, the Ijssel lake and the marinas along the coastline of the province of Friesland (Waterrecreatieadvies & Oranjewoud, 2010). Because of this, the Wadden Sea area will be excluded from further investigation in this research.

From now on, when talking about potential locations for marinas at the Dutch coast, the two mentioned gap areas within the Hollandse Boog will be considered.

The different landscapes along the coast also give different interests by different stakeholders. There are several perspectives that have different benefits in the coastal area:

- Economic perspective: seeing the coast as an economic motor businesses and leisure
- Recreational perspective: making sure there are enough facilities for tourism (e.g. Restaurants, accommodation, souvenir shops and activities)
- Ecological perspective: making sure the Dutch National Landscapes are preserved, and that plant and wildlife are able to exist in the natural reserves
- Safety perspective: making sure that the coast will remain a fortification and defence mechanism of the land behind it.
- Spatial planning perspective: this is where the perspectives come together: there can be only one of the above mentioned activities at one place. Choices between the different activities should be made, which will provide a dynamic, strong, safe and attractive coastline.

These different perspectives create a necessity to evaluate the potential location of marinas that could be planned in the (near) future. These perspectives are all important when selecting criteria for a decision process to determine the location of future marinas. Because the time scale on which DPC is operating is until 2100, it is not necessary to only look at marina planning in the near future. Not only locations that are considered already as a possible location will be part of this study. Also, a few locations that were not thought of before (in studies) are considered.

This problem is an example of a locational decision problem (Triantaphyllou & Sánchez, 1997). The focus lies on evaluating and ranking different locations. Many studies have been performed on decision making (Sargent, 1991), (Behzadian, Kazemzadeh, Albadvi, & Aghdasi, 2010). In the 1980's, some rational models were presented like Multi-criteria analysis. These models are using a traditional method for coming to a decision. The question is however whether these methods can still be used. Within the last 30 years a lot has changed, also in decision making.

1.2 Research objectives

The objectives of this study is two folded. On the one hand, this study is making a comparison of location options for new marinas along the Dutch coast, for vision development. This comparison will be based on a systematic analysis of criteria that determine the choice for different locations.

At the end of this research, a ranking of the possible alternatives for two gap-areas will be given, including an evaluation of suitability of each alternative.

Because these alternatives are based on both tangible (e.g. Physical) and non-tangible (e.g. opinions) criteria, it is necessary to apply a locational decision making model on these alternatives which can deal with quantitative and qualitative information. Not all models in decision making can deal with this, for instance the mathematical regression model is not suitable to use in this case (Sargent, 1991)

On the other hand, this research will evaluate a method for decision making in a vision development context. Modern policy making is often based on more than linear and rational decisions (Bertsimas & Thiele, 2006). Many existing models cannot take political and social factors into account (Redlawsk, 2002). However, this study will look if a traditional model for decision making, more specific a Multi-criteria analysis (MCA) model, which has been developed, innovated and used in the past 35 years, is still applicable for vision development purposes. Vision development is seen here in a governmental perspective, dealing with a broad view on the problem. A detailed view is not necessary in this case. The social factors will not be considered in the model itself, however, it will be included in the process of this study through feedback rounds.

Because Multi-criteria analysis methods are often easy to understand for people without knowledge of decision making models, and MCA is widely known within the academic community, the method is chosen for this study. However, in MCA multiple types of models are available to the researcher. A study on these models will be performed in the theoretical framework.

1.3 Research questions

The key questions in this study, which can be derived from the objectives are:

- How could new marinas on the coast be distributed so that a distribution (based on needs of stakeholders, land use and economic feasibility) of marinas at the coast is created that is useful to coastal sailors?
- Can traditional decision making models be used for governmental vision development?

From the first research question, the following sub-questions can be derived:

- Where are the current marinas and what is their profile (target groups, boat partition, number of moorings)?
- What are the future plans regarding marinas of municipalities and provinces?
- Are there criteria for the spatial planning of marinas? What are these criteria?
- What could be potential areas for new marinas, based on the criteria in the gap-areas?
- What are the strengths and weaknesses for these potential areas?

Based on these second research question, the following sub-questions can be derived:

- What traditional decision making methods are available for locational decision problems?
- What are the strengths and weaknesses?
- Can traditional decision making models be used for governmental vision development?

1.4 Significance of thesis

This thesis will deal with on the one hand a case study that will be performed on spatial marina planning. There have been many studies on individual locations for new marinas[1]. These studies all show, in different degree, how important a new marina is for the municipalities. However, a study on the whole coastal region has not been performed yet. The current study will fill this gap. It will assess the different locations along the coast, and will evaluate these different locations and make a comparison between the alternatives. In this way, different studies that have been performed on the individual locations can be evaluated and compared as well.

On the other hand, this research will give insight into the different methods for locational decision making models and it will evaluate the method that has been used. It will combine both tangible and non-tangible models to create a complete overview in locational decision making. A discussion will follow on whether these methods are still valid in modern times for governmental vision development.

[1] Studies on Zandvoort (Gemeente Zandvoort, 2012), Noordwijk aan Zee (Smits, 2008), Katwijk aan Zee (Grontmij & Stichting Intraval, 2008) and Petten (Stichting JAS, 2010).

1.5 Summary of chapters

Chapter 2 will give a framework on the different models that are available for spatial decision making. An overview will be given on the methods for qualitative and quantitative aspects in location decision making models. It will offer an answer to the second question, and its sub-questions.

Chapter 3 will be a description on which method is chosen and why this is chosen. This will be a full description on how the model works.

In chapter 4, the case study will be introduced. Furthermore, the analysis of the case study will be performed and the results will be presented including an observation of the results.

In chapter 5 the method will be evaluated via a discussion on the case study and on the model.

This chapter is followed by a conclusions chapter (chapter 6) and recommendations (chapter 7).

2. Theoretical framework

Decision making is a concept that can be found in many different types of studies. In order to have a structured overview of the process of decision making, seven phases (or steps) can be identified (Bodily, 1985). These phases are a traditional way of decision making.

These seven phases are:

- Problem definition
- Requirement determination
- Goal establishment
- Alternatives identification
- Criteria definition
- Selection of decision making tool
- Evaluation of alternatives against criteria
- Validation of solutions against problem statement

These stages together create a model that offers opportunities for the analysis of a decision problem. Below, the stages will be explained, based on (Bodily, 1985) and (Sargent, 1991).

The first phase (problem definition) was already dealt with in the introduction of this research. It deals with an outline of the situation and the reason why this decision problem needs a solution. The problem definition needs to be clear and unambiguous, so that every stakeholder in the process is aware of the problem to be solved.

The requirement determination (second phase) sets the conditions which the required solution must meet in order to become a feasible solution. These requirements are the constraints of the model.

In the third step of the decision making process, the goals of the research are established. The solutions coming out of the process should meet the goals defined in this stage. Goals contain the requirements from the second phase, but also could and would haves (desires and wants).

After determining the goals of the decision making, the alternatives (phase four) are identified. In the case of this research, the alternatives are the different locations that are available for marina planning.

In order to assess the different alternatives in term of suitability, criteria need to be defined (phase five). These criteria can vary into many different aspects, as long as they contribute to a thorough assessment of the problem.

The next step (phase 6) is one of the most complex steps of the decision making process. It is selecting the tool(s) that guides you through the rest of the process of decision making. There are various tools (or methods) available to the researchers. The theoretical framework in this study will focus on this part of the decision making process, for it determines how the assessment is performed.

After selecting the tool, the actual analysis can begin by evaluating the different alternatives with each other (phase 7). This is done by using the guidelines of the tool.

Finally, a validation of the analysis is performed (phase 8) in order to check if the results are stable and whether they could be different when for instance criteria are changed.

Most decision problems deal with multiple aspects (criteria) of the real world. A decision is almost always based on opinions, facts and experiences. Decisions should be based on the solution that brings consensus for a certain problem. When looking at a decision, multiple alternatives are available, and the question is which of the alternatives represents the answer to the problem in the best way (Brans & Mareschal, 2005)

For this study, the decision making process will be used to compare different alternatives and evaluate this comparison. A final decision is not made in this thesis. However, because close links can be found with decision making, this method is used in this thesis. The focus will be on the comparison and evaluation of the alternatives.

During this study, all the phases of the decision making process will be followed. However, in order to select the best model in the sixth phase, some more background information is necessary. The following paragraph will deal with different models for decision making.

2.1 Models for decision making

The choice of a model (tool) is a very important aspect in the decision making process. It determines the way the analysis (phase seven of the decision making process) is performed. There are many models for decision making available to a researcher. These can vary from models created from a marketing perspective (e.g. AIDA, Abdell) to models that are pure mathematical (regression analysis, optimization algorithm models).

In the introduction, a preference for multi criteria models was stated. In this type of model multiple criteria are assessed on different alternatives. These criteria are pre-defined and weighted by the model, based on pre-defined weights.

In multi-criteria analysis, different methods are available. The most known, and most widely used, models are Multi-Attribute Utility models (among them the Analytical Hierarchy Process) and outranking models (among them ELECTRE and PROMETHEE) (Figueira, Greco, & Ehrgott, 2005).

There are many fields in which decision making plays a role, for instance marketing, economics and social science. Many different models were created for these typical branches. However, for spatial decision making processes there are no specific models in Multi-criteria analysis available (Ligmann-Zielinska & Jankowski, 2012). Over the past years, studies were performed on Spatial Planning Support Systems (SPSS), a series of applications dealing with spatial planning and decision making issues. These applications include a variety of methods on spatial decision making. However, discussing a complete SPSS is beyond the scope of this study. This study deals with multi-criteria analysis and an evaluation of this method. This paragraph will take a look at the different models available for decision making in a spatial context.

In spatial decision making, a combination between a decision model and GI (geographical information) application is often made. In this case, a GIS (Geographical Information System) is used in order to perform the spatial analysis which is necessary for the final decision making process: because the decision problem is about locational aspects of new marinas, a GIS is very suitable as an analysis tool (Ligmann-Zielinska & Jankowski, 2012).

In order to process the spatial information in decision models, a criteria analysis is often used. In a criteria analysis, the problem is defined in one or more criteria. These criteria should cover the whole problem. Most problems are therefore divided into multiple criteria (Sargent, 1991).

The use of criteria is possible in a variety of models, and will be described below.

In spatial decision making, it is often about searching for the best suitable location of an entity. This suitable location has got a physical component (e.g. proximity to other entities) and a social component (opinions on placing the entity; opinions from politicians, citizens, exploiters, and social parties). This last component is however often forgotten in a spatial analysis (Redlawsk, 2002). In this study, the social component will return in the discussion section. Furthermore, it will be introduced in the process of coming towards a conclusion. It will however not be taken into account in the ranking procedure.

First, the Multi-attribute utility Theory (MAUT) will be discussed. After this, some counter models on MAUT will be discussed, ELECTRE and PROMETHEE. These two models are part of the Outranking family.

There are many other models available (e.g. agent based models, for modelling networks and movement within networks; cellular automata, for determining the likelihood of spread of a phenomenon; these models are not considered in this study. Cellular Automata (CA) is a model that calculates the occurrence of phenomenon next to each other in subsequent time periods based on a given set of rules (Wolfram, 1994). This makes cellular automata not suitable. The same goes for Agent Based Models (ABM), where the focus lies on networks and movement of entities. In this study there are no moving entities. The CA and ABM are typical models to evaluate land use and land cover change (Parker D. et al., 2003). In the case of this study, land use and land cover change are not applicable. However, for further research on actual locational planning, these methods could be interesting to study.

There are different families of MCA models. For instance the MAUT (Multi-attribute utility theory). In this theory, weights are assigned to criteria in order to determine relative importance of the criteria on a dimensionless scale (San Cristóbal Mateo, 2012). In practice, the scale 0-1 or 0-100 is used for these scores. Both factual and judgmental criteria can be applied in this model. Alternatives can then be measured by using the weighted criteria. The outcome of these models is a ranking of alternatives based on a score from 0-1 or 0-100. The scores are based on a utility function. A utility function is a function that shows the preference of criteria over each other. Based on this the ranking is created (Sargent, 1991).

In the MAUT weighted sum and the AHP (Analytical Hierarchy Process) are the most common methods. The weighted sum method calculates the mean of all criteria per alternative. This mean gives the preference ranking of the alternatives. However, because the mean diminishes the relative importance of the weights assigned before, the result is a weakened score (Dyer, Fishburn, Steuer, Wallenius, & Zionts, 1992). To solve this, other options are available such as the AHP.

The Analytical Hierarchy Process (AHP) was proposed by Saaty in 1980. The AHP was designed to put relative importance of criteria into weights, for helping to prioritize alternatives (Bogdanovic D., D. Nikolic & I. Ilic, 2012). This is done by constructing a hierarchy in the decision problem (Sargent, 1991). The criteria are compared to each other by pairwise comparison: all criteria are compared in sets of two, each time asking the question: How important is criterion C_i relative to criterion C_j? To this question, a score is given on a scale of 1-9, which makes a matrix of the criteria in dimension x and y, with the scores 1-9 and 0.1-1. From this, the relative importance per criterion is derived in a scale of 0-1 (Saaty, 1990). This score can be used in the models when the criteria per alternative are inserted. The final score of the AHP will give a ranking of the different alternatives, assuming that all criteria have a same scale (Saaty, 1990). This score is based on the eigenvector of the criteria, which determines how much a value changes when a criterion changes. In the scientific community, this method has been criticised on consistency and prioritization (Zahedi, 1996). However, the concept of pairwise comparison (the first step in AHP) is often used in combination with other methods.

A different family is the Outranking models (Sargent, 1991). These models also use criteria and weights, as has been used in MAUT models. These models often don't have guidelines for assigning of weights (Figueira, Greco, & Ehrgott, 2005). The AHP or weighted sum method could be used often in this case. The difference between the MAUT and Outranking models can be mostly found in the analysis part after scoring the criteria (Figueira, Greco, & Ehrgott, 2005). Within the Outranking models, the ELECTRE and PROMETHEE methods are the most known methods that have been developed (Sargent, 1991).

According to outranking models, there are three possible outcomes for alternatives: preference, indifference or incomparable (Brans & Mareschal, Chapter 5: PROMETHEE Methods, 2005). With preference, all criteria are better in alternative a. than in alternative b. With indifference, there is no difference in alternatives. When alternatives are incomparable, some criteria are better for alternative a, and some criteria are better for alternative b. In this case, it cannot be decided which alternative is better. To reduce the existence of incomparable alternatives, the relative weights can help.

ELECTRE (ELimination Et Choix Traduisant la REalité; ELimination and Choice Expressing REality) is used for searching the best alternative from a set of alternatives. It was proposed in 1965 by Bernard Roy, working at SEMA, an IT services company (Figueira, Greco, & Ehrgott, 2005). The method uses two variables per criteria: importance coefficients, which give the actual weight to a criterion, and the veto threshold, a value that gives a veto threshold: a value that gives the imperfect nature of the criterion, and thus give a certain value of uncertainty (Figueira, Greco, & Ehrgott, 2005).

Closely related to ELECTRE is PROMETHEE (Preference Ranking Organisation Method for Enrichment Evaluation). This method is proposed in 1982 by Brans (Brans, JP. & B. Mareschal, 2013).

PROMETHEE can be used for different decision making problems. It can provide a solution for (Brans & Mareschal, 2005):

- Choice selection (what is the best choice in alternatives)
- Prioritization (determining the relative ranking of alternatives: what are the differences)
- Resource allocation (where should a resource be allocated to, considering multiple alternatives)
- Ranking (making a ranking list of possible alternatives, with one as the best option)
- Conflict resolution (conducting a mathematical study on a conflict between parties, by showing the best result)

This method starts with an evaluation table of alternatives (a_n) and criterion (c_n)with scores for each combination $C_1(A_1)$….. $C_n(A_n)$. These scores can be for instance be derived from the AHP model.

A	C_1	C_2	…	…	C_n
a_1	$C_1(a_1)$	$C_2(a_1)$	…	…	$C_n(a_1)$
a_2	$C_1(a_2)$	$C_2(a_2)$	…	…	$C_n(a_2)$
…	…	…	…	…	…
…	…	…	…	…	…
a_n	$C_1(a_n)$	$C_2(a_n)$	…	…	$C_n(a_n)$

Table 2.1.: PROMETHEE Evaluation table

The input of the evaluation table (see table 2.1) is used to calculate the score for $C_i(a_j)$, which will then make ranking possible per alternative (Brans, JP. & B. Mareschal, 2013). So far, apart from some mathematical differences in calculation, the PROMETHEE, ELECTRE, AHP and weighted sum method are quite similar.

However, the differences can be found in the final visualization, and the calculation of the final score of the decision problem. With ELECTRE and PROMETHEE the alternatives are ranked, and being outranked when one is better over another (Bogdanovic D., D. Nikolic & I. Ilic, 2012). This gives a clear overview of which alternatives can be considered, and which alternatives can be left out (PROMETHEE I method). This makes the analysis more clear than the AHP and weighted sum, were all alternatives are considered during the whole analysis (Bogdanovic D., D. Nikolic & I. Ilic, 2012). It seems useless to consider alternatives in a decision that actually are not interesting. The outranking models provide a solution to this, by checking whether an alternative should be considered or not (for instance when an alternative is incomparable, because it is completely different from the rest, the alternative is left out). There are various options on visualizing the outcomes of the PROMETHEE analysis (Brans & Mareschal, 2005), however, this will not be discussed here.

PROMETHEE uses a positive Phi ($\emptyset^{+}$) and negative Phi flow ($\emptyset^{-}$) calculation to rank the different alternatives. The net flow (the difference between the positive and negative flow) is the result of the pairwise comparison of the criteria. The higher the net flow, the better the alternative. These outranking flows are expressing how the alternative is outranking the other alternatives ($\emptyset^{+}$), and how the alternative is outranked by the other alternatives ($\emptyset^{-}$). These outranking flows are used for the ranking possibilities within PROMETHEE (PROMETHEE I partial ranking, were incomparable alternatives are not accounted for, and PROMETHEE II complete ranking, where all alternatives are considered) (Brans & Mareschal, 2005) (Fülöp, 2012).

Outranking methods can be used to combine quantitative and qualitative data for making decisions. It is possible to use different scales for the values inserted in the model (Figueira, Greco, & Ehrgott, 2005).

When looking at the different models, the strengths and weaknesses can be assessed. This assessment is done by assessing the model itself, the results, and the usability in vision development. This last category is added because this study is dealing with an evaluation on multi-criteria analysis for vision development purposes.

Table 2.2 gives an overview of the assessment. The four models that have been discussed previously in this chapter are given, including a score (--, -, +/-, + or ++) on each topic. The assessment shows that on most topics, PROMETHEE is scoring very well. A weakness of PROMETHEE, however, can be found in the weight assignation of the criteria (Bogdanovic D., D. Nikolic & I. Ilic, 2012). The way in which this is done is not fully structured. However, AHP can offer a clear hierarchical structured way in which the weights are assigned, as an enhancement (Bogdanovic D., D. Nikolic & I. Ilic, 2012). It is possible to combine this first stage of AHP with the latter analysis stages of PROMETHEE (Bogdanovic D., D. Nikolic & I. Ilic, 2012). This will be done in this study.

PROMETHEE has got some clear tools in performing the analysis, like Visual PROMETHEE. This is a computer program designed to perform a complete PROMETHEE analysis (Brans, JP. & B. Mareschal, 2013). Furthermore, PROMETHEE has got even more properties that could be useful in the case study:

- It integrates quantitative and qualitative data
- It uses mathematical calculations to base all answers on the same conditions
- It ranks and outranks the different alternatives with the possibility to view the differences between the alternatives

- It uses some powerful visualisation methods to study the alternatives and their ranking.

		MAUT models		**Outranking models**	
		Weighted sum	AHP	ELECTRE	PROMETHEE
Model	Structuring	+/-	++	-	--
	Criteria selection	+	+	--	--
	Criteria weighting	+	++	+/-	-
	Consideration of external factors	-	-	+	++
	Combining with spatial data	+/-	+/-	+	+
	Multiple scales (answering)	+/-	+/-	++	++
	Analysing	+	+	+	+
	Combining possibilities*	+/-	+	+	+
Results	Ranking	+/-	+/-	++	++
	Sensitivity options	-	-	+	++
	Data quality check	+/-	+/-	+	+
	Visualisation of results	-	+/-	+	++
Vision development	Broad view	-	-	+	+
	Able to enable discussion	+	+	+	+
	Clear conclusion on facts	+	+	+	+
	Easy to understand	+	--	-	+/-
	Easy to interpret	+	+/-	+/-	+

* when necessary

Table 2.2: Assessment of models

A weakness of PROMETHEE is however that it is a linear and rational model. This means that it is looking for an optimum in alternatives. It seems to find an optimal solution based on criteria. However, in modern times it might be more effective to look for the right alternative via discussion, not via models. On the other hand, a model can be a starting point for discussion, because it gives values to alternatives that could be discussed via opinion discussions (Keyser, de & Peeters, 1996).

The case study will be performed by using the PROMETHEE method. It will be used for ranking the alternatives: providing a ranked list of the alternatives, with a description on what this ranking is based on. The model will be enhanced with AHP by using the criteria structure and weighting method of AHP. This method will also be combined with spatial data, which is a special type of data, not frequently assessed in the AHP/PROMETHEE combination. The evaluation objective will therefor deal with the AHP/PROMETHEE combination.

3. Methodology

In the previous chapter, different models were described for decision making analysis. This study focusses on the evaluation of a method for suitability of possible locations for marinas at the coast, taking physical, demographical and economic criteria into account.

As established in the previous chapter, the PROMETHEE method in combination with AHP will be used.

This is a testing study, which combines methods for MCA (AHP with PROMETHEE) in order to increase the stability of the criteria, and thus of the outcomes. This form is chosen, because the methods have been theoretically combined before (Macharis, Springael, De Brucker, & Verbeke, 2004) (Dağdeviren, 2008). It has also been used before, but never in spatial decision making studies.

For this study two methods are combined in an enhanced method:

- basis for this method is PROMETHEE (preference ranking). The tool "Visual PROMETHEE" will be used to conduct this research.
- AHP will enhance PROMETHEE in the hierarchy building and assigning weights to the criteria, in order to reduce subjectivity on assigning weights

PROMETHEE is chosen as prime method because it gives clear and distinct outcomes when conducting a multi-criteria analysis (Kasperczyk & Knickel, 2005):

- It can combine multiple scales of research
- It integrates a possibility of a sensitivity analysis
- It can be easily combined with other methods
- It is suitable for an explorative research
- It is a widely known and accepted method in the academic world

Because this study is an evaluation of alternatives for vision development and for enabling discussion in the vision, the PROMETHEE method is sufficient. The PROMETHEE model can be used as a starting point for enabling discussion on planning issues by giving a ranking based on rational criteria. Although in modern times discussion and input of human knowledge become more important than rational models (Bertsimas & Thiele, 2006), the PROMETHEE method seems suitable for a study that is a first step in explorative research (Bodily, 1985). The fact that PROMETHEE can include different value scales for criteria makes the use of the method easier. Because all criteria have different characteristics, different scales will be used.

In order to ensure the results of the study are stable, a sensitivity analysis should be performed (Triantaphyllou & Sánchez, 1997). With this sensitivity analysis, the outcomes are tested on how stable they are when criteria (and weights) change. The option of the sensitivity method within PROMETHEE (stability intervals) is another plus for choosing PROMETHEE as a method for this research. Finally, because PROMETHEE is accepted and known within the academic world, it is presumed that answers that are based on the outcomes of this study are based on scientific accepted research.

This chapter will deal with the following steps for the case study methodology:

- Explanation PROMETHEE method
- Criteria selection
- Weighting of the criteria
- Using spatial data
- Model building
- Model analysis

The final part of this chapter will give a short explanation on how the method of PROMETHEE will be evaluated.

The methods of this thesis is depicted in figure 3.1 This figure shows the conceptual model of this study and integrates both the case study and the model evaluation.

There are five bounding boxes in figure 3.1, which give the stages of the model. The first part of the figure however, does not have a bounding box, for this is the preparing phase. In the first phase, the study is formed and the stakeholders are defined. These stakeholders play a large role in the phases of criteria selection and criteria weighting. The iterative lines show the interaction with stakeholders: after the criteria are selected in interviews with stakeholders, they were evaluated by the stakeholders. Furthermore, after assigning the weights, the stakeholders are consulted again for verification purposes.

After this, the model is built and the data which is needed is selected. In this internal stage (no interaction with stakeholders) the basis is formed for the analysis in the next stage. In this next stage (analysis), the results are presented and interpreted. These results are then sent to the stakeholders to verify.

In the final stage of the modelling, the evaluation of both the case study and the evaluation of the model itself are discussed. The figure concludes with final report writing.

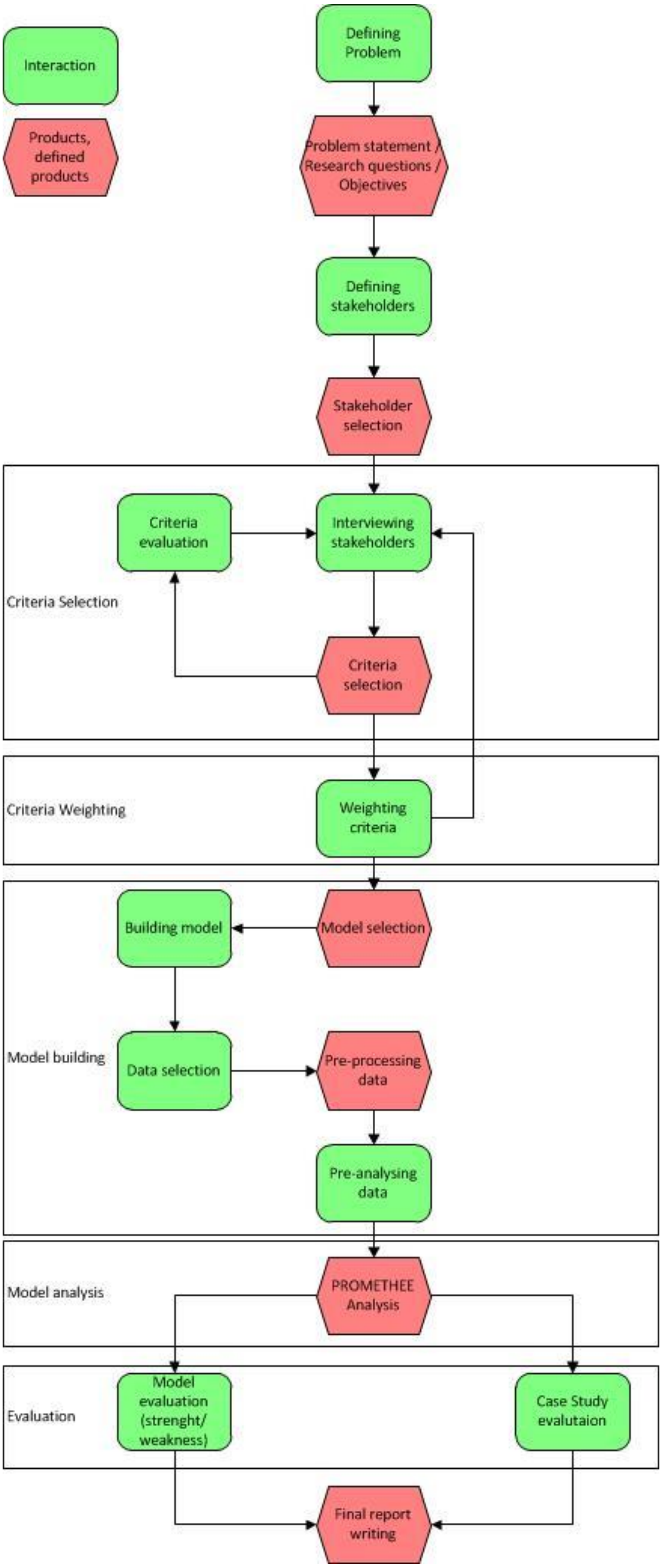


Figure 3.1: Flowchart of methodology

3.1 PROMETHEE method

The following section is based on the article of Brans & Mareschal from 2005 (Brans & Mareschal, Chapter 5: PROMETHEE Methods, 2005) and Brans & Mareschal, 2013 (Brans & Mareschal, How to Decide with PROMETHEE, 2013).

PROMETHEE is a model that has been used since the 1980's when it was designed by Brans (1982). It has had several extensions and developments since that time. Nowadays, it is seen as a stable multi-criteria model which is often used in decision making.

The PROMETHEE method was already briefly discussed in the theoretical framework. In this section, it will be discussed more thoroughly.

As stated before, the PROMETHEE method uses an evaluation table as the basis (table 2.1.1). This table gives an overview of the criteria (columns) and the alternatives (rows). The values in the table represent the values of the criteria per alternative.

However, only the evaluation table is not enough to complete the analysis. Each criterion has got a preference function. This preference function is used to compute the degree of preference associated to the best action in case of pairwise comparison (Brans, JP. & B. Mareschal, 2013). This means that it will take the overall preference of a criterion into account, and will make a rectification on the criterion[2]. Part of the preference function are the indifference threshold (q) and the preference threshold (p). The indifference threshold is the largest deviation that is considered negligible when comparing two actions (the combination of alternative and criteria). The preference threshold represents the smallest definition that is considered as important (Mareschal, 2011-2013).

PROMETHEE is based on 7 requisites, that make sure that the model is solid and gives the best results. These requisites help building the model (Brans & Mareschal, 2005). These requisites form the basis of the model, and the model should be built according to these requisites. Criteria with weights on its own are not sufficient to conduct a PROMETHEE evaluation. More information is necessary. This information will be also provided for this study.

- Requisite 1: The difference between the different alternatives per criterion should be taken into account. This means: $\Delta j(ab) = Cj(a) - Cj(b)$, where C stands for Criterion, a stands for alternative a, and b stands for alternative b.
- Requisite 2: Scaling effects between criterion should be diminished. The outcome of the analysis must not be affected by multiple scales of criteria.
- Requisite 3: When using pairwise comparison, there should be three possibilities:
    - Criterion a is preferred to b
    - Criterion a and b are indifferent
    - Criterion a and b are incomparable.

  By using the AHP method for pairwise comparison, the problem of having incomparable criteria is solved. In AHP, it is not possible to have incomparable criteria. This is an enhancement on PROMETHEE.

[2] There are different types of preference functions. For an overview, see (Brans & Mareschal, 2005).

- Requisite 4: Black box procedures should be avoided: because human interpretation is a problem in MCA, clear procedures in adding additional information should be provided
- Requisite 5: Procedures should not include technical parameters not having significance to the researcher.
- Requisite 6: Information should be provided on the conflicting nature of criterion. It may be possible that some criteria conflict each other. The model should know what to do with this.
- Requisite 7: The method should be subject to a sensitivity analysis, for checking the human interpretation in the model.

PROMETHEE has got multiple analysis tools, developed through the years. PROMETHEE I and II give rankings on the alternatives. PROMETHEE I gives a partial ranking, only displaying results that matter. This means that when alternatives are incomparable, they will not be ranked. To solve this problem, the PROMETHEE II was designed. This is a complete ranking method, which ranks all alternatives, including the criteria ranked within the alternatives (Brans & Mareschal, 2005).

In 1988 the interactive visual module GAIA was proposed by Brans and Mareschal. This module can make graphic presentations of the outcomes. This option is included in the Visual PROMETHEE software.

In the next section of this study, the PROMETHEE model will be filled with data. Beginning with the selection of the criteria.

3.2 Criteria Selection

In order to perform a multi-criteria analysis, it is necessary to have criteria. These criteria form the basis of the model, and score the individual alternatives and rank them.

The criteria used in the case study are derived from interviews and discussions with experts in the field of sailing, marina planning and marina exploitation (see Appendix 1).

The researcher proposed several criteria to the experts, in order to start a dialogue on which criteria are important when talking about marina planning. Several criteria were added and deleted after having multiple conversations.

The final list of criteria was presented to the experts mentioned above, for a final approval.

The criteria used in this study are mentioned in table 3.2.1.

Criterion	Description
Number of inhabitants	Number of inhabitants in the age category 35-75 within a distance of 30 kilometre (potential sailors)
Attractions (hinterland)	Possibility to make day trips, visit attractions (including nature) within 5 kilometres
Accessibility land (PT)	Availability of good public transport connections to the marina
Accessibility land (roads)	Availability of good road networks near the marina
Accessibility water	Connections via water to other destinations (hinterland and sea)
Safety water (proximity of busy professional navigational routes)	Proximity of busy professional navigational routes, like at Rotterdam and IJmuiden, should be avoided.
Basic facilities marina	Basic facilities of a marina are: port warden, toilet- and shower facility , drinking water, power, slip way
Shelter	Shelter provides calm water in the marina (resistant to wind and waves). This can be natural shelter, a bay, lots of greenery around the marina, but it may also be high buildings around the marina. Used: Kustlijnkaarten 2012, Ministry of Infrastructure & Planning, the Netherlands.
Extensive facilities marina	Presence of additional facilities around the marina (nautical: boat repair, shipyard, water sports shops
Accommodation	Possibility to stay overnight near the marina (within 1 kilometre)
Facilities (Horeca, category 1)	Horeca 1: cheap, quick horeca like cantinas and cafeterias (within 500 meters)
Facilities (Horeca, category 2)	Horeca like restaurants, cafes and dinners (multiple options within 500 meters)
Facilities (shops for food and beverages)	Supermarkets and other stores for food and beverages nearby (within 500 meter)
Facilities (other shops)	Other stores that are for instance in a centre of a city or village (no water sports shops or stores for food and drink) (within 1 kilometre)

Table 3.2.1: Criteria used in analysis

3.3 Weighting the criteria

The negative aspect of PROMETHEE, not having a clear guideline for assigning the weights of criteria, can be easily solved by using the AHP criteria weighting (Bogdanovic, Nikolic, & Ilic, 2012). AHP compares criteria in sets of two, where the researcher (or users) can give a score of 1 to 9 to each set of criteria. The users ask themselves for each set of criteria the following question: which of the two criteria is more important, and to what extent?

The scores that are possible to use in this study are given in table 3.3.1 (Saaty, 1990), (Teknomo, 2007).

Scale	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment strongly favour one activity over another
5	Essential or strong importance	Experience and judgement strongly favour one activity over another
7	Very strong importance	An activity is strongly favoured and its dominance demonstrated in practise
9	Extreme importance	The evidence favouring one activity over another is of tile highest possible order of affirmation
2, 4, 6, 8	Intermediate values between two adjacent judgements	When compromise is needed
Reciprocals	If activity i has one of the above numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	

Table 3.3.1: Values of possible score in AHP pairwise comparison

When A is more important than B, cell AB in the decision matrix will get a value larger than 1. When B is more important than A, cell AB in the decision matrix will get a value smaller than 1 (reciprocal).

At the end, when all combinations of sets have been subject to comparison, the weights will be calculated by multiplying the matrix of weights to one final weight, based on the eigenvector of the criteria matrix.

Example: A following matrix can be derived (example based on (Teknomo, 2007)).

Example	A	B	C
A	1,0000	3,0000	0,2000
B	0,3333	1,0000	0,1250
C	5,0000	8,0000	1,0000

This matrix needs to be squared in order to be able to calculate the eigenvector of the matrix, and thus to calculate the weights of the criteria

The following matrix is derived (squared matrix)

Example	A	B	C
A	3,0000	7,6000	0,7750
B	1,2917	3,0000	0,3167
C	12,6667	31,0000	3,0000

Next, the first eigenvector can be calculated by summing the rows, and normalize these sums.

Example	A	B	C		Sum	Eigenvector 1
A	3,0000	7,6000	0,7750	=	11,3750	0,1816
B	1,2917	3,0000	0,3167	=	4,6083	0,0736
C	12,6667	31,0000	3,0000	=	46,6667	0,7449
				Total	62,6500	1,0000

In order to check if these eigenvectors are representing the best weight, an iteration of the whole process is needed. This iteration takes the squared matrix as a basis, and calculates a new eigenvector. Then, the difference (Δ) between eigenvector 1 and eigenvector 2 is calculated. The iteration of the calculations stops when the $\Delta = 0$

For the example, 3 iterations are needed to see that $\Delta = 0$. The eigenvector for Criteria A, B and C is:

$$\begin{pmatrix} 0.1830 \\ 0.0752 \\ 0.7418 \end{pmatrix}$$

Criteria C is in this example the most important criterion, and will have the largest impact on the final result of the analysis.

The AHP has also got a method for further analysis, however, because PROMETHEE has been chosen as basic method for this analysis, the analysis with AHP will stop after weighting the criteria.

The AHP considers a criteria multiple times, and is thus more objective than the method in PROMETHEE, where criteria a considered only once. Both methods are however subject to human interpretation (Saaty, 1990).

3.4 Using spatial data

Because this study deals with spatial allocating new marina's, the spatial component is very eminent.

Spatial data is used in various parts of the analysis

1. in the gap-analysis, and gap selection
2. in the criteria pre-processing stage
3. in visualizing the results of the analysis

Combining GIS and MCA analysis creates a powerful tool to make the results more clear (Ligmann-Zielinska & Jankowski, 2012). The rankings of the MCA, as well as pre-processed information for the analysis will be visualised in maps created in GIS. The maps will help explaining the results of the locational search for new marinas.

Most of the criteria need pre-processing in a GIS environment before it can be inserted in the PROMETHEE model.

Various analysis techniques are used to get the right input for the model. The following criteria involve GIS pre-processing (See appendix 3 for an extensive description and the basic analysis layers):

- Criterion 1: Number of inhabitants. For this criteria, a buffer of 30 km around the possible new marinas is created. Then, some inhabitant data is projected. Via selection and table statistics, the number of people living in de buffer zone can be found.
- Criterion 2: number of attractions: A complete dataset of companies in the Netherlands is used to select the attractions within a buffer of 5 kilometres from the possible new marinas.
- Criterion 4: the road network is used to measure the distance of the possible new marina to the nearby national road (N-road).
- Criteria 7 (Basic facilities), 9 (extensive facilities): A buffer of 500 meter is created to see the companies within 500 meter that deal with marina facilities (bike rental, launderettes, water sport shops, etc.)[3]
- Criteria 10 (Accommodation possibilities) and 14 (other shops): a buffer of 1 kilometre is created and the companies dealing with accommodation are selected. For the other shops, the shops are selected as well.
- Criteria 11 (Horeca 1), 12 (Horeca 2) and 13 (shops in food and beverage): a buffer of 500 meters is created around the possible new marina. The companies dealing in these categories are selected from the database.

Combining GIS information with a multi-criteria analysis is often used in spatial research.

Pre-processing the criteria in GIS also means that the visualization of the final results of the analysis can be done in GIS. The final rankings will be visualized in a GIS.

3.5 Model building

The model for assigning the weights is based on AHP. This is done by filling in matrices with the criteria in the rows and columns. Next, these matrices are squared, and the eigenvector is calculated, as was done in the example in this chapter.

In Visual PROMETHEE, the model for the multi-criteria analysis is built. Visual PROMETHEE allows the criteria to be inserted, including their weights, their direction (min/max) and their preference function.

The alternatives, the possible locations per gap that need to be ranked, will be inserted as well.

Finally, the values that represent the criteria can be inserted per alternative. These values are derived from GIS analysis, Coastline Maps, public transportation information, and visual interpretations of the specific locations.

[3] Basic facilities in the marina, like showers toilets, slip way are seen as part of the new to be developed marina, and are thus not included in the criteria.

3.6 Model Analysis

After the weights are assigned via the AHP method, the criteria, their values and the weights are entered into the PROMETHEE tool.

PROMETHEE offers the possibility of having different scenarios for the alternatives. The 5 different surveys will be entered as scenario, to be able to compare the results of the different groups (users, owners and politicians).

Furthermore, the weights per stakeholder group are added up, and divided by the number of surveys. This gives a mean weight per stakeholder group. All the results will be discussed in the results section of this study. The results will show the ranking of the different locations, the strengths and weaknesses of these locations (according to the criteria) and evaluation of stability intervals: an evaluation on how the ranking changes when the weight of an individual criterion is changed.

Now that the model, methodology and the steps in the analysis are described, the next chapter (4) will deal with the case study and the presentation of the results.

3.7 PROMETHEE evaluation

The research consists of a case study and an evaluation of the method when it is used for vision development. The strengths and weaknesses of the PROMETHEE method, enhanced with the AHP method for weighting criteria will be discussed in a separate chapter from the case study. The evaluation will be presented as a strength and weakness analysis, in order to enable the discussion that will follow this chapter.

4. Case Study

The case study in this research deals with potential new marinas at the Dutch coast. The Deltaprogramma Coast is creating a vision for the Dutch coast up to 2100. Main priority in this vision is water safety. However, some side steps will be taken to also address the economic and visual situation at the coast.

This study includes a ranking and strength and weakness analysis of new possible locations for marinas. The selected method for this study is a combination of different models as described in the methodology section.

4.1 Current Marrinas

Water sports are very popular among people in different age categories. Most of the sailors in the Netherlands stay at the lakes of Friesland, the IJssellake or the Wadden Sea. However, a substantial group of sailors is using the North Sea on their sailing route (Stichting Recreatietoervaart Nederland, 2011). In order to be able to sail the North Sea, marinas are needed.

At the moment, the Dutch North Sea coast has got 7 marinas, where 3 of them are behind sluices. Figure 1.1 gave an overview of these existing marinas. Table 4.1 gives a short description of the different marinas according to the harbour typology of Havens à la Carte (Kenniscentrum Kusttoerisme, 2010), created for distinguishing different harbour types.

		Type	Expected users
Current	Breskens	Full-service marina	Coastal- and day trip sailors
	Vlissingen	Marina for city guests	Day trip sailors
	Roompot	Marina resort	Coastal- and day trip sailors
	Stellendam		Coastal- and day trip sailors
	Scheveningen	Marina for city guests, regattacenter	Adventurers, Coastal- and day trip sailors
	IJmuiden	Full-service marina	Adventurers, Coastal- and day trip sailors
	Den Helder (via sluice)	Marina for city guests and inhabitants, marina resort	Adventurers, Coastal sailors

Table 4.1: typology of marinas at the Dutch Coast.
Source: Gulmans, 2012

In Table 4.1 a few types of marinas are listed. Below, these types will be explained, as they are important for understanding the type of marina.

- Full-Service Marina: Big and complete marina in which everything is equipped for the water sport and boats. It is a combination of moorings, possibilities for maintenance, water sport shops, boat rentals and school for water sports.
- City guest marina: Marina as a touristic destination and reception of guest of the city. The marina has a large economical spin-off. It enhances tourism, tour sailing, and summer usage. Most short stays. This type is often a historical harbour with a connection with horeca and recreational facilities.
- City inhabitants marina: simple marina, used by inhabitants of cities. Low profile, and often exploited by associations. Mostly for smaller boats.
- Marina Resort: complete marina with everything for boat and human: moorings, accommodation, recreational facilities are integrated in one concept. Intensive concentration of recreational facilities, accommodation and boat services.
- Regatta enter: a marina that focusses on competition. Facilities and accommodation is well taken care of, and available within walking distance.

These different types characterize the users, but also the available facilities in a marina and thus characterize the profile of the existing marinas. This answers the first research question in this study:

- Where are the current marinas and what is their profile (target groups, facilities and size)

The question in this case study is, whether it is enough to have 7 marinas, or that more are necessary to enable coastal hopping. This phenomenon is the possibility of sailing along the coast, with regular stops. At these stops, all facilities that are needed for sea sailors are available. Furthermore, there are possibilities for activities and accommodation. To make Coastal Hopping a success, the marinas shouldn't be too far apart from each other. The rule of thumb in sailing, is that for an average sailor 5 hours of sailing is convenient (based on HISWA and Watersportverbond interviews). Much longer is not preferred. Furthermore, the average speed of sailing at the North Sea is around 5 knots per hour, which means that marinas should be approximately 25 nautical miles apart from each other (See appendix 2 for a detailed overview of travel times). Figure 4.1 gives an overview of the existing harbours including the travel time between them.

Most of the current marinas are built in areas that have a natural suitability. The marina of Breskens was built in a small bay, protected from the rough sea, Vlissingen and Scheveningen are protected by the waterworks in the cities, Stellendam and Roompot are both protected by the Delta Works, IJmuiden has got the protection of the harbour dams from IJmuiden harbour and the marinas of Den Helder are either protected by sluices or waterworks of Den Helder. When looking at the possible bays and inlets in the land for marinas, most of them are used already. This makes it hard to plan new marinas: a direct connection with the open sea is not preferred, because of protection of the marinas during storms. It is necessary that a shelter is provided to the boats and their crew. It is therefore assumed that it is not possible to plan a marina directly upon the coastline. There must be an inlet, bay or a possibility to develop buildings around the marina. Currently, only one natural inlet, near Katwijk aan Zee, is left. However, because it is part of a drainage system, this inlet is not yet suitable for a marina.

This case study will look at the economic and social demographical potential of new marinas, in order to create a system ready for coastal hopping. It will not take safety or building costs into account. The reason for this is that an extensive research on safety is already performed by Rijkswaterstaat. Furthermore, the time scope of this research is not limited to the near future. As stated before, this research is conducted in the context of Deltaprogramme Coast, for the National Vision. This vision will serve as a guideline for the next ninety years ahead of us. It is thus possible that a marina is not an option today, but might be a possibility in the future.

The problem then arises that it is not possible to predict demographics, economics and changes in technology and construction. The research is based on the current developments, so it can serve as a starting point for the National Vision.

Source: Gulmans, 2013

Figure 4.1: Existing marinas with travel times in hours

4.2 New possible marinas

At the moment, there is one marina being developed. This is Marina Cadzand-Bad, in the Southern part of Zeeland. This marina will be a small marina of around 140 moorings. This marina will be built as from 2015 onwards (RBOI Middelburg, 2012). It will not be considered in this study as an alternative, because it will be created in the near future. Furthermore, because the Cadzand-Bad marina is not influencing the need for new marinas (it is not within a gap), this marina is not considered.

When looking at the map of the North Sea coastal area, and when taking into account the rule of thumb for sailors mentioned earlier, it becomes clear that two gaps can be identified in the coastal hopping system. Between Scheveningen and IJmuiden (from now on called Gap one) and between IJmuiden and Den Helder (from now on called Gap two), some new marinas are needed to complete the coastal hopping network. In the past, multiple studies have been conducted for new marinas on different locations.

Figure 4.2 gives an overview of the gaps based on the travel times exceeding 5 hours (see also figure 4.1). For Gap one, the possible locations are Zandvoort, Noordwijk aan Zee and Katwijk aan Zee. For Gap two, studies have been performed, or mentioned locations by the local, provincial and state governments for the city of Petten.

Table 4.2 gives an overview of these plans, the possible marina type, and their expected users, based on the individual studies on marinas (Stichting JAS, 2010) (Grontmij & Stichting Intraval, 2008) (RBOI Middelburg, 2012) (Provincie Noord-Holland, 2012) (Provincie Zuid-Holland, 2012) (Smits, 2008) (Gemeente Zandvoort, 2012). Figure 4.2 gives also an overview of the possible locations for new marinas within the gaps. These locations are derived from individual Marina reports and on the notion that no marina should lie beyond 5 hours travel time from each other..

		Type	Status	Expected Users
	Cadzand-Bad	Village guests marina	Planned marina	Day trip sailors
	Katwijk aan Zee	City guests marina	Studied. At this moment not an option. Too expensive	Costal sailors
	Noordwijk aan Zee	City guests marina, business marina	Studied by TU Delft. No further actions.	
	Zandvoort	City guests marina	Part of research on reshaping boulevard	Coastal- and day trip sailors
	Petten	Village guests marina, camping marina	Marina desired by different governments and local business	Daytrip sailors

Table 4.2: Studies on possible new marinas by municipalities and provinces
Source: Gulmans, 2012

Figure 4.2: Gaps within the coastal hopping network based on exceeding 5 hours travel time including possible locations for new marinas within the gaps

Additional to the already mentioned marina types, we can find the following types in Table 4.2 based on Havens à la Carte (Kenniscentrum Kusttoerisme, 2010):

- Village guest marina: a marina as a touristic mooring place at a village scale. Big economic spin-off for the village. Often short stays. Most marinas in this type have a strong connection with Horeca and recreational services.
- Camping marina: a marina near a campsite or bungalow park. The services around the marina are maintained by the campsite or bungalow park itself,
- Business Marina: a marina which focusses on office usage and business meetings.

The above answers the second research question of the first objective:

- Are there future plans regarding marinas of municipalities and provinces?

There are currently plans for Cadzand-Bad. This location will be developed in the near future. Also, within the province of Zeeland, there is a study on a new marina in the Grevelingen lake, one of the former sea arms, that is now closed by the Brouwersdam. However, it is not sure yet whether this new marina will have a direct connection with the North Sea. For this study, this does not have any impact, for the gap between the two neighbouring marinas (Stellendam and Roompot) is less than 5 hours of sailing.

The studies that dealt with possible new marinas at other places along the coast were mentioned in figure 4.2. Additionally, table 4.2 gave a profile (marina type from Havens à la Carte) and the expected users of these possible locations for new marinas. To have a more clear view on the characteristics of these marinas.

In this phase, these different types of marinas do not influence the analysis. However, for future planning the typology is relevant for the expected users and the facilities that should be available. Also, when discussing the different alternatives in the future, it should be noted that a business marina has got different needs as a camping marina. Because this report does not go into detail in marina planning, this topic is left for the future.

The locations mentioned in table 4.2 will be identified as alternatives for this study. An alternative is nothing more than a possible location for a new marina. There are two additional alternatives that will be considered, namely: Egmond aan Zee and Bergen aan Zee. These two villages are situated at the coast, and have also opportunities for a new marina. There are no studies performed yet for these villages. These villages are both part of Gap one.

During the analysis, Gap one and Gap two will be considered separately: in both Gaps one marina is necessary to complete the coastal hopping network. This means that two analysis will be performed: one for each gap.

The next part will deal with the results, conducted from the analysis.

4.3 Analysis

In chapter two, the phases for decision making were mentioned. These steps help to structure the process and help to keep overview. Filling this overview will be the first part of this paragraph, to clarify the problem and to structure the information.

Phase 1: Defining the problem

The problem, as was mentioned in the introduction, is two folded. There is a gap in information on future marina planning on the Dutch North Sea coast. And there is a question on whether multi-criteria methods are usable for vision development on a governmental level.

The need for information on marina planning is to be able to attach future safety works at the coast to possible marina development. This will be used for the National Vision Coast.

Phase 2: Requirement determination

In order to have this, a method should be selected. This method should be able to have a broad view, different scales and must be able to start discussion. A rational model is preferred in this case, for it is based on facts, and not yet on opinions and emotions. Furthermore, political situations are not included, because this will be dealt with in a later stadium of the planning. This is not dealt with in this thesis.

A list of criteria is created that should be included in the study. These criteria form the basis on a ranking of the alternatives.

Phase 3: Goal establishment

The goal of this study is to rank different alternatives and to evaluate the outcomes in giving different visions on the results. Furthermore, the stability of the results must be shown. This is for the marina planning part. On the other hand, the goal is to study whether MCA is still usable for vision development.

Phase 4: Alternatives identification

There are two gaps identified: a gap between Scheveningen and IJmuiden (gap one), and a gap between Den Helder and IJmuiden (gap two). These gaps have each got three alternatives:

- Gap one: Katwijk aan Zee, Noordwijk aan Zee, Zandvoort
- Gap two: Egmond aan Zee, Bergen aan Zee, Petten

Phase 5: Criteria definition

A set of 14 criteria are defined that will be evaluated in this study. These criteria can be found in section 3.2 of this thesis.

Phase 6: Selection of decision making tool

For this study, the PROMEHTEE tool was selected. It is enhanced with AHP for weighting the criteria. The evaluation of the model will be done by using a strength and weakness analysis.

Phase 7: Evaluation of alternatives against criteria

This phase will be carried out in the next section of this chapter with displaying the results. Furthermore, the discussion section will deal with the evaluation.

Phase 8: Validation of solutions against problem statement

Like phase 7, this phase will be carried out in the next section of the chapter and in the next chapter.

4.3.1 Analysis via Survey

The criteria are selected via a list provided by Deltaprogramme Coast. After this, in various meetings with stakeholders, the criteria are discussed and a final selection is made. This final selection is then again provided to the stakeholders for a final discussion. The criteria were mentioned in the part above.

After the selection, the different stakeholders were able to assign weights to the criteria. This was done via meetings and a survey (see appendix 1).

The weights of the criteria are assigned via weighted sum per stakeholder group: (a detailed overview of the surveys handed out, and the interviews, can be found in appendix 1)

- Marina exploiter/marina managers (2 surveys)
- Marina users (sailors) (2 surveys)
- Policy makers/politicians (1 survey)

The marina exploiters/managers are people working with or for marinas. They are dealing with the daily management of the marinas and their customers. They have a clear view on how marinas should be run, their audience and the frequency of visitors to the marina. They stand for the possible exploiters of new marinas. The marina user groups stand for the users of marinas. They are united in associations that deal with water sports in its variety: sailing, yachting, surfing, rowing etc. The have a good overview on who are using coastal marinas and why. The Watersportverbond, one of the marina users associations is solely representing the users. HISWA association however, is a bridge association between the users and exploiters, and is an commercial association. These stakeholders are important for they represent the future customers of the marinas. Finally, the politicians represent the people that are part of the planning and decision process of the marinas. Because planning and developing a marina comes with a lot of money spending, it is important to have the politicians involved.

Per group, the scores in the surveys are added up, and divided by the number of surveys. A note must be given here: most of the surveys are filled in by a group of people together: for instance, the survey of Watersportverbond was filled in by multiple people, and reflects the opinion of the sailing community.

These scores are then normalized according to the AHP standards, as was mentioned in the methodology section of this study.

After discussing the research with various policy makers, it became clear that they are not the right target group for this study. For water boards and Rijkswaterstaat, the Dutch governmental organization for water and infrastructural planning and maintenance, the main concern is water safety. Marina exploitation is only interesting when a concrete plan is being presented. Then, the water board and Rijkswaterstaat can look at the impact on the water safety.

Other governmental policy makers would be provincial and municipality policy makers. Because provincial policy makers also deal with tourism, planning and (to minor detail) water management, a survey was added with provincial politicians.

4.3.2 Building the model

The model is built in Visual PROMETHEE, the software tool for performing PROMETHEE analysis. In this tool, the criteria, alternatives and weights are inserted. Furthermore, the values of the criterion are inserted in the model per alternative. The inserted parameters for this analysis are visualized in appendix 5.

The model automatically assigned preference thresholds to the model. These thresholds are based on the preference function. The preference function is based on the sort of values inserted for the criteria. There are preference functions for qualitative data (linear and v-shape) and quantitative data (usual and level). The v-shape function is an extension of the linear function. This is chosen when an indifference threshold is chosen (the largest deviation that is considered negligible). It is thus chosen when values are close to each other. The software uses a tool to assign the right preference function to the criterion, based on some user-asked questions (see appendix 4).

Per alternative, the different values are then assigned for the criterion. An overview of the pre-processing and the value collection is given in Appendix 4.

Because not all phenomenon of the real world are taken into account, the final results of the model shall have an overlay of costs on the results.

An additional cost variable will be discussed. This cost variable is based on knowledge on development costs, that were derived from interviews and talks with various politicians working on water safety and development and on Atelier workshops organised by Atelier Kustkwaliteit, 2012. Because real costs are hard to calculate, a three-point scale will be used:

- Low implementation costs
- Medium implementation costs
- High implementation costs

These costs consist of road network development, facility development, water safety costs (sluices, dams, creation of new dunes) and maintenance costs. These costs do not include the actual construction costs of the marinas, as it is assumed that these costs will remain nearly the same for each location.

Criterion	Unit	Scale (if applicable)	Preference function	
			Gap 1	*Gap 2*
Inhabitants	number		linear	V-shape
Attractions	number		linear	linear
Accessibility (PT)	4pt scale	every hour, every 30 minutes, every 15 minutes, often/multiple modes	usual	usual
Accessibility (Roads)	number		linear	V-shape
Accessibility (Water)	yes/no	yes/no	usual	usual
Water safety	3pt scale	not safe, moderate, safe	usual	usual
Basic facilities	5pt scale	Very low-very high	usual	usual
Shelter	3pt scale	Easy, moderate, difficult	usual	usual
Extended facilities	5pt scale	Very low-very high	usual	usual
Accommodation	number		linear	V-shape
Horeca 1	number		linear	V-shape
Horeca 2	number		V-shape	V-shape
Food shops	number		linear	V-shape
Other shops	number		linear	V-shape

Table 4.1.2: Parameters for the model

4.4 Results

After pre-processing the results of the surveys into a matrix, the eigenvectors of each criterion were calculated per survey. The resulting weights are presented in table 4.2.1.

This table displays the eigenvectors of each criterion per survey (weight), the difference of the weight from the mean weight (Δ mean) of the stakeholder group and the mean for all surveys in one stakeholder group (last column of the user group). Furthermore, the average weight for all surveys is given in the last column.

Between and within the stakeholder groups, some variations are noticeable. Some even have a variation of 9% (criterion Shelter for Breskens and Ijmuiden). This can for instance be explained by the natural location of the different marinas. Breskens is situated in a small bay, and does not have to worry much about shelter. It is important, but for them accessibility is more important. The nature of the marina is shown here.

Also the variations between the stakeholder groups become clear from these weights: the policy makers are more concerned with safety and facilities (accommodation, Horeca) than with the accessibility and facilities and services around the marina.

Finally, there are some huge differences noticeable within the users category. This has to do with the fact that HISWA is a commercial association between users and exploiters, and Watersportverbond is an association solely for users. These figures thus give a nice overview of the differences in thinking between the two.

	Marina surveys					User surveys					Policymaker survey	All surveys
Criterion	Marina IJmuiden		Marina Breskens		All marinas	Watersport-verbond		HISWA		All users	Province NH	Mean weight all surveys
	weight	Δ mean	weight	Δ mean	mean	weight	Δ mean	weight	Δ mean	mean	weight	weight
Inhabitants	0,095	0,043	0,010	-0,043	0,053	0,183	0,085	0,012	-0,085	0,097	0,033	0,066
Attractions	0,085	0,037	0,011	-0,037	0,048	0,159	0,070	0,020	-0,070	0,090	0,028	0,061
Accessibility (PT)	0,122	0,050	0,022	-0,050	0,072	0,148	0,059	0,030	-0,059	0,089	0,039	0,072
Accessibility (Roads)	0,083	0,011	0,062	-0,011	0,073	0,055	0,002	0,051	-0,002	0,053	0,034	0,057
Accessibility (Water)	0,109	0,002	0,106	-0,002	0,108	0,030	-0,001	0,031	0,001	0,030	0,080	0,071
Water safety	0,065	-0,072	0,208	0,072	0,136	0,076	-0,017	0,109	0,017	0,093	0,129	0,117
Basic facilities	0,056	-0,025	0,106	0,025	0,081	0,056	-0,048	0,152	0,048	0,104	0,138	0,102
Shelter	0,129	0,035	0,058	-0,035	0,093	0,023	-0,083	0,189	0,083	0,106	0,075	0,095
Extended facilities	0,039	-0,027	0,093	0,027	0,066	0,039	-0,048	0,134	0,048	0,086	0,064	0,074
Accommodation	0,035	0,011	0,013	-0,011	0,024	0,057	0,016	0,025	-0,016	0,041	0,056	0,037
Horeca 1	0,065	-0,029	0,123	0,029	0,094	0,061	-0,022	0,106	0,022	0,083	0,092	0,089
Horeca 2	0,050	-0,009	0,069	0,009	0,060	0,019	-0,008	0,035	0,008	0,027	0,051	0,045
Food shops	0,053	-0,023	0,099	0,023	0,076	0,040	-0,026	0,092	0,026	0,066	0,128	0,082
Other shops	0,014	-0,003	0,020	0,003	0,017	0,056	0,021	0,014	-0,021	0,035	0,054	0,032

Table 4.2.1: weights per survey per criterion

Furthermore, the values per criterion for each alternative are filled. Below, a description of how the values were derived is given.

- Criterion 1, number of inhabitants: a buffer of 30 km around the potential marina combined with a data layer of number of inhabitants in the age of 35-75 per postal code resulted in a field statistics analysis
- Criterion 2, attractions: a buffer of 5 km around the potential marinas combined with a selection of attraction companies within this buffer
- Criterion 3, accessibility Public Transport: a research on number of connections in a Saturday from (and to) the marina to (and from) the nearest city with railway connection
- Criterion 4, accessibility Roads: a measurement of the potential marina to the nearest national road (N-road)
- Criterion 5, accessibility Water: a possible connection to a water in the hinterland
- Criterion 6, Water safety: it deals with the absence or presence of professional harbours nearby. A sailor should preferably not have to cross sailing routes for large container ships (as is the case for IJmuiden or Rotterdam).
- Criterion 7, Basic facilities: a buffer of 500 meter around the potential marinas combined with a selection of companies in rental and water sports
- Criterion 8, Shelter: a study on coastlines with a landward and seaward trend. This makes it easier or harder to create shelter when build upon the coast
- Criterion 9, Extended facilities: a buffer of 500 meter around the potential marinas combined with a selection of companies in boat services (selling, repairing, storing)
- Criterion 10, Accommodation possibilities: a buffer of 1 km around the potential marinas combined with a selection of companies in accommodation
- Criterion 11, Horeca 1 (Fast Horeca): a buffer of 500 meter around the potential marinas combined with a selection of companies in cantinas, snack bars and other fast food concepts
- Criterion 12, Horeca 2 (Slow Horeca): a buffer of 500 meter around the potential marinas combined with a selection of companies in restaurants, cafes and other slow food concepts
- Criterion 13, Shops in food and beverage: a buffer of 500 meter around the potential marinas combined with a selection of companies in food and beverage, including supermarkets
- Criterion 14, Other shop: a buffer of 1 km around the potential marinas combined with a selection of companies in retail which can be find in shopping areas

A full overview of the values that were filled, including a motivation where necessary is given in Appendix 1.

In the next section of this chapter, the results will be displayed in various graphics. This can be as overall image or per marina. The results will be presented per gap (paragraph 4.2.1 and 4.2.2). First, the overall visualisations will be presented, and after that the individual results. Furthermore, the analysis was done in several ways: with weights per survey, per stakeholder group and a mean weight for all groups.

In this last paragraph of this chapter, the results will be presented in a matrix, where different scenario's will be showed as discussed in the introduction on the case study. This will be from a cost perspective and a change in the social-demographics perspective.

4.4.1 Results Gap 1: Scheveningen-IJmuiden

In the following section, the analysis results of gap 1 will be presented with a short explanation. The results will involve the following image:

- an action profile, displaying the nature of the values entered for each criterion per alternative
- the ranking, based on the surveys, and mean weight
- a rainbow overview, which gives the pros and cons of the different locations
- an overview of the stability in the weight, which can be considered as a sensitivity analysis.

Furthermore, the preference flows for each gap will be presented in table 4.2.1.1, as well as the PHI scores per stakeholder group (table 4.2.1.2), which displays the preference of an alternative in a positive or negative direction per criteria. These preference flows are a correction on each criteria that shows a natural preference for each criterion. The preference flows are based on the values inserted in the model.

		Populatio n	Attractio ns	Accessibility land (PT)	Accessibili ty land (roads)	Accessibili ty Water	Safety water	Basic facilities
Gap 1	Katwijk aan Zee	0,819	0,875	0	0	1	1	1
	Noordwijk aan Zee	-0,5	-0,375	-1	-1	-0,5	-0,5	-0,5
	Zandvoort	-0,319	-0,5	1	1	-0,5	-0,5	-0,5

		Shelter	Extended facilities	Accommodati on	Horeca 1	Horeca 2	Shops food	Other shops
Gap 1	Katwijk aan Zee	1	0	-0,8013	-0,4394	-0,8935	0,7906	-1
	Noordwijk aan Zee	-1	0	0,0502	0,8787	0,5781	- 0,3953	1
	Zandvoort	0	0	0,7511	-0,4394	0,3153	- 0,3953	0

Table 4.2.1.1: Preference flows per criterion for each alternative

From table 4.2.1.1 it becomes clear that the criterion “extended facilities” does not contribute to the final ranking. This has to do with the fact that the inserted values in the model are for each alternative the same. There is no preference of one alternative over the other when considering extended facilities.

The preference flow, together with the Phi scores (the net ∅ flow scores) per alternative determine the final position in the ranking of each alternative. The preference flow is multiplied with the PHI score to get the resulting score for each criterion per alternative. Then, these scores are multiplied for the final alternative score.

Below, the results of the PROMETHEE analysis are depicted in graphs, including a description and explanation of the results.

The PHI scores in table 4.2.1.2 show for every case that Katwijk aan Zee has got the most positive scores in every survey. This means that Katwijk aan Zee is the most obvious alternative to have the best results in the ranking. Zandvoort has got scores around 0, in both plus and minus regions. Noordwijk aan Zee has got the lowest PHI scores, all lying in the minus range.

The PHI scores are only telling something on the natural preference. However, the outcome from the PHI score can still be overruled by the weights and their final scores. In order to analyse this, a series of overviews are given in the next section of this chapter.

Figure 4.2.1.1 to figure 4.2.1.3 display the action profiles of each alternative. These action profiles show the values that were inserted for each criterion per alternative and their positive or negative effect on the final score. Figure 4.2.1.4 displays the ranking of each alternative per stakeholder group (users, marinas and policy makers. Figure 4.2.1.5 to 4.2.1.7 display a rainbow overview of the criteria per alternative, including pros and cons per alternative. The overviews are given per stakeholder group (users, marina, policymakers). Finally, figure 4.2.1.8 will present the stability values of each influential, symbolizing the sensitivity of the model.

Not all results are depicted in this chapter. Only a summarization of the most important results are presented in this chapter. Appendix 5 gives a complete overview of the results.

Survey		Phi-scores			Survey	Phi-scores			Survey	Phi-scores		
		Phi	Phi+	Phi-		Phi	Phi+	Phi-		Phi	Phi+	Phi-
Breskens	Katwijk aan Zee	0,4273	0,6155	0,1883	Watersport-verbond	0,3578	0,6052	0,2474	Province NH	0,3899	0,6108	0,2209
	Zandvoort	-0,1968	0,1602	0,357		-0,0093	0,2929	0,3022		-0,1574	0,2001	0,3575
	Noordwijk aan Zee	-0,2304	0,1724	0,4028		-0,3485	0,1383	0,4868		-0,2325	0,1807	0,4132
		Phi	Phi+	Phi-		Phi	Phi+	Phi-				
IJmuiden	Katwijk aan Zee	0,4373	0,6555	0,2182	HISWA	0,4115	0,5804	0,169				
	Zandvoort	0,0106	0,3235	0,3129		-0,0919	0,2388	0,3307				
	Noordwijk aan Zee	-0,4479	0,1106	0,5584		-0,3195	0,1496	0,4691				
		Phi	Phi+	Phi-		Phi	Phi+	Phi-				
All	Katwijk aan Zee	0,4323	0,6355	0,2032	All	0,3846	0,5928	0,2082				
	Zandvoort	-0,0931	0,2418	0,3349		-0,0506	0,2659	0,3165				
	Noordwijk aan Zee	-0,3392	0,1415	0,4806		-0,334	0,1439	0,478				

Table 4.2.1.2: PHI scores per alternative

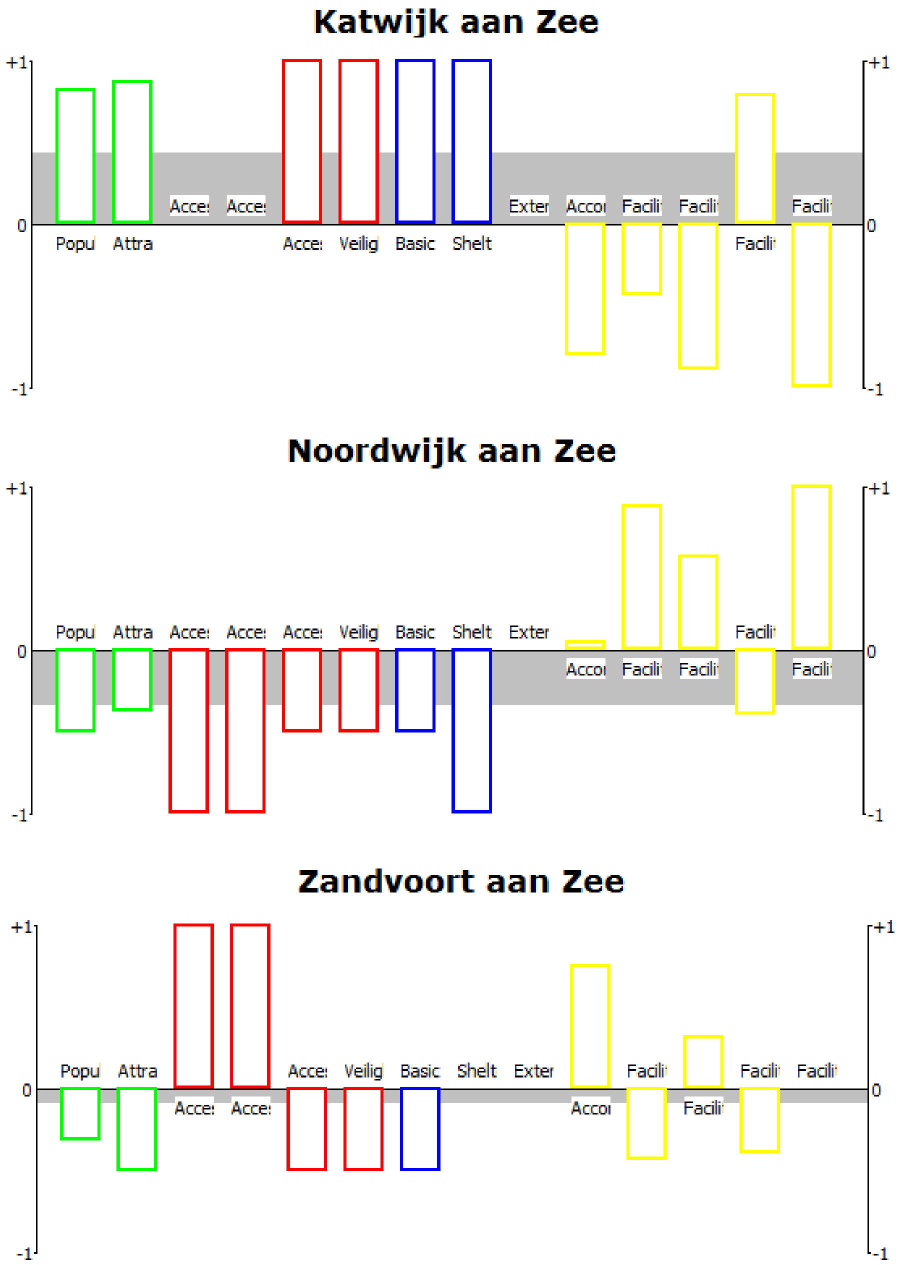


Figure 4.2.1.1: Action profile per alternative (grey area is PHI score, based on marina surveys)

In this profile, the different criteria are stated including their score of the value entered per criterion for each alternative. The criterion are expressed in the following order:

- Number of inhabitants (green): Popu
- Number of attractions (green): Attra
- Accessibility (PT) (red): Acce (first stave)
- Accessibility (Roads) (red): Acce (second stave)
- Accessibility (Water) (red): Acce (third stave)
- Water safety (red): Veilig
- Basic marina facilities (blue): Basic
- Shelter (blue): Shelt
- Extended marina facilities (blue): Exten
- Accommodation possibilities (yellow): Acco
- Horeca 1 facilities (yellow): Facill (first stave)
- Horeca 2 facilities (yellow): Facill (second stave)
- Shops food & beverage (yellow): Facill (third stave)
- Other shops (yellow): Facill (fourth stave)

The colours stand for:

Green: Hinterland
Red: Accessibility
Blue: Marina facilities and services
Yellow: Nearby facilities

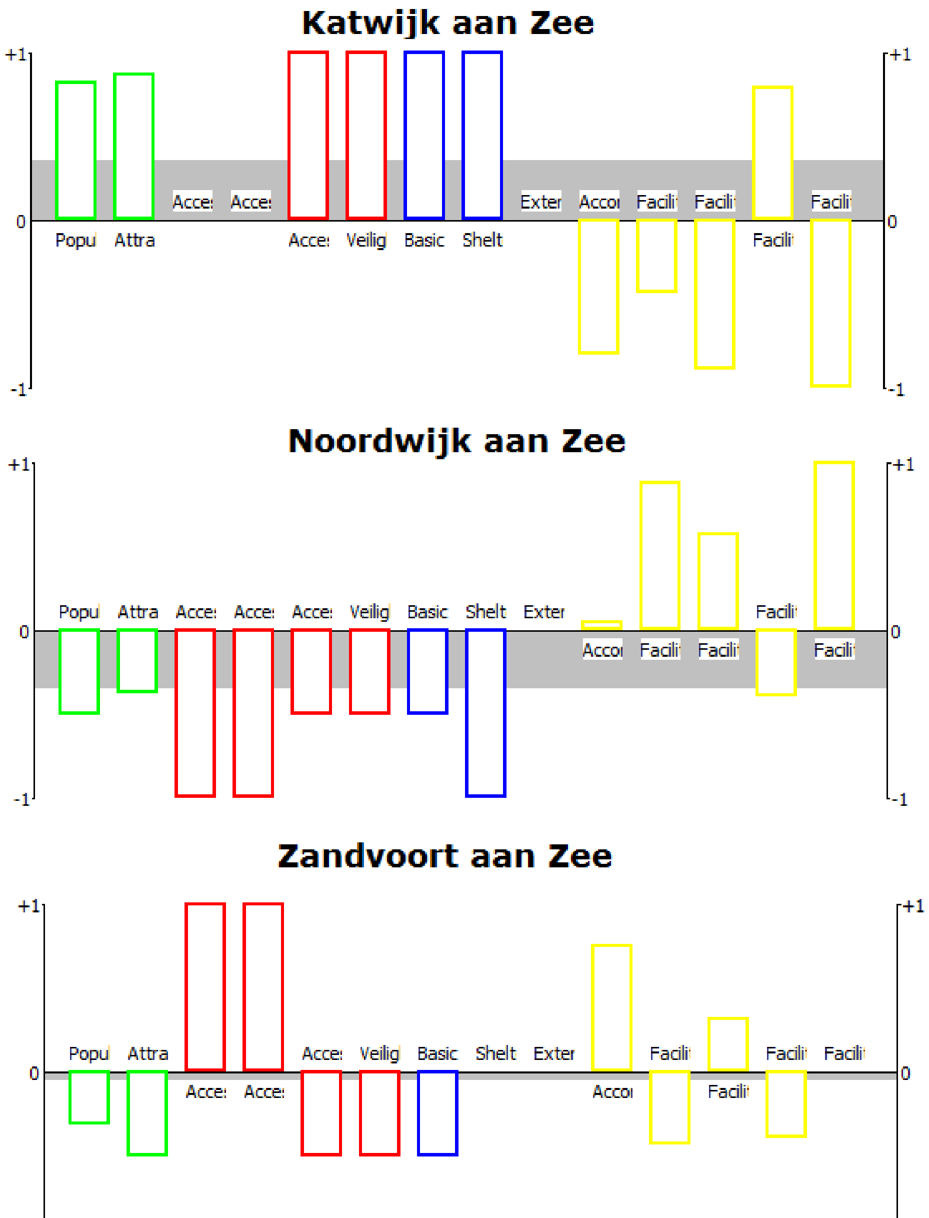


Figure 4.2.1.2: Action profile per alternative (grey area is PHI score, based on users surveys)

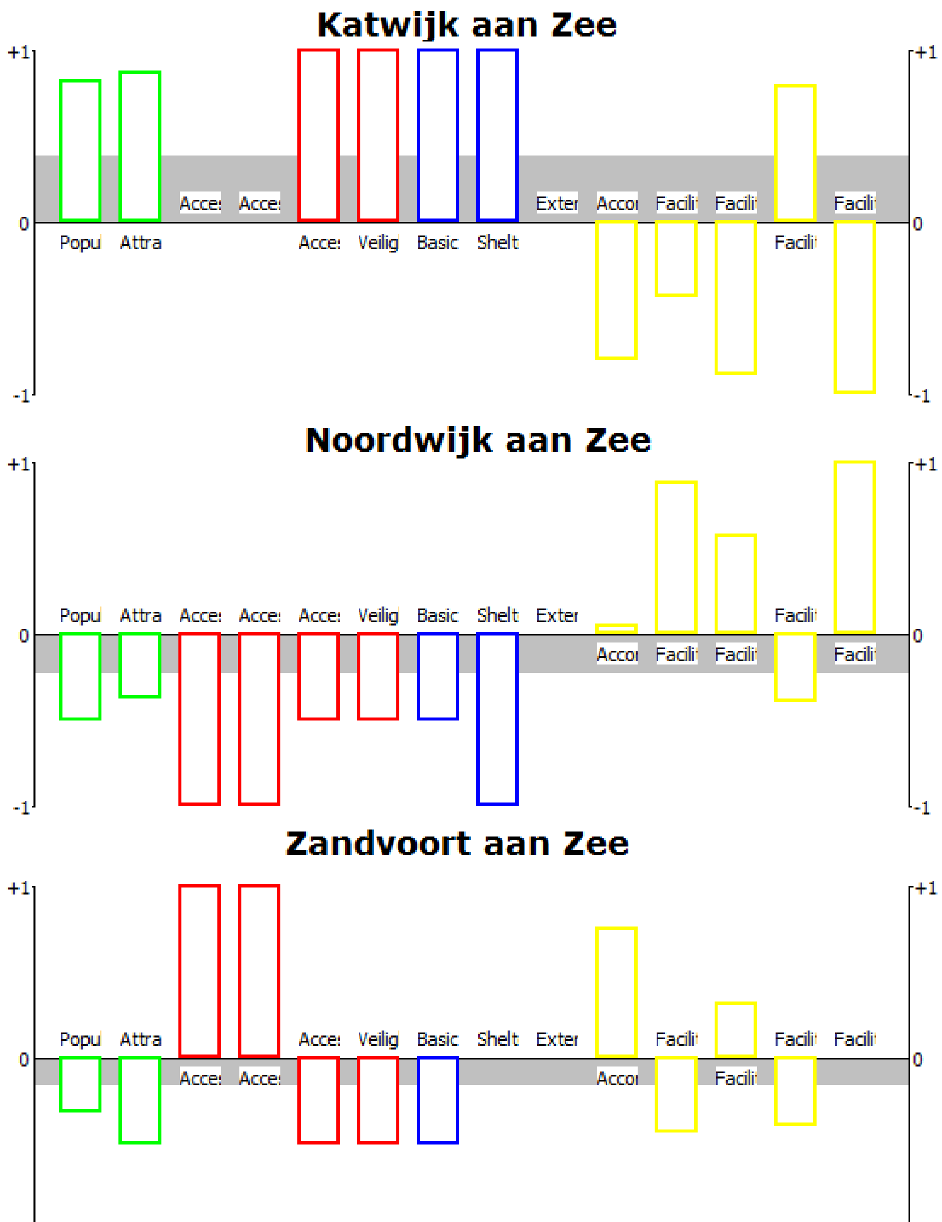


Figure 4.2.1.3: Action profile per alternative (grey area is PHI score, based on policy survey)

The action profiles show the strengths and weaknesses of the alternatives based on the inserted values. Here, the weights do not play a role yet. It shows that Katwijk aan Zee doing well on hinterland and marina facilities & services (green and yellow) and stays a bit behind on accessibility over land (red) and facilities (yellow). Noordwijk is scoring best on facilities and Zandvoort on accessibility over land and some of the facility categories. In most surveys, the marina facilities & services and the accessibility were important factors for planning new marinas. In the case of the action profiles it can't be said which alternative is better, for Katwijk aan Zee is doing well on marina facilities & services and Zandvoort on Accessibility. The final ranking depends on the weights. Only when facilities are important, Noordwijk may be able to become a favourable alternative. However, this is not the case in the surveys. The PHI scores however show that Katwijk has got a positive net score of the pairwise comparison result. Zandvoort has got a small negative number, and Noordwijk is even more negative. These scores give a natural preference for Katwijk.

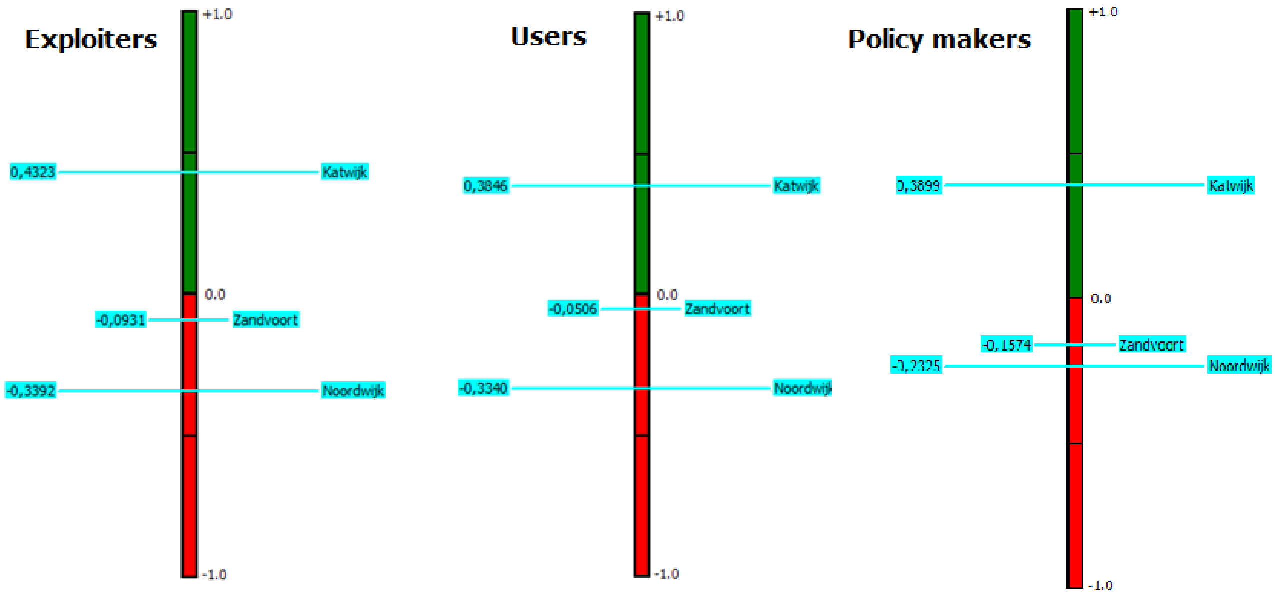


Figure 4.2.1.4: Ranking results per stakeholder group.

Figure 4.2.1.4 gives an overview of the PROMETHEE II ranking. This ranking gives an overview of all alternatives, including their preference score. This score is the final score of the analysis (weights, preference functions and values for the criteria per alternative). The ranking is for all three groups the same. However, the values differ a bit. For the policy makers, Zandvoort and Noordwijk are relatively close together, which means there is only a slight preference of Zandvoort above Noordwijk (score is -0.2325 for the policy survey). For the Exploiters and the users, there is a larger preference of Zandvoort over Noordwijk. The fact that the policy makers are less negative on Noordwijk comes from the fact that Noordwijk did well on facilities (see also the action profiles in figures 4.2.1.1 to 4.2.1.3). The policy makers are mainly interested in tourism, when talking about marinas. This is why the difference is smaller. However, it is not enough to favour Noordwijk above Zandvoort. A complete ranking of the alternatives (including the ranking per individual survey) can be found in appendix 6, Figure A6.1 to A6.3)

The next figures (figures 4.2.1.5 to 4.2.1.7) show the rainbow overviews derived from the PROMETHEE software module. These overviews show, again, the ranking per stakeholder group, and adds criteria to this. On the top, the strengths per alternative can be found based on the final ranking. On the bottom, the weaknesses can be found.

When coupling this image to the action profiles, depicted earlier in this chapter, some interesting things can be seen:

- Katwijk has got a positive score on Accessibility on land (roads and public transportation), whereas in the action profile they were neutral (Zandvoort was positive, Katwijk neutral and Noordwijk negative). However, Zandvoort is still doing better on the accessibility: the criteria are also ranked on importance.
- Based on the rainbow overviews, it is easier to choose locations when preferences are changing: they show they strengths and weaknesses of the different alternatives, and thus, when for instance accessibility is becoming more important, the ranking might shift to Zandvoort instead of Katwijk.
- In the overview per stakeholder group, it becomes also clear what the preferences are of the different groups. This explains the variation in the criteria ranking among the different figures (look for instance at the position of shelter of Katwijk within the different figures).

In order to make solid conclusions on the alternatives on the objective of the case study, it is important to know whether the ranking would change when the weights would change. From the PHI scores, a natural preference was derived for Katwijk, however, this might change when weights change. PROMETHEE offers a sensitivity analysis on the different weights by displaying their stability intervals. In these displays, the individual criteria are depicted in graphs with their weight (in percentage), and per alternative a line which represents the upward or downward trend when the criteria weight is changed. A selection of the results are depicted in figure 4.2.1.8 to 4.2.1.10.

From the stability interval analysis it became clear that most of the criteria (and their weights) do not influence the ranking. This is proven by the fact that there are no intersections of the lines of the different alternatives. In appendix 6 all stability interval overviews are given (A6.11 to A6.13) however, in this chapter only the intersecting, and thus ranking influencing, criteria are depicted.

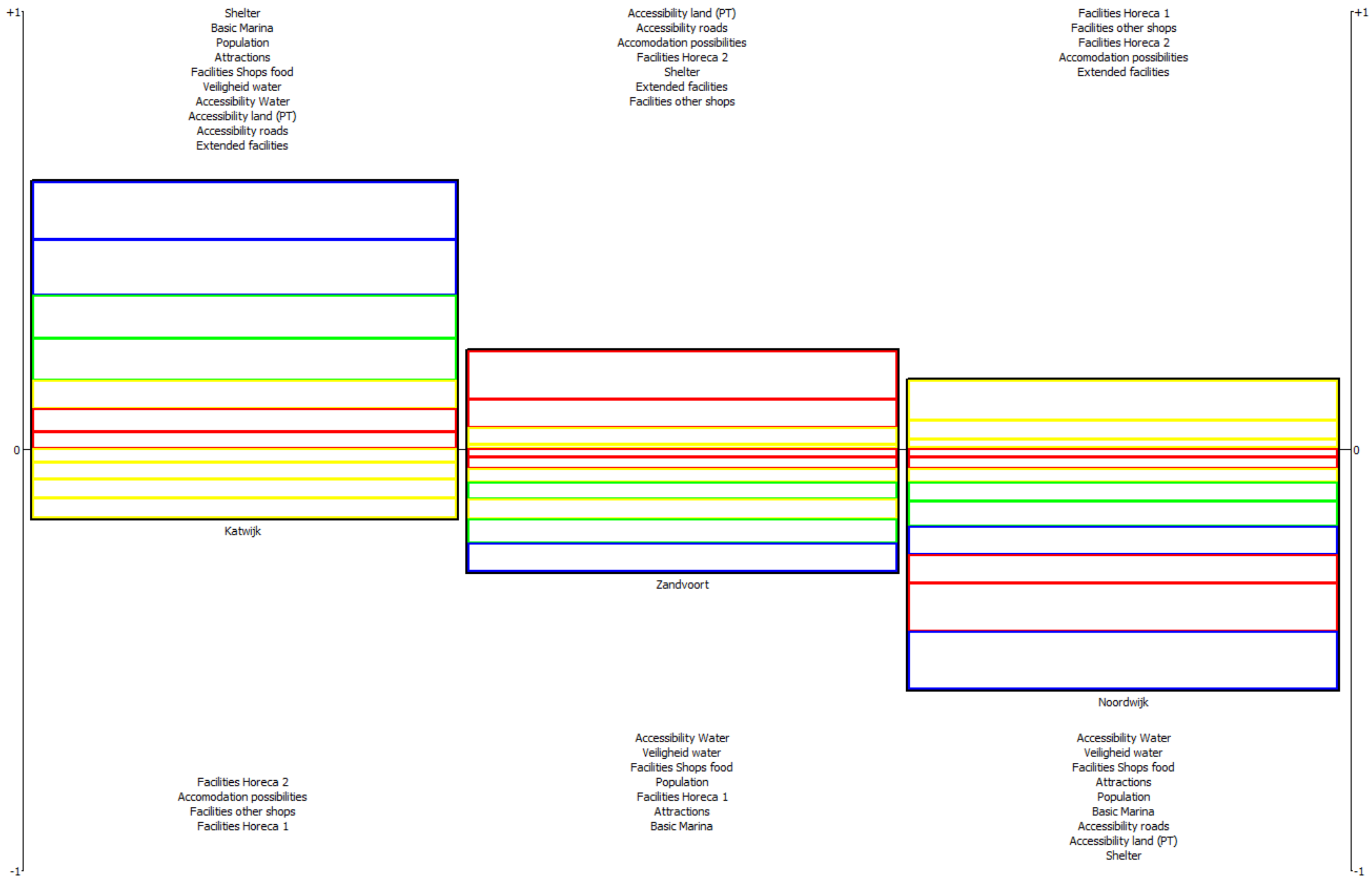


Figure 4.2.1.5: Rainbow overview users mean (from Watersportverbond and HISWA)

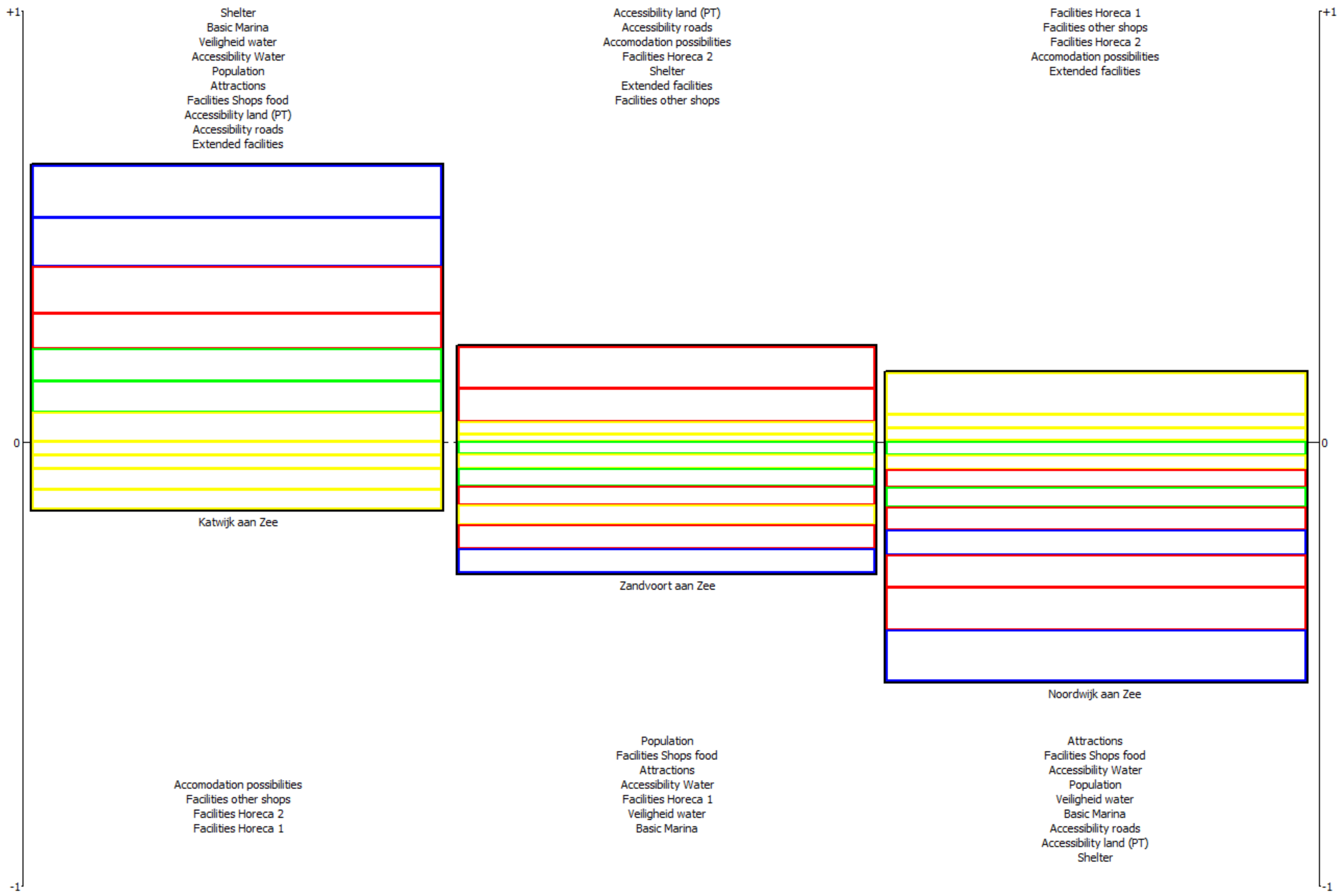


Figure 4.2.1.6: Rainbow overview marinas mean (from Marina IJmuiden and Marina Breskens)

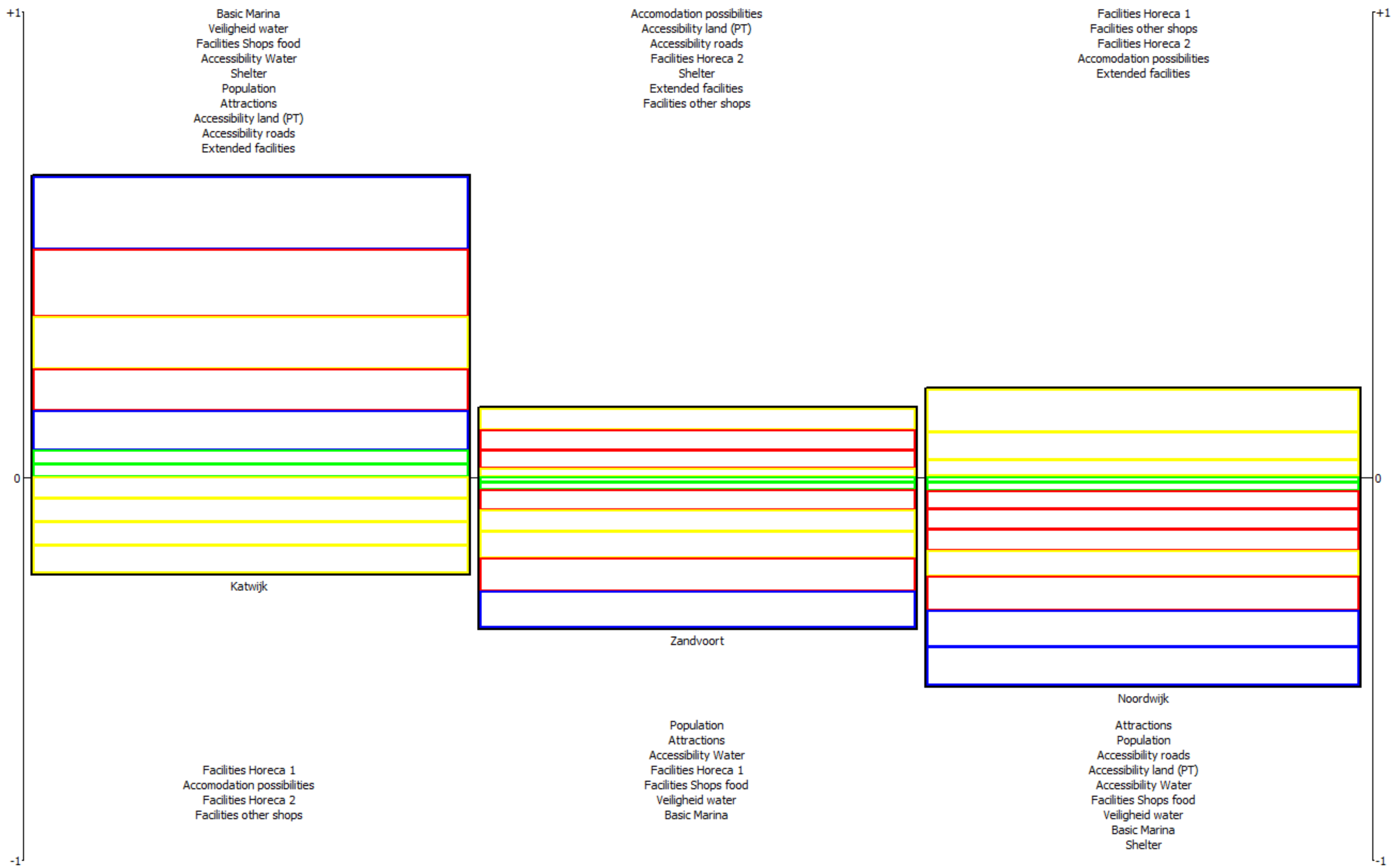


Figure 4.2.1.7: Rainbow overview policymakers

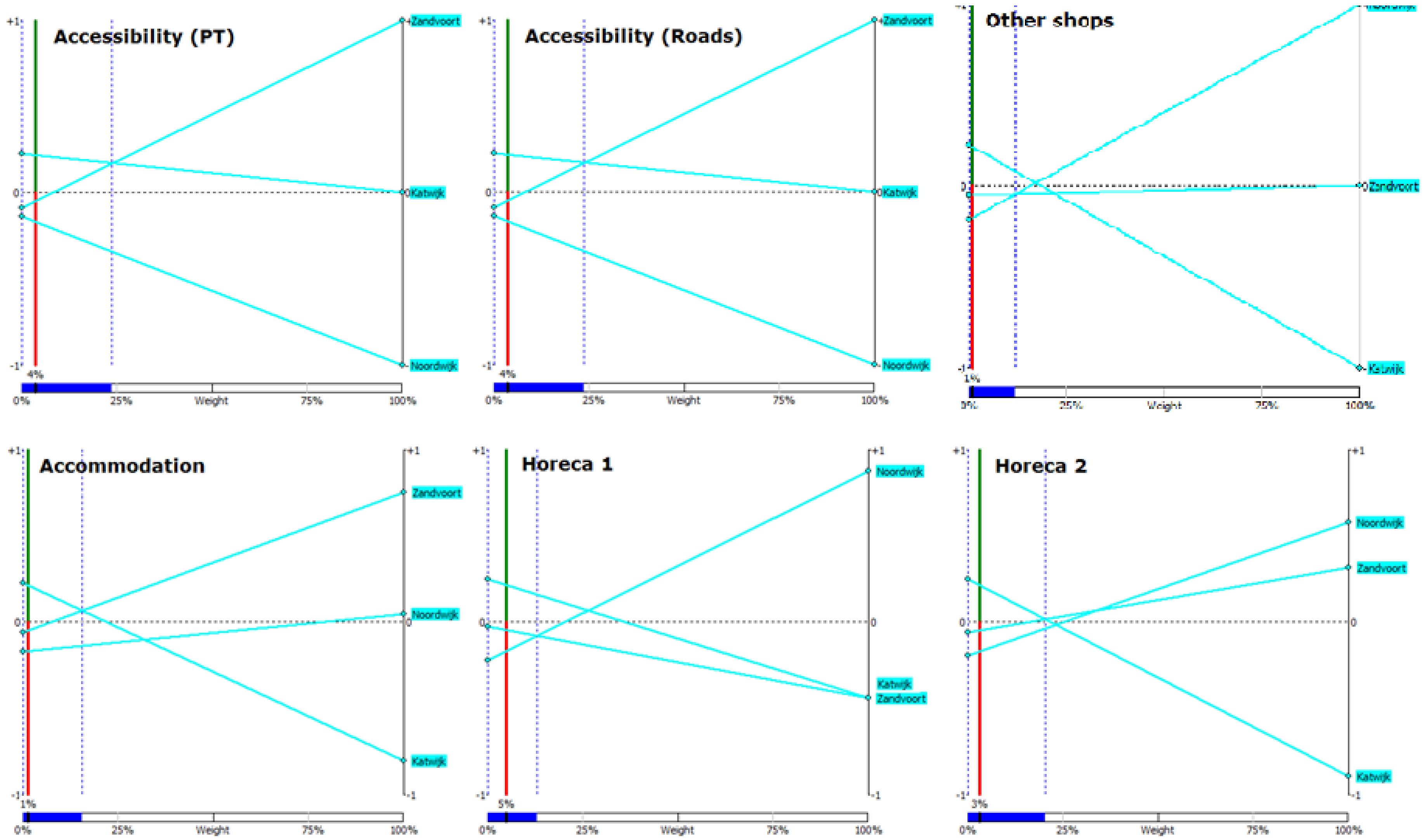


Figure 4.2.1.8: Stability intervals **marina surveys** (criteria that might change the ranking)

Only six of the fourteen criteria seem to have an effect in the marina surveys (figure 4.2.1.8). These criteria are able to change the ranking when the weight of these criteria is increased. The green-red line represents the current weight of the criterion. The aqua blue lines is the ranking of the alternative when only looking at this criterion. The dark blue line on the x-axis of the graph in the stability interval: it gives a percentage on how much the weight should be increased to be able to make a change in the ranking. For both accessibility criteria and for the Horeca 2 criterion, this value lies around 25%. When considering an equal weight for all criteria, each criterion would have a weight of around 7%. Some are more important, and some are less important. However, a weight of 25% is too high for this research, and is not expected to be given to any criterion.

Accommodation, Horeca 1 and other shops however, have a stability interval of around 12%. For accommodation and other shops, this means an increase of 11%. This is something that will not happen, considering the fact that in all surveys (except for the policy makers) the hinterland and facilities were the least important aspects for new possible marinas. This leaves only Horeca 1 to be influential when there is a weight increase of 7%. This might be possible. It would be influencing the ranking by Noordwijk favoured over Zandvoort. However, because this is the only criterion that might be influential in a possible situation, and the other 13 criteria are not, the actual ranking will not be changed: there are too many other criteria that favour Zandvoort above Noordwijk. For the marina surveys, the results can be considered stable.

Similar graphs can be found for the user surveys. However, there the stability intervals are all well above the 25%, which means none of the criterion could be influential enough to change the ranking in gap 1.

The policy makers survey shows again, only one influential criterion, and again this is Horeca 1. Although the value of the stability interval is only around 3% away from the actual weight (figure 4.2.1.9), again it will not influence the final ranking, for Zandvoort has got a higher natural preference than Noordwijk (figure 4.2.1.3).

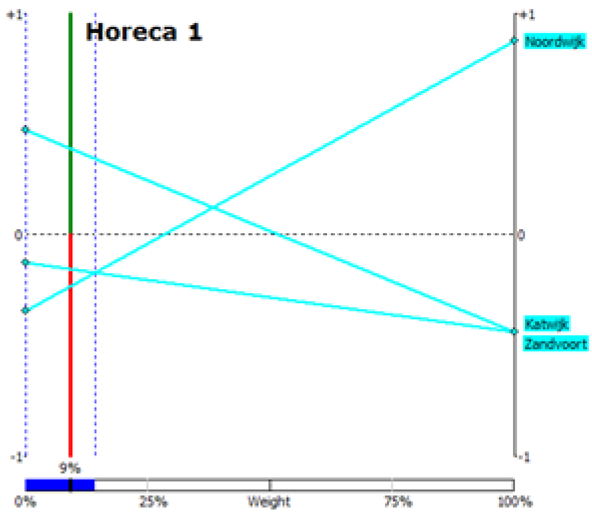


Figure 4.2.1.9: Stability interval **Policy makers** (criteria that might change the ranking)

It can be concluded that for gap one, a stable ranking can be found:

1. Katwijk aan Zee
2. Zandvoort
3. Noordwijk aan Zee

Because of the natural preference of Katwijk, a neutral preference for Zandvoort and a negative preference for Noordwijk, conducted from PHI scores, this ranking could be verified. None of the criteria could be influential enough to change the complete ranking. This can only be done when looking at only a small selection of the criteria.

The marinas have different strengths and weaknesses. When looking at hinterland, Katwijk is scoring high. On accessibility, it is Zandvoort that would be preferred. On Marina facilities and services, it is Katwijk again. On facilities outside the marina, Noordwijk is preferred. This could be discussed, when planning new marinas in the future. Is the ranking of the criteria still valid in the future? This could be a discussion.

4.4.2 Results Gap 2: IJmuiden-Den Helder

In the following section, the analysis results of gap 2 will be presented with a short explanation. The results will involve the following image:

- an action profile, displaying the nature of the values entered for each criterion per alternative
- the ranking, based on the surveys, and mean weight
- a rainbow overview, which gives the pros and cons of the different locations
- an overview of the stability in the weight, which can be considered as a sensitivity analysis.

Furthermore, in the preference flows for the gap will be presented in table 4.2.2.1, as well as the PHI scores per stakeholder group (table 4.2.2.2), which displays the preference of an alternative in a positive or negative direction.

		Population	Attractions	Accessibility land (PT)	Accessibility land (roads)	Accessibility Water	Safety water	Basic facilities
Gap 2	Egmond aan Zee	0,7111	0,3333	1	0	0	0	0,5
	Bergen aan Zee	0,1217	0,4167	-0,5	-1	0	0	-0,25
	Petten	-0,8327	-0,75	-0,5	1	0	0	-0,25

		Shelter	Extended facilities	Accommodation	Horeca 1	Horeca 2	Shops food	Other shops
Gap 2	Egmond aan Zee	-0,5	0	0,5	0,8213	0,88	0,8546	0,8825
	Bergen aan Zee	-0,5	0	0,3285	-0,3731	-0,2459	-0,1773	-0,4163
	Petten	1	0	-0,8285	-0,4482	-0,6341	-0,6773	-0,4662

Table 4.2.2.1: Preference flows per criterion for each alternative

The preference flows mentions in table 4.2.2.1 show that accessibility via water, water safety and extended facilities do not impact the ranking, for the values inserted for the alternatives are the same. However, in the overall analysis, these criterion are used, for they have been weighted.

The preference flow, together with the PHI scores per alternative determine the final position in the ranking of each alternative. The preference flow is multiplied with the PHI score to get the resulting score for each criterion per alternative. Then, these scores are multiplied for the final alternative score.

When looking at the net PHI scores in table 4.2.2.2, there is a natural preference in all surveys for Egmond aan Zee. Furthermore, Petten is ranked on the second place according the PHI scores. For the Watersportverbond and the Policy makers there is a very strong natural preference for Egmond aan Zee. This could be because Egmond is the biggest town of the three alternatives, and this has got the most facilities and services to offer, two of the criteria that score highest with the users and policy makers, This can also be seen in the action profiles, in figure 4.2.2.1 to 4.2.2.2. These action profiles show the values that were inserted for each criterion per alternative and their positive or negative effect on the final score.

Figure 4.2.2.4 to figure 4.2.2.6 display the ranking of each alternative per survey, including a mean score per stakeholder group (users, marinas and policy makers.

Figure 4.2.2.7 to 4.2.2.13 display a rainbow overview of the criteria per alternative, including pros and cons per alternative. The overviews are given per survey, including a mean overview per stakeholder group (users, marina, policymakers).

Finally, figure 4.2.2.14 to figure 4.2.2.16 will present the stability values of each criterion, symbolizing the sensitivity of the model.

A complete overview of the results can be found in appendix 7.

Survey			Phi-scores		
Gap 2 (IJmuiden-Den Helder)	Breskens		Phi	Phi+	Phi-
		Egmond aan Zee	0,3626	0,4285	0,066
		Bergen aan Zee	-0,1339	0,1319	0,2658
		Petten	-0,2287	0,0436	0,2722
	IJmuiden		Phi	Phi+	Phi-
		Egmond aan Zee	0,299	0,4468	0,1478
		Bergen aan Zee	-0,0705	0,1712	0,2417
		Petten	-0,2286	0,1704	0,3989
	All		Phi	Phi+	Phi-
		Egmond aan Zee	0,3308	0,4377	0,1069
		Bergen aan Zee	-0,1496	0,1074	0,2569
		Petten	-0,1812	0,1511	0,3324

Survey		Phi-scores		
Watersportverbond		Phi	Phi+	Phi-
	Egmond aan Zee	0,5259	0,5647	0,0388
	Bergen aan Zee	-0,1047	0,1563	0,2609
	Petten	-0,4213	0,0776	0,4988
HISWA		Phi	Phi+	Phi-
	Egmond aan Zee	0,273	0,4185	0,1455
	Bergen aan Zee	-0,0846	0,2145	0,2991
	Petten	-0,1885	0,0911	0,2796
All		Phi	Phi+	Phi-
	Egmond aan Zee	0,3995	0,4916	0,0921
	Bergen aan Zee	-0,1466	0,1237	0,2703
	Petten	-0,2529	0,146	0,399

Survey		Phi-scores		
Province NH		Phi	Phi+	Phi-
	Egmond aan Zee	0,4428	0,5146	0,0719
	Bergen aan Zee	-0,1522	0,1031	0,2553
	Petten	-0,2906	0,0922	0,3828

Table 4.2.2.2: PHI scores per alternative

The PHI scores for Egmond aan Zee are positive for all surveys. This means there is a positive natural preference for Egmond aan Zee when looking at the values that where inserted per criterion for each alternative. There is a negative natural preference for both Bergen aan Zee and Petten. Petten has got the lowest natural preference ranging from -0,1812 to -0.4213.

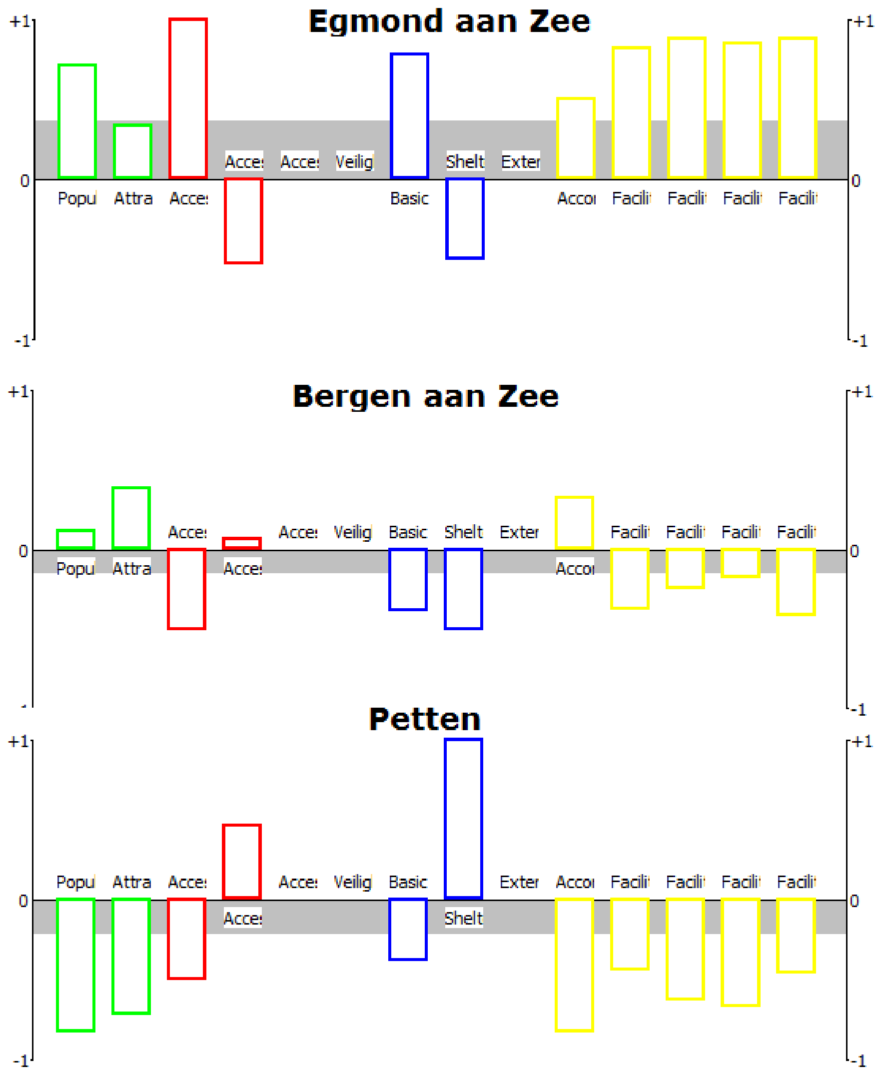


Figure 4.2.2.1: Action profile per alternative (grey area is PHI score, based on marina surveys)

In this profile, the different criteria are stated including their score of the value entered per criterion for each alternative. The criterion are expressed in the following order:

- Number of inhabitants (green): Popu
- Number of attractions (green): Attra
- Accessibility (PT) (red): Acce (first stave)
- Accessibility (Roads) (red): Acce (second stave)
- Accessibility (Water) (red): Acce (third stave)
- Water safety (red): Veilig
- Basic marina facilities (blue): Basic
- Shelter (blue): Shelt
- Extended marina facilities (blue): Exten
- Accommodation possibilities (yellow): Acco
- Horeca 1 facilities (yellow): Facill (first stave)
- Horeca 2 facilities (yellow): Facill (second stave)
- Shops food & beverage (yellow): Facill (third stave)
- Other shops (yellow): Facill (fourth stave)

The colours stand for:

Green: Hinterland
Red: Accessibility
Blue: Marina facilities and services
Yellow: Nearby facilities

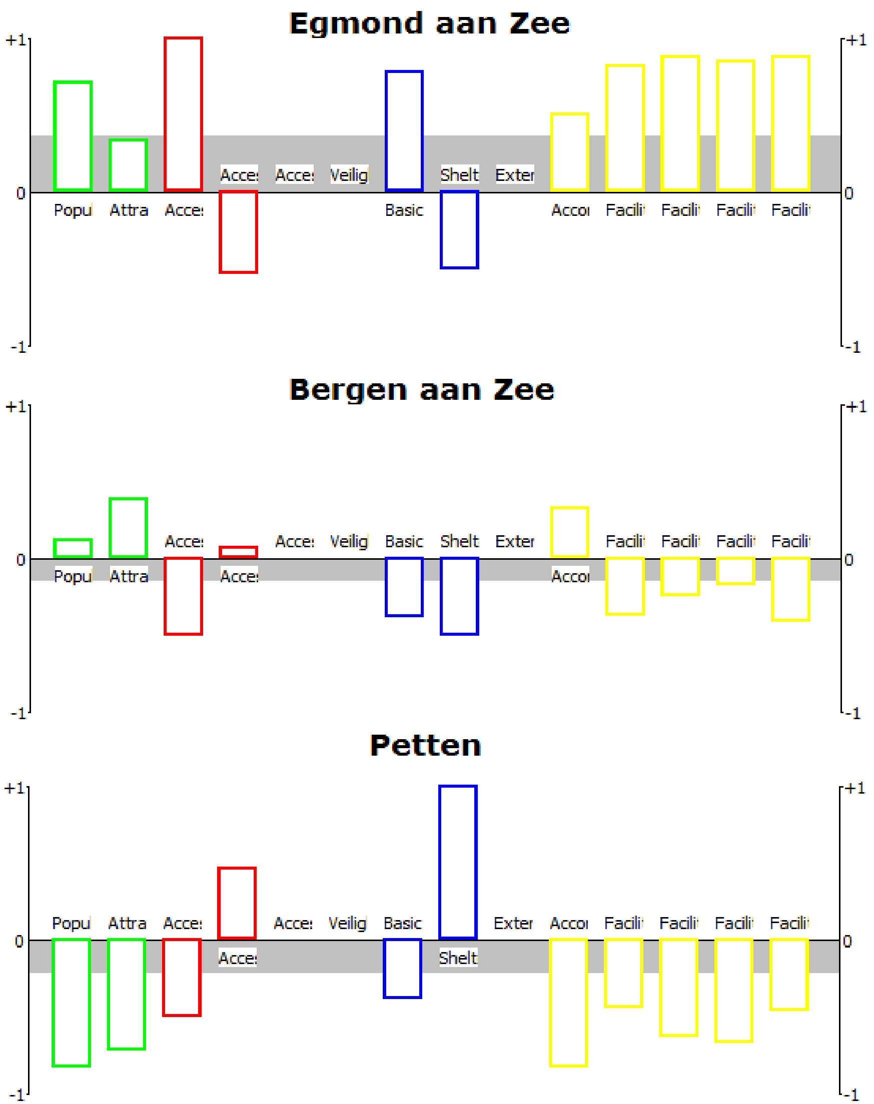


Figure 4.2.2.2: Action profile per alternative (grey area is PHI score, based on users surveys)

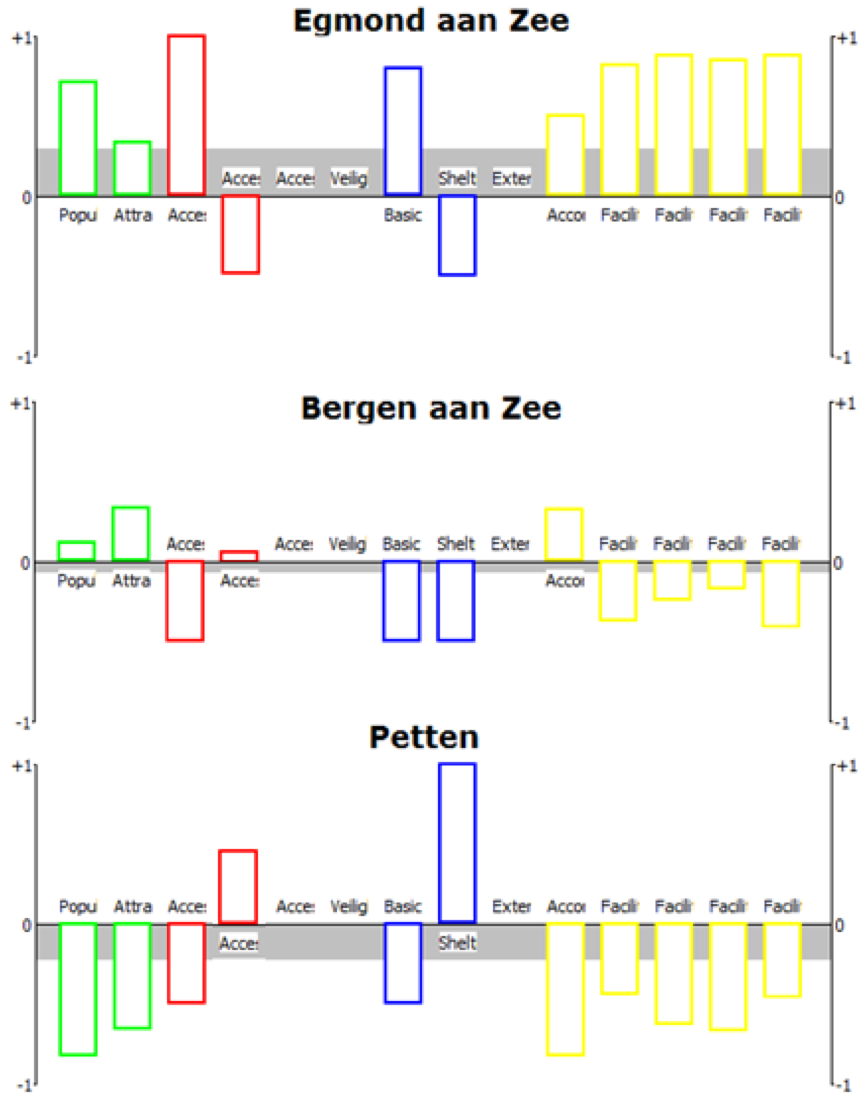


Figure 4.2.2.3: Action profile per alternative (grey area is PHI score, based on policymakers survey)

In the action profiles of the alternatives of the second gap, it becomes clear that Egmond scores mostly on the positive and neutral side when looking at the criteria. Only the accessibility by road and the shelter option is giving a negative flow to the ranking. Bergen aan Zee could be considered in between, and Petten is, apart from shelter and road accessibility the least favourable. Petten could be considered the complete opposite from Egmond aan Zee. What is interesting to see, is that in the surveys the accessibility over land and the marina facilities (for instance shelter with a mean weight between 9 and 10 %) is a very important criterion. Petten is according to the action profile scoring good on both these criteria. This might be interesting to see if this influences the final ranking of the alternatives

Figure 4.2.2.4 gives the ranking of the second gap per stakeholder group.

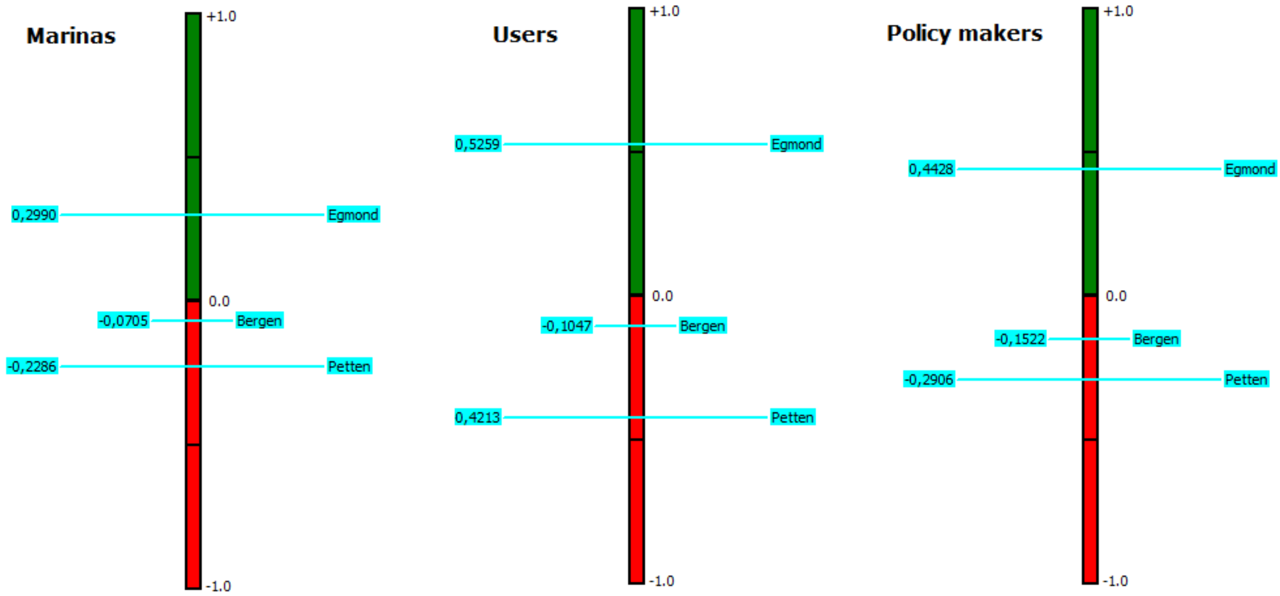
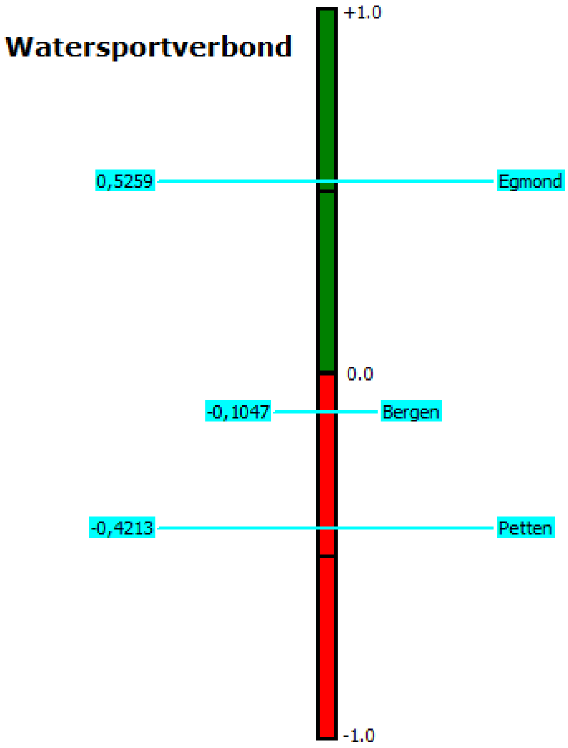
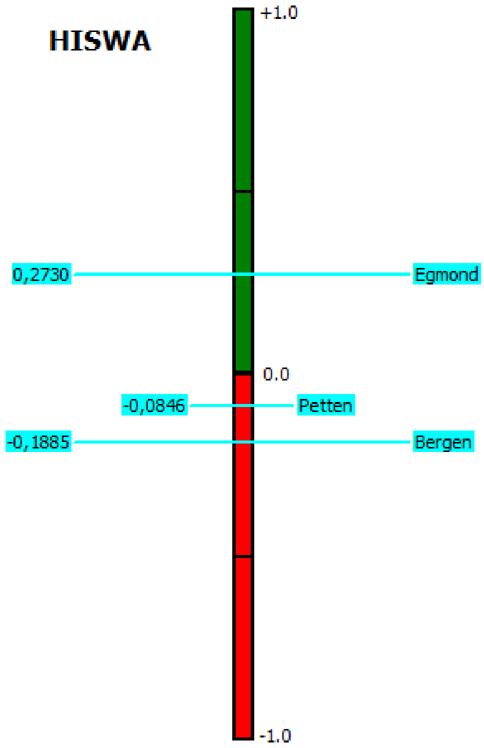


Figure 4.2.2.4: Ranking results per stakeholder group

For almost all surveys, there is a clear ranking of the alternatives: 1. Egmond, 2. Bergen and 3. Petten. This is according to PHI scores the same outcome. However, for the marina's there is only a smaller difference between Egmond and Petten. For the other groups it is a bit bigger. The fact that Petten and Egmond are closer to each other is because their action profiles are very different. This seems odd, however, Egmond is outstanding on all criteria. Petten however, is scoring high on two criteria that are relatively important for the marinas. This makes the difference between them quite small. In the stability interval, we will see if this has an effect on the rest of the ranking.

The HISWA survey showed a different ranking. This has got to do with the relative high weight given to shelter. Figure 4.2.2.4a gives the individual rankings of the users: Watersportverbond and HISWA. In the HISWA survey, Bergen aan Zee and Petten are relatively close to each other. In the mean result of the two surveys, depicted in figure 4.2.2.4, the ranking is there for the same as for the other stakeholder groups.





In the rainbow overviews (figures 4.2.2.5 to 4.2.2.7) , it becomes clear that there is a large variety in the criteria when looking at Egmond. Along the vertical axis, the length is much longer than for instance Bergen. This has to do with the fact that Egmond scores on most criteria the highest scores. Because this is a stacked graph, the outcomes are stacked on each other. Bergen is for most criteria in the middle range, and is thus the smallest. Petten is again bigger in range, however, its length reaches downwards, which means a negative range. As shown before, Egmond and Petten can nearly be reversed in terms of strengths and weaknesses. However, it becomes also clear that Egmond can really be favoured above the other alternatives even when some values are change: there are only two negative criteria for Egmond.

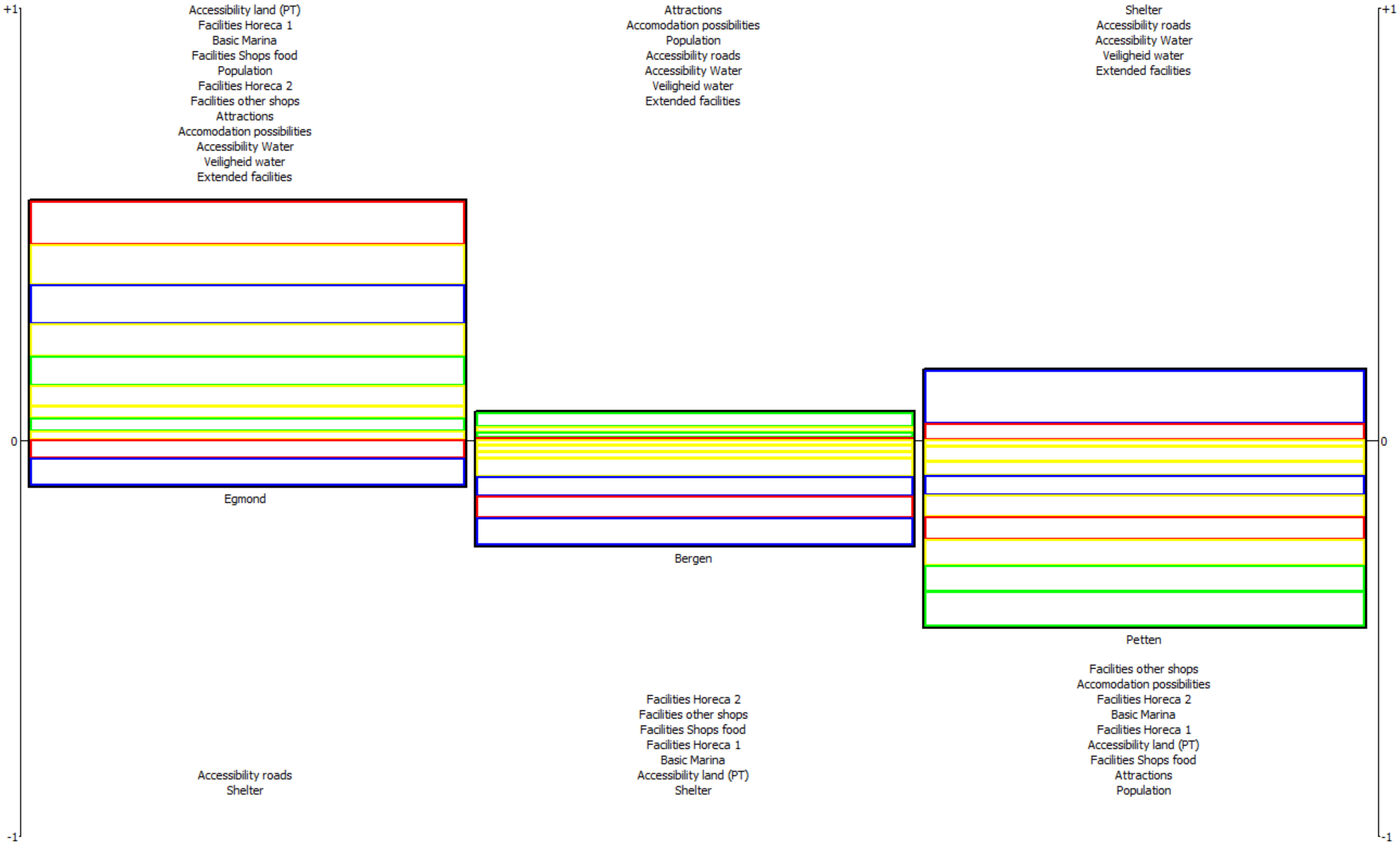


Figure 4.2.2.5: Rainbow overview marinas mean (from Marina IJmuiden and Marina Breskens)

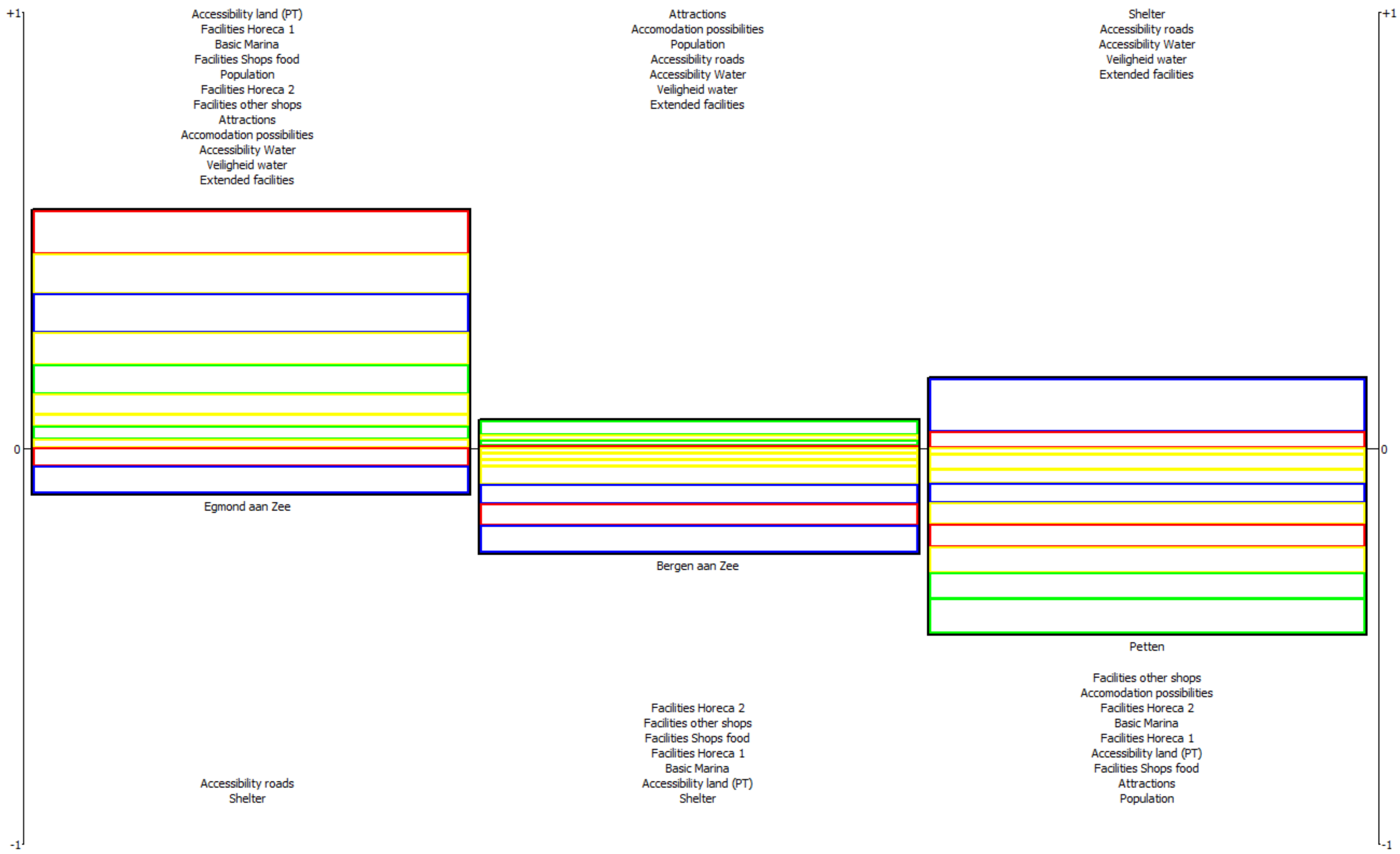


Figure 4.2.2.6: Rainbow overview users mean (from Watersportverbond and HISWA)

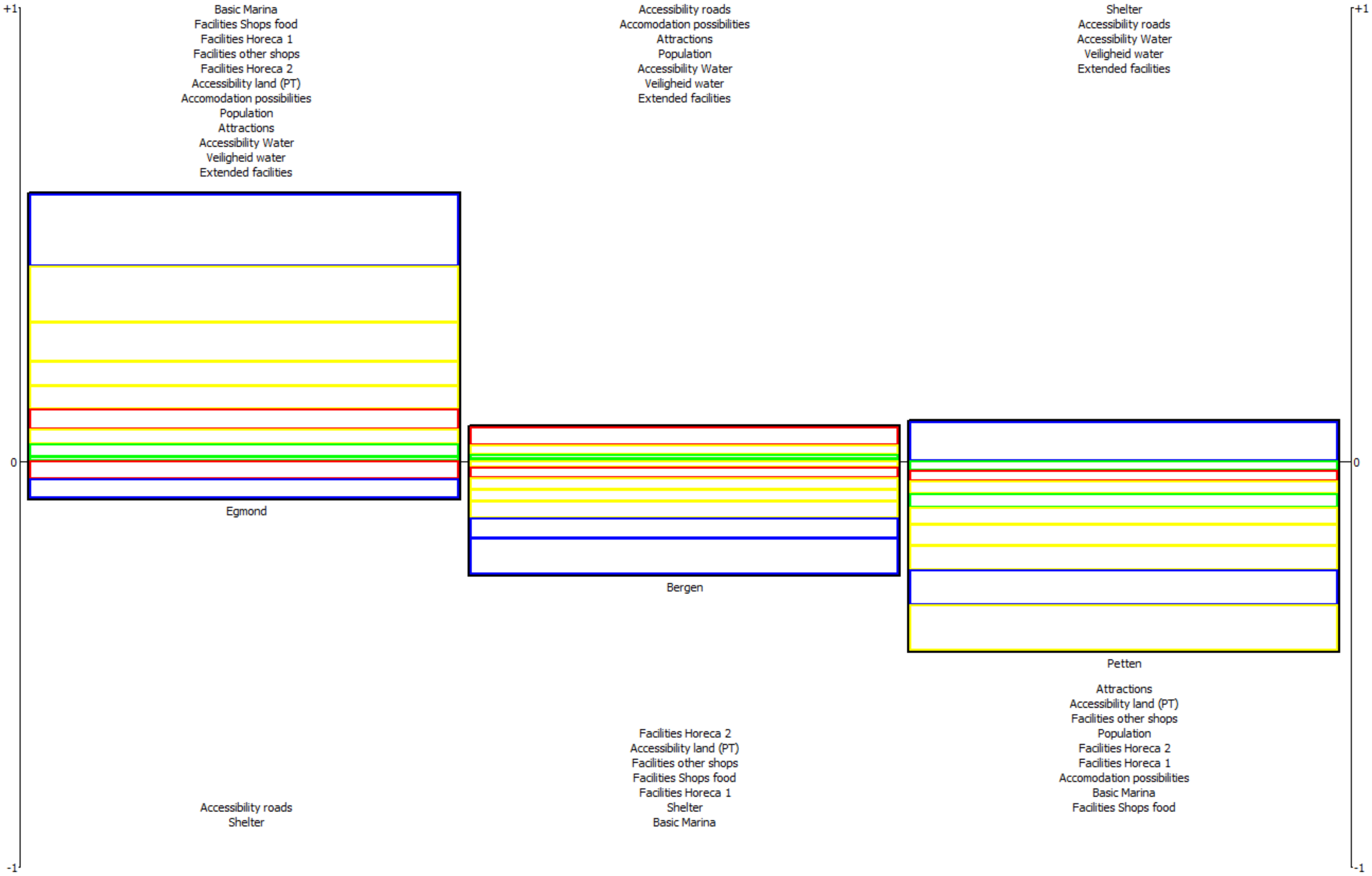


Figure 4.2.2.7: Rainbow overview policymakers

The next step is again the stability intervals. Figure 4.2.2.8 to 4.2.2.10 give the two criteria per stakeholder group that might change the ranking. Again, this can be seen via the crossing of the lines that depict the alternatives. For the accessibility, the gap between the current weight and the weight which could change the ranking is too big, and is therefore not considered as a thread for model stability. However, the shelter criterion might be a thread. In the action profile, we already saw that shelter was scoring high at the alternative Petten. In the weights it became clear that shelter was in important factor and was given a high weight in most surveys. The current weight is for most surveys very close to the changing point, where the ranking would change if only would be looked at the shelter criterion.

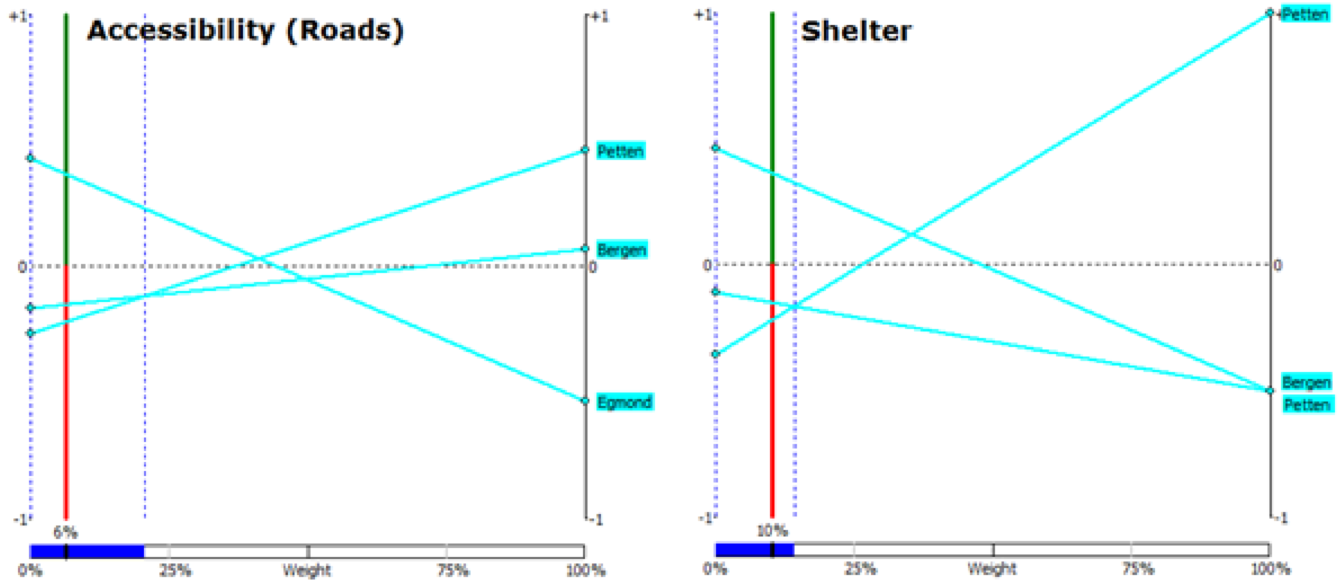


Figure 4.2.2.8: Stability interval **marina exploiters** (criteria that might change the ranking)

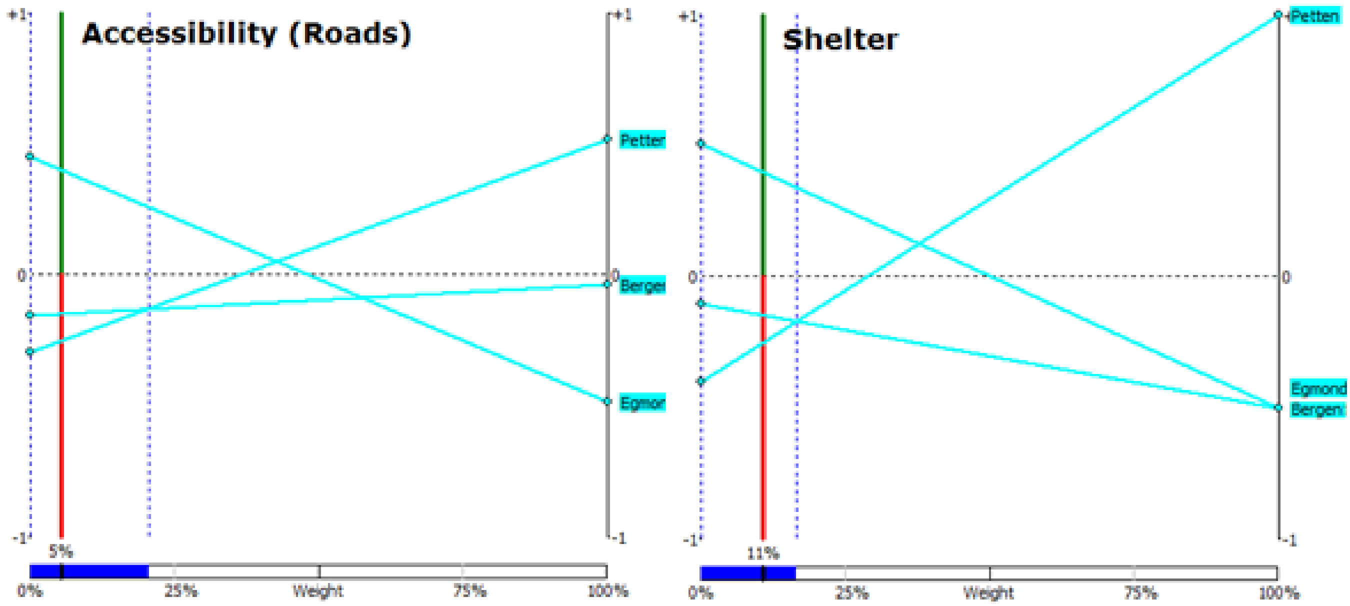


Figure 4.2.2.9: Stability interval **marina users** (criteria that might change the ranking)

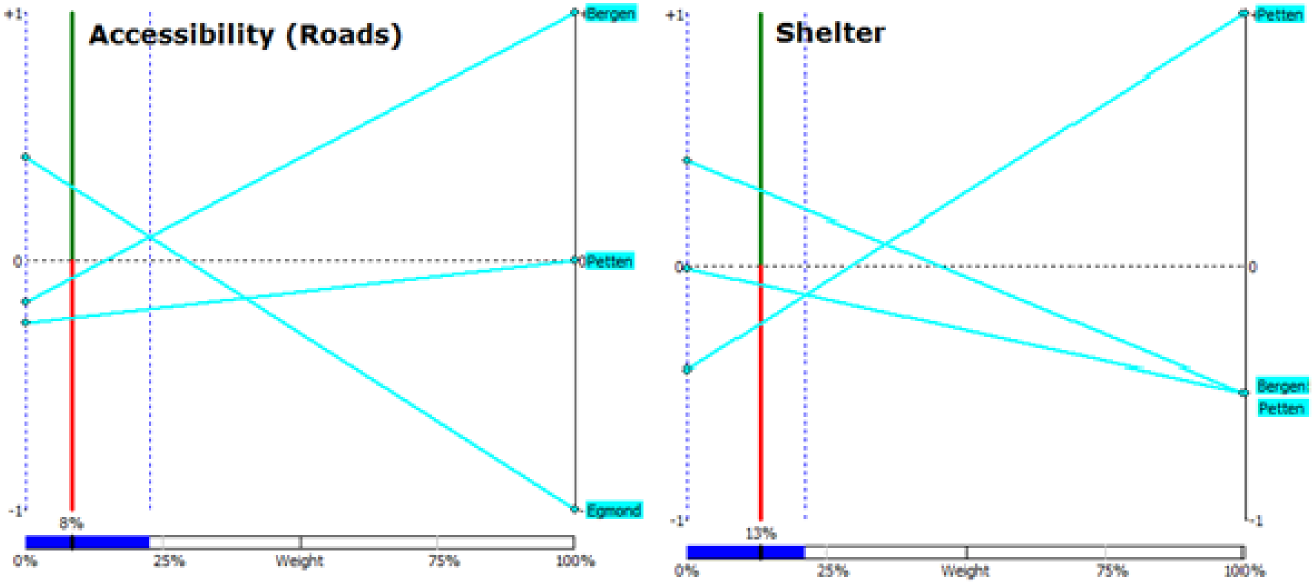


Figure 4.2.2.10: Stability interval **policy makers** (criteria that might change the ranking)

In order to be able to say whether the ranking would change, another tool within the PROMEHTEE software module can be used: walking weights. In this tool, the weights can be adjusted, and it will show the new ranking based on this adjustment. Figure 4.2.2.11 gives the walking weights overview.

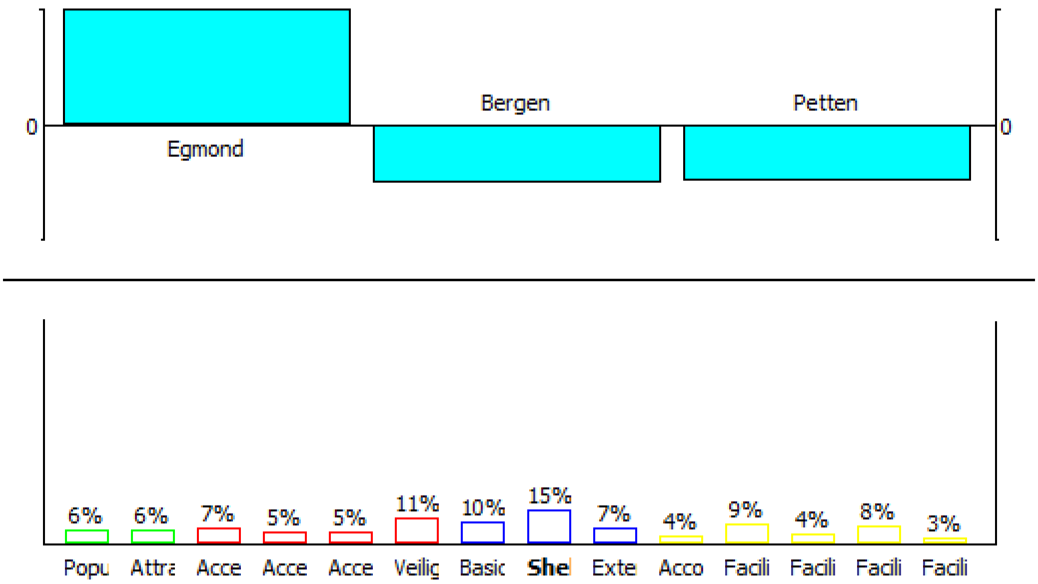


Figure 4.2.2.11: Walking weights overview for criterion shelter

The overview gives the weight for shelter that would be influential on the ranking. It is based on the mean of all surveys, and thus takes all different weights derived from the different stakeholders into account. Shelter would get here a weight of 10%.

The figure shows here that when there is an increase of 5% (shelter gets a weight of 15%) Bergen and Petten have are on the same position of the ranking. When shelter counts for 16%, Petten is ranked second, and Bergen is ranked third. This should be taken into account when making decisions on the final location of new marinas. However, also figure 4.2.2.11 shows that Egmond aan Zee is preferred far above the other two marinas.

4.4.3 Results: Matrix of costs

Below, a matrix can be found on a cost projection. This is a projection on expected costs in a 3-scale range. This projection is not connected to an amount. It solely ranks the alternatives per gap into a cost division. Furthermore, a short motivation is given on why this projection is given. The projection is derived from knowledge perceived from workshop ateliers organised by Atelier Kustkwaliteit in 2012.

Alternative		Cost projection	Motivation on costs
Gap 1	Katwijk aan Zee	low costs	Because of the inlet, the costs for development are reasonable. However, the current sluice is part of drainage system and is not suitable yet for marina development. Katwijk aan Zee has got development space near the sluices.
	Noordwijk aan Zee	high costs	Noordwijk aan Zee has got a coastline that goes landwards. This makes it harder to build upon the coast. However, for every marina at the coast a dam should be created. However, because of this coastline going landwards the maintenance costs for the dam are higher. The marina of Noordwijk aan Zee can only be built upon the coastline, because the areas around Noordwijk aan Zee are protected nature. As long as this nature remains protected, building a marina will be very expensive.
	Zandvoort	medium costs	Zandvoort has got a growing coastline. This makes maintenance costs for the dam lower than for instance at Noordwijk aan Zee. However, it generates higher coastal erosion behind the dam, which means maintenance costs will be higher elsewhere, However, it is better to build here than at a coastal erosion spot. Zandvoort has got development space next to the racing circuit.
Gap 2	Egmond aan Zee	medium costs	Egmond aan Zee lies in a protected nature area. However, plans are being made to reshape the southern part of the coastline area. Planning a marina here is one of the possibilities. The coastline is going landward, which means higher maintenance costs when building a dam here. On the other hand, because the landwards moving coastline, there is already need for extra maintenance. A dam could help here to maintain the coastline on the north-side of the dam.
	Bergen aan Zee	high costs	Bergen aan Zee has got the same problem as Egmond aan Zee. It has got an eroding coast which moves

		landwards. Bergen aan Zee is furthermore situated in protected nature, which means only building upon the coast is possible. Then, creating shelter and a safe marina, is very hard to create: around the marina, buildings should be built in order to safeguard the marina. This means building in the sea, which enables very high development and maintenance costs. In a costs perspective, Bergen aan Zee is far from being an interesting location for marinas.
Petten	low costs	Petten is situated at the end a of sea wall. The area around Petten is not protected, so it can be situated either on the north our south side of Petten. Currently, the sea wall is converted into dunes, however, maintain ace costs will remain. It might be possible to have a marina behind the sea wall, with a small dam going into the sea, which creates minor impact on the environment. This makes Petten actually the best location when looking solely at the costs.

Table 4.2.3.1: Matrix results on costs implementation new marinas

4.5 Result interpretation

The most obvious result can be found when looking at the ranking lists of each survey. All point out that for gap one Katwijk aan Zee is the most obvious choice, and for gap two this is Egmond aan Zee. Both cities are the biggest when comparing them with their alternatives. This creates an advantage on the facilities.

However, the surveys all pointed out that marina facilities (blue in the action profiles) and the accessibility (red) are the most important aspects when thinking of planning new marinas. On marina facilities it is Katwijk aan Zee and Egmond aan Zee that win, however, on accessibility it is Zandvoort and Petten. However, in the overall score, this is not enough to “win first place”.

The rainbow planes in figure 4.2.1.7 to 4.2.1.13 and 4.2.2.7 to 4.2.2.13 give a good overview on how the criteria are present at the different alternatives. Here, the strengths and weaknesses of the alternatives can be found. The higher the blue and red criterion are for an alternative, the better (these criteria have, in most cases, a higher weight than the yellow (facilities nearby) and green (hinterland) criterion).

For most rainbow overviews, the facilities nearby and the hinterland are mostly situated in the middle part of the stave. This means that the availability or absence of marina services (including shelter) and accessibility are determining the final ranking as it is.

When not looking at the weights, already the PHI scores give a natural preference for Katwijk aan Zee and Egmond aan Zee. This is only based on the values inserted for each criterion per alternative and the character of these values. The weight does influence sometimes on this

PHI score, however, this was only the case in the HISWA rainbow plane for gap 2 (here, Petten is preferred above Bergen aan Zee).

When looking at the stability intervals, dealing with the sensitivity of the model, it can be noted that most of the criteria are quite stable and do not change the ranking. As stated before, the accessibility and marina services are the most important in most surveys. This means that it is important for these criteria to have the highest weight. The accessibility on roads and on public transport give a change in ranking around 25%, which would have been a weight of (0.25). However, the actual scores show that (for all cases depicted in the stability intervals) the criteria where change may occur when changing the weights is quite far from the actual weight they were given. This means, that based on the criteria used in this survey, some solid conclusions can be given.

The matrix in paragraph 4.2.3 gave an overview of the projected costs of implementing new marinas. Summarizing the ranking of the alternatives, including these costs, the following matrix can be derived:

	Alternative	Ranking	Cost ranking
Gap 1	Katwijk aan Zee	1	1
	Zandvoort	2	2
	Noordwijk aan Zee	3	3
Gap 2	Egmond aan Zee	1	2
	Bergen aan Zee	2	3
	Petten	3	1

Table 4.3.1: Summarizing ranking

5. Discussion

This chapter will deal with two separate sections: a discussion on the case study, its data and the results, and another section will be a discussion on the model itself.

5.1 Case study discussion

This section will deal with a discussion on the outcomes of the model. It will solely deal with the results on the potential marinas.

The model creates a clear picture on the possible new marinas based on physical criteria. According to the model, in both gaps all the different analyses show that Katwijk aan Zee and Egmond aan Zee are the best options for having marinas. This mainly has to do with the fact that these places have the most facilities, This has to do with the fact that these villages are bigger than their alternatives. The size of the village also plays a role in the accessibility.

When looking at the criteria groups, all surveys pointed out that marina services and accessibility are the most important criteria in this study. This is an obvious notion: most people that are using marinas are there to be able to sail. This is the most important thing for them. In order to do so, they want their marina to be accessible, safe, and have the services they need in the neighbourhood (e.g. water sport shops, nautical repairing).

From a final discussion with HISWA, it became clear that most marinas are making their profit on rental of seasonal moorings. Passers-by are interesting for the municipalities and shops, Horeca and accommodation facilities around the marina, but not as much for the marinas itself. The model on this study was based on rental of both seasonal moorings and passers-by. For the first group, the surrounding area of the marina is not that important, except for the marina facilities and services (including extended facilities). Accommodation, shops and Horeca in the second category are not that important for this group. The prior thing for this group is to be able to sail their boat. This distinction was not made in the model. This is something to keep in mind when looking at the outcomes. It deals with both groups of sailors.

The data used in this model were all based on factual data. However, this data is from the last 2 years (2011-2013). The model is a representation of today's world. Because the outcomes of this research are used in a vision that will look upon the next 90 years, this should be considered as well. On the other hand, the whole vision is based on today's situation. We do not know what lies ahead of us. The purpose of the vision is to give a guideline for the future. However, it does not implicate that the future will be the same as presented in the vision.

Because Katwijk aan Zee is in the Randstad area, the expectations are at least a stable growth. Furthermore, this part of the Netherlands will remain the richest part. On the other hand, sea sailors are often not based in the Randstad. Sailing is, ass the Dutch population, aging. This means that the growth of the younger sailors is not that big. This will mean less boats in the future. This might cause a halt to all new marinas. The expectations are that after 2030 the population will grow again. Between 2020 and 2030 there will be a small decline in population (based on CBS Statline numbers, 2013). The marina planning should be evaluated before actually planning the marinas on a shorter term. The projection of the population should then be considered again.

A final very important factor for marina planning, which has not been accounted for, is politics. This is a very unpredictable factor. Politics are able to determine the fate of a marina, by political lobby, but also through budget spending (both decrease and increase). The final outcome on IF and WHERE the marinas will be planned, will hugely be dependent on the local, provincial and the state governments. This notion should be accounted for. However, for the purpose of vision development, this has not been included.

On the handling of the data the following should be considered. Because there are no planning details on the actual positioning of the marinas, the researcher chose the most obvious location for a new marina. When this was not possible, the most central location was chosen. Especially for the facilities nearby the marina, this can have an impact on the value of considered facilities. However, it is not expected that this will change the ranking. Furthermore, the criteria used were for both seasonal mooring keepers and for passers-by. When conducting a study on either of the two, different outcomes may occur: for seasonal moorings keepers the facilities and the hinterland are not important, except for the fast food options nearby the marina. However, for passers-by, these aspects are important. Throughout the process it became clear that sailors are not all the same. Before the study was conducted, the notion was given that there should be a focus on sailors, to narrow the study down. However, the question rises if this was narrowed down enough. Future research might be needed to answer this question.

5.2 Model Discussion

In the case study an analysis was performed on potential coastal marinas for vision development on a national scale. This section will look at the PROMETHEE method that was used, and will elaborate on the strengths and the weaknesses of the model. In table 5.2.1, the strengths and weaknesses of the model are mentioned.

Strengths & Weaknesses PROMETHEE (with AHP enhancement)
Strengths
Based on clear and solid requisites
Easy to understand: no heavy mathematical calculations
Multiple scales can be combined (quantitative, qualitative)
Combination of fuzzy, numerical and binary logic
Not only weights, but also nature of the values are considered
Possibility to have cross border analysis
Displaying possibilities
User friendliness in software
Easy to implement other methods into PROMETHEE
Weaknesses
Rational model, with no room for discussion implementation
Might be an aged method, although it is innovated
Optimum is (almost) always a compromise
It remains a model: it is not the real world

Table 5.2.1: Strengths and Weaknesses of PROMETHEE

Strengths of PROMETHEE with AHP

The PROMETHEE method was chosen because of various reasons (see Methodology section). This MCA technique is able to combine multiple scales between criteria, without having the problem that one scale is overruling the other (Figueira, Greco, & Ehrgott, 2005). This is both on the answering scale as for the spatial scale of the datasets used to derive the answers. Because all criteria are different, and have a different scope, this is a powerful strength. This is common for MCA's. What is not common however, is the ease to implement these different scales. The combination of numerical, fuzzy logic and binary answering methods is a very good feature of the PROMETHEE. Furthermore, the fact that it does not only take criteria and weights into account, but also the nature of the inserted values (via phi scores) makes PROMETHEE a very solid decision making tool: it corrects the scores of the weights with the natural preference of the values to make them more objective

Another strength of PROMETHEE is the way in which the results can be displayed (Kasperczyk & Knickel, 2005) . The different planes on which the results can be displayed, and the possibility of using a sensitivity analysis within the tool makes PROMETHEE a strong and reliable method for rational decision making. By using the different options, different knowledge can be derived such as the ranking, the pro's and con's, but also the webs that show the strong points of an alternative could be very useful to compare the alternatives. The GAIA interactive visualisation of the outcomes make the PROMETHEE method to a very informative and qualified method.

Next, another major strength of PROMETHEE is the user friendly software. Manuals are not needed and the wizards for building the model are very clear.

The way in which the AHP method for weighting can be implemented is very easy (Triantaphyllou & Sánchez, 1997). The weights can just be inserted in the model, and are instantly converted into percentages. Because AHP works with numbers between 0 and 1, and PROMETHEE works with numbers between 0 and 100, the fact that the weights are being transformed in the back to percentages is very good. The possibly of enhancement of the model with AHP makes the model more powerful and gives more reliable answers that are closer to the real world.

Weaknesses of PROMETHEE with AHP

PROMETHEE (and other Multi Criteria Analyses) are rational and linear models, that search for an optimum of alternatives within a set of criteria. However, this optimum is always a compromise. In the 1980's/1990's there was a need for rational models that would show the best option by using multiple criteria. Many times, these solutions have been taken for granted, and were implemented. However, modern times ask for modern methods. Today, discussion on alternatives is much more important, because interaction between different stakeholders is needed to get a supported solution. This can be found in new methods of decision making: for instance, planning support systems often use a very interactive method of decisions. In these methods, a combination of facts (data, spatial data), information (human knowledge) and discussion can be combined to make the right decisions on planning cases (Figueira, Greco, & Ehrgott, 2005). In the case of PROMETHEE, human knowledge could be implemented (to a lesser extent), however, discussion is harder to implement. This is one of the major critique points of PROMETHEE, and with this in multi-criteria analysis.

All models, and thus Multi-criteria models, are a representation of the real world. However it is a simplified representation of the world. This means that not all processes are accounted for in the analysis. It has been stated before that for instance political lobby is not taken account into the model. A model of the world will always be subject to human interpretation and things will be left out. This is an important issue that should always be considered.

Overall evaluation

The question arises whether multi-criteria analysis is still usable these days. And if yes, for what kind of problems MCA can be used?

In the case of this research, an explorative research on a large spatial scale with boarders that cross (municipalities, water boards and provinces), it is useful to have a rational model to start the discussion. It can show the strengths and weaknesses of alternatives, and the preference of alternatives based only on facts (physical and countable criteria). For vision development, were the focus lies on describing possibilities for the future, basing the vision on facts is sufficient. After all, a vision is also a document to enable a discussion for the future. PROMETHEE is one of the tools to do this. However, one must bear in mind that making hard decisions only based on a PROMETHEE analysis is not sufficient for actual planning. Most likely, the outcome of a decision based on pure facts will not be accepted. The rise of importance of citizens participation is one of the examples that discussion is necessary nowadays. The discussion can start as of now about the best location for marinas.

The fact that PROMETHEE was chosen, and not another model like ELECTRE has been of influence on the final results. There are many choices when choosing a model. This selection process is not guided. The researcher is able to choose a method himself. This makes the phase of the decision making process before the analysis already biased: it is already subject to human interpretation and human interaction. It was clear that this thesis would deal with a multi-criteria analysis, as it is a clear and well known concept in the academic world. Furthermore, it's process and outcomes are mostly easy to understand for people not involved in decision making tools. The fact that MCA was chosen limits the number of possible methods. However, it is recommended that the different multiple analysis methods are studied before making a decision (as has been done in this thesis).

6. Conclusion

This study is based on a two folded research question. On the one hand, it dealt with a case study on possible new marinas at the Dutch coast. On the other hand, it dealt with the question whether a MCA method, in this case PROMETHEE/AHP is still a good tool to use in decision analysis for vision development.

The main question for the first part of the research was:

"How could new marinas on the coast be distributed so that a distribution (based on needs of stakeholders) of marinas at the coast is created that is useful to coastal sailors?"

From the analysis some clear conclusions can be drawn. First of all, Katwijk aan Zee and Egmond aan Zee are the most suitable location for new marinas. These marinas are lying in the two identified gaps between Scheveningen and Ijmuiden (Katwijk aan Zee) and Ijmuiden and Den Helder (Egmond aan Zee). The results from three different stakeholder groups (marina exploiters, users (sailors) and policymakers) all came to the same conclusion. Least favoured in the alternatives are Noordwijk aan Zee for the first gap and Petten for the second gap. Both places are less focussed on tourism and marina activities. The fact that Katwijk aan Zee and Egmond aan Zee are the biggest places of all, certainly plays a role, especially when looking at the facilities.

When new marinas are placed at Katwijk aan Zee and Egmond aan Zee, a network of coastal hopping will be completed, which may enable a sailing network across the Dutch coast.

However, the analysis did not take costs into account. Because this study is performed for national vision development, and the scope is until the year 2100, it is hard to implement costs. On the other hand, an overview was given on each alternative on a costs indication. Building directly upon the coastline is expensive and has got huge environmental impacts (sea stream are heavily disrupted). This makes it only for Katwijk aan Zee easier to implement a new marina, for there is still an "unused" inlet. However, because Egmond aan Zee has got a growing coastline (the basic coast line is growing towards the sea), implementation of a new marina might be possible here. However, an individual study on this location is necessary. This also applies to all other locations. This study only dealt with a broad view on marina planning. It does not go into detail on local aspects and the environmental impacts. Thus, when actually planning a marina, an extensive study should be performed.

For the vision development, this research came to some helpful answers. The next part of the conclusion will deal with the second part of this research, which dealt with the following research question:

"Can traditional decision making models be used for governmental vision development?"

For the analysis a combination of AHP and PROMETHEE was used. Both are multi-criteria analysis tools which date from the 1980's. During their life time, they have been evaluated and enhanced, changed and new tools within these methods became available.

In this day and age, decision problems can't be solved without discussion and involving many difficult processes as political opinions and emotions. This makes a rational model, like PROMETHEE and AHP, hard to use, for they are based on rational criteria and mathematical calculations. However, the question was specifically looking at vision development, a process where it is important to have a broad view on the future, not to have many political influences from this period and to be able to enable discussion.

For this purpose, it seems that rational models are very suitable. It can create a ranking of alternatives, including information on how this ranking was created. Furthermore, because opinions and emotions are left out, it can be seen as a ranking that is based on facts. In a discussion various sources are used to keep the dialogue going. A factual study can help to make a final decision on a problem. However, it should not be solely based on facts. As stated before, this society needs more than only facts.

The fact that the National Vision Coast, created by Deltaprogramma Coast, is mostly a discussion paper on possible scenarios for the future, this study can be used as a building block for factual support on these different scenarios.

7. Recommendations

This study was conducted for the purpose of vision development on a state governmental level. It has got a broad view, taking a large part of the Dutch coast in consideration. There was no attempt to view this on a small spatial scale (local marina level). It is therefore recommended not to make statements on small scale levels.

The results of this study can be used for broad view and large scale conclusions on marina planning in the Hollandse Boog.

The other side of the research was to conduct an evaluation on a combination of PROMETHEE and AHP. It is a good way to start a discussion on planning issues. However, it is not recommended to use this method as a decision tool on its own. Politics, discussion and, to a lesser extent, opinions are hard to incorporate in this model. Planning support systems might take up this challenge. For this other studies are available.

This study can be concluded by saying that the PROMETHEE/AHP method should not be forgotten when conducting a broad view research for opening a discussion. It is a strong and powerful tool to create a decision on alternatives, based on facts and opinions (expressed in criteria and weights).

Bibliography

Behzadian, M., Kazemzadeh, R., Albadvi, A., & Aghdasi, M. (2010). PROMETHEE: A comprehensive literature review on methodologies and applications. *European Journal of Operational Research, Issue 200*, pp. 198-215.

Bertsimas, D., & Thiele, A. (2006). Robust and Data-Driven Optimization: Modern Decision-Making. *Tutorials in operations research*, pp. 95-122.

Bodily, S. (1985). *Modern decision making: A guide to modeling with decision support systems.* New York: McGraw-Hill.

Bogdanovic, D., Nikolic, D., & Ilic, I. (2012). Mining method selection by integrated AHP and PROMETHEE method. *Anais da Academia Brasileira de Ciências, vol.84, issue 1*.

Brans, J., & Mareschal, B. (2005). Chapter 5: PROMETHEE Methods. *Multiple Criteria Decision Analysis: State of the Art Surveys*, 163–196.

Brans, J., & Mareschal, B. (2013). *How to Decide with PROMETHEE*. Retrieved 03 15, 2013, from ULB and VUB Brussels Free Universities: http://homepages.ulb.ac.be/~bmaresc/PromWeb.htm

Dağdeviren, M. (2008). Decision making in equipment selection: an integrated approach with AHP and PROMETHEE. *Journal of Intelligent Manufacturing, Volume 19, Issue 4*, 397-406.

Deltaprogramma Kust. (2011). *Nationaal Kader Kust.* Den Haag: Deltaprogramma Kust.

Deltaprogramma Kust. (2013). *Nationale Visie Kust.* Den Haag: Deltaprogramma Kust.

Den Helder Willemsoord. (2012, juni). Retrieved from http://www.watersportalmanak.nl/artikel/den-helder-jachthaven-willemsoord

Dyer, J., Fishburn, P., Steuer, R., Wallenius, J., & Zionts, S. (1992). Multiple Criteria Decision Making, Multiattribute Utility Theory: The Next Ten Years. *Management Science, Volume 38, Issue 5.*, 645-654.

Figueira, J., Greco, S., & Ehrgott, M. (2005). *Multiple Criteria Decision Analysis: State of the Art Surveys.* New York: Springer Science Business Media, Inc.

Fülöp, J. (2012). *Introduction to Decision Making Method.* Retrieved April 2013, from Laboratory of Operations Research and Decision Systems, Computer and Automation Institute, Hungarian Academy of Sciences: http://www.cs.ubbcluj.ro/~per/Dss/Dss_7.pdf

Gemeente Den Helder. (2006). *Havenvisie Den Helder.* Retrieved from www.denhelder.nl: http://www.denhelder.nl/div/HavenvisieDenHelderdeel1en2.pdf

Gemeente Zandvoort. (2012, februari). *Pilot Zandvoort*. Retrieved 7 juli, 2012, from www.zandvoort.nl: http://www.zandvoort.nl/website/webgen.nsf/pages/_6543CAF5822F6B77C1257324003829AD/$file/Pilot+Zandvoort+rapportage.pdf

Grontmij & Stichting Intraval. (2008). *Zicht op een Zeejachthaven.* Grontmij & Intraval.

Jachthaven Schiermonnikoog. (2012, juni). Retrieved from www.jachthavenschiermonnikoog.nl

Jachthaven Terschelling. (2012, juni). Retrieved from www.jachthaventerschelling.nl

Kasperczyk, N., & Knickel, K. (2005). *Preference ranking organisation method for enrichment evaluations (PROMETHEE).* Retrieved 2013, from Institure for Environmental Studies: http://www.ivm.vu.nl/en/Images/MCA4_tcm53-161530.pdf

Kenniscentrum Kusttoerisme. (2010). *Havens à la Carte.* Vlissingen: ADZ.

Keyser, de, W., & Peeters, P. (1996). A note on the use of PROMETHEE multicriteria methods. *European Journal of Operational Research, Issue 89*, 457-461.

Ligmann-Zielinska, A., & Jankowski, P. (2012). Impact of proximity-adjusted preferences on rank-order stability in geographical multicriteria decision analysis. *Journal of Geographical Systems, Volume 14, Issue 2.*, 167-187.

Macharis, C., Springael, J., De Brucker, K., & Verbeke, A. (2004). PROMETHEE and AHP: The design of operational synergies in multicriteria analysis.: Strengthening PROMETHEE with ideas of AHP. *European Journal of Operational Research, Volume 153, Issue 2*, 307-317.

Mareschal, B. (2011-2013). *The PROMETHEE-GAIA FAQ*. Retrieved 04 15, 2013, from http://www.promethee-gaia.net/faq-pro/index.php?action=article&cat_id=003002&id=6&lang=

Panteia. (2012). *De kracht van dde kusteconomie.* Panteia: Zoetermeer.

Parker, D., Manson, S., Janssen, M., Hoffmann, M., & Deadman, P. (2003). Multi-Agent systems for the simulation of Land-Use and Land-Cover Change: a review. *Annals of the Association of American Geographers. Volume 93, Issue 2*, 314-357.

Provincie Noord-Holland. (2012). *Proviniciale Visie Noord-Holland.*

Provincie Zuid-Holland. (2012). *Provinciale Visie Zuid-Holland.*

RBOI Middelburg. (2012). *Jachthaven Cadzand-Bad.* Gemeente Sluis.

Redlawsk, D. (2002). Hot Cognition or Cool Consideration? Testing the Effects of Motivated Reasoning on Political Decision Making. *The Journal of Politics, Volume 64, Issue 04*, pp. 1021-1044.

Saaty, T. (1990). How to make a decision: The Analytical Hierarchy Process. *European Journal of Operational Research, Volume 48.*, 9-26.

San Cristóbal Mateo, J. (2012). Multi-Attribute Utility Theory. In *Multi Criteria Analysis in the Renewable Energy Industry* (pp. 63-72). New York: Springer.

Sargent, P. (1991). *Materials Information for CAD/CAM, chapter 5.* Retrieved November 8th 2012, from Materials Information for CAD/CAM: http://home.klebos.net/philip.sargent/book/5_decisions_and_selection.html

Smits, M. (2008). *Erkennende haalbaarheidsstudie naar de ontwikkeling van een zeejachthaven bij Noordwijk.* Delft: TU Delft.

Stichting JAS. (2010, augustus). *Petten aan Zee nog niet verzand*. Retrieved juni 2012, from www.stichting-jas.nl/newsread.asp?newsID=15271

Stichting Recreatietoervaart Nederland. (2011). *Toekomstvisie Waterrecreatie 2025.* Amsterdam: Boer & Croon.

Teknomo, K. (2007). *AHP Tutorial*. Retrieved April 2013, from Kardi Teknomo's page: http://people.revoledu.com/kardi/tutorial/AHP/Weight.htm

Triantaphyllou, E., & Sánchez, A. (1997). A Sensitivity Analysis approach for some determenistic multi-criteria decision making methods. *Decision Sciences, volume 28, issue 1*, pp. 151-194.

Waddenhaven Ameland. (2012, juni). Retrieved from www.waddenhavenameland.nl

Waddenhaven Texel. (2012, juni). Retrieved from www.waddenhaventexel.nl

Waddenhaven Vlieland. (2012, juni). Retrieved from www.waddenhavenvlieland.nl

Waterrecreatieadvies & Oranjewoud. (2010). *Havenvisie Wadden, verantwoord varen op het Wad.* Retrieved juni 2012, from www.waterrecreatieadvies.nl: http://www.waterrecreatieadvies.nl/eng/pdf/Havenvisie%20Wadden.pdf

Wolfram, S. (1994). *Cellular Automata and Complexity: Collected Papers.* London: Addison-Wesley.

Zahedi, F. (1996). The Analytic Hierarchy Process—A Survey of the Method and its Applications. *Interfaces, Volume 16, Issue 4,* 96-108.

Appendix 1: Survey and interviews

For this thesis, multiple meetings have been arranged with various experts and professionals in the marina business and governmental vision development.

Surveys

Institute	Stakeholder group	Contact	Function
Watersportverbond	Users/sailors	Ernst Kaars Sijpesteijn	Member Team North Sea
HISWA Association	Users/sailors	Gerdina Krijger	Manager Regional Public Affairs
Marina IJmuiden	Exploiters	Funke Kupper	Manager/Director
Marina Breskens	Exploiters	Roy van Aller	Member board Marina Breskens
Province Noord-Holland	Politicians	Rieneke Kanner	Policy Director

Interviews/meetings

Institute	Stakeholder group	Contact	Function
Watersportverbond	Users/sailors	Ernst Kaars Sijpesteijn	Member Team North Sea
HISWA Association	Users/sailors	Gerdina Krijger	Manager Regional Public Affairs
Marina IJmuiden	Exploiters	Funke Kupper	Manager/Director
Marina Breskens	Exploiters	Roy van Aller	Member board Marina Breskens
Roompot Marina	Exploiters	Jaap van Oosterom	Manager
Province Noord-Holland	Politicians	Rieneke Kanner	Policy director
Kenniscentrum Toerisme	Knowledge centre	Diana Korteweg Maris	Projectmanager
Deltaprogramma Kust	Politicians	Emmy Bolsius	Project director
Deltaprogramma Kust	Politicians	Marianne Walgreen	Project employee

Table A1.1: List of surveys and interviews and meetings

Meetings

With several stake holders meetings were held. These meeting were mostly talks about the marinas, the way in which they were organised and the analysis conducted in this study. These meetings were the basis for the list of criteria. At each meeting, the list was presented and new criteria were added and some were deleted.

A final meeting with the stake holders was held to present and discuss the final list of criteria. Also, the survey with weights was explained so the stake holders could fill the survey after discussing it with colleagues.

On the next pages, the survey can be found.

Welkom!

Welkom bij de invulenquete voor het onderzoek "Nieuwe jachthavens aan de Nederlandse Kust"
Dit onderzoek is in opdracht van het Deltaprogramma Kust, en is een afstudeeronderzoek van Jelle Gulmans.

In deze enquete wordt u gevraagd een aantal criteria met elkaar te vergelijken en te scoren. Het is belangrijk dat u het hele formulier invult. De criteria moeten voor het onderzoek worden gewaardeerd met een score. Dit gebeurd via paar-vergelijking. Hierover straks meer.

Het onderzoekt bekijkt de mogelijkheden voor nieuwe jachthavens langs de Nederlandse kust. In overleg met professionals en experts zijn er een 14-tal criteria opgesteld die het slagen van een jachthaven kunnen bepalen. Deze criteria moeten een score krijgen om zo de mate van belangrijkheid te bepalen. Hierbij hebben wij uw hulp nodig!

Het invullen van de enquete duurt ongeveer 10-15 minuten. De witte velden kunt u invullen. Overige velden zijn geblokkeerd.

Vul hier uw naam en bedrijf/instantie in:

Naam	
Bedrijf/instantie	

Volgende scherm

Welkom!

Hieronder ziet u een de opgestelde categorieën met daar achter de criteria die worden gebruikt in het onderzoek.
Ook is er een korte omschrijving bij gegeven. Tijdens het invullen kunt u altijd de beschrijving lezen door op de opmerking te klikken bij de criteria

Categorie	Criterium	Omschrijving
Achterland	Aantal inwoners	Aantal inwoners in de categorie leeftijdscategorie 35-75 (potentiele zeilers)
Achterland	Attracties (achterland)	De mogelijkheid om uitstapjes, attracties te ondernemen in de buurt (hier valt ook natuur onder)
Bereikbaarheid	Bereikbaarheid land (OV)	De beschikbaarheid van goede OV verbindingen naar de jachthaven
Bereikbaarheid	Bereikbaarheid land (wegen)	De bereikbaarheid over land: moet er worden geinvesteerd in wegen bij aanleg van een nieuwe jachthaven
Bereikbaarheid	Bereikbaarheid water	Bereikbaarheid water kijkt naar de verbindingen met het achterland over water vanaf en naar zee.
Bereikbaarheid	Veiligheid water (nabijheid van drukke beroepsvaart)	Nabijheid van drukke beroepsvaart, zoals bij Rotterdam of Ijmuiden, kan het succes van een jachthaven belemmeren.
Jachthaven	Basisfaciliteiten jachthaven	Aanwezigheid van basisfaciliteiten in de jachthaven (havenmeester, toilet- en doucheruimten, drinkwater, electra, boothelling etc.)
Jachthaven	Beschutting	Beschutting zorgt voor rustig water in de haven (door wind en golven). Dit kan natuurlijke beschutting zijn, door een baai, veel groen om de haven, maar het kan ook door hoge bebouwing om de haven te bouwen.
Jachthaven	Uitgebreide faciliteiten	Aanwezigheid van extra faciliteiten rondom de jachthaven (nautisch: bootreparatie, jachtwerf, watersportwinkel)
Voorzieningen	Overnachtingsmogelijkheden aan land	Mogelijkheid om in de nabijheid van de jachthaven te overnachten
Voorzieningen	Voorzieningen (Horeca, categorie 1)	Horeca 1: goedkope, snelle horeca zoals kantines en cafetaria's
Voorzieningen	Voorzieningen (Horeca, categorie 2)	Horeca: gezelligheids- en verblijfshoreca, zoals (eet)cafees, restaurants
Voorzieningen	Voorzieningen (winkels voor eten/drinken/ enz)	Supermarkten en andere eten- en drankwinkels
Voorzieningen	Voorzieningen (overige winkels)	Overige winkels die in bijvoorbeeld een centrum van een stad of dorp zouden zitten, geen watersportwinkels of winkels voor eten en drinken

Volgende scherm
Vorige scherm

Categorieën

Er zijn een aantal categorieën gebruikt in dit onderzoek. Kunt u deze naar mate van belangrijkheid rangschikken?

Categorie	Beschrijving
Achterland	De mogelijkheid tot het maken van uitstapjes, bezoeken van evenementen en attracties
Bereikbaarheid	De bereikbaarheid van de jachthaven over land en over water
Jachthaven	De faciliteiten en mogelijkheden in de jachthaven zelf, en jachthaven gebonden voorzieningen (als een jachtwerf en watersportwinkel)
Voorzieningen	De nabijheid van voorzieningen rondom de jachthavens

1. Meest belangrijk
2.
3.
4. Minst belangrijk

Volgende scherm
Vorige scherm

Invulhulp

LEES DEZE INSTRUCTIES ZORGVULDIG VOOR U VERDER GAAT!

In het volgende scherm ziet u zodadelijk de lijst met criteria staan. Ze moeten allemaal per paar worden vergeleken.
U ziet de volgende opmaak:

Aantal inwoners			Score
	Aantal inwoners		1
	Attracties (achterland)	☐	
	Bereikbaarheid land (OV)	☐	
	Bereikbaarheid land (wegen)	☐	
	Bereikbaarheid water (toegang vanuit zee of binnenland)	☐	
	Veiligheid water (nabijheid van drukke beroepsvaart)	☐	
	Basisfaciliteiten jachthaven	☐	
	Beschutting	☐	
	Uitgebreide faciliteiten	☐	
	Overnachtingsmogelijkheden aan land	☐	
	Voorzieningen (Horeca, categorie 1)	☐	
	Voorzieningen (Horeca, categorie 2)	☐	
	Voorzieningen (winkels voor eten/drinken/ enz)	☐	
	Voorzieningen (overige winkels)	☐	

Het is de bedoeling het criterium dat boven de reeks (hoofdcriterium) staat telkens wordt vergeleken met de ingesprongen criteria (nevencriterium).
Eerst moet worden bepaald welk criterium belangrijker is, het hoofdcriterium of het nevencriterium.
Is het nevencriterium belangrijker, vink dan de checkbox aan. Is het hoofdcriteruim belangrijker, of is er een gelijk belang, vink dan niets aan.

Geef vervolgens een score op van 1 tot 9 met de volgende schaal:

1	Gelijke belangrijkheid
3	Gematigde belangrijkhei
5	Sterke belangrijkheid
7	Erg sterke belangrijkheid
9	Extreme belangrijkheid

2,4,6 en 8 kunnen uiteraard ook worden gekozen, en gelden als tussenstap voor de hierboven beschreven waarden.

Om alle criteria per paar te kunnen vergelijken zijn er meerdere reeksen gemaakt, zodat alles vergeleken wordt. Deze reeksen staan onder elkaar.
Zorg er dus voor dat alle witte vakjes een score hebben!

Voorbeeld

In dit geval is "aantal inwoners" het hoofdcriterium die u met alle andere criteria gaat vergelijken.
Aantal inwoners is niet te vergelijken met aantal inwoners, vandaar dat hier de score 1 reeds is ingevuld (gelijke belangrijkheid).
Vervolgens gaat u de rijen af: eerst stelt u zich de vraag: welk criterium is belangrijk: aantal inwoners, of het
criterium dat in de rij wordt genoemd (in dit voorbeeld nemen we attracties)

Vraag: is aantal inwoners belangrijker of attracties?
Antwoord: attracties
Vink de checkbox aan, attracties is immers belangrijker dan inwoners.

Geef vervolgens een score van 1 tot 9, volgens de gegeven schaal.
Ga door naar het volgende criterium en vergelijk deze op dezelfde wijze.

Volgende scherm
Vorige scherm

Aantal inwoners		Score
Aantal inwoners		1
Attracties (achterland)	☐	
Bereikbaarheid land (OV)	☐	
Bereikbaarheid land (wegen)	☐	
Bereikbaarheid water (toegang vanuit zee of binnenland)	☐	
Veiligheid water (nabijheid van drukke beroepsvaart)	☐	
Basisfaciliteiten jachthaven	☐	
Beschutting	☐	
Uitgebreide faciliteiten	☐	
Overnachtingsmogelijkheden aan land	☐	
Voorzieningen (Horeca, categorie 1)	☐	
Voorzieningen (Horeca, categorie 2)	☐	
Voorzieningen (winkels voor eten/drinken/ enz)	☐	
Voorzieningen (overige winkels)	☐	

1 Gelijke belangrijkheid
3 Gematigde belangrijkhei
5 Sterke belangrijkheid
7 Erg sterke belangrijkheid
9 Extreme belangrijkheid

Ga naar invulhulp

Attracties (achterland)		Score
Attracties (achterland)		1
Bereikbaarheid land (OV)	☐	
Bereikbaarheid land (wegen)	☐	
Bereikbaarheid water (toegang vanuit zee of binnenland)	☐	
Veiligheid water (nabijheid van drukke beroepsvaart)	☐	
Basisfaciliteiten jachthaven	☐	
Beschutting	☐	
Uitgebreide faciliteiten	☐	
Overnachtingsmogelijkheden aan land	☐	
Voorzieningen (Horeca, categorie 1)	☐	
Voorzieningen (Horeca, categorie 2)	☐	
Voorzieningen (winkels voor eten/drinken/ enz)	☐	
Voorzieningen (overige winkels)	☐	

1 Gelijke belangrijkheid
3 Gematigde belangrijkhei
5 Sterke belangrijkheid
7 Erg sterke belangrijkheid
9 Extreme belangrijkheid

Ga naar invulhulp

Bereikbaarheid land (OV)		Score
Bereikbaarheid land (OV)		1
Bereikbaarheid land (wegen)	☐	
Bereikbaarheid water (toegang vanuit zee of binnenland)	☐	
Veiligheid water (nabijheid van drukke beroepsvaart)	☐	
Basisfaciliteiten jachthaven	☐	
Beschutting	☐	
Uitgebreide faciliteiten	☐	
Overnachtingsmogelijkheden aan land	☐	
Voorzieningen (Horeca, categorie 1)	☐	
Voorzieningen (Horeca, categorie 2)	☐	
Voorzieningen (winkels voor eten/drinken/ enz)	☐	
Voorzieningen (overige winkels)	☐	

1 Gelijke belangrijkheid
3 Gematigde belangrijkhei
5 Sterke belangrijkheid
7 Erg sterke belangrijkheid
9 Extreme belangrijkheid

Ga naar invulhulp

Bereikbaarheid land (wegen)		Score
Bereikbaarheid land (wegen)		1
Bereikbaarheid water (toegang vanuit zee of binnenland)	☐	
Veiligheid water (nabijheid van drukke beroepsvaart)	☐	
Basisfaciliteiten jachthaven	☐	
Beschutting	☐	
Uitgebreide faciliteiten	☐	
Overnachtingsmogelijkheden aan land	☐	
Voorzieningen (Horeca, categorie 1)	☐	
Voorzieningen (Horeca, categorie 2)	☐	
Voorzieningen (winkels voor eten/drinken/ enz)	☐	
Voorzieningen (overige winkels)	☐	

1 Gelijke belangrijkheid
3 Gematigde belangrijkhei
5 Sterke belangrijkheid
7 Erg sterke belangrijkheid
9 Extreme belangrijkheid

Ga naar invulhulp

Bereikbaarheid water (toegang vanuit zee of binnenland)		Score
Bereikbaarheid water (toegang vanuit zee of binnenland)		1
Veiligheid water (nabijheid van drukke beroepsvaart)	☐	
Basisfaciliteiten jachthaven	☐	
Beschutting	☐	
Uitgebreide faciliteiten	☐	
Overnachtingsmogelijkheden aan land	☐	
Voorzieningen (Horeca, categorie 1)	☐	
Voorzieningen (Horeca, categorie 2)	☐	
Voorzieningen (winkels voor eten/drinken/ enz)	☐	
Voorzieningen (overige winkels)	☐	

1 Gelijke belangrijkheid
3 Gematigde belangrijkhei
5 Sterke belangrijkheid
7 Erg sterke belangrijkheid
9 Extreme belangrijkheid

Ga naar invulhulp

Veiligheid water (nabijheid van drukke beroepsvaart)		Score
Veiligheid water (nabijheid van drukke beroepsvaart)		1
Basisfaciliteiten jachthaven	☐	
Beschutting	☐	
Uitgebreide faciliteiten	☐	
Overnachtingsmogelijkheden aan land	☐	
Voorzieningen (Horeca, categorie 1)	☐	
Voorzieningen (Horeca, categorie 2)	☐	
Voorzieningen (winkels voor eten/drinken/ enz)	☐	
Voorzieningen (overige winkels)	☐	

1 Gelijke belangrijkheid
3 Gematigde belangrijkhei
5 Sterke belangrijkheid
7 Erg sterke belangrijkheid
9 Extreme belangrijkheid

Ga naar invulhulp

Basisfaciliteiten jachthaven (havenmeester, toilet- en doucheruimten, drinkwater, electra, boothelling etc.)		Score
Basisfaciliteiten jachthaven		1
Beschutting	☐	
Uitgebreide faciliteiten	☐	
Overnachtingsmogelijkheden aan land	☐	
Voorzieningen (Horeca, categorie 1)	☐	
Voorzieningen (Horeca, categorie 2)	☐	
Voorzieningen (winkels voor eten/drinken/ enz)	☐	
Voorzieningen (overige winkels)	☐	

1 Gelijke belangrijkheid
3 Gematigde belangrijkhei
5 Sterke belangrijkheid
7 Erg sterke belangrijkheid
9 Extreme belangrijkheid

Ga naar invulhulp

Beschutting		Score		
Beschutting		1	1	Gelijke belangrijkheid
Uitgebreide faciliteiten	☐		3	Gematigde belangrijkhei
Overnachtingsmogelijkheden aan land	☐		5	Sterke belangrijkheid
Voorzieningen (Horeca, categorie 1)	☐		7	Erg sterke belangrijkheid
Voorzieningen (Horeca, categorie 2)	☐		9	Extreme belangrijkheid
Voorzieningen (winkels voor eten/drinken/ enz)	☐			Ga naar invulhulp
Voorzieningen (overige winkels)	☐			

Uitgebreide faciliteiten (nautisch: bootreparatie, jachtwerf, watersportwinkel)		Score		
Uitgebreide faciliteiten		1	1	Gelijke belangrijkheid
Overnachtingsmogelijkheden aan land	☐		3	Gematigde belangrijkhei
Voorzieningen (Horeca, categorie 1)	☐		5	Sterke belangrijkheid
Voorzieningen (Horeca, categorie 2)	☐		7	Erg sterke belangrijkheid
Voorzieningen (winkels voor eten/drinken/ enz)	☐		9	Extreme belangrijkheid
Voorzieningen (overige winkels)	☐			Ga naar invulhulp

Overnachtingsmogelijkheden aan land		Score		
Overnachtingsmogelijkheden aan land		1	1	Gelijke belangrijkheid
Voorzieningen (Horeca, categorie 1)	☐		3	Gematigde belangrijkhei
Voorzieningen (Horeca, categorie 2)	☐		5	Sterke belangrijkheid
Voorzieningen (winkels voor eten/drinken/ enz)	☐		7	Erg sterke belangrijkheid
Voorzieningen (overige winkels)	☐		9	Extreme belangrijkheid

Ga naar invulhulp

Voorzieningen (Horeca, categorie 1: cafetaria, kantine)		Score
Voorzieningen (Horeca, categorie 1)		1
Voorzieningen (Horeca, categorie 2)	☐	
Voorzieningen (winkels voor eten/drinken/ enz)	☐	
Voorzieningen (overige winkels)	☐	

Voorzieningen (Horeca, categorie 2: (eet)cafees, restaurants)		Score
Voorzieningen (Horeca, categorie 2)		1
Voorzieningen (winkels voor eten/drinken/ enz)	☐	
Voorzieningen (overige winkels)	☐	

Voorzieningen (winkels voor eten/drinken/ enz)		Score
Voorzieningen (winkels voor eten/drinken/ enz)		1
Voorzieningen (overige winkels)	☐	

Voorzieningen (winkels: geen watersportwinkels, geen winkels voor eten en drinken)	Score
Voorzieningen (overige winkels)	1

Volgende scherm
Vorige scherm

Bedankt!

Bedankt voor het invullen!

Sla de volledige excel op, en stuur deze retour naar
jelle.gulmans@minienm.nl
met een CC naar jelle.gulmans@gmail.com

IJMUIDEN	1 Inhabs	2 Attractions	3 Public Trans	4 Roads	5 Water	6 Safety	7 Basic	8 Shelter	9 Extended	10 Acco	11 Horeca 1	12 Horeca 2	13 Shops	14 Other
1 Inhabs	1,00	5,00	0,25	0,17	0,13	5,00	6,00	7,00	8,00	5,00	0,17	0,20	0,13	0,50
2 Attractions	0,20	1,00	2,00	0,20	0,50	5,00	5,00	6,00	5,00	7,00	0,17	0,20	0,20	7,00
3 Public Trans	4,00	0,50	1,00	5,00	5,00	5,00	5,00	0,14	5,00	5,00	5,00	5,00	5,00	5,00
4 Roads	6,00	5,00	0,20	1,00	1,00	4,00	2,00	0,33	5,00	3,00	2,00	2,00	2,00	5,00
5 Water	8,00	2,00	0,20	1,00	1,00	5,00	5,00	0,20	5,00	5,00	5,00	5,00	5,00	5,00
6 Safety	0,20	0,20	0,20	0,25	0,20	1,00	5,00	0,20	5,00	6,00	6,00	5,00	4,00	5,00
7 Basic	0,17	0,20	0,20	0,50	0,20	0,20	1,00	0,50	6,00	5,00	6,00	5,00	4,00	4,00
8 Shelter	0,14	0,17	7,00	3,00	5,00	5,00	2,00	1,00	4,00	5,00	5,00	6,00	6,00	5,00
9 Extended	0,13	0,20	0,20	0,20	0,20	0,20	0,17	0,25	1,00	4,00	5,00	4,00	3,00	5,00
10 Acco	0,20	0,14	0,20	0,33	0,20	0,17	0,20	0,20	0,25	1,00	4,00	4,00	5,00	4,00
11 Horeca 1	6,00	6,00	0,20	0,50	0,20	0,17	0,17	0,20	0,20	0,25	1,00	4,00	5,00	4,00
12 Horeca 2	5,00	5,00	0,20	0,50	0,20	0,20	0,20	0,17	0,25	0,25	0,25	1,00	4,00	5,00
13 Shops	8,00	5,00	0,20	0,50	0,20	0,25	0,25	0,17	0,33	0,20	0,20	0,25	1,00	4,00
14 Other	2,00	0,14	0,20	0,20	0,20	0,20	0,25	0,20	0,20	0,25	0,25	0,20	0,25	1,00

Scoring results of the different survey groups.

In the left corner, the survey is indicated. The yellow area gives the scores derived from the survey. The white are is the score found by dividing 1 through the yellow score.

These matrices are squared to get the eigenvectors until the difference between sequent eigenvectors do not change within a four decimal range.

Breskens

	1 Inhabs	2 Attractions	3 Public Trans	4 Roads	5 Water	6 Safety	7 Basic	8 Shelter	9 Extended	10 Acco	11 Horeca 1	12 Horeca 2	13 Shops	14 Other
1 Inhabs	1,00	0,33	0,20	0,20	0,14	0,11	0,14	0,20	0,14	1,00	0,14	0,20	0,14	0,33
2 Attractions	0,20	1,00	0,33	0,33	0,14	0,11	0,14	0,20	0,14	1,00	0,14	0,20	0,14	1,00
3 Public Trans	4,00	3,00	1,00	1,00	0,14	0,11	0,14	0,20	0,14	3,00	0,14	0,20	0,14	3,00
4 Roads	5,00	3,00	1,00	1,00	0,14	0,11	0,14	0,20	0,14	3,00	0,14	0,20	7,00	3,00
5 Water	7,00	7,00	7,00	7,00	1,00	0,33	1,00	3,00	1,00	5,00	1,00	3,00	1,00	3,00
6 Safety	9,00	9,00	9,00	9,00	3,00	1,00	3,00	5,00	3,00	7,00	3,00	5,00	3,00	7,00
7 Basic	7,00	7,00	7,00	7,00	1,00	0,33	1,00	3,00	1,00	5,00	1,00	3,00	1,00	3,00
8 Shelter	5,00	5,00	5,00	5,00	0,33	0,20	0,33	1,00	0,33	5,00	0,20	0,33	0,20	7,00
9 Extended	7,00	7,00	7,00	7,00	1,00	0,33	1,00	3,00	1,00	7,00	0,33	1,00	0,33	5,00
10 Acco	1,00	1,00	0,33	0,33	0,20	0,14	0,20	0,20	0,14	1,00	0,20	0,14	0,20	0,33
11 Horeca 1	7,00	7,00	7,00	7,00	1,00	0,33	1,00	5,00	3,00	5,00	1,00	3,00	1,00	3,00
12 Horeca 2	5,00	5,00	5,00	5,00	0,33	0,20	0,33	3,00	1,00	7,00	0,33	1,00	0,33	3,00
13 Shops	7,00	7,00	7,00	0,14	1,00	0,33	1,00	5,00	3,00	5,00	1,00	3,00	1,00	3,00
14 Other	3,00	1,00	0,33	0,33	0,33	0,14	0,33	0,14	0,20	3,00	0,33	0,33	0,33	1,00

Watersport-bond

	1 Inhabs	2 Attractions	3 Public Trans	4 Roads	5 Water	6 Safety	7 Basic	8 Shelter	9 Extended	10 Acco	11 Horeca 1	12 Horeca 2	13 Shops	14 Other
1 Inhabs	1,00	3,00	5,00	5,00	9,00	3,00	5,00	7,00	5,00	3,00	1,00	7,00	1,00	1,00
2 Attractions	0,20	1,00	5,00	5,00	9,00	3,00	5,00	9,00	5,00	3,00	1,00	7,00	1,00	1,00
3 Public Trans	4,00	0,20	1,00	3,00	9,00	3,00	5,00	9,00	5,00	1,00	1,00	5,00	3,00	1,00
4 Roads	0,20	0,20	0,33	1,00	3,00	0,13	0,50	6,00	3,00	3,00	2,00	2,00	1,00	1,00
5 Water	0,11	0,11	0,11	0,33	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
6 Safety	0,33	0,33	0,33	8,00	1,00	1,00	1,00	9,00	1,00	1,00	1,00	3,00	3,00	1,00
7 Basic	0,20	0,20	0,20	2,00	1,00	1,00	1,00	9,00	1,00	1,00	1,00	5,00	3,00	1,00
8 Shelter	0,14	0,11	0,11	0,17	1,00	0,11	0,11	1,00	1,00	1,00	1,00	1,00	1,00	1,00
9 Extended	0,20	0,20	0,20	0,33	1,00	1,00	1,00	1,00	1,00	1,00	1,00	3,00	3,00	1,00
10 Acco	0,33	0,33	1,00	0,33	1,00	1,00	1,00	1,00	1,00	1,00	3,00	5,00	3,00	1,00
11 Horeca 1	1,00	1,00	1,00	0,50	1,00	1,00	1,00	1,00	1,00	0,33	1,00	5,00	3,00	1,00
12 Horeca 2	0,14	0,14	0,20	0,50	1,00	0,33	0,20	1,00	0,33	0,20	0,20	1,00	1,00	1,00
13 Shops	1,00	1,00	0,33	1,00	1,00	0,33	0,33	1,00	0,33	0,33	0,33	1,00	1,00	1,00
14 Other	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00

HISWA	1 Inhabs	2 Attractions	3 Public Trans	4 Roads	5 Water	6 Safety	7 Basic	8 Shelter	9 Extended	10 Acco	11 Horeca 1	12 Horeca 2	13 Shops	14 Other
1 Inhabs	1,00	0,33	0,17	0,14	0,17	0,13	0,14	0,13	0,13	0,33	0,20	0,33	0,25	1,00
2 Attractions	0,20	1,00	1,00	1,00	1,00	0,14	0,14	0,14	0,13	0,17	0,14	0,17	0,17	5,00
3 Public Trans	4,00	1,00	1,00	0,50	1,00	0,14	0,14	0,13	0,14	3,00	0,20	3,00	0,25	2,00
4 Roads	7,00	1,00	2,00	1,00	0,33	0,17	0,33	0,17	0,14	6,00	0,33	5,00	0,33	7,00
5 Water	6,00	1,00	1,00	3,00	1,00	0,13	0,14	0,20	0,20	1,00	0,20	0,50	0,25	1,00
6 Safety	8,00	7,00	7,00	6,00	8,00	1,00	0,33	0,20	0,33	5,00	1,00	3,00	1,00	8,00
7 Basic	7,00	7,00	7,00	3,00	7,00	3,00	1,00	0,50	1,00	8,00	2,00	5,00	3,00	8,00
8 Shelter	8,00	7,00	8,00	6,00	5,00	5,00	2,00	1,00	2,00	8,00	2,00	4,00	2,00	8,00
9 Extended	8,00	8,00	7,00	7,00	5,00	3,00	1,00	0,50	1,00	6,00	1,00	2,00	1,00	6,00
10 Acco	3,00	6,00	0,33	0,17	1,00	0,20	0,13	0,13	0,17	1,00	0,13	0,50	0,33	2,00
11 Horeca 1	5,00	7,00	5,00	3,00	5,00	1,00	0,50	0,50	1,00	8,00	1,00	5,00	1,00	6,00
12 Horeca 2	3,00	6,00	0,33	0,20	2,00	0,33	0,20	0,25	0,50	2,00	0,20	1,00	0,17	2,00
13 Shops	4,00	6,00	4,00	3,00	4,00	1,00	0,33	0,50	1,00	3,00	1,00	6,00	1,00	5,00
14 Other	1,00	0,20	0,50	0,14	1,00	0,13	0,13	0,13	0,17	0,50	0,17	0,50	0,20	1,00

Noord-Holland

	1 Inhabs	2 Attractions	3 Public Trans	4 Roads	5 Water	6 Safety	7 Basic	8 Shelter	9 Extended	10 Acco	11 Horeca 1	12 Horeca 2	13 Shops	14 Other
1 Inhabs	1,00	0,33	3,00	3,00	0,14	0,20	0,20	0,33	0,33	0,33	0,33	1,00	0,20	1,00
2 Attractions	0,20	1,00	0,50	0,50	0,20	0,20	0,14	0,20	1,00	1,00	0,20	2,00	0,20	1,00
3 Public Trans	4,00	2,00	1,00	0,50	0,20	0,20	0,14	0,20	2,00	1,00	0,33	1,00	0,20	1,00
4 Roads	0,33	2,00	2,00	1,00	0,20	0,20	0,20	0,20	1,00	1,00	0,20	2,00	0,20	1,00
5 Water	7,00	5,00	5,00	5,00	1,00	0,50	0,33	1,00	1,00	1,00	1,00	1,00	0,33	1,00
6 Safety	5,00	5,00	5,00	5,00	2,00	1,00	0,20	3,00	3,00	1,00	2,00	1,00	3,00	2,00
7 Basic	5,00	7,00	7,00	5,00	3,00	5,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
8 Shelter	3,00	5,00	5,00	5,00	1,00	0,33	1,00	1,00	1,00	1,00	0,50	1,00	0,50	1,00
9 Extended	3,00	1,00	0,50	1,00	1,00	0,33	1,00	1,00	1,00	1,00	1,00	1,00	2,00	1,00
10 Acco	3,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	0,20	1,00	0,20	2,00
11 Horeca 1	3,00	5,00	3,00	5,00	1,00	0,50	1,00	2,00	1,00	5,00	1,00	1,00	0,50	1,00
12 Horeca 2	1,00	0,50	1,00	0,50	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	0,20	1,00
13 Shops	5,00	5,00	5,00	5,00	3,00	0,33	1,00	2,00	0,50	5,00	2,00	5,00	1,00	1,00
14 Other	1,00	1,00	1,00	1,00	1,00	0,50	1,00	1,00	1,00	0,50	1,00	1,00	1,00	1,00

Appendix 2: Travel times between marinas and gap identification

Excisiting marinas		Excisiting marinas								Possibilities gap 1			Possibilities gap 2				
		Cad-zand	Bres-kens	Vlissin gen	Room-pot	Stellen-dam	Schev-eningen	Ijmui-den	Den Helder	Zand-voort	Noord-wijk	Kat-wijk	Callants -oog	Pet-ten	Ber-gen	Eg-mond	Wijk aan Zee
	Cadzand	-	1,5	1,8	4,4	9,4	14,4	19,7	26,8	13,3	11,6	11,0	24,6	23,7	22,6	22,0	20,5
	Breskens	1,5	-	0,7	4,4	9,4	14,4	19,7	26,8	13,3	11,6	11,0	24,6	23,7	22,6	22,0	20,5
	Vlissing-en	1,8	0,7	-	4,0	8,9	14,0	19,3	26,3	12,9	11,1	10,6	24,2	23,3	22,1	21,5	20,0
	Roompot	4,4	4,4	4,0	-	**5,0**	10,0	15,3	22,4	14,1	12,3	11,8	20,2	19,3	18,2	17,6	16,1
	Stellen-dam	9,5	9,5	9,1	**5,0**	-	5,0	10,3	17,4	9,0	7,2	6,6	15,3	14,3	13,2	12,6	11,1
	Scheve-ningen	14,5	14,5	14,1	10,1	5,0	-	**5,3**	12,3	3,9	2,2	1,6	10,2	9,3	8,1	7,5	6,0
	Ijmuiden	19,6	19,6	19,2	15,2	10,1	**5,3**	-	**7,0**	1,4	3,1	3,7	4,9	4,0	2,8	2,2	0,7
	Den Helder	26,7	26,7	26,2	22,3	17,1	12,1	**7,0**	-	8,4	10,2	10,7	2,1	3,1	4,2	4,8	6,3

Excisiting marinas

Possibilities gap one

Possibilities gap two

distances above 5 hours

distances between 4,1 and 5 hours

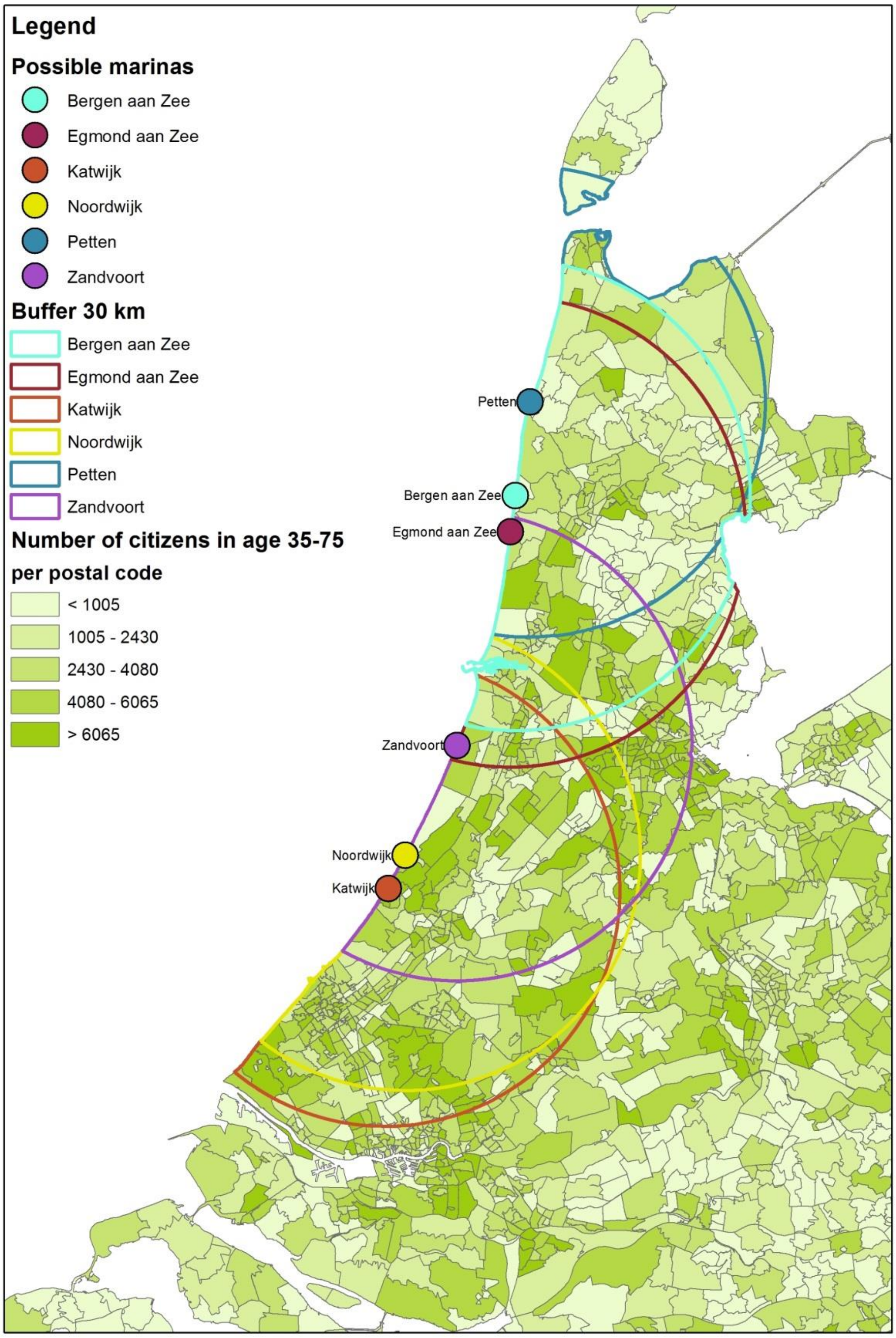
Distances of 4 hours or less

Gap identification

Appendix 3: Spatial datasets

Criterion 1: Number of inhabitants

Number of inhabitants per postal code, including a 30 km buffer around the possible marina.

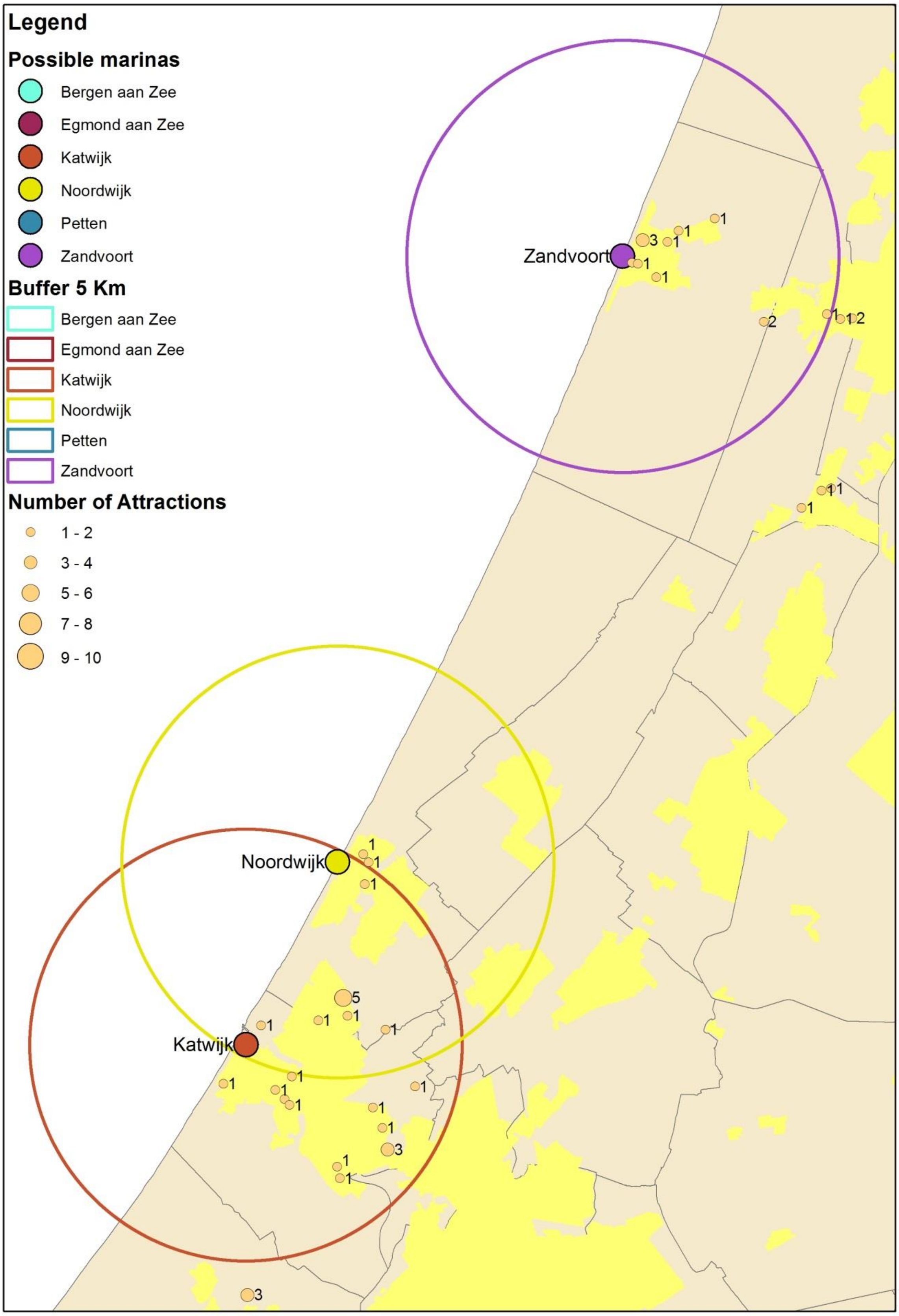


The statistics were derived by selecting all the postal codes in the buffer, and calculating the number of people in the age of 35-75 and summing them up. This is based on a join with a CBS Population statistics table (CBS Statline, 2013).

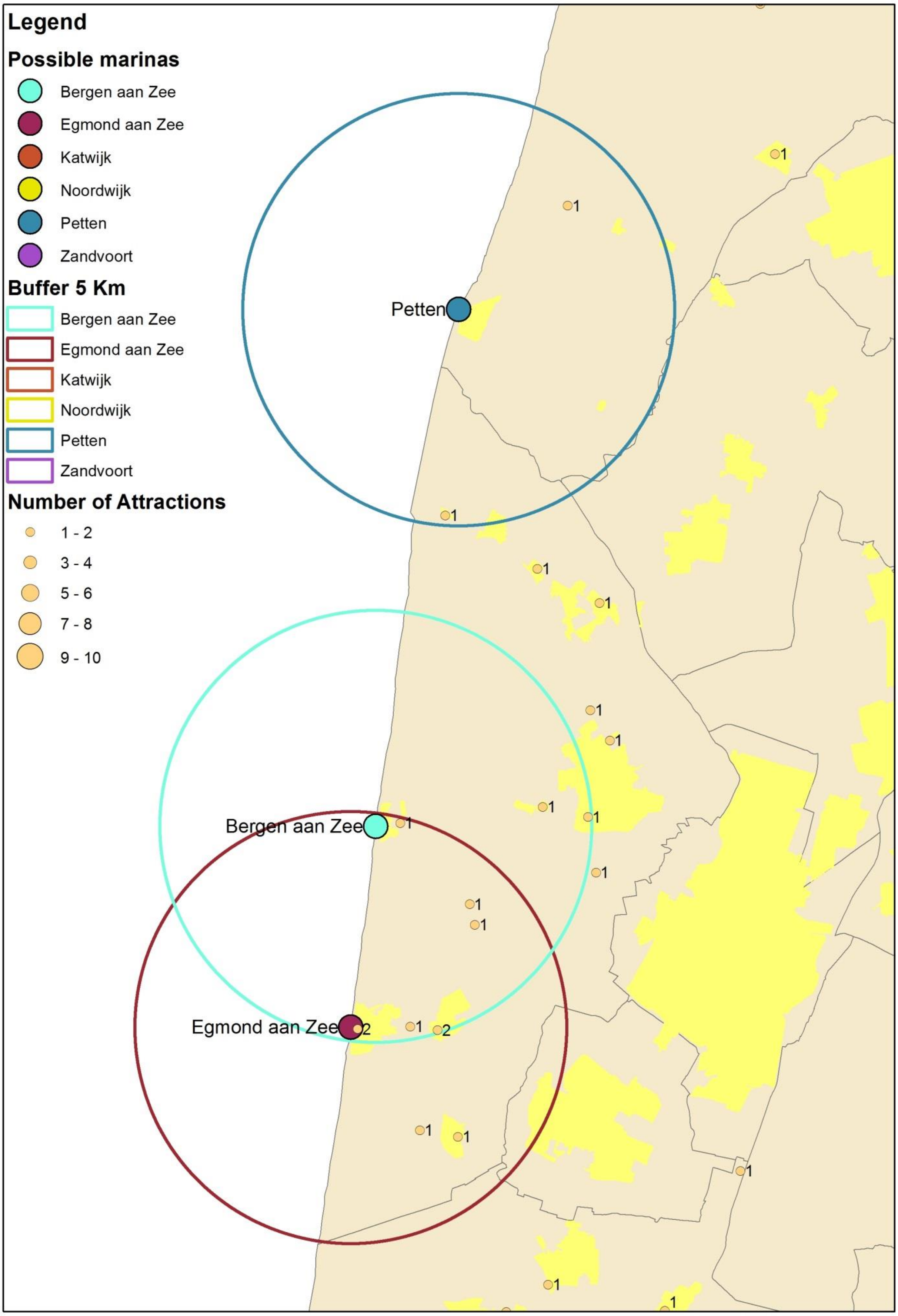
The 30km buffer was set after a discussion with marina owners and users. The spatial dataset lists all inhabitants in the age of 35-75 in 2012. However, only a small portion of these people are seen as potential sailors. Unfortunately, the percentage is not known, and should require additional research. This research has been proposed to the Watersportverbond.

Criterion 2: Number of attractions

Number of attractions within a vicinity of 5 kilometres, gap one.

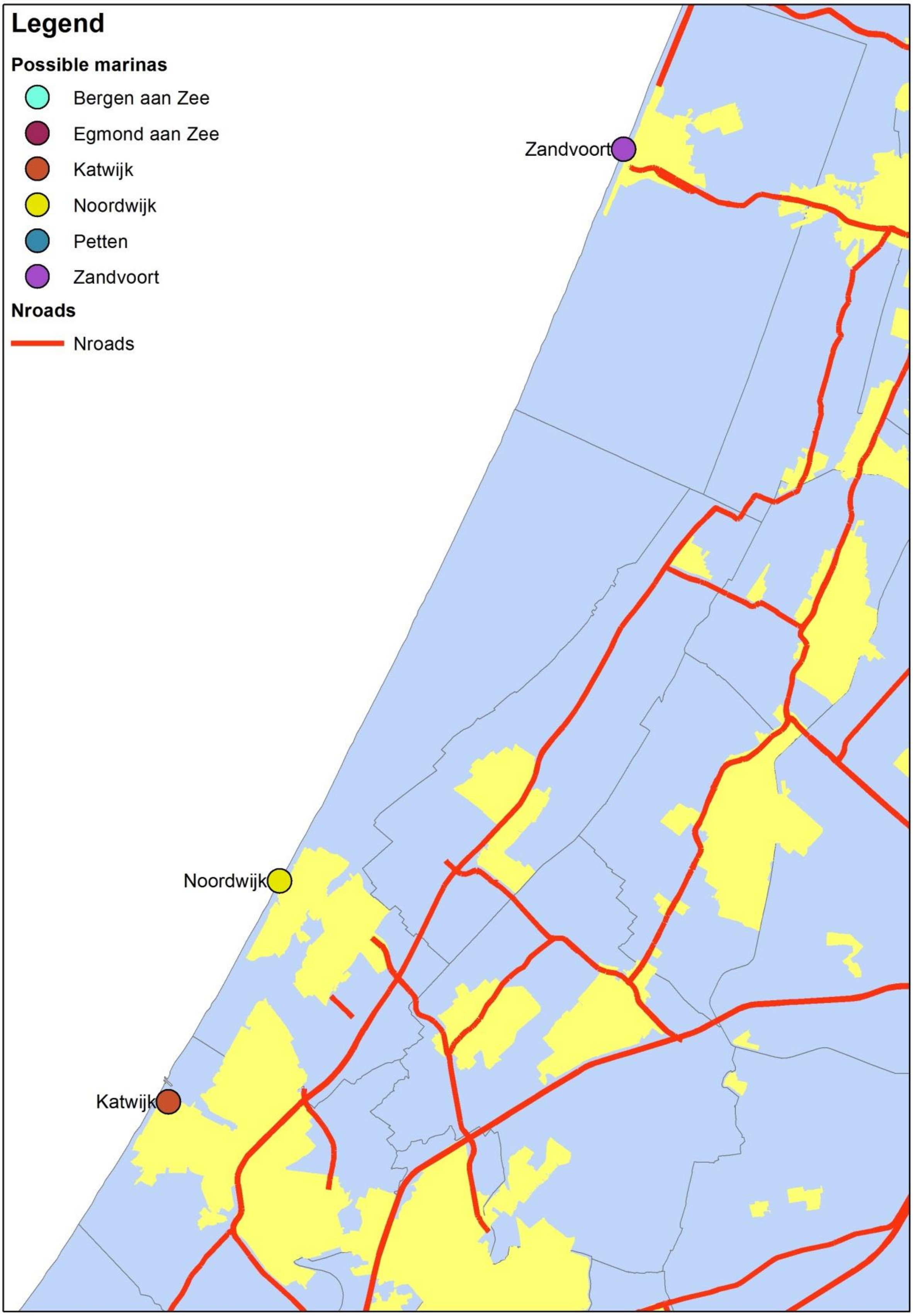


Number of attractions within a vicinity of 5 kilometres, gap two

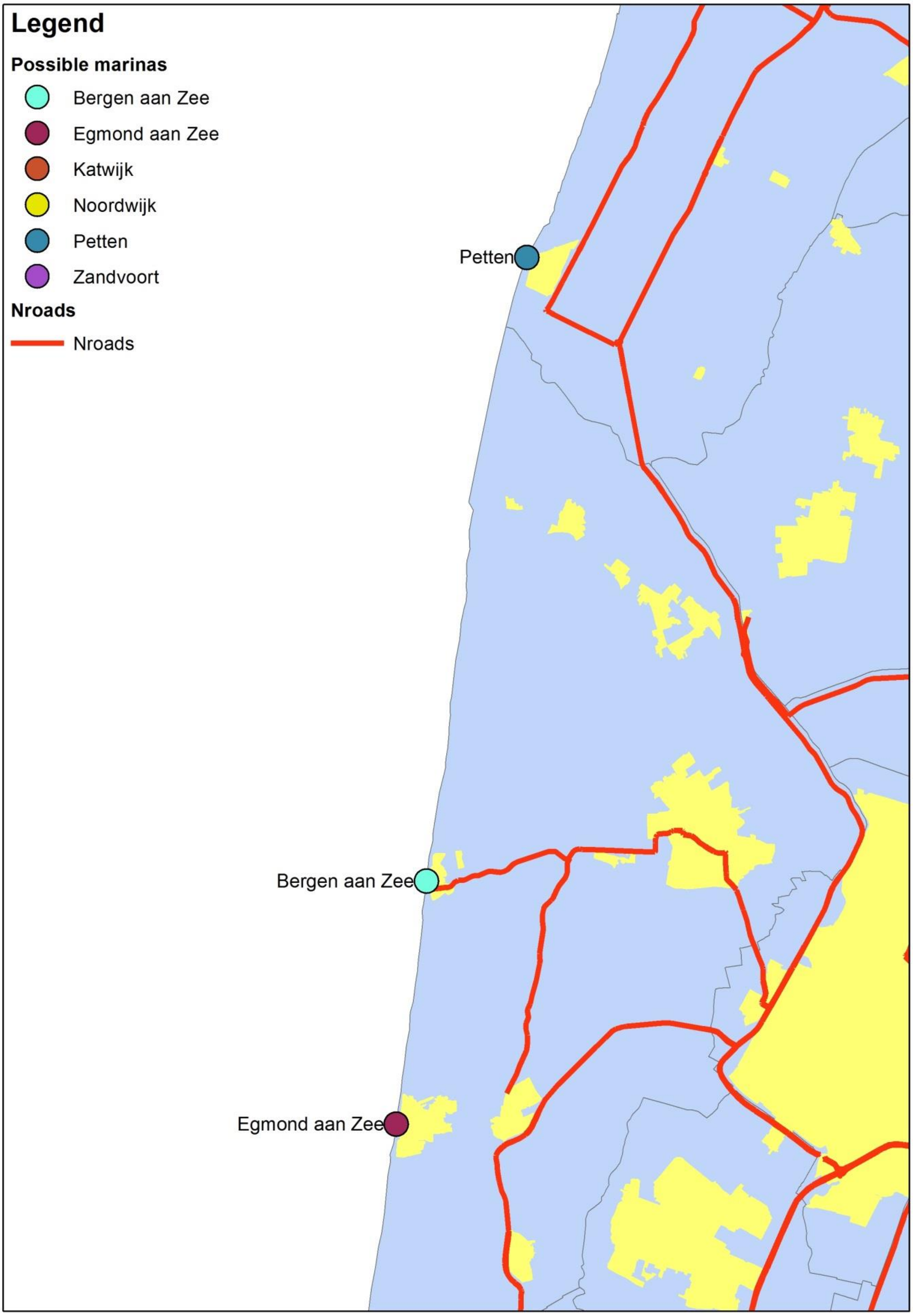


Criterion 4: Accessibility Roads

Distance to N-Roads (measurement done in ArcGIS, gap one

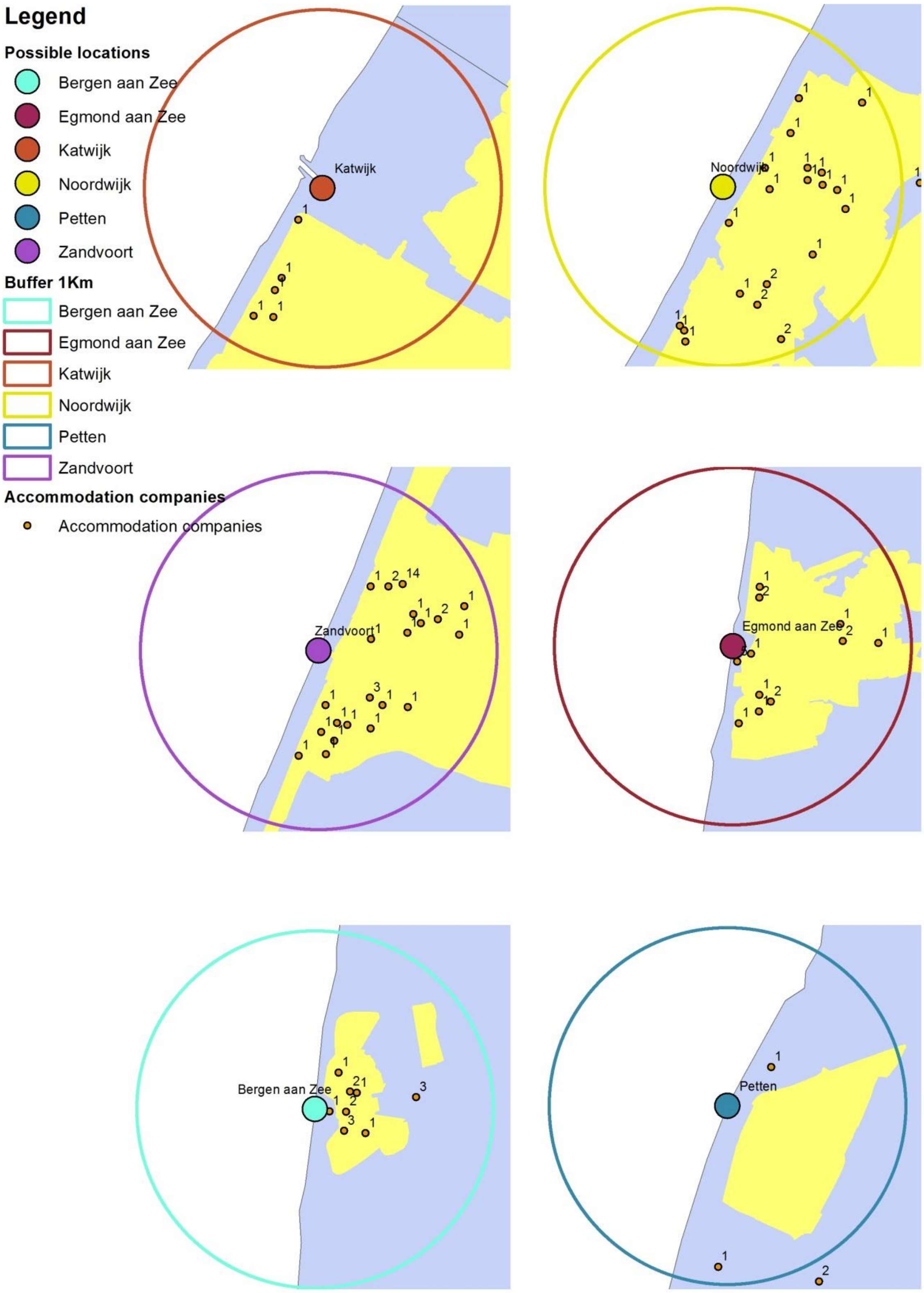


Distance to N-Roads (measurement done in ArcGIS, gap one



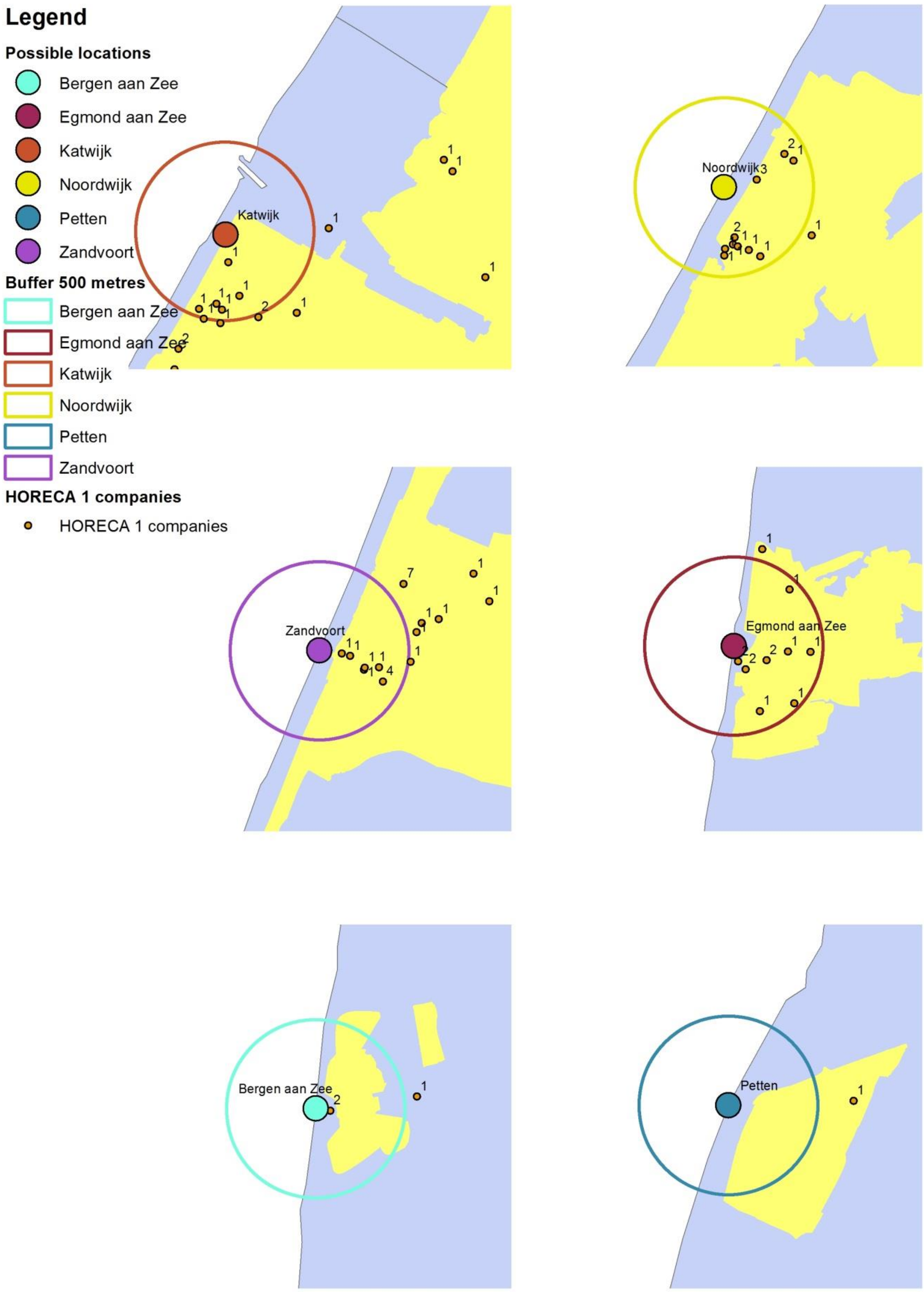
Criterion 10: Accommodation possibilities

Number of accommodation companies within 1 km distance



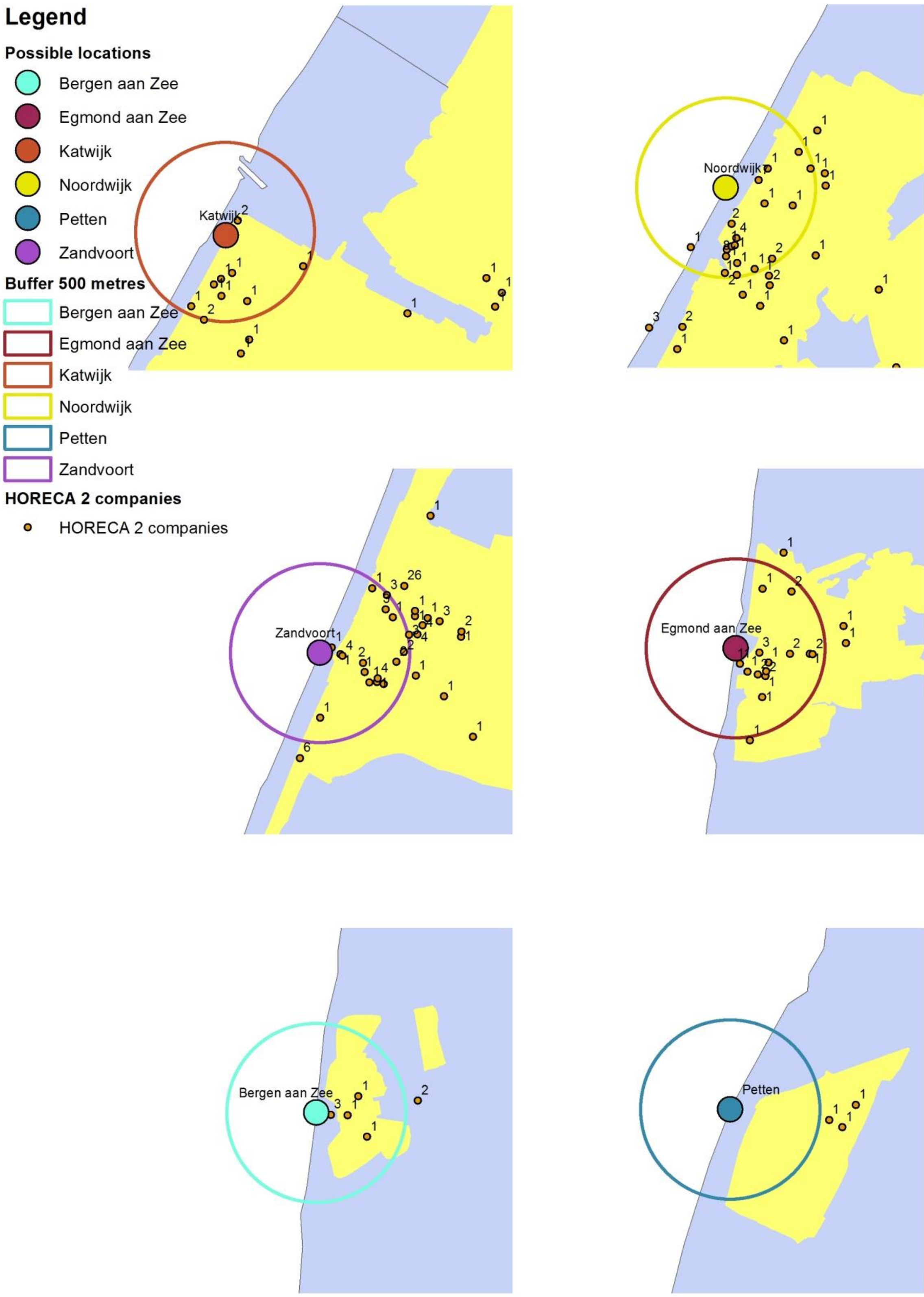
Criterion 11: HORECA 1

Number of HORECA 1 companies within 500 metres



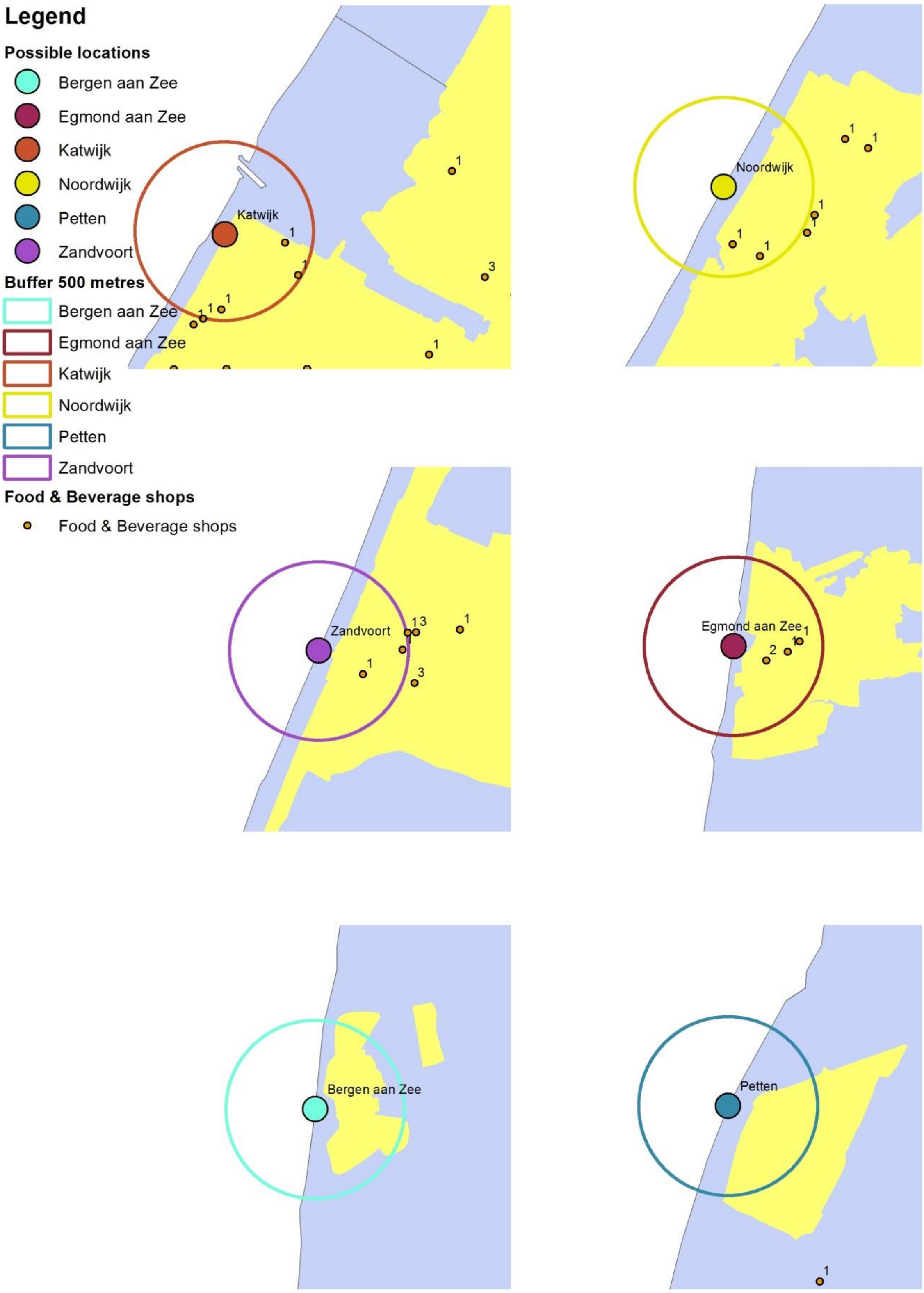
Criterion 12: HORECA 2

Number of HORECA 2 companies within 500 metres



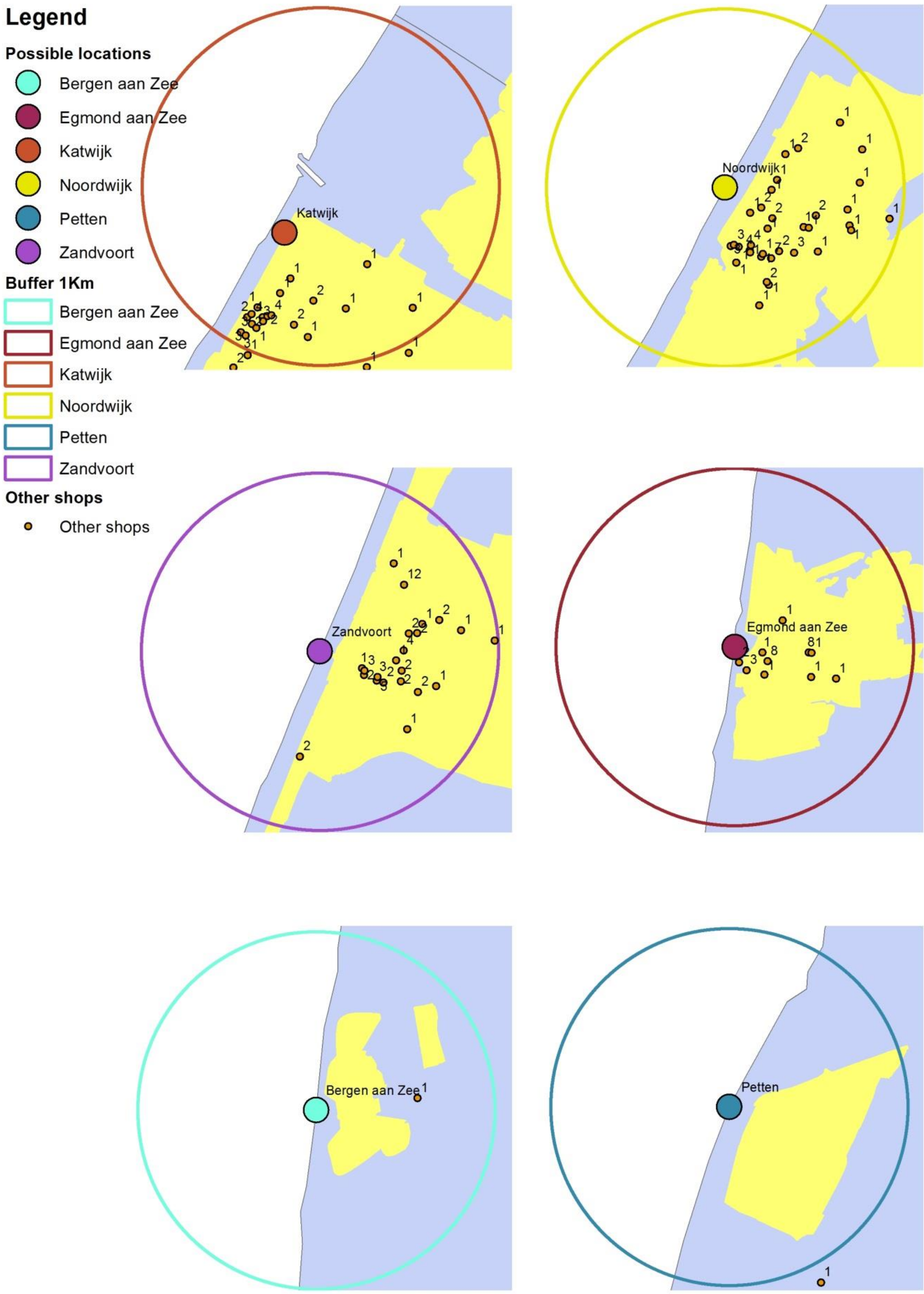
Criterion 13: Food & Beverage shops

Number of food & beverage shops within 500 metres



Criterion 14: Other shops

Number of other shops within 1 km

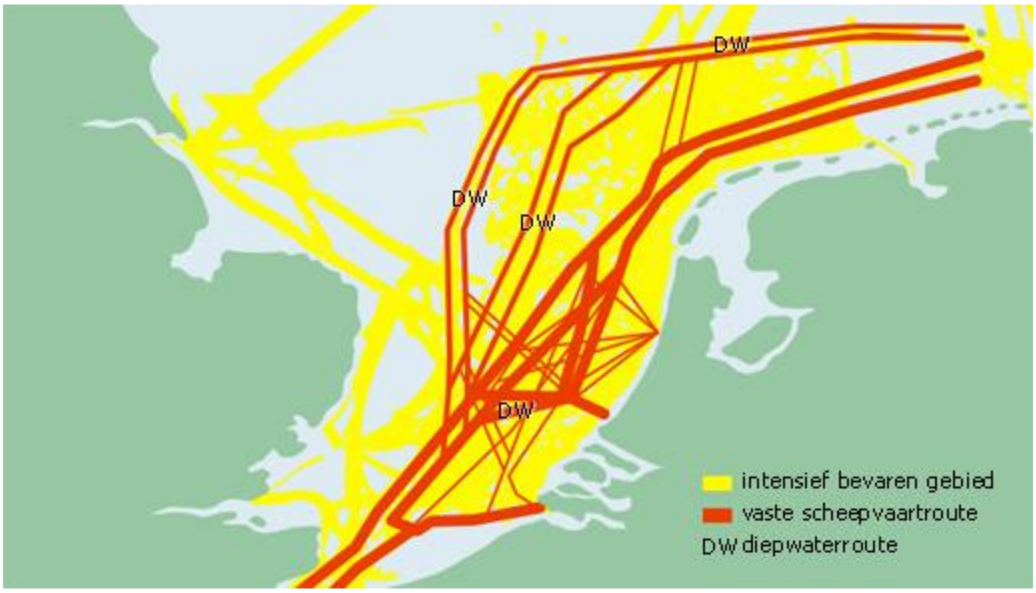


The above mentioned criteria were pre-processed in ArcGIS. For the criteria with a buffer, the statistics option was used in combination with a selection of attributes by location. For the attraction criterion, each alternative gained one extra attraction for nature.

Criterion 3 (Accessibility PT), is derived from www.9292.nl.

Criterion 5 (Accessibility Water) is derived from Google Maps.

Criterion 6 (Water safety) is derived from the following map:



Source: www.zeeinzicht.nl

Criterion 7 (basic marina facilities) is based on the companies on rentals of bikes and scooters, and on shops in water sports.. Other facilities should be implemented in the marina itself. Only Katwijk and Egmond had some rental shops for bikes, scooters and motorcycles in the vicinity. Furthermore, both had shops for water sports.

Criterion 8 (shelter) is based on Kustlijnkaarten 2012, a book by the ministry of Infrastructure and Planning/Rijkswaterstaat of the Netherlands.

Criterion 9 (extended facilities) is based on companies in yachting, repairing and construction of boats. These companies are not in the vicinity yet.

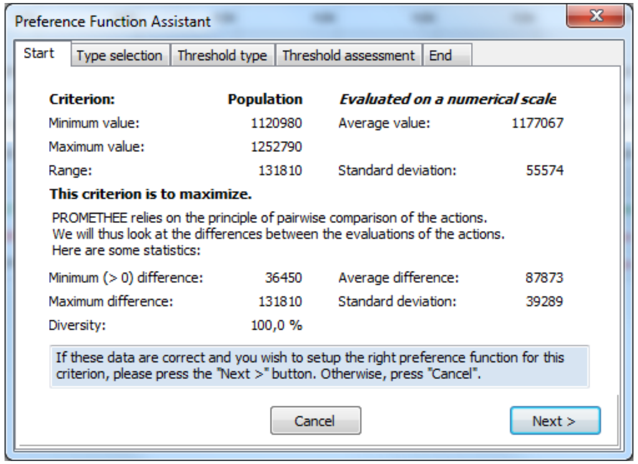
Appendix 4: Model building

Marina Breskens	Population	Attractions	Accessibility I...	Accessibility ...	Accessibility ...	Veiligheid wa...	Basic Marina	Shelter	Extended fa...	Accomodatio...	Facilities Hor...	Facilities Hor...	Facilities Sho...	Facilities oth...
Unit	people	unit	public tp	unit	y/n	Water	impact	Shelter	impact	number of	impact	unit	unit	unit
Cluster/Group														
Preferences														
Min/Max	max	max	max	min	max	max	max	min	min	max	max	max	max	max
Weight	0,01	0,01	0,02	0,06	0,11	0,21	0,11	0,06	0,09	0,01	0,12	0,07	0,10	0,02
Preference Fn.	Linear	Linear	Usual	Linear	Usual	Usual	Usual	Usual	Usual	V-shape	V-shape	V-shape	Linear	Linear
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	39289	4	n/a	0,03	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0,47	0,03
- P: Preference	127162	12	n/a	0,25	n/a	n/a	n/a	n/a	n/a	29,87	5,69	28,54	1,14	0,25
- S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics														
Minimum	1120980	13	2,00	0,10	0,00	2,00	1,00	1,00	1,00	5,00	9,00	6,00	2,00	47,00
Maximum	1252790	25	4,00	3,60	1,00	3,00	3,00	3,00	1,00	38,00	14,00	34,00	3,00	58,00
Average	1177067	18	3,00	1,63	0,33	2,33	1,67	2,00	1,00	22,00	10,67	23,00	2,33	52,67
Standard Dev.	55574	5	0,82	1,46	0,47	0,47		0,82	0,00	13,49	2,36	12,19	0,47	4,50
Evaluations														
Katwijk aan Zee	1252790	25	every 15 mins	1,20	yes	Safe	moderate	Easy	very low	5,00	9,00	6,00	3,00	47,00
Noordwijk aan Zee	1120980	15	every 30 mins	3,60	no	Moderate	very low	Difficult	very low	23,00	14,00	34,00	2,00	58,00
Zandvoort aan Zee	1157430	13	often/multiple	0,10	no	Moderate	very low	Moderate	very low	38,00	9,00	29,00	2,00	53,00

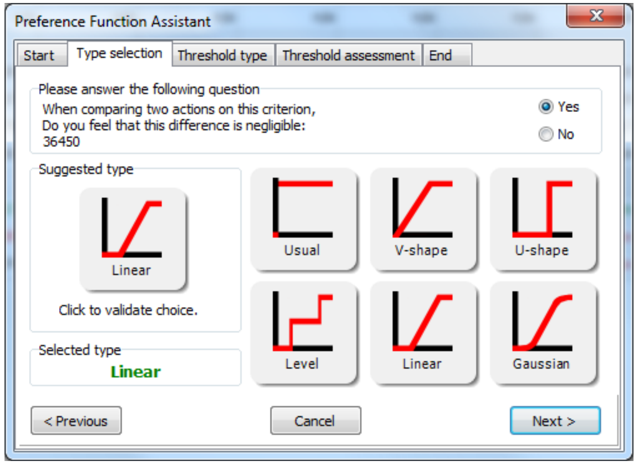
1. Survey selection
2. Criterion
3. Weights
4. Preference function and thresholds (see section “Selecting preference function and thresholds” in this appendix as well)
5. Alternatives (called evaluations in programme)
6. Values of criterion per alternative

Selecting preference function and thresholds

Step 1: overview of inserted data

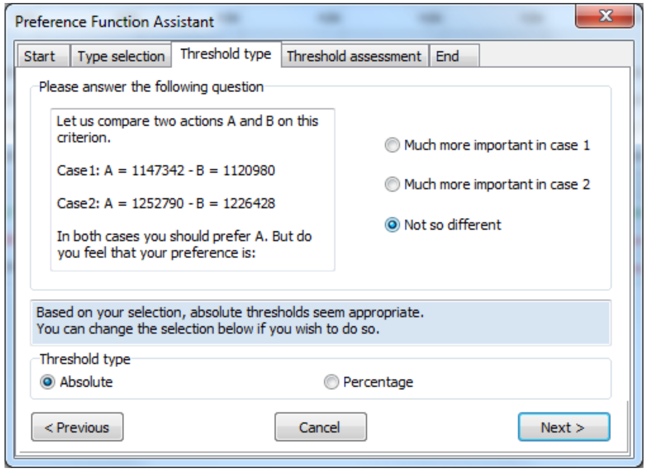


Step 2: selecting the function by answering a simple question

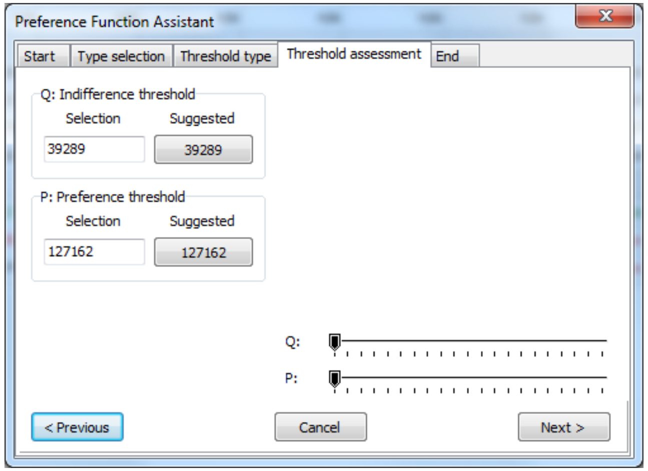


De preference function is based on the information inserted in the model. In this study linear, usual and V-shape are used.

Step 3: Threshold type (absolute or percentage) by answering a simple question



Step 4: assigning the indifference en preference threshold



Step 5: applying parameters to model

Appendix 5: Inserted values in the model

		Population	Attractions	Accessibility l...	Accessibility ...	Accessibility ...	Veiligheid wa...	Basic Marina	Shelter	Extended fa...	Accomodatio...	Facilities Hor...	Facilities Hor...	Facilities Sho...	Facilities oth...
Unit		people	unit	public tp	unit	y/n	Water	impact	Shelter	impact	number of	impact	unit	unit	unit
Cluster/Group		◇	◇	◇	◇	◇	◇	◇	◇	◇	◇	◇	◇	◇	◇
Preferences															
Min/Max		max	max	max	min	max	max	max	min	min	max	max	max	max	max
Preference Fn.		Linear	Linear	Usual	Linear	Usual	Usual	Usual	Usual	Usual	V-shape	V-shape	V-shape	Linear	Linear
Thresholds		absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
- Q: Indifference		39289	4	n/a	0,03	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0,47	0,03
- P: Preference		127162	12	n/a	0,25	n/a	n/a	n/a	n/a	n/a	29,87	5,69	28,54	1,14	0,25
- S: Gaussian		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics															
Minimum		1120980	13	2,00	0,10	0,00	2,00	1,00	1,00	1,00	5,00	9,00	6,00	2,00	47,00
Maximum		1252790	25	4,00	3,60	1,00	3,00	3,00	3,00	1,00	38,00	14,00	34,00	3,00	58,00
Average		1177067	18	3,00	1,63	0,33	2,33	1,67	2,00	1,00	22,00	10,67	23,00	2,33	52,67
Standard Dev.		55574	5	0,82	1,46	0,47	0,47	0,94	0,82	0,00	13,49	2,36	12,19	0,47	4,50
Evaluations															
Katwijk		1252790	25	every 15 mins	1,20	yes	Safe	moderate	Easy	very low	5,00	9,00	6,00	3,00	47,00
Noordwijk		1120980	15	every 30 mins	3,60	no	Moderate	very low	Difficult	very low	23,00	14,00	34,00	2,00	58,00
Zandvoort		1157430	13	often/multiple	0,10	no	Moderate	very low	Moderate	very low	38,00	9,00	29,00	2,00	53,00

Figure A5.1: Model values for gap one

	Population	Attractions	Accessibility l...	Accessibility ...	Accessibility ...	Veiligheid wa...	Basic Marina
Unit	people	unit	public tp	unit	y/n	Water	impact
Cluster/Group	◇	◇	◇	◇	◇	◇	◇
Preferences							
Min/Max	max	max	max	min	max	max	max
Preference Fn.	V-shape	Linear	Usual	V-shape	Usual	Usual	Usual
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	n/a	4	n/a	n/a	n/a	n/a	n/a
- P: Preference	284489	10	n/a	0,25	n/a	n/a	n/a
- S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics							
Minimum	337925	3	2,00	0,21	0,00	3,00	1,00
Maximum	647335	11	3,00	2,40	0,00	3,00	3,00
Average	504170	8	2,33	1,40	0,00	3,00	1,67
Standard Dev.	127366	4	0,47	0,90	0,00	0,00	0,94
Evaluations							
Egmond	647335	11	every 15 mins	2,40	no	Safe	moderate
Bergen	527250	11	every 30 mins	0,21	no	Safe	very low
Petten	337925	3	every 30 mins	1,60	no	Safe	very low

	Shelter	Extended fa...	Accomodatio...	Facilities Hor...	Facilities Hor...	Facilities Sho...	Facilities oth...
Unit	Shelter	impact	number of	impact	unit	unit	unit
Cluster/Group	◇	◇	◇	◇	◇	◇	◇
Preferences							
Min/Max	min	min	max	max	max	max	max
Preference Fn.	Usual	Usual	Linear	Linear	V-shape	V-shape	V-shape
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	n/a	n/a	4,99	4,03	n/a	n/a	n/a
- P: Preference	n/a	n/a	15,66	10,69	22,37	2,82	30,03
- S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics							
Minimum	2,00	1,00	2,00	1,00	2,00	1,00	0,00
Maximum	3,00	1,00	18,00	11,00	25,00	4,00	27,00
Average	2,67	1,00	11,33	4,67	11,67	2,33	9,33
Standard Dev.	0,47	0,00	6,80	4,50	9,74	1,25	12,50
Evaluations							
Egmond	Difficult	very low	18,00	11,00	25,00	4,00	27,00
Bergen	Difficult	very low	14,00	2,00	8,00	2,00	1,00
Petten	Moderate	very low	2,00	1,00	2,00	1,00	0,00

Figure A5.2: Model values for gap two

Appendix 6: Results gap 1 (complete)

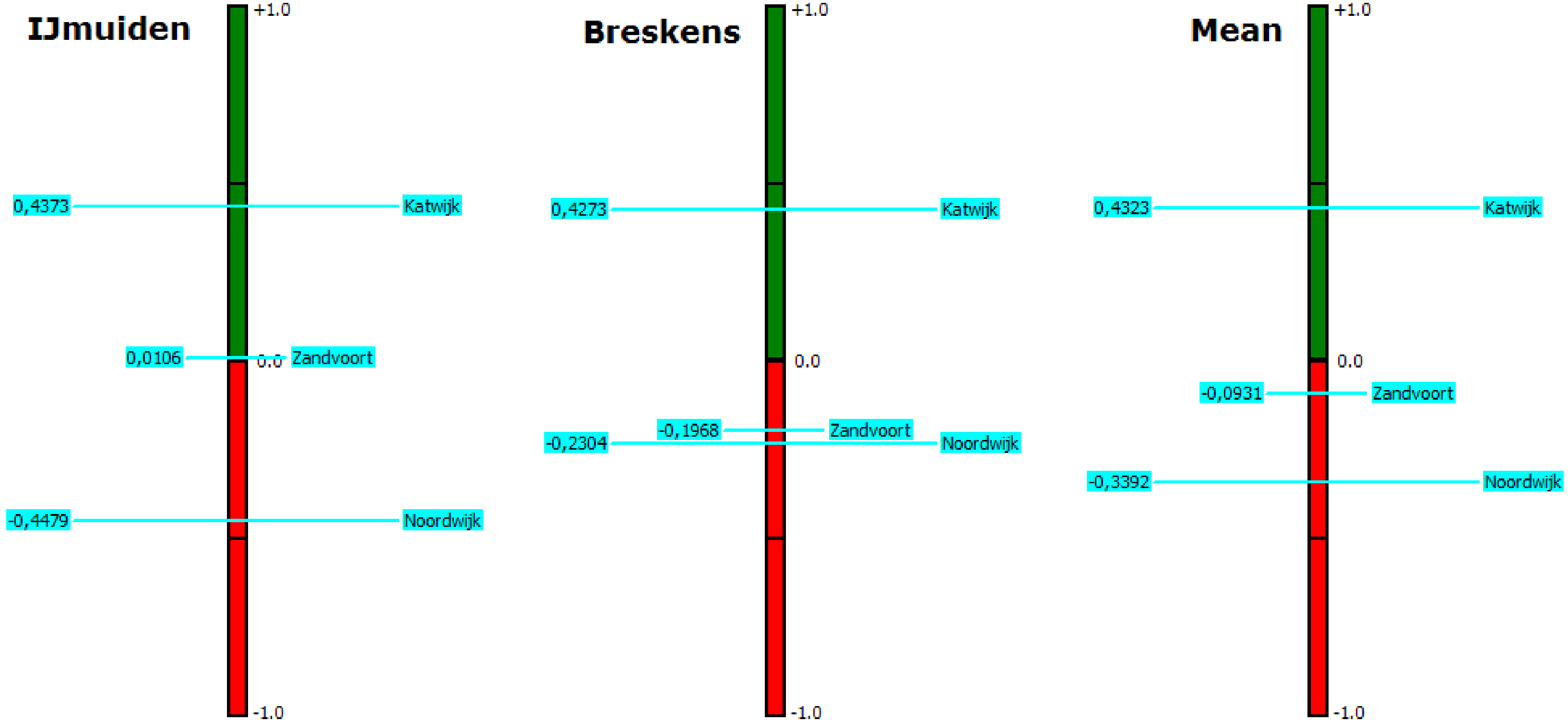


Figure A6.1: PROMETHEE Ranking: Results of Marinas

Figure A6.1 shows the ranking of the alternatives in gap one, based on the weights derived from the two marina surveys (Marina IJmuiden and Marina Breskens), including a mean weight. The ranking is the same for all three depicted analyses. Zandvoort is however changing from a positive ranking (IJmuiden) to a negative ranking (Breskens & mean).

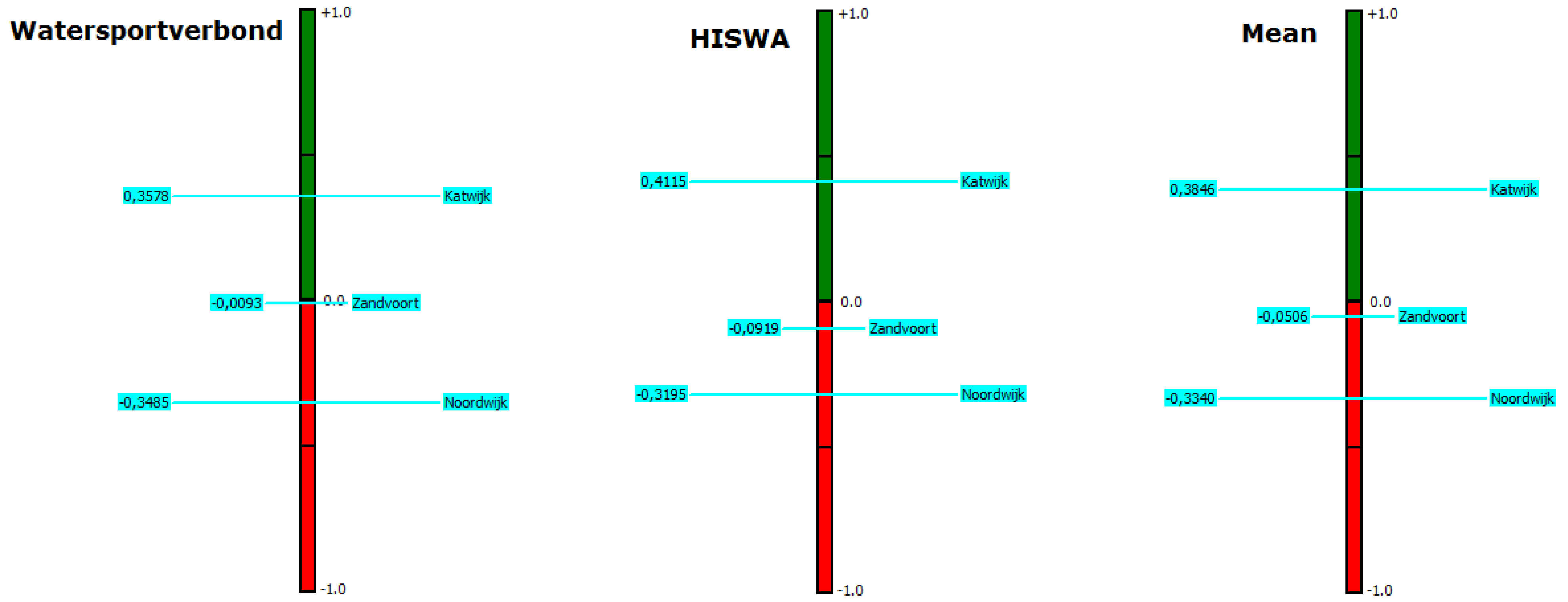


Figure A6.2: PROMETHEE Ranking Results of Users

Figure A6.2 shows the ranking of the alternatives in gap one, based on the weights derived from the two user surveys (Watersportverbond and HISWA), including a mean weight. The ranking is the same for all three depicted analyses.

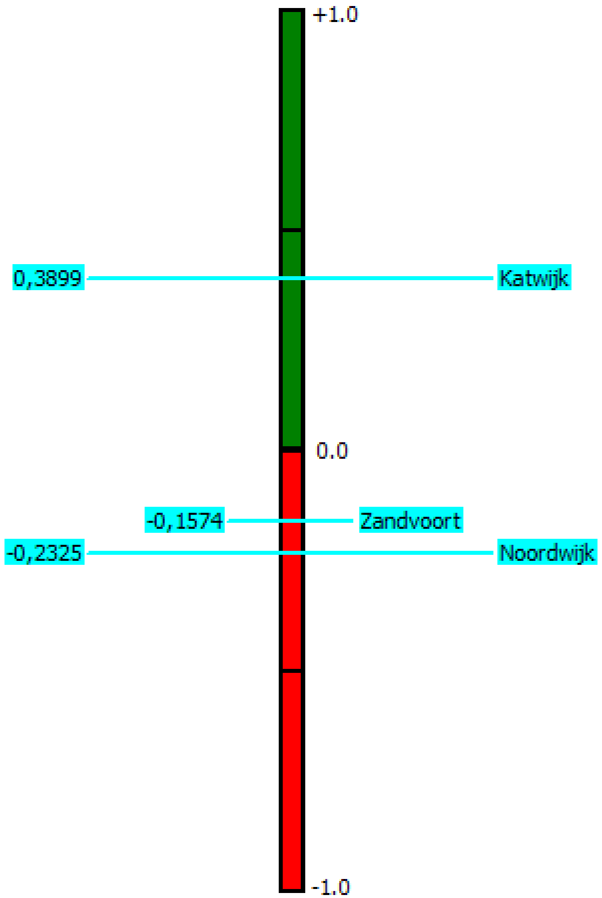


Figure A6.3: PROMETHEE Ranking: Results of Policymakers

Figure A6.3 shows the ranking of the alternatives in gap one, based on the weights derived from the policymaker's survey (Province Noord-Holland). The ranking resembles most to the Breskens ranking (figure A6.1).

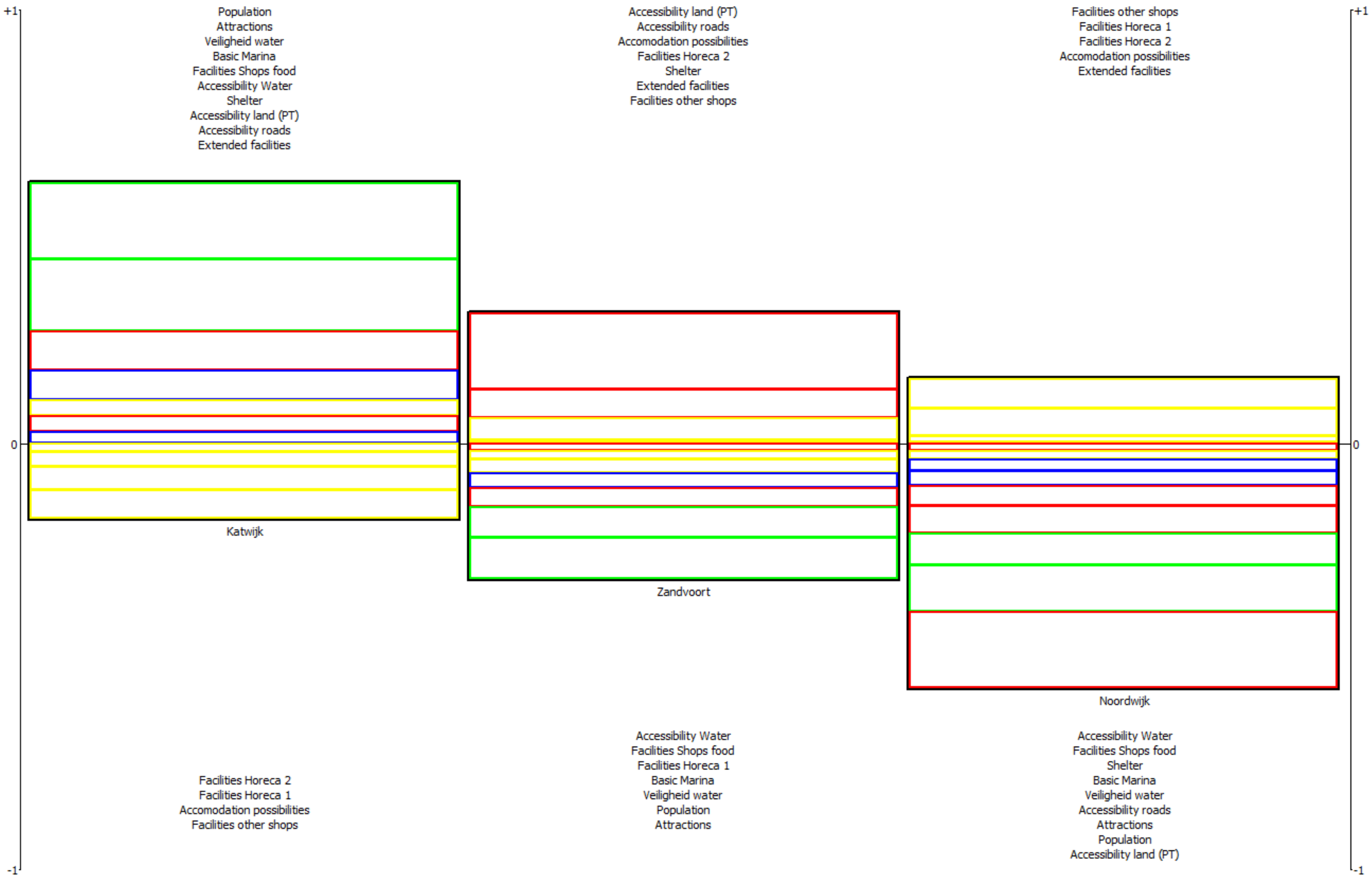


Figure A6.4: Rainbow overview Watersportverbond

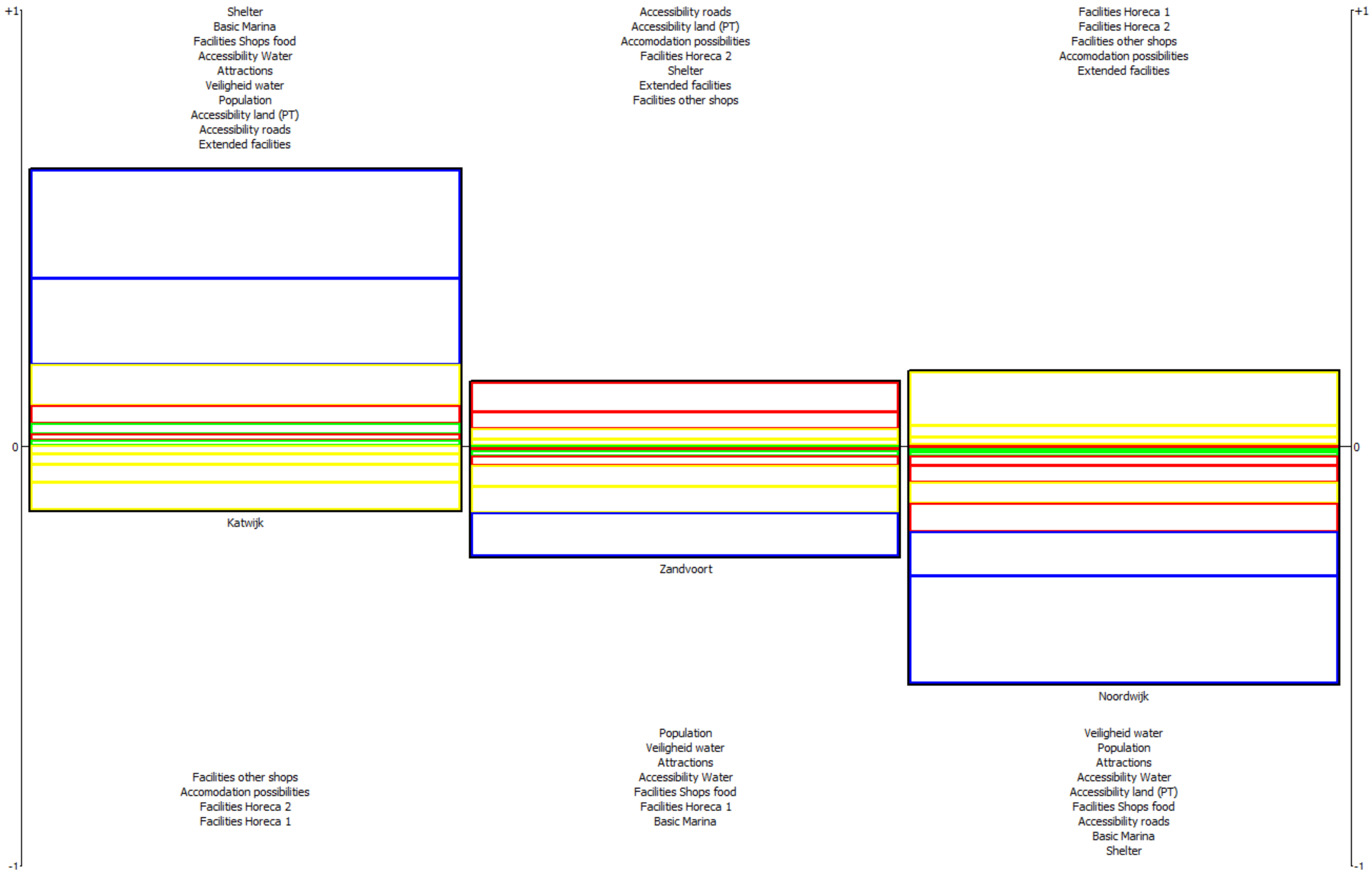


Figure A6.5: Rainbow overview HISWA

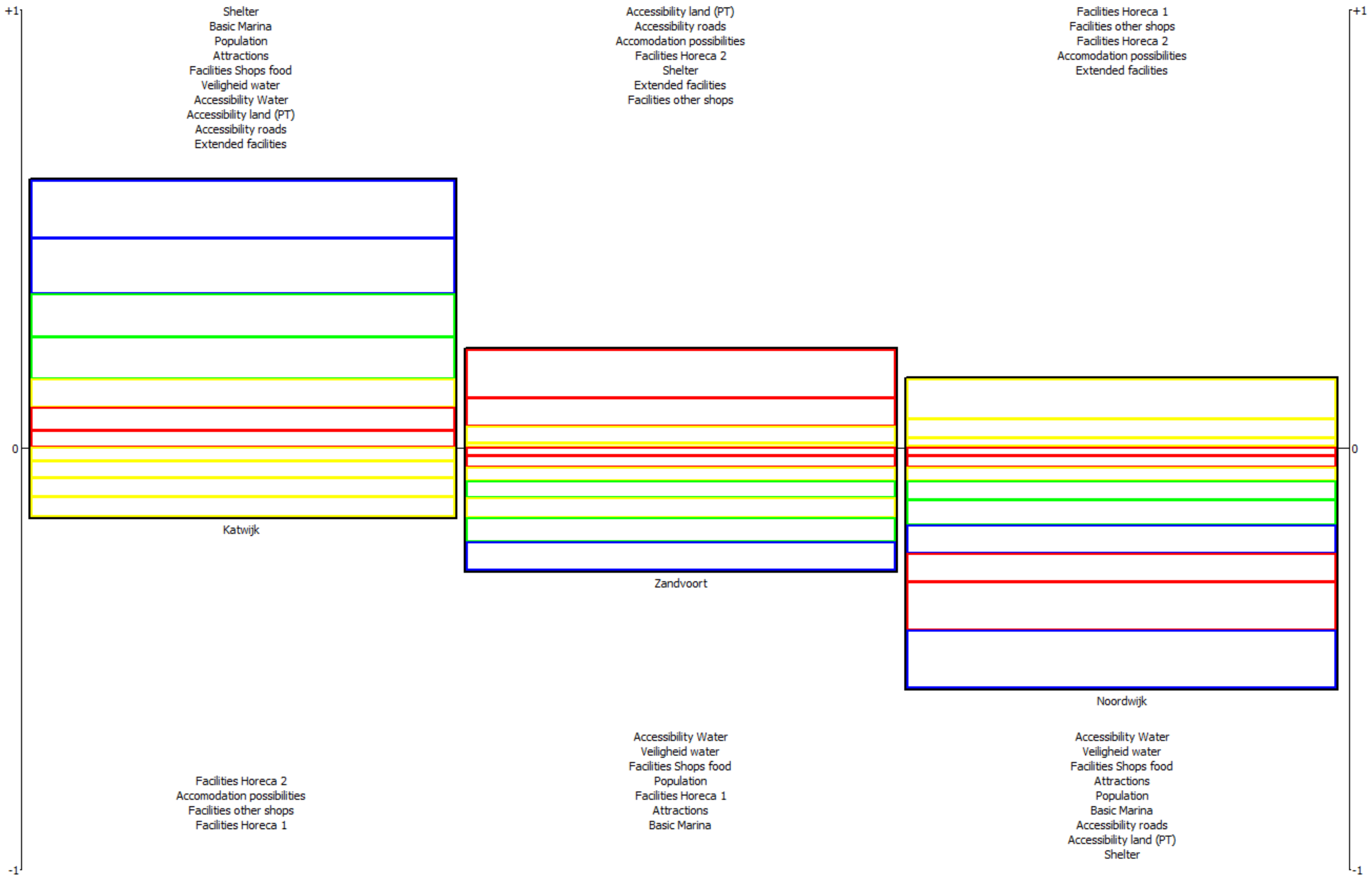


Figure A6.6: Rainbow overview users mean (from Watersportverbond and HISWA)

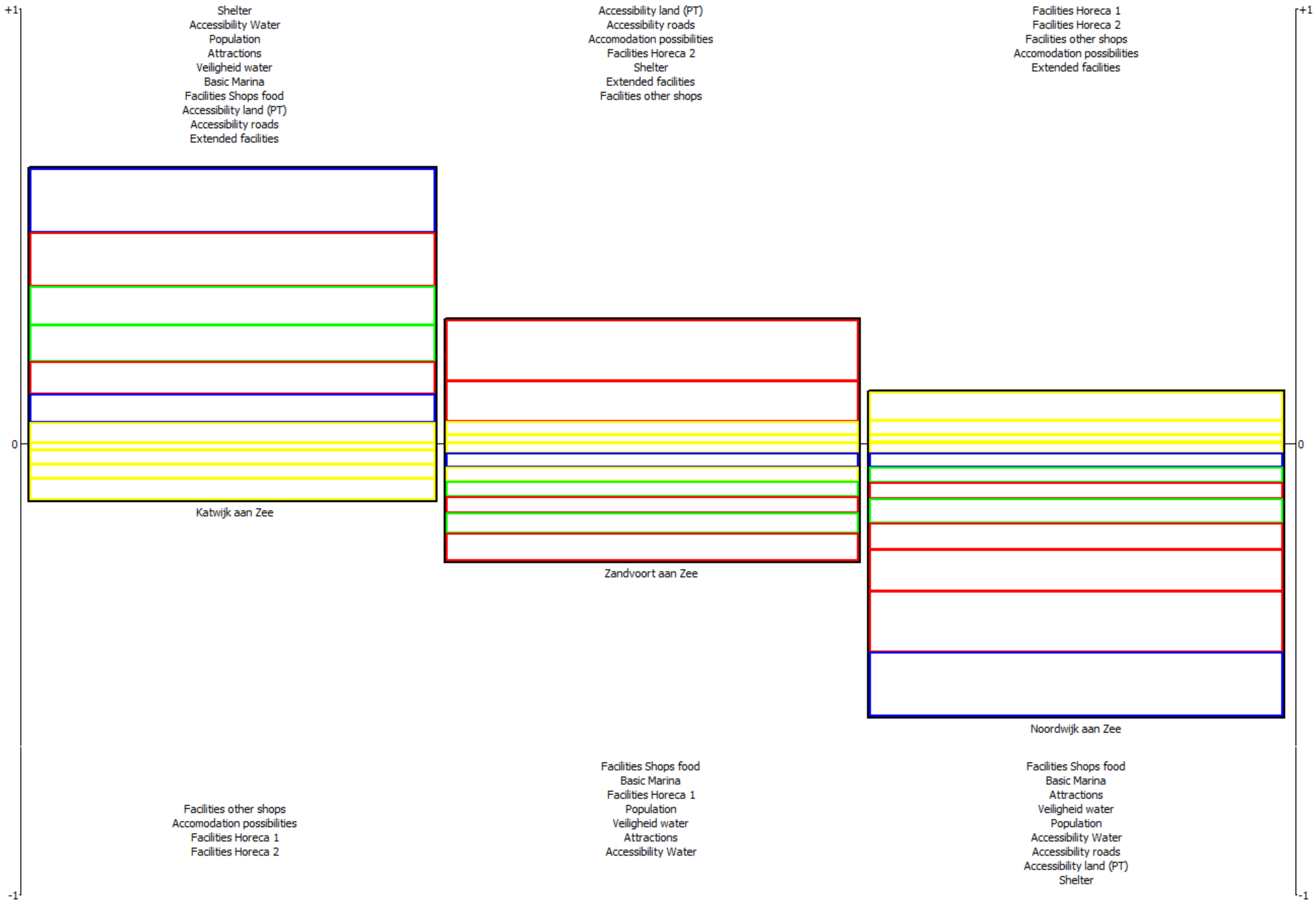


Figure A6.7: Rainbow overview marina IJmuiden

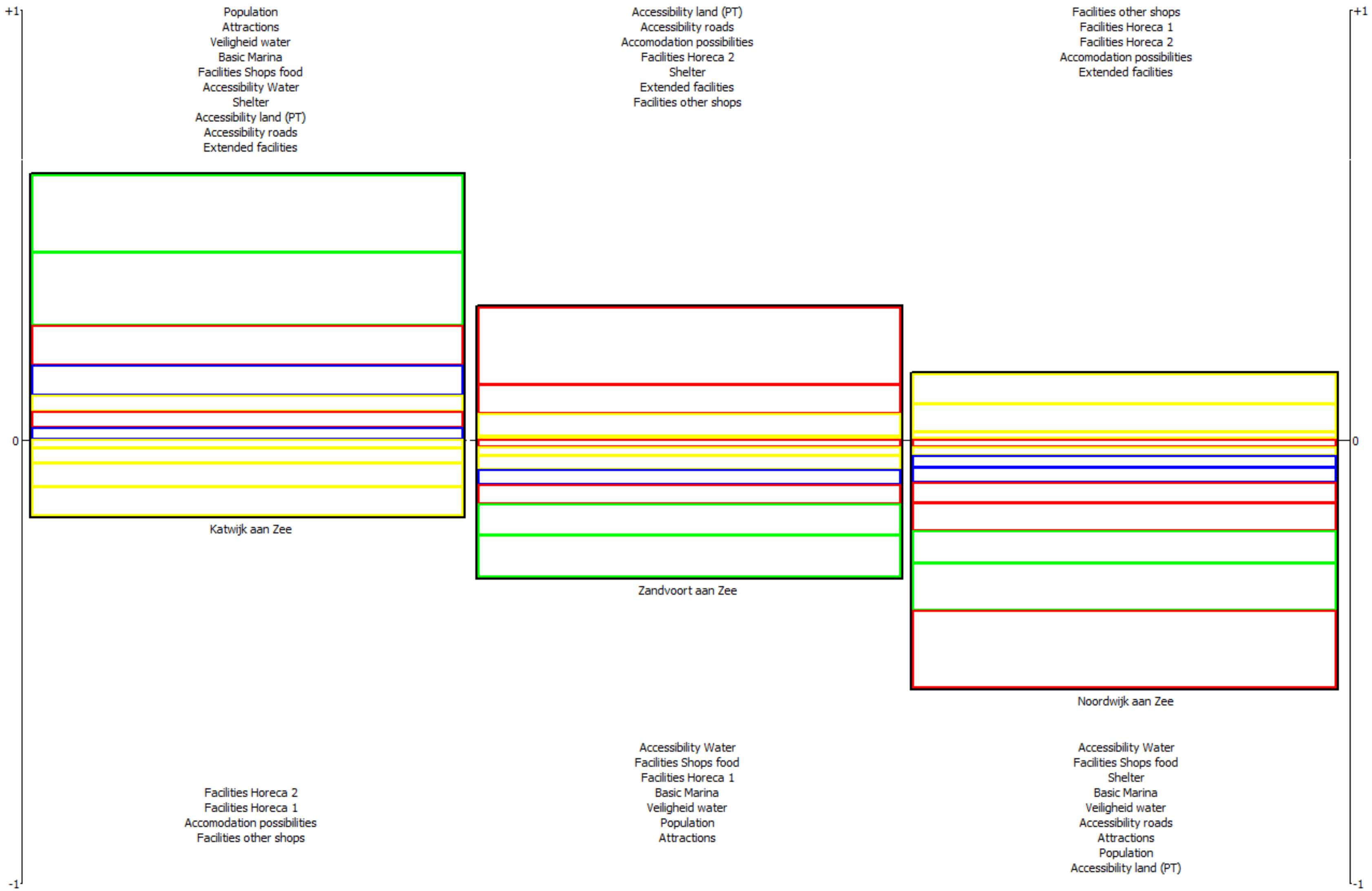


Figure A6.8: Rainbow overview Marina Breskens

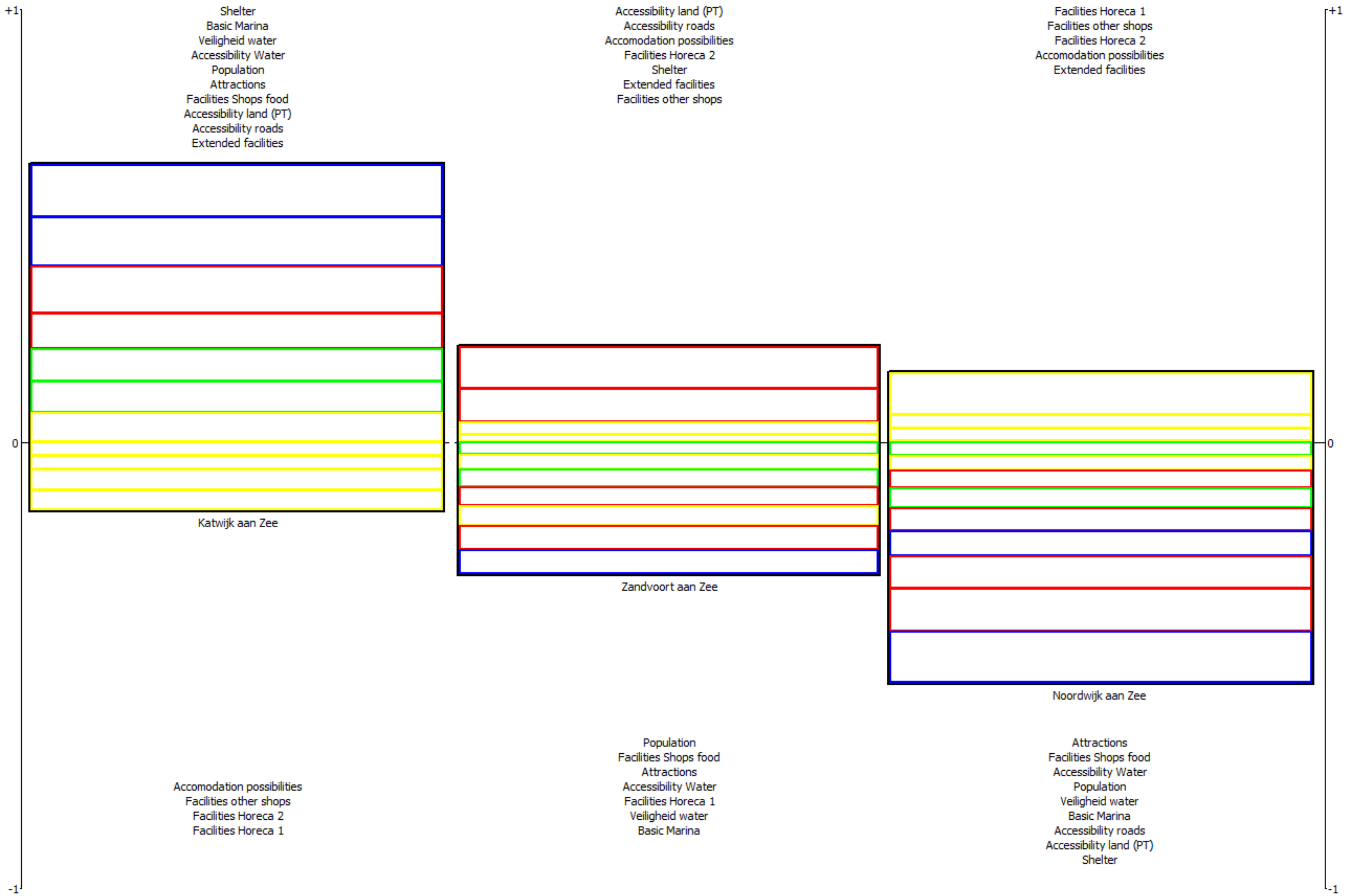


Figure A6.9: Rainbow overview marinas mean (from Marina IJmuiden and Marina Breskens)

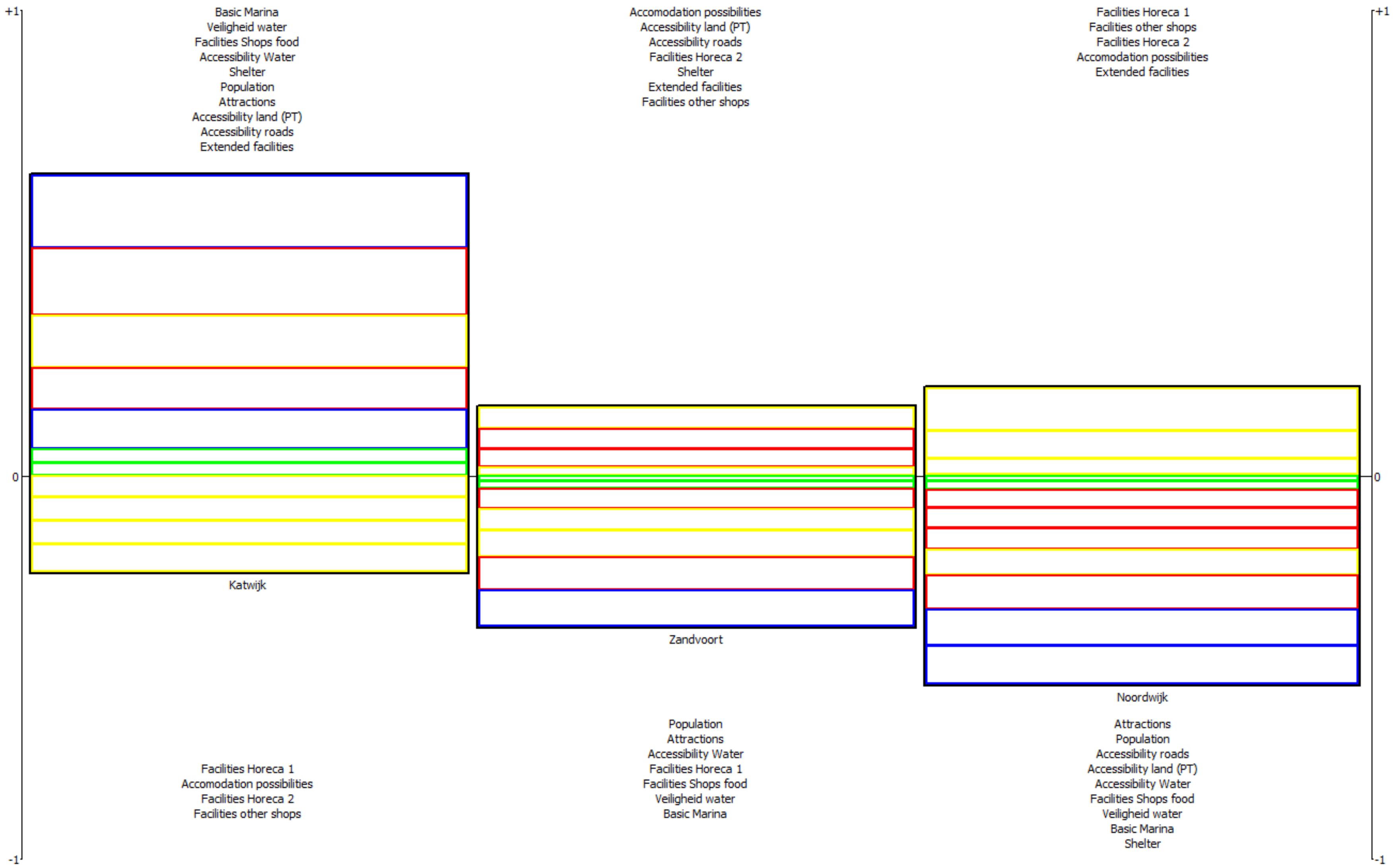


Figure A6.10: Rainbow overview policymakers

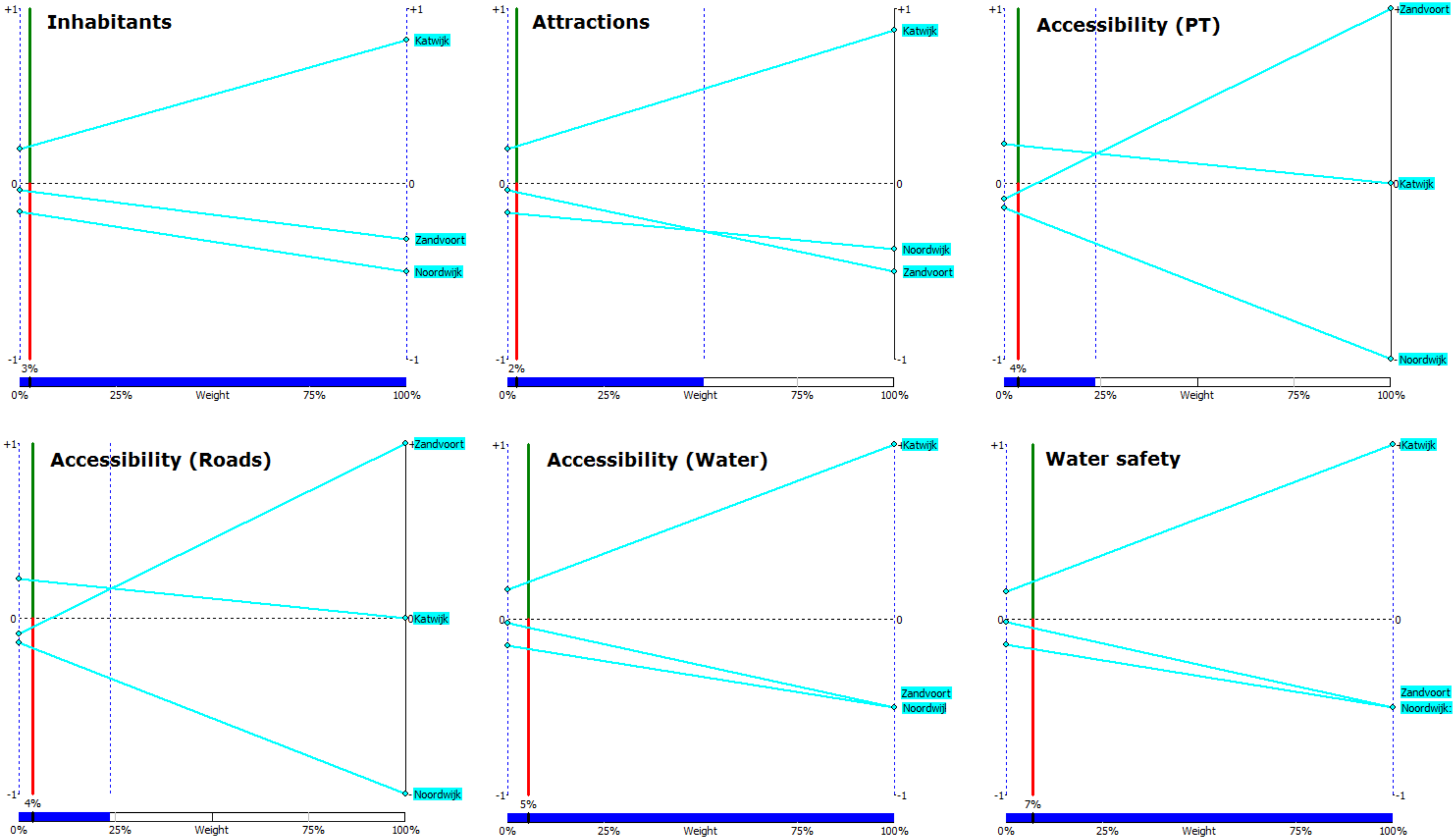


Figure A6.11a: Stability intervals for criteria 1 to 6 from the **marina surveys** (all marina surveys together)

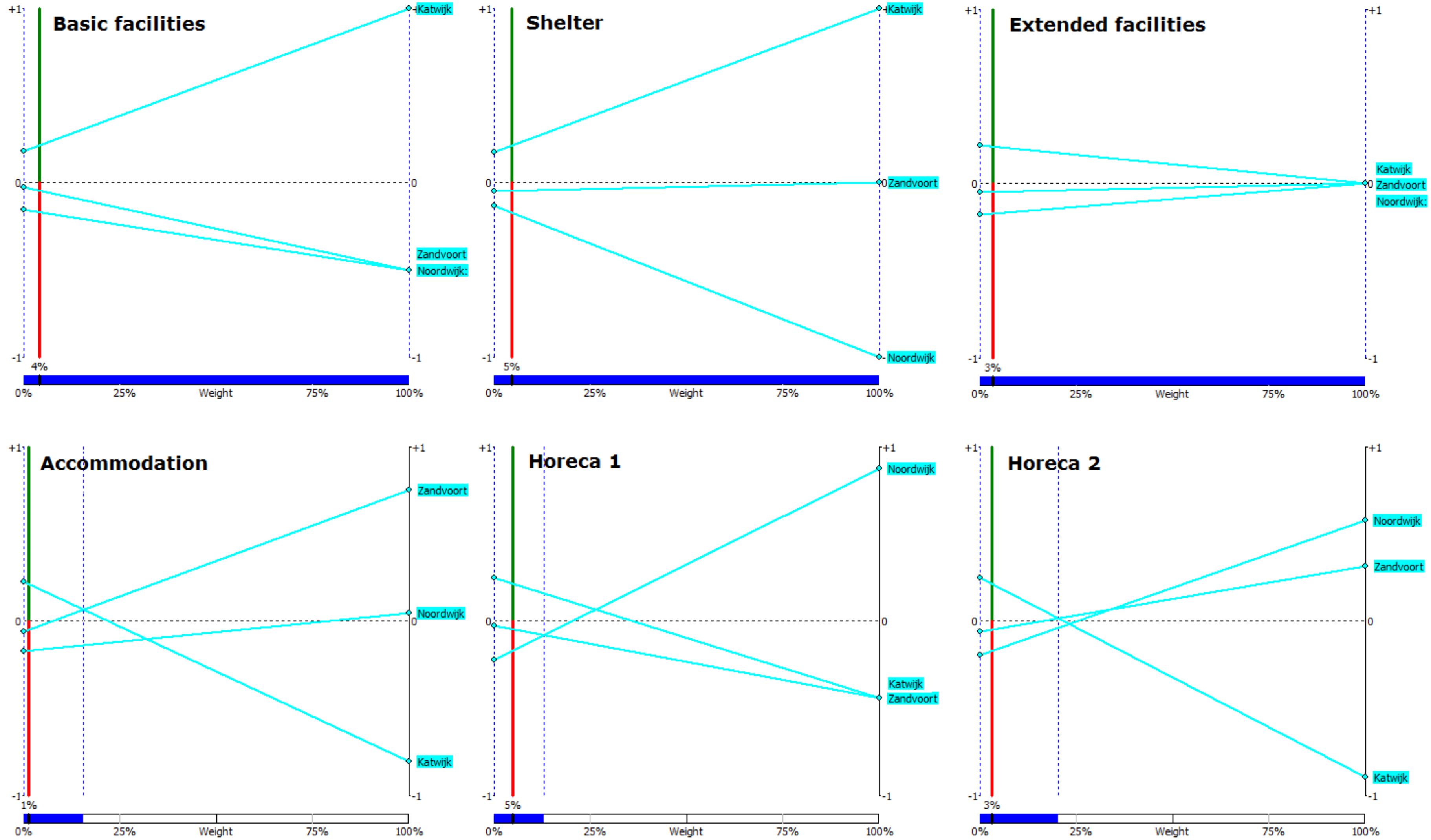


Figure A6.11b: Stability intervals for criteria 7 to 12 from the **marina surveys** (all marina surveys together)

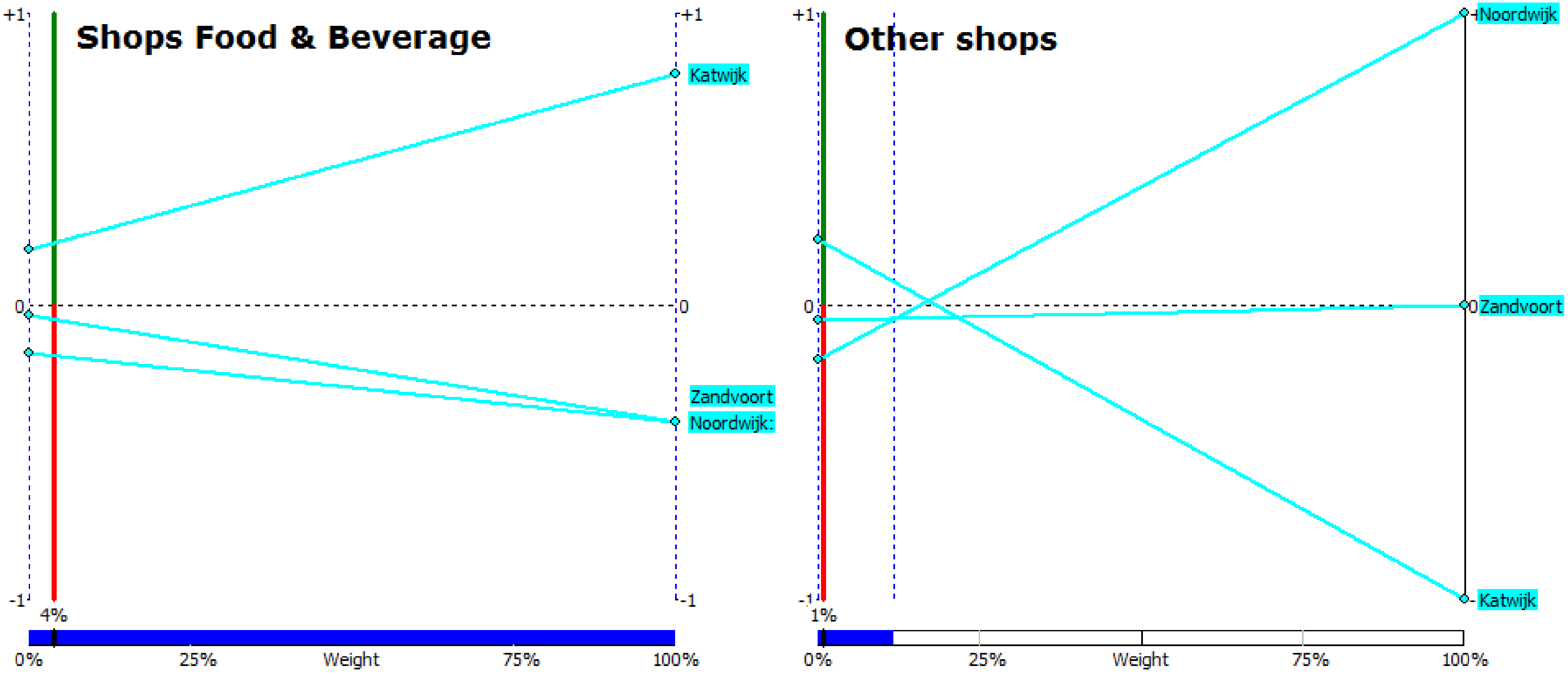


Figure A6.11c: Stability intervals for criteria 13 and 14 from the **marina surveys** (all marina surveys together)

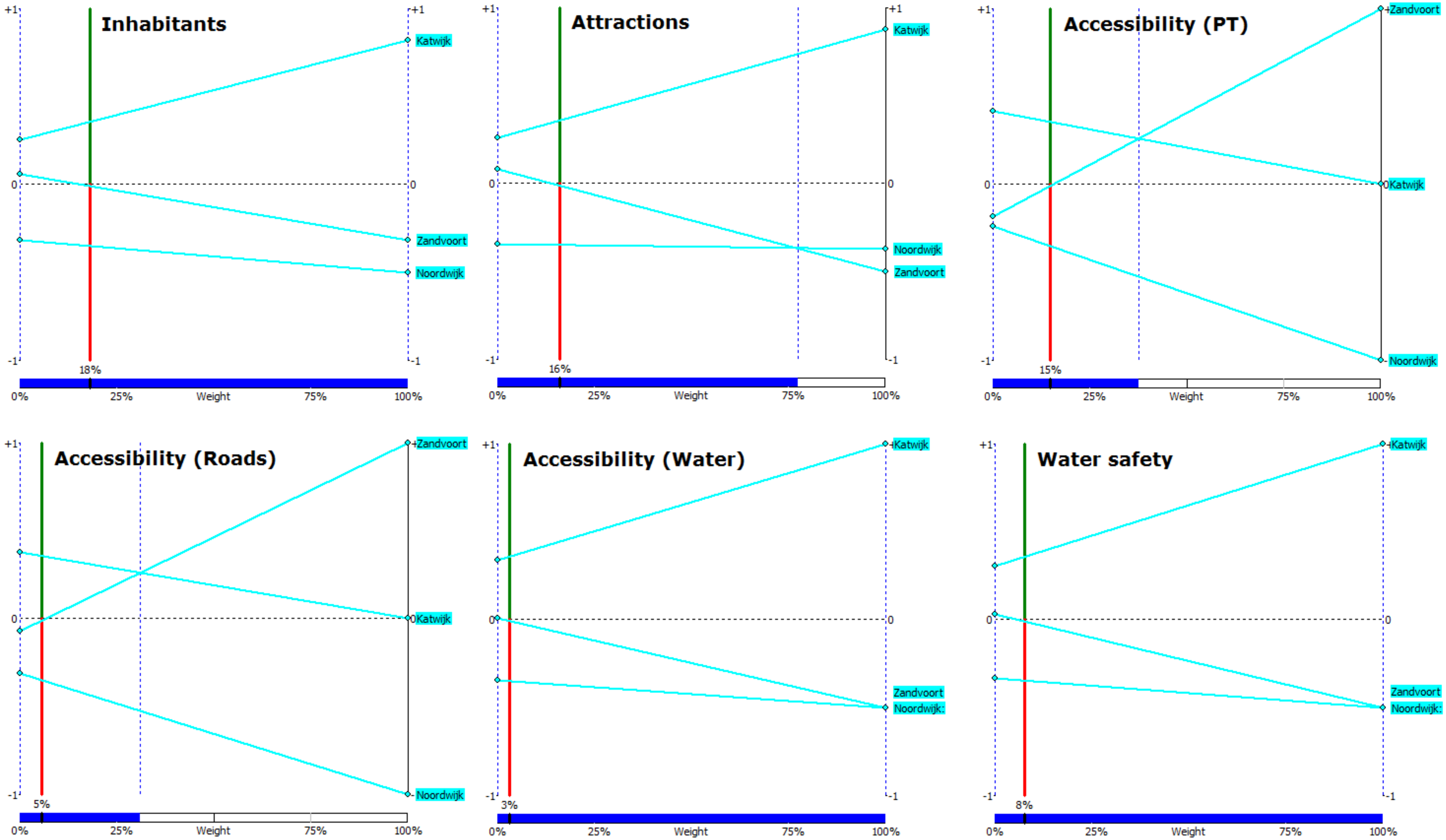


Figure A6.12a: Stability intervals for criteria 1 to 6 from the **user surveys** (all user surveys together)

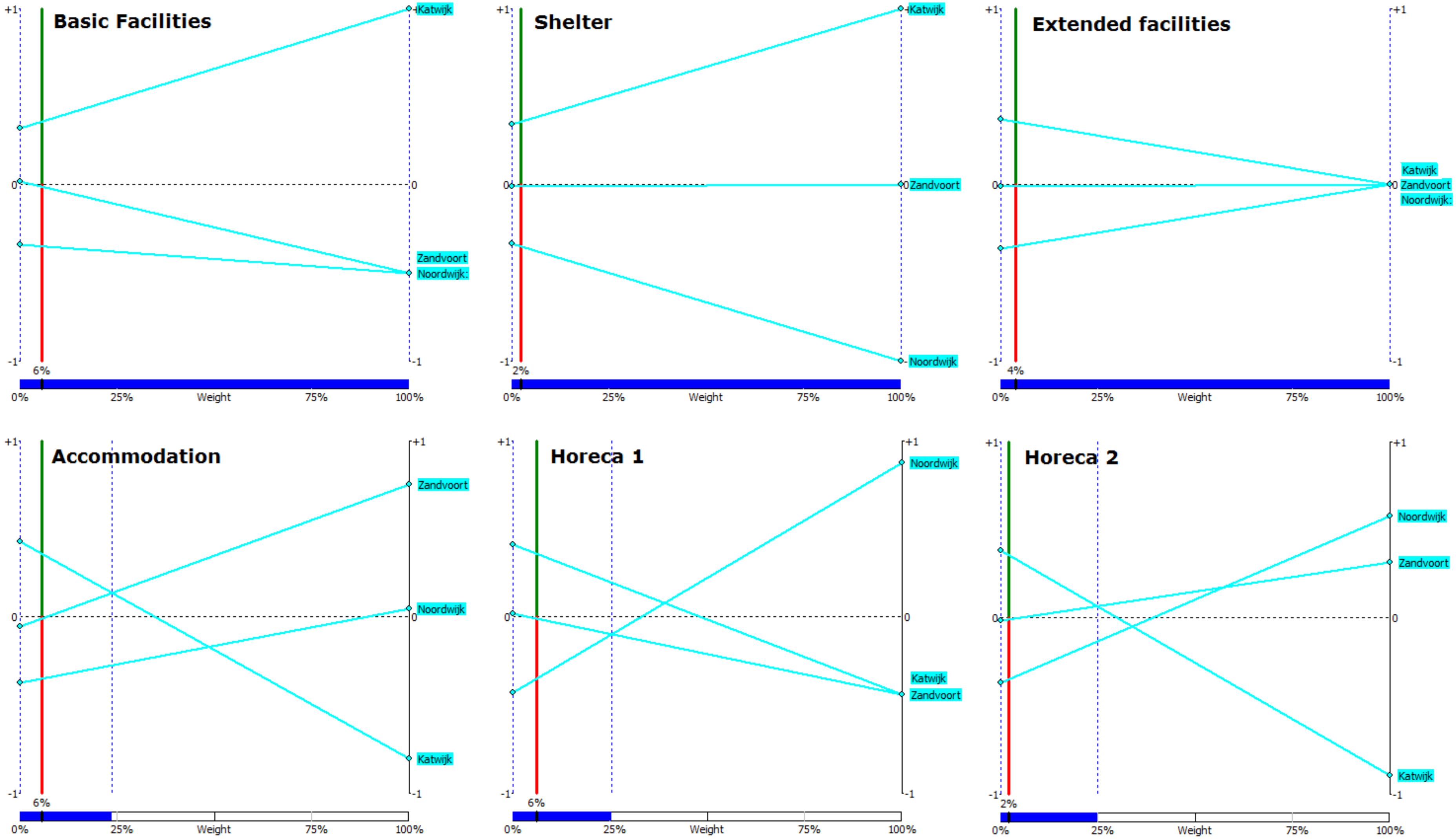


Figure A6.12b: Stability intervals for criteria 7 to 12 from the **user surveys** (all user surveys together)

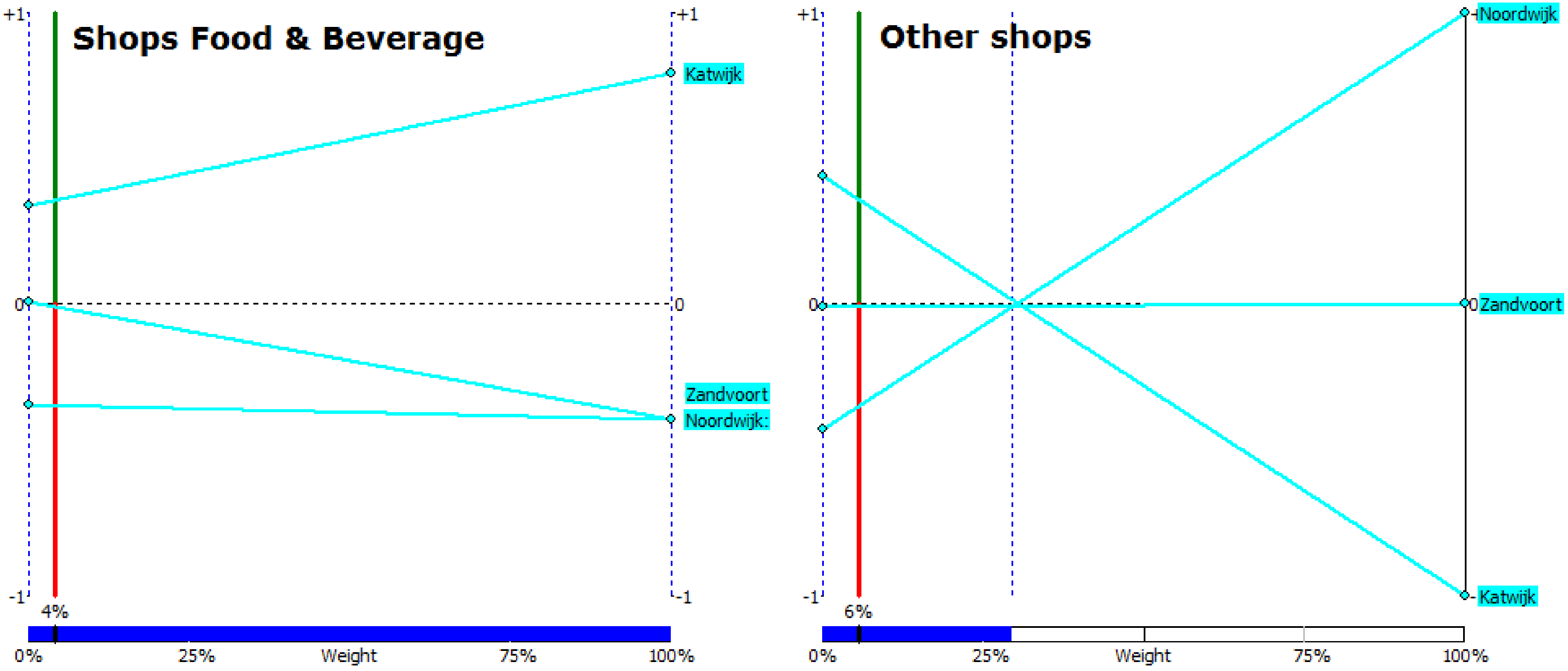


Figure A6.12c: Stability intervals for criteria 13 and 14 from the **user surveys** (all user surveys together)

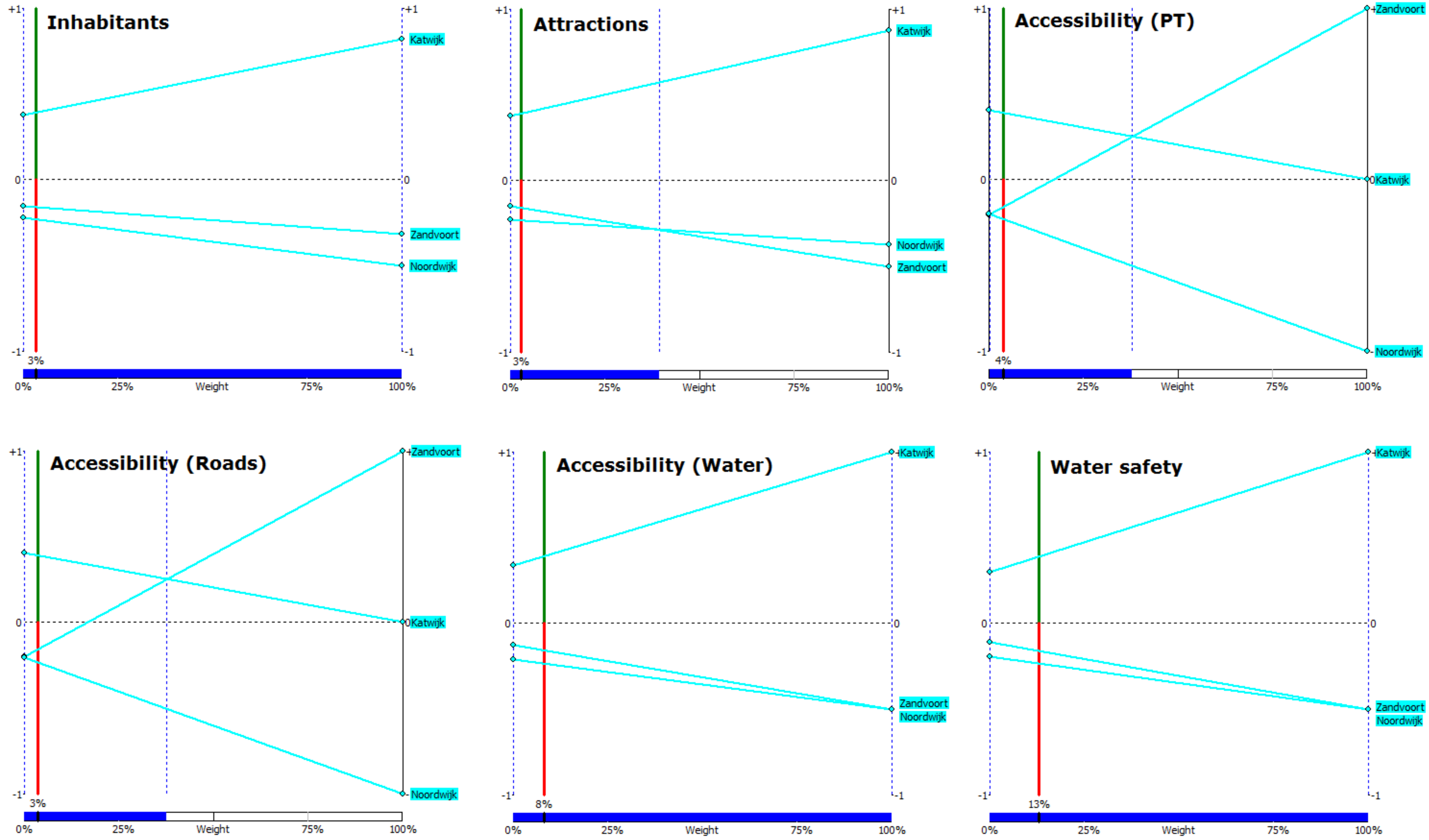


Figure A6.13a: Stability intervals for criteria 1 to 6 from the **policymaker survey**

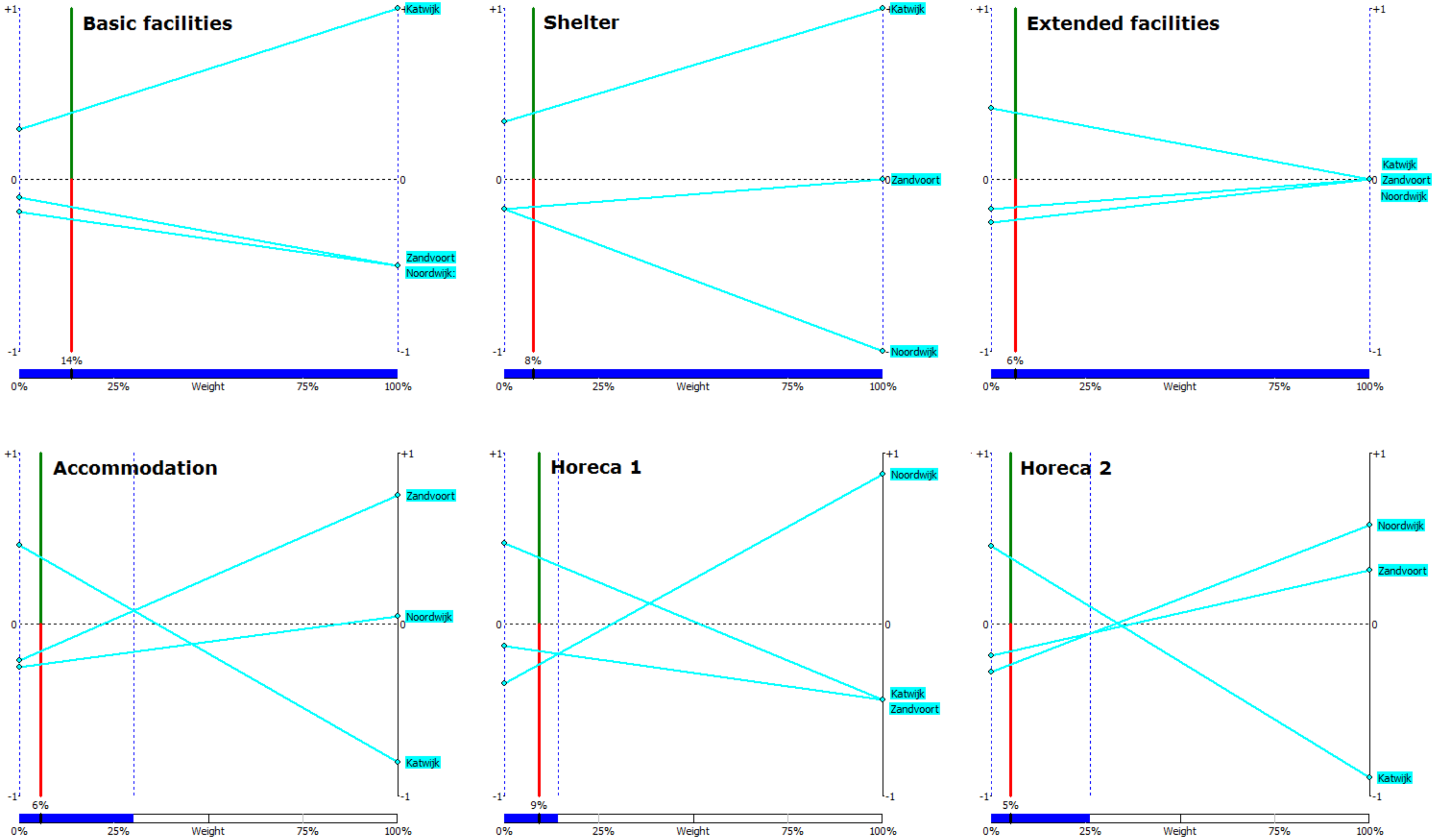


Figure A6.13b: Stability intervals for criteria 7 to 12 from the **policymaker survey**

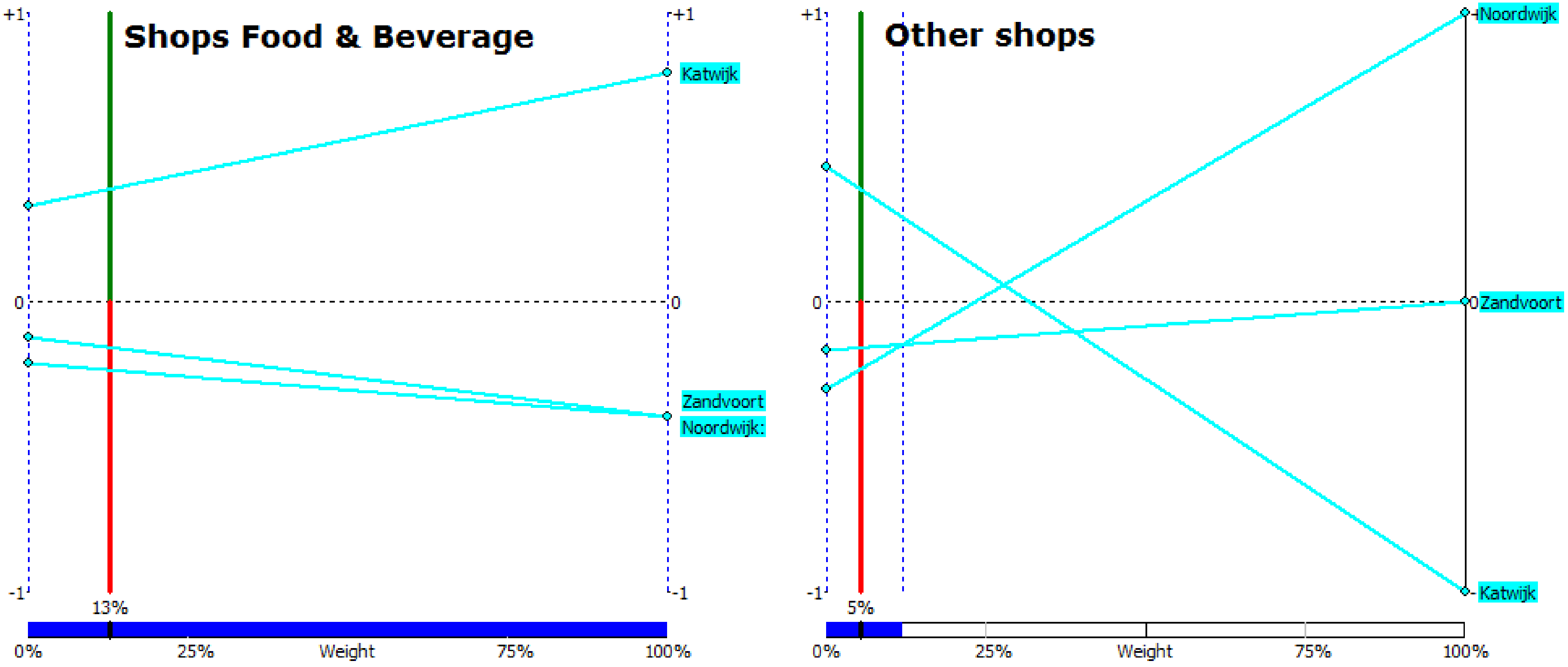


Figure A6.13c: Stability intervals for criteria 13 and 14 from the **policymaker survey**

Appendix 7: Results gap 2 (complete)

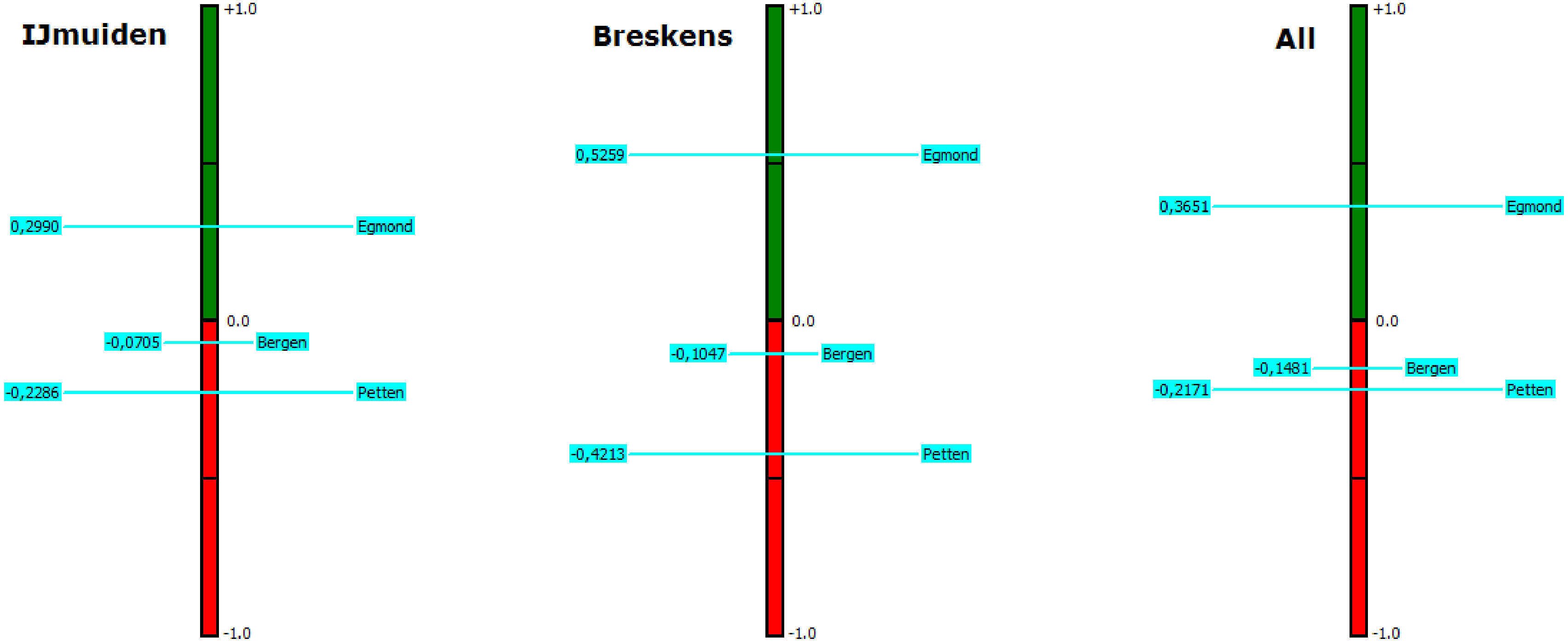


Figure A7.1: PROMETHEE Ranking: Results of Marinas

Figure A7.1 shows the ranking of the alternatives in gap two, based on the weights derived from the two marina surveys (Marina IJmuiden and Marina Breskens), including a mean weight. The ranking is the same for all three depicted analyses. Zandvoort is however changing from a positive ranking (IJmuiden) to a negative ranking.

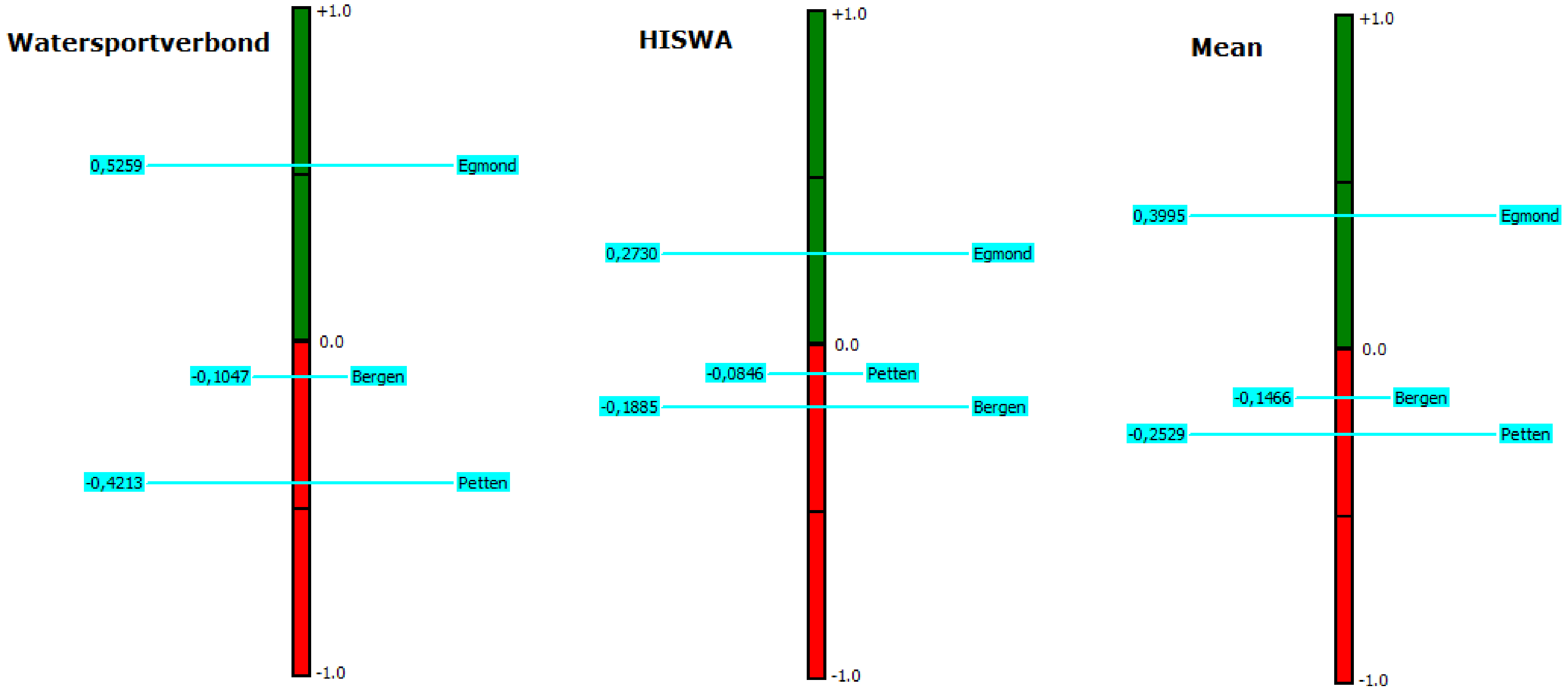


Figure A7.2: PROMETHEE Ranking Results of Users

Figure A7.2 shows the ranking of the alternatives in gap two, based on the weights derived from the two user surveys (Watersportverbond and HISWA), including a mean weight. The ranking is the same for all three depicted analyses.

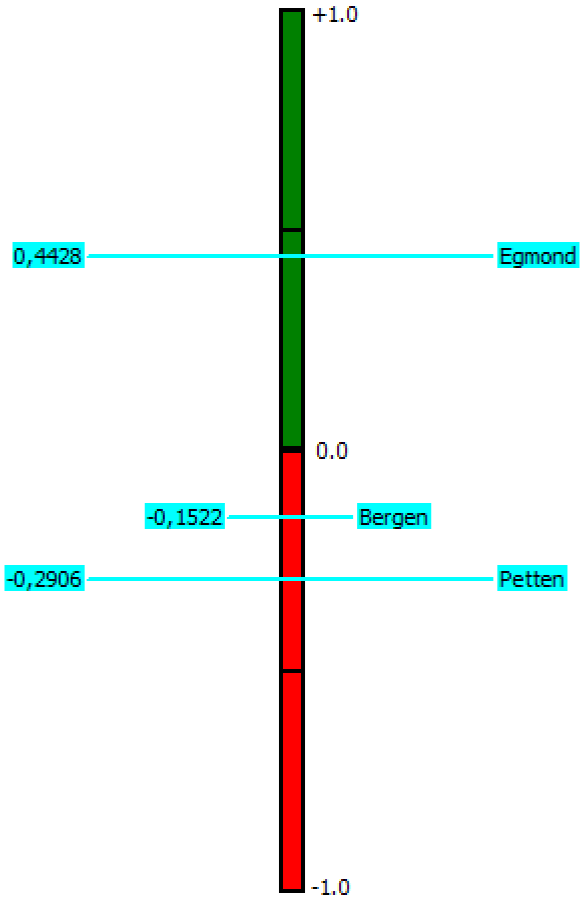


Figure A7.3: PROMETHEE Ranking: Results of Policymakers

Figure A4.3 shows the ranking of the alternatives in gap two, based on the weights derived from the policymaker's survey (Province Noord-Holland). The ranking resembles most to the mean ranking of the marinas (figure 4.2.2.1).

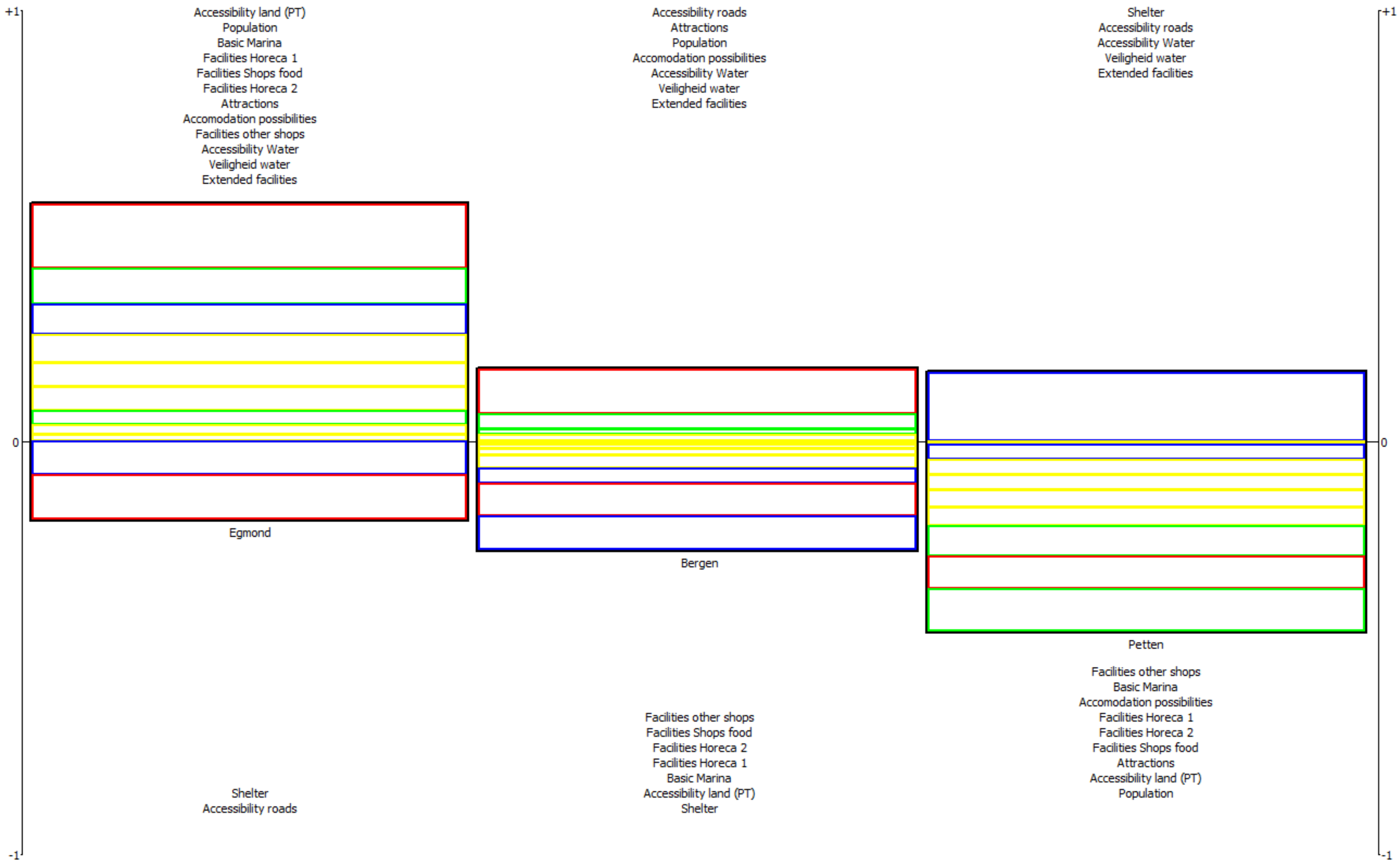


Figure A7.4: Rainbow overview marina IJmuiden

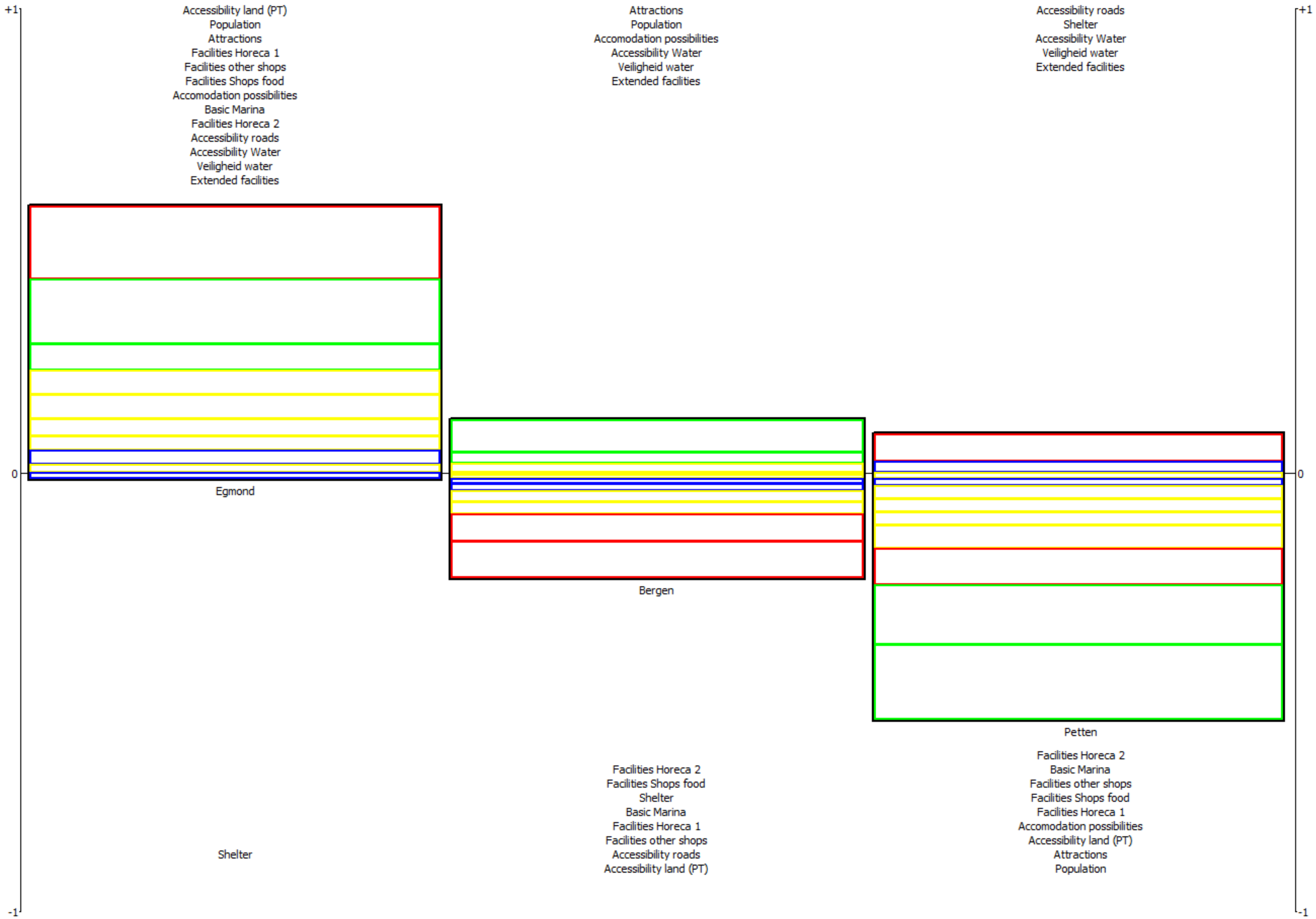


Figure A7.5: Rainbow overview Marina Breskens

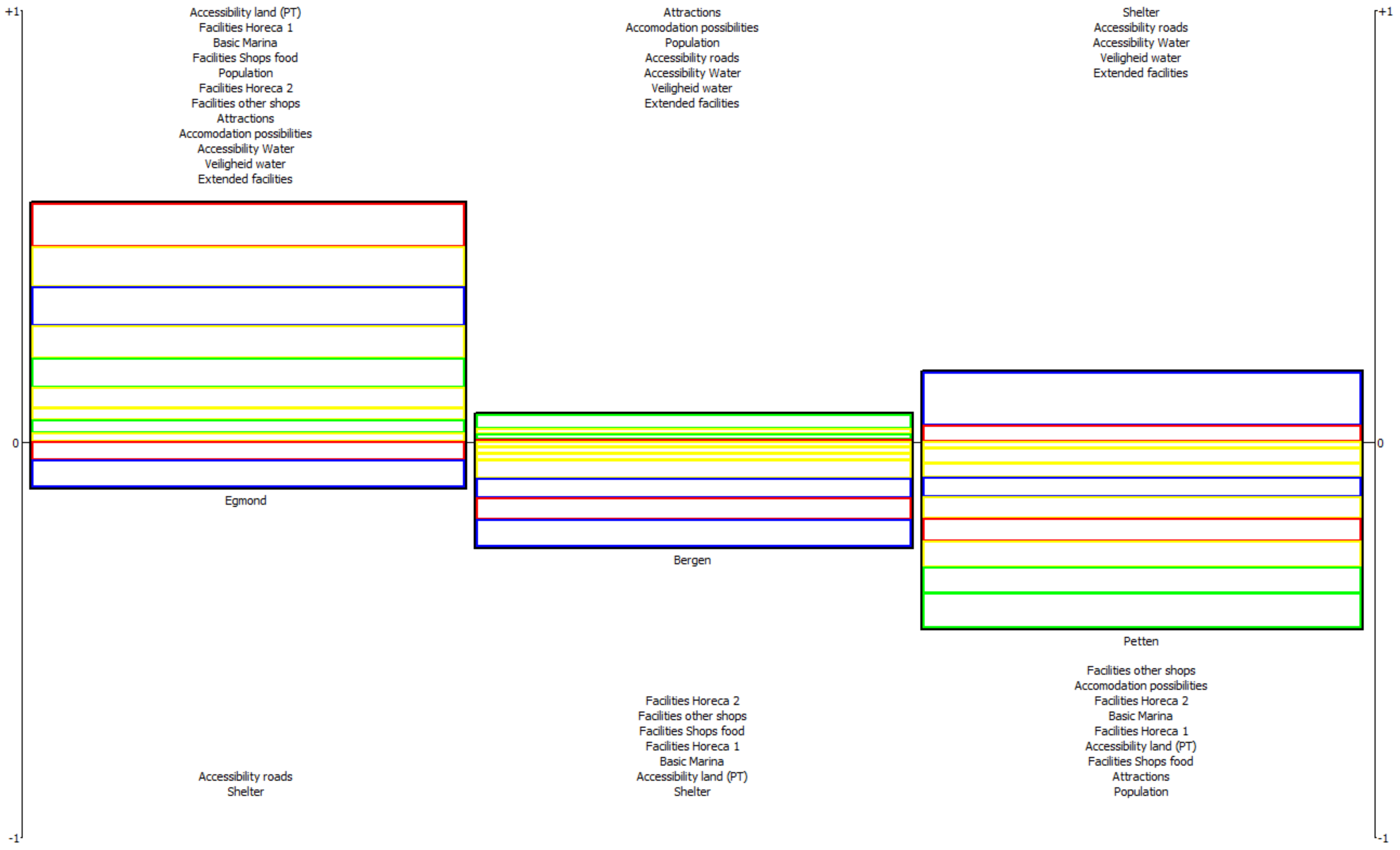


Figure A7.6: Rainbow overview marinas mean (from Marina IJmuiden and Marina Breskens)

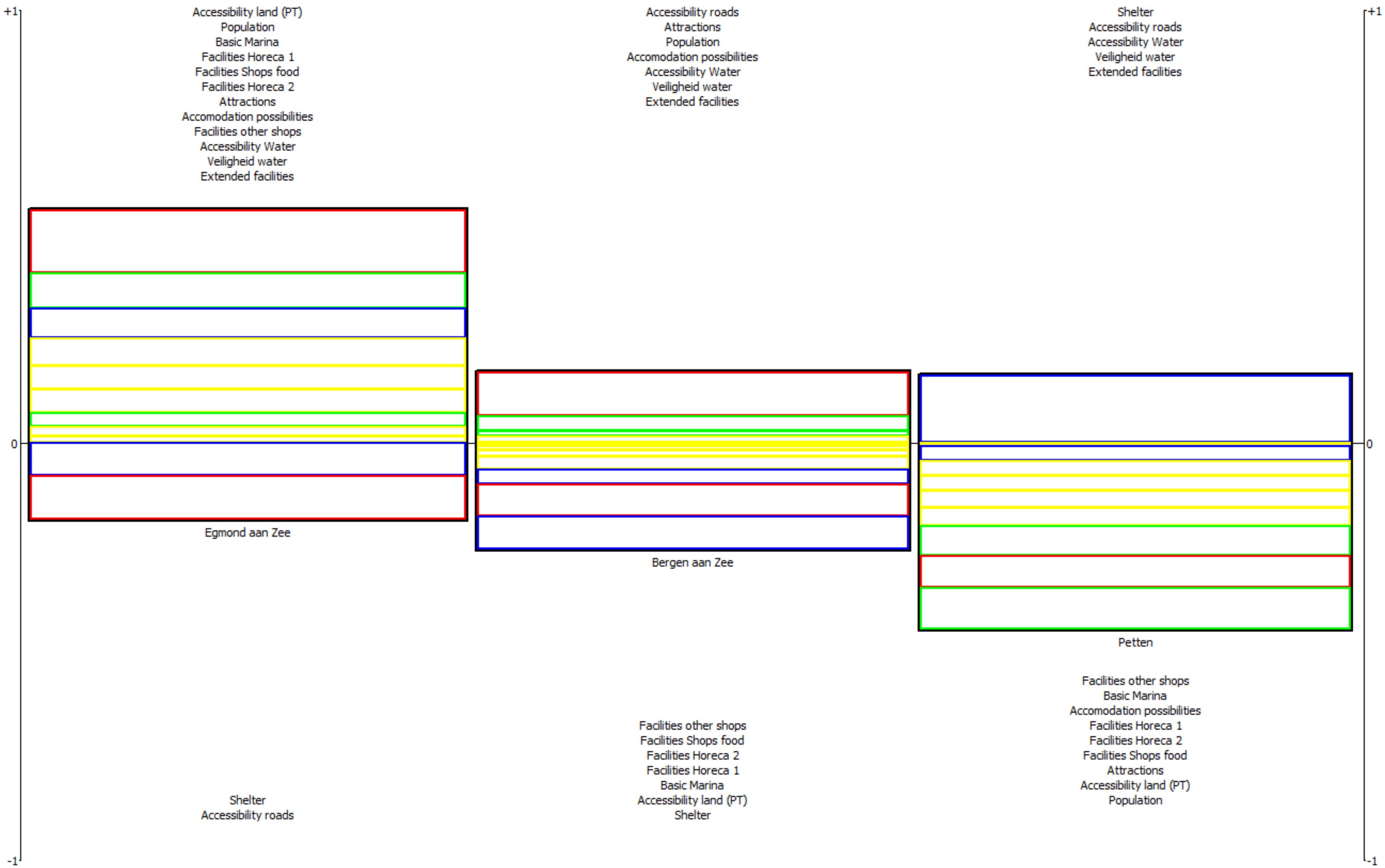


Figure A7.7: Rainbow overview Watersportverbond

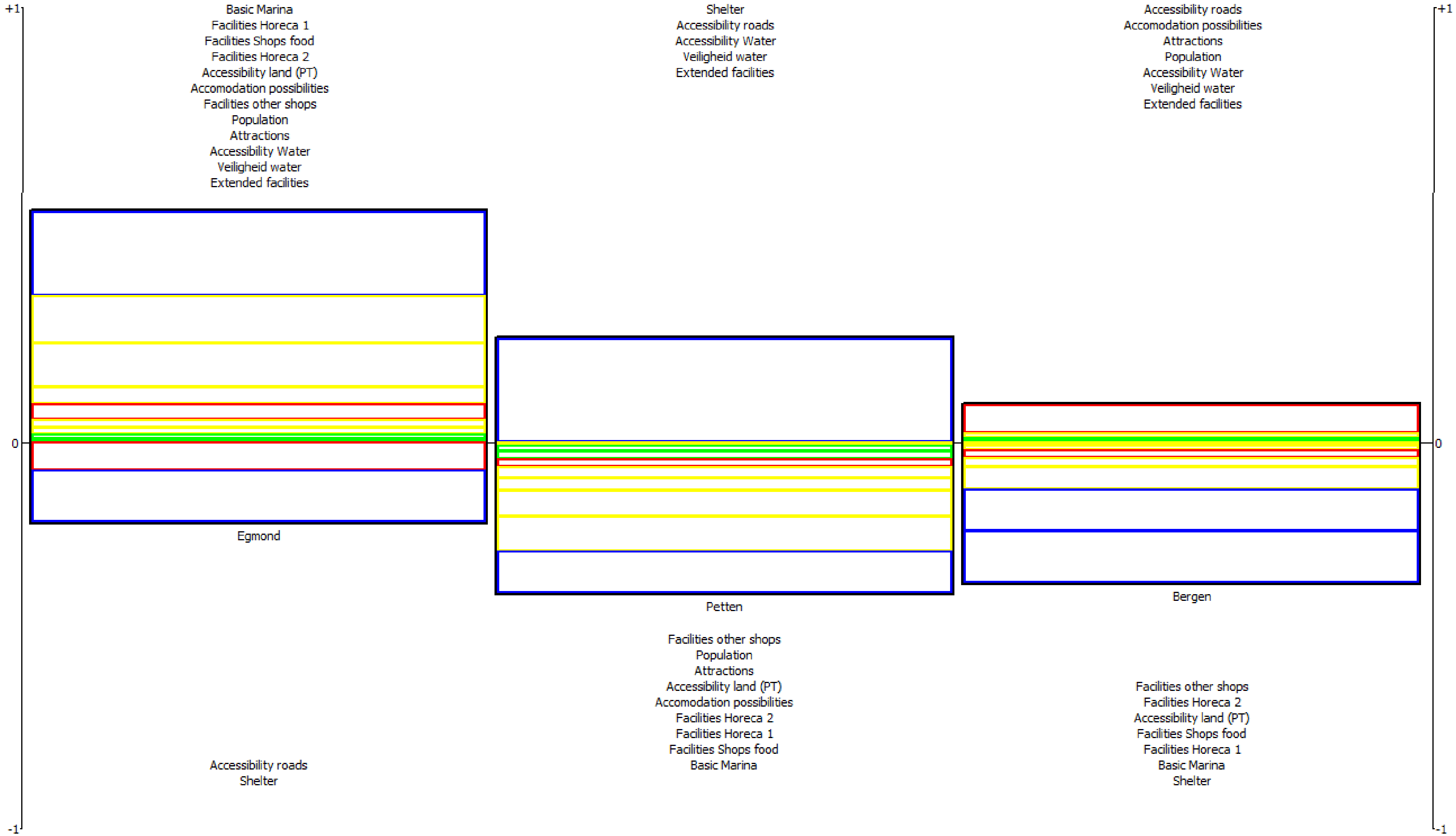


Figure A7.8: Rainbow overview HISWA

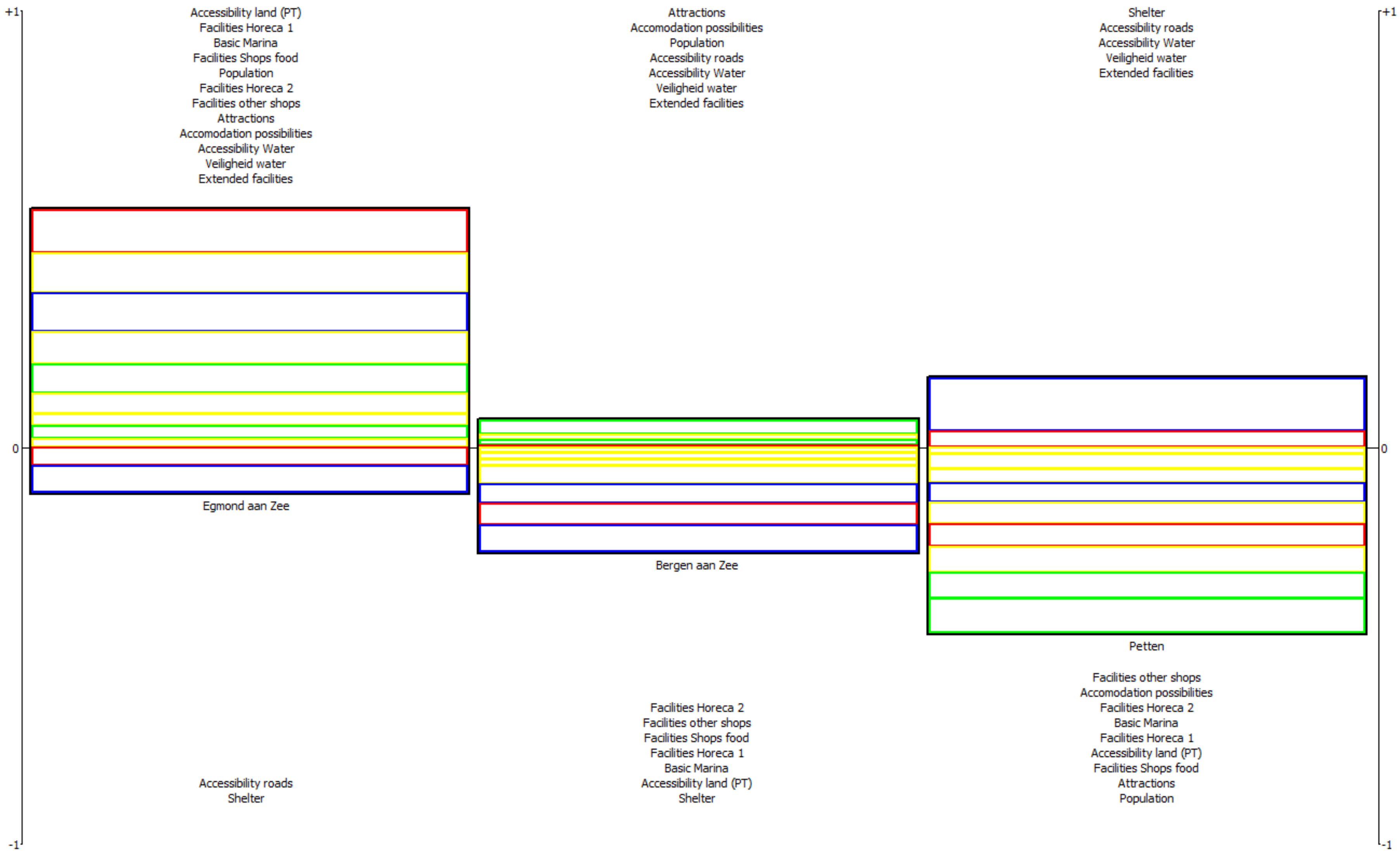


Figure A7.9: Rainbow overview users mean (from Watersportverbond and HISWA)

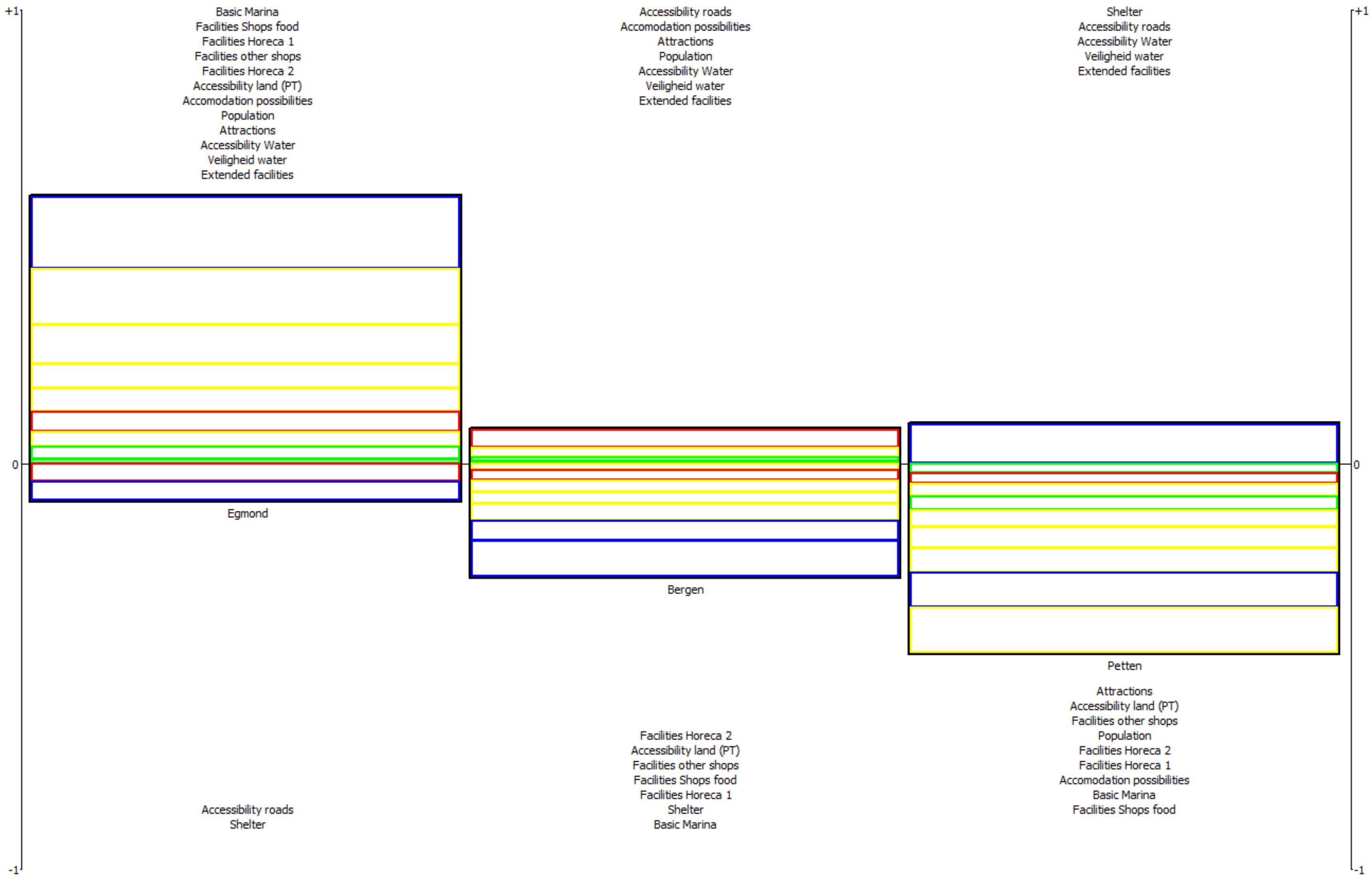


Figure A7.10: Rainbow overview policymakers

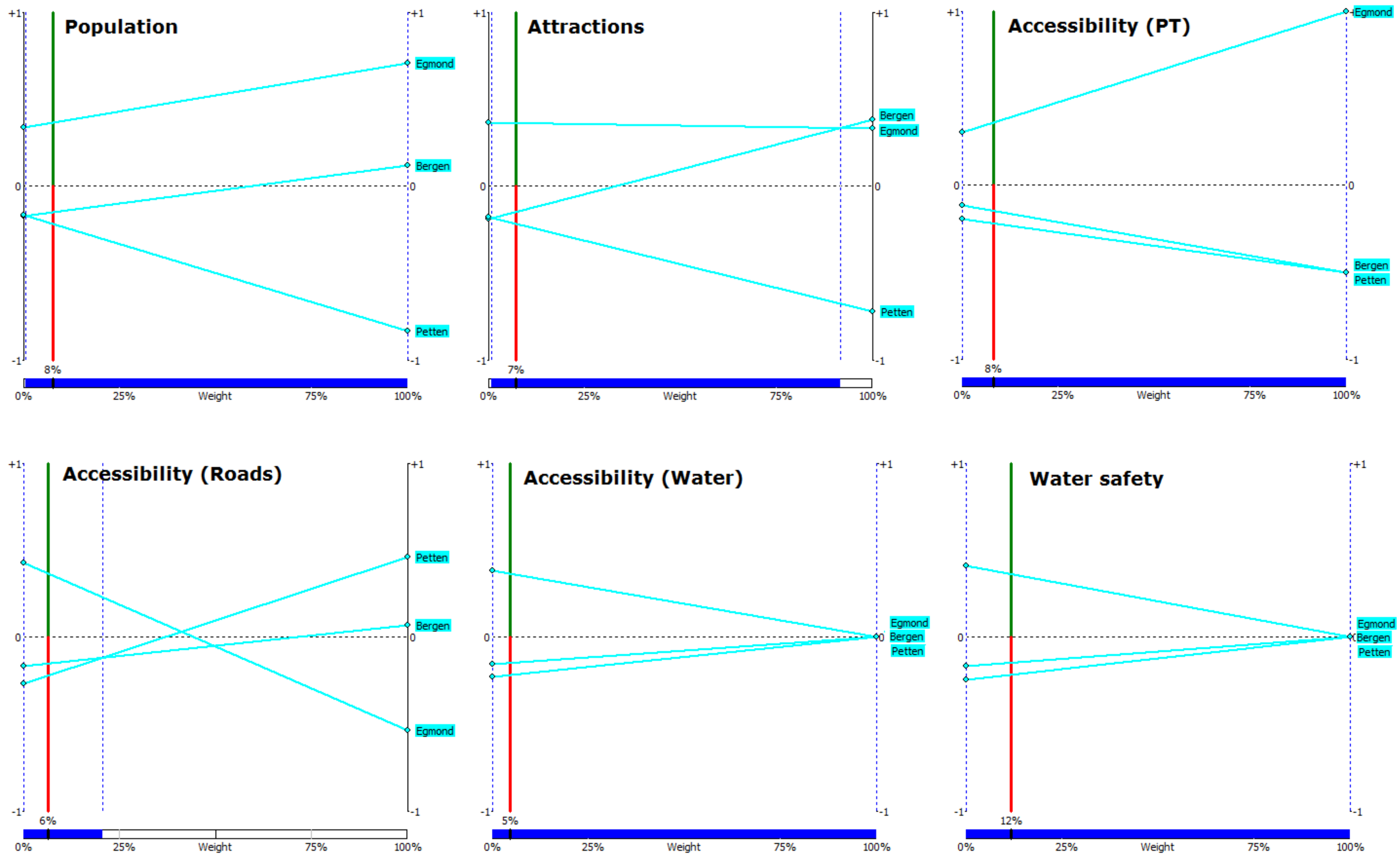


Figure A7.11a: Stability intervals for criteria 1 to 6 from the **marina surveys** (all marina surveys together)

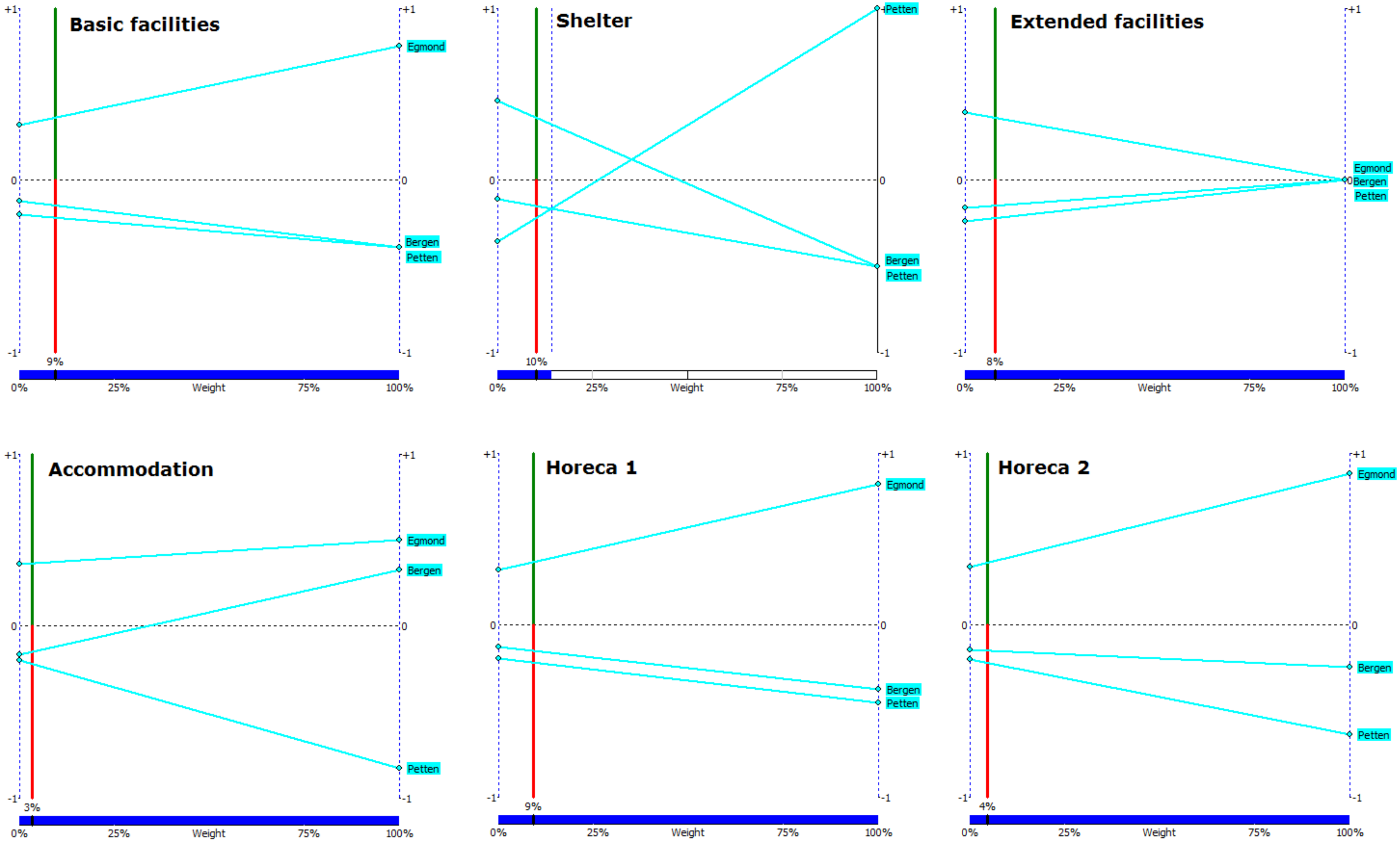


Figure A7.11b: Stability intervals for criteria 7 to 12 from the **marina surveys** (all marina surveys together)

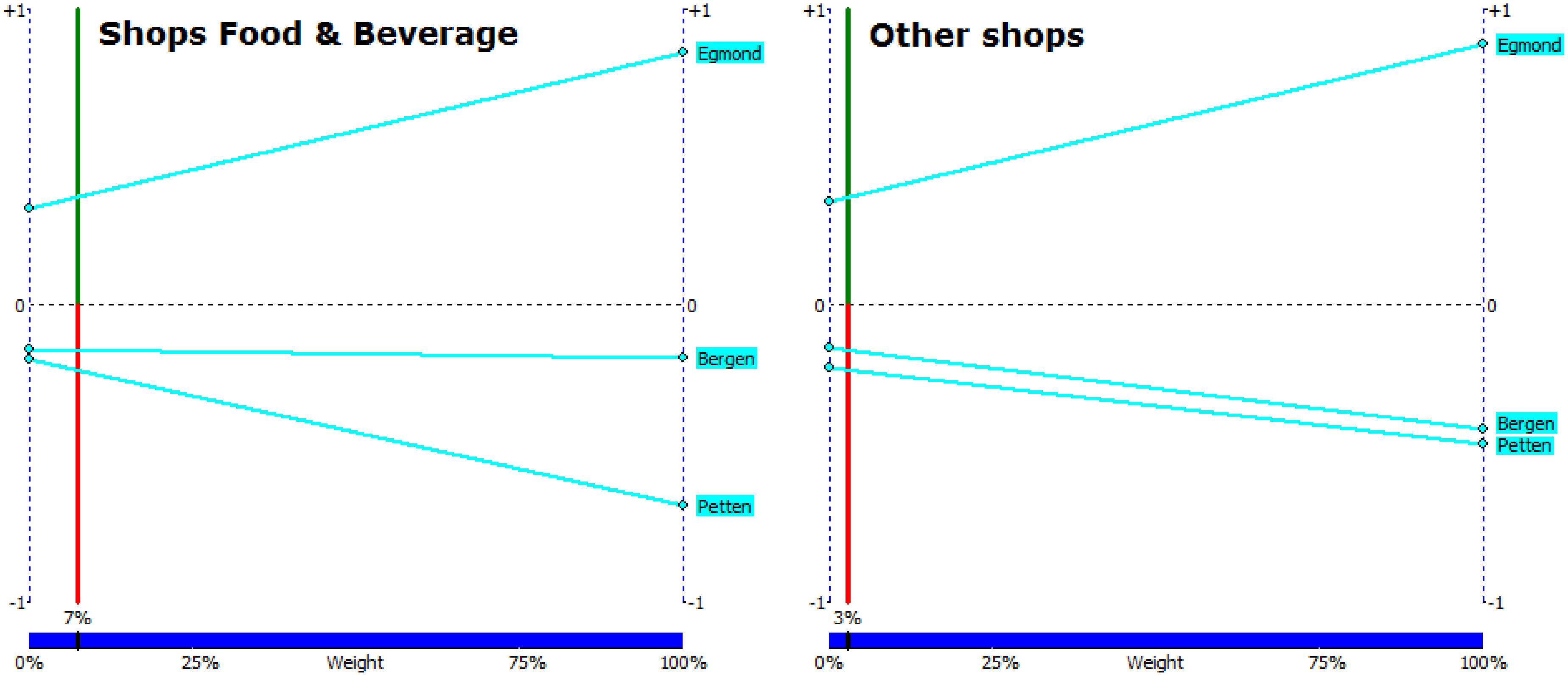


Figure A7.11c: Stability intervals for criteria 13 and 14 from the **marina surveys** (all marina surveys together)

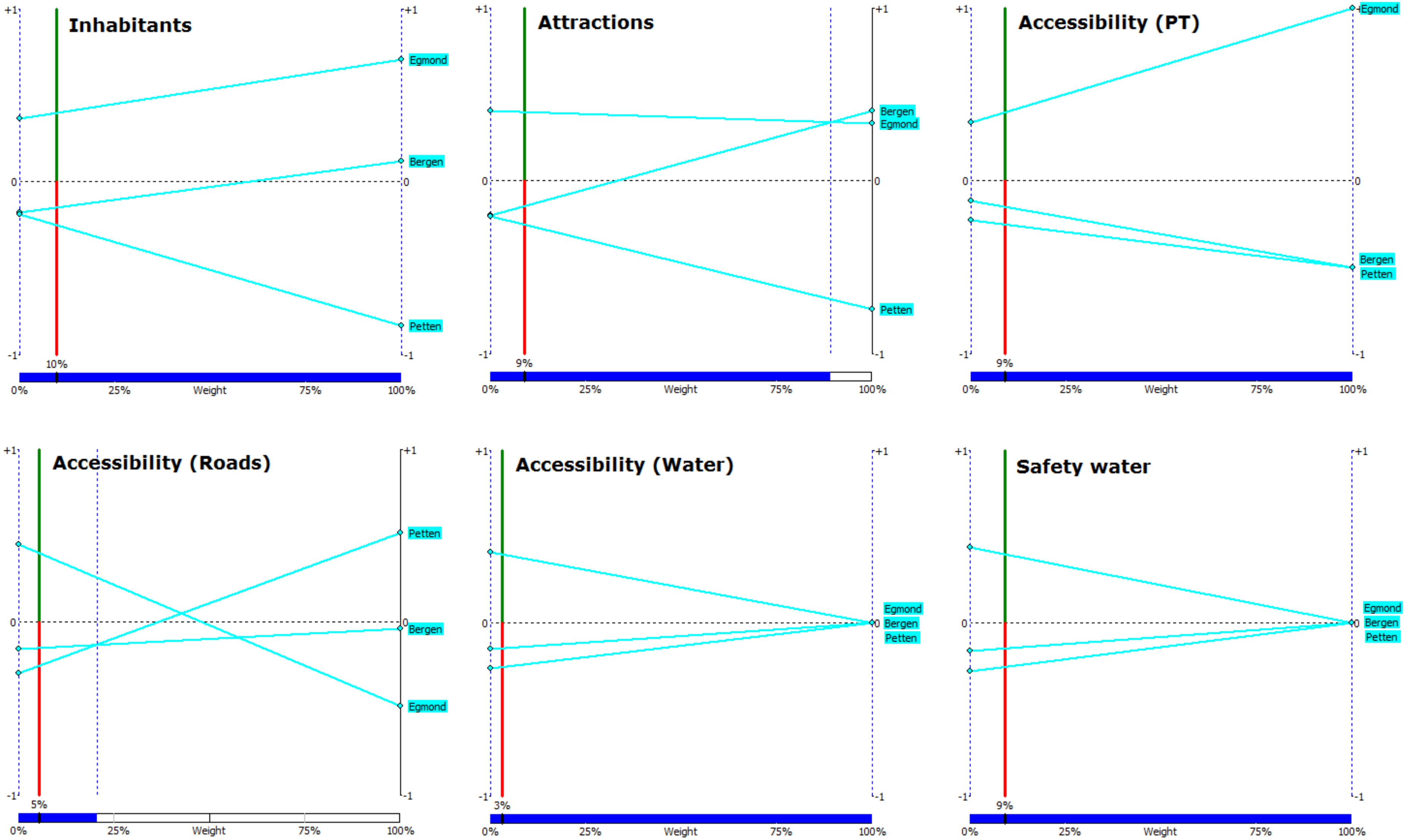


Figure A7.12a: Stability intervals for criteria 1 to 6 from the **user surveys** (all user surveys together)

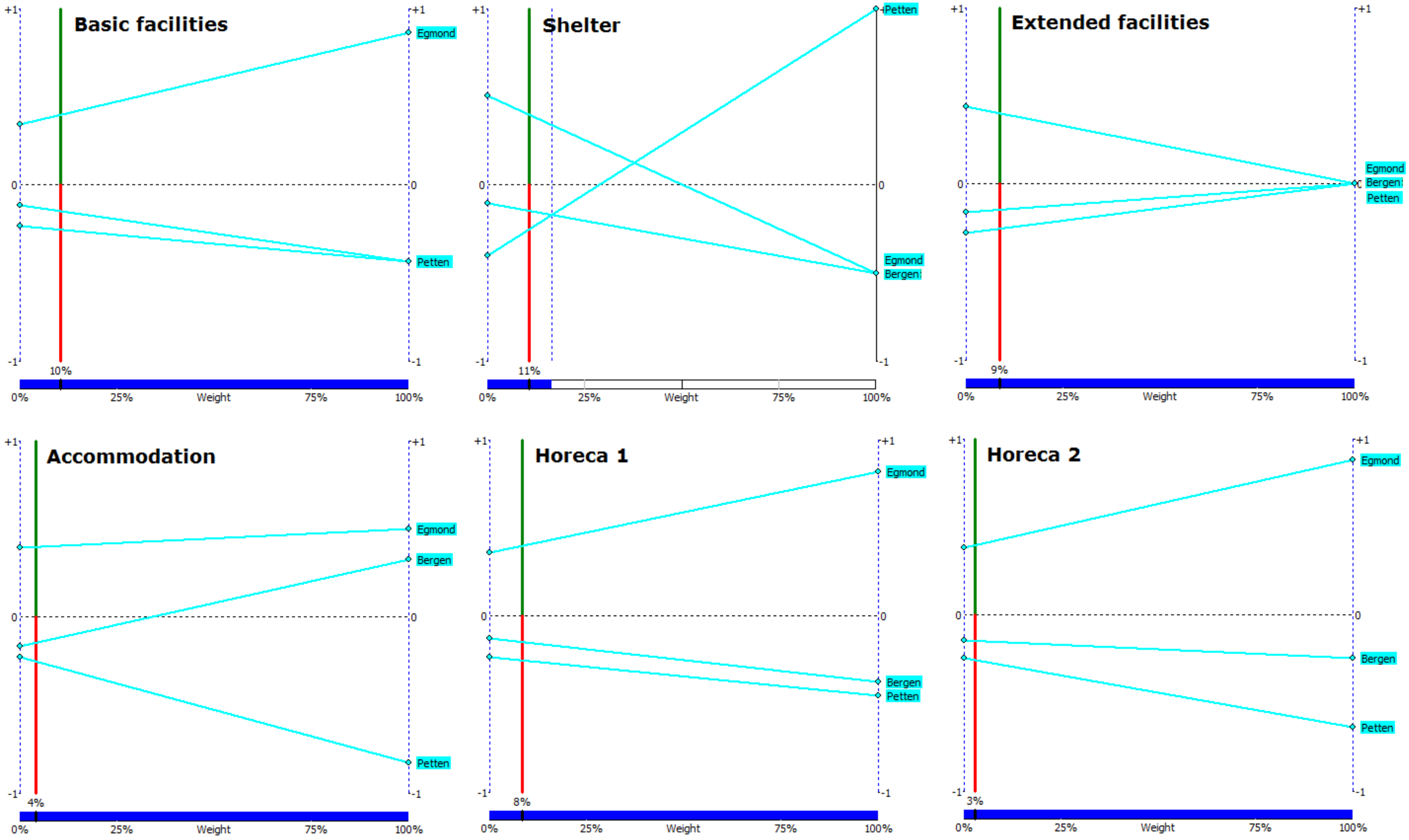


Figure A7.12b: Stability intervals for criteria 7 to 12 from the **user surveys** (all user surveys together)

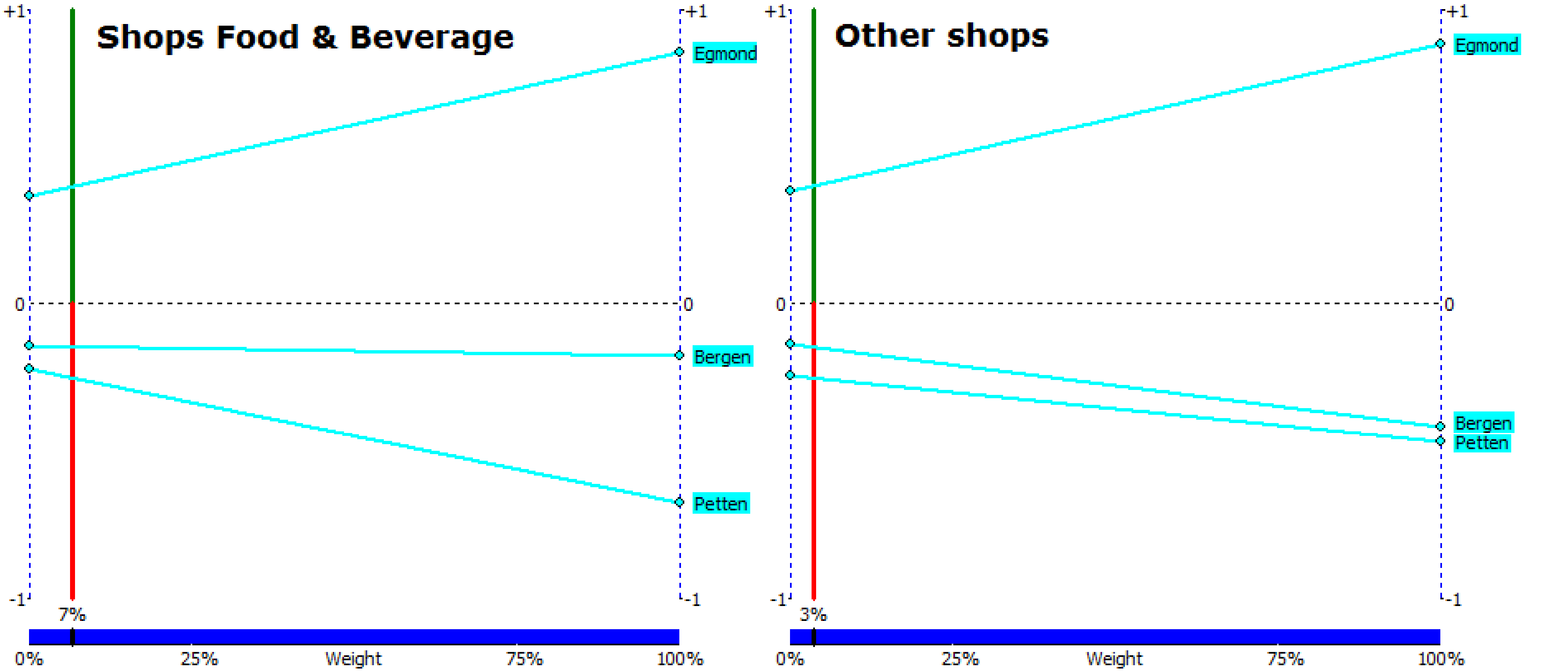


Figure A7.12c: Stability intervals for criteria 13 and 14 from the **user surveys** (all user surveys together)

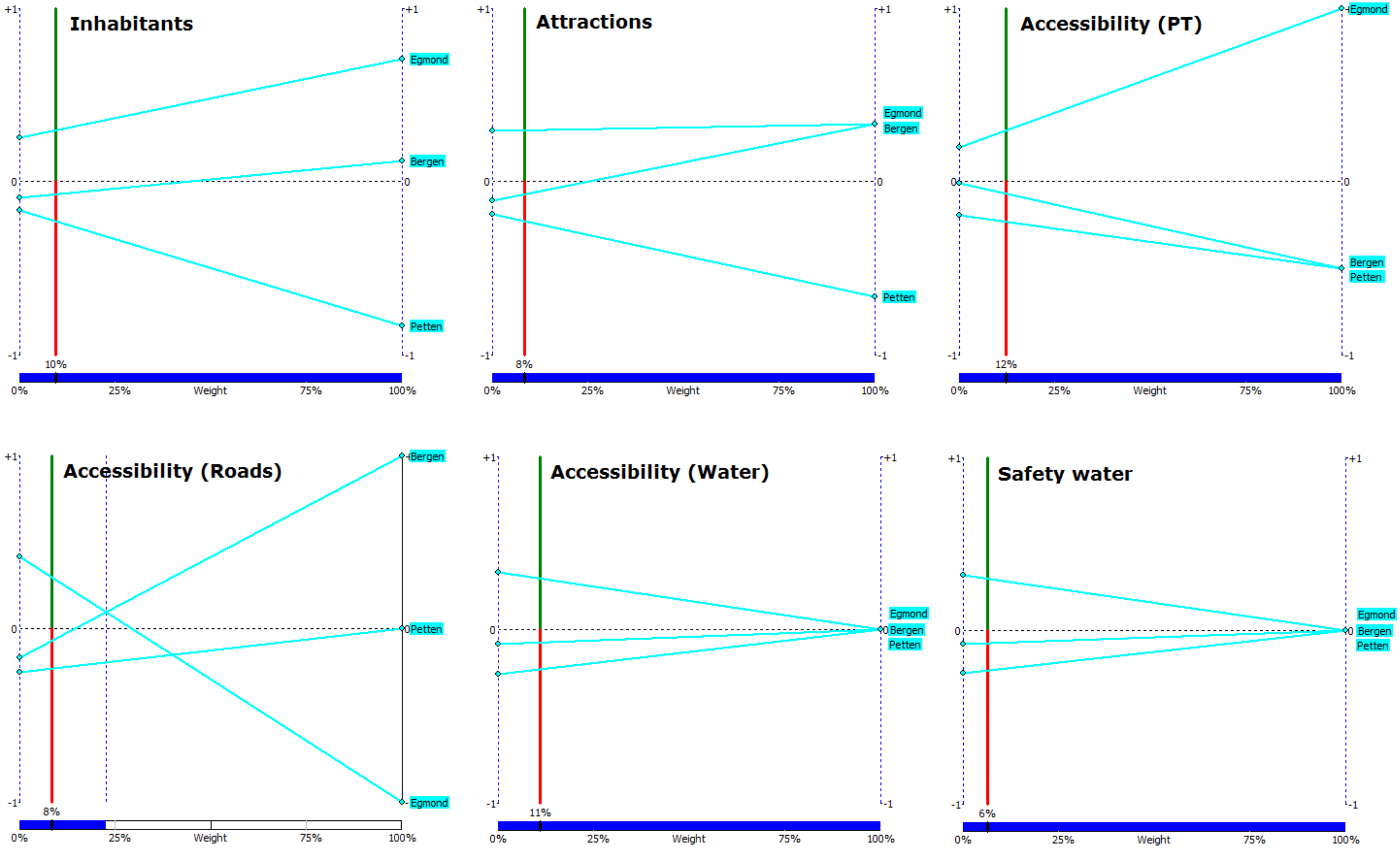


Figure A7.13a: Stability intervals for criteria 1 to 6 from the **policymaker survey**

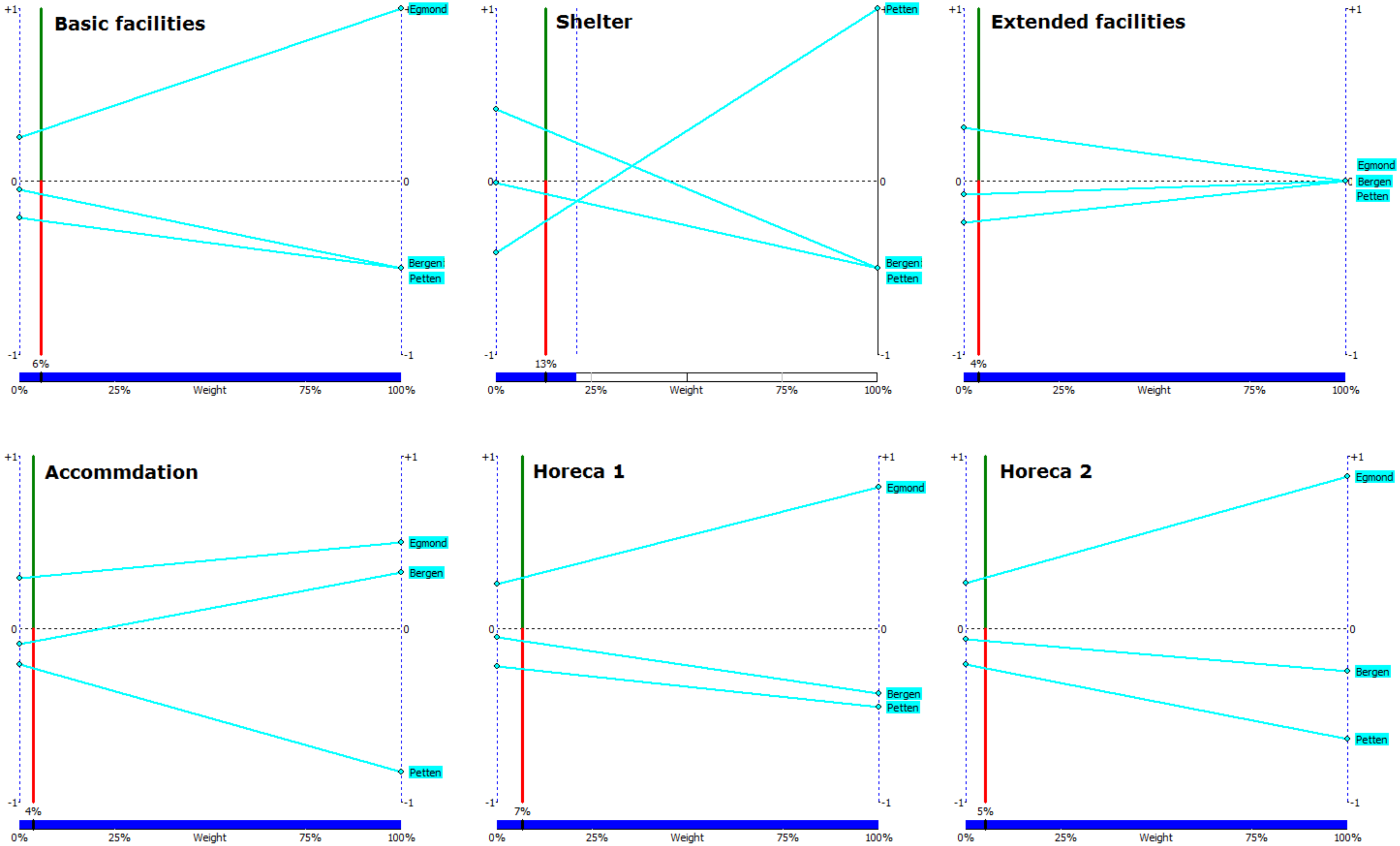


Figure A7.13b: Stability intervals for criteria 7 to 12 from the **policymaker survey**

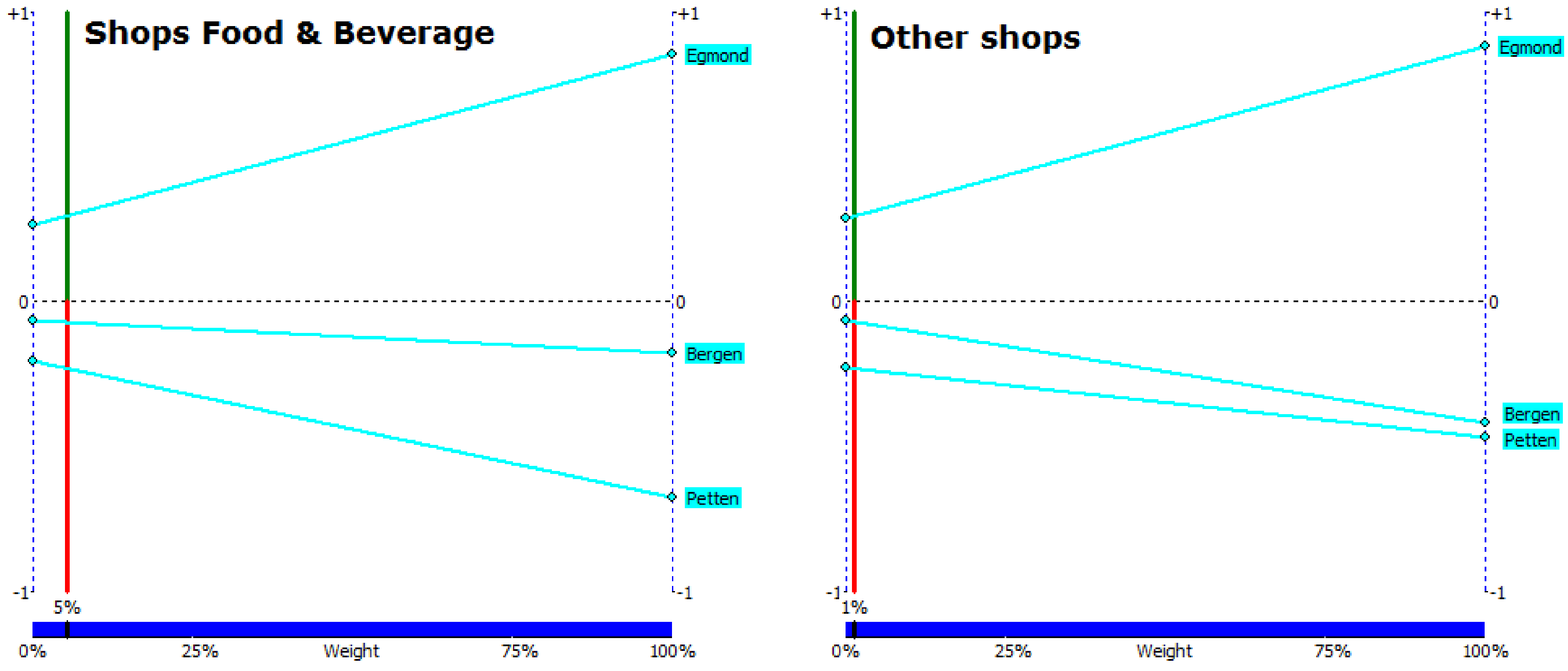


Figure A7.13c: Stability intervals for criteria 13 and 14 from the **policymaker survey**