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The accuracy of the maps of Zeeland; Accuracy measurement as part of the cartobibliography

Keywords: accuracy measurement; Zeeland; cartobibliography

Summary

Recently, a cartobibliography of maps of the province of Zeeland was published by Explokart, the Dutch research group for the history of cartography. This bibliography is the tenth volume in a series of cartobibliographies. The bibliography of maps of Zeeland is the first one which includes a chapter on the accuracy of the maps. The maps of Zeeland can be categorized in four groups, each containing one main map and several derivatives. The four main maps are the maps of Jacob van Deventer (dated 1560), Visscher-Roman (1656), the Hattinga-family (1753) and Krayenhoff (1806). The research to the accuracy of those four maps shows that the 16th century Van Deventer map has been the most accurate map of Zeeland until the 19th century Krayenhoff map. This contribution will contain a short introduction of the mapping of Zeeland, an introduction to the method used in the research project to the accuracy of the four Zeeland maps, the results and conclusion of the project and finally some remarks on the surplus value of an accuracy analysis as part of a cartobibliography.

Introduction

Explokart, the research group for the history of cartography of the Utrecht University, has a long tradition of publishing cartobibliographies. These cartobibliographies are the result of research done by volunteers, under editorial board of the professionals of Explokart. In the year 2000 the first cartobibliography, of the province of Holland, was published. Besides some bibliographies on specific topics (Zuiderzee, Petermann's Mitteilungen or the Royal Dutch Geographic Society) or publishers (Guicciardini, Von Derfelden von Hinderstein or Covens & Mortier) also the cartobibliographies of the provinces of Friesland and Zeeland appeared. The bibliography of the province of Brabant is in preparation.¹

The cartobibliography of Zeeland (Blonk & Blonk – van der Wijst, 2010) is the first one in the Explokart series which includes an analysis of the accuracy of some of the maps. Now it is possible to investigate some of the assumptions about the maps, done in the bibliography. For example, one of the assumptions is that the Zeeland map of Jacob van Deventer is the result of triangular surveys, while the maps of Visscher-Roman and the Hattinga were compiled. The Krayenhoff map is definitely the result of a triangulation measurement, see the section on this map later. As a result, the first maps should be more accurate than the second ones. With MapAnalyst, the free computer program to analyze maps on their geodetic accu-

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¹ For a complete list of the volunteer works of Explokart and their other research projects, see: <http://cartography.geog.uu.nl/>

racy, the maps of Zeeland by Jacob van Deventer, Visscher-Roman, Hattinga and Krayenhoff were analyzed. The following questions can now be answered:

- Is the map of Jacob van Deventer compiled or is it the result of a new survey? And is it possible that Van Deventer used the triangulation method?
- Are the Visscher Roman map and the Hattinga map compiled and if they are, is there any difference between them?
- Is the Krayenhoff map, the most recent one of the four maps investigated here, really more accurate than its predecessors?
- Is an accuracy analysis a valuable addition to a cartobibliography?

This paper starts with an overview of the mapping history of the province of Zeeland. The four maps subject to this research will be introduced here.

In the next section, the used method will be explained, followed by the results of the research project. Finally, in the conclusion section, the question mentioned above will be answered and some remarks on the use of accuracy research in cartobibliographies will be given.

The mapping of the province of Zeeland

The province of Zeeland

Zeeland is a province in the southwestern part of The Netherlands. Because the province consists mainly of islands, often is spoken about the Zeeuwse Delta. Figure 1 shows a map of the province, with its islands.

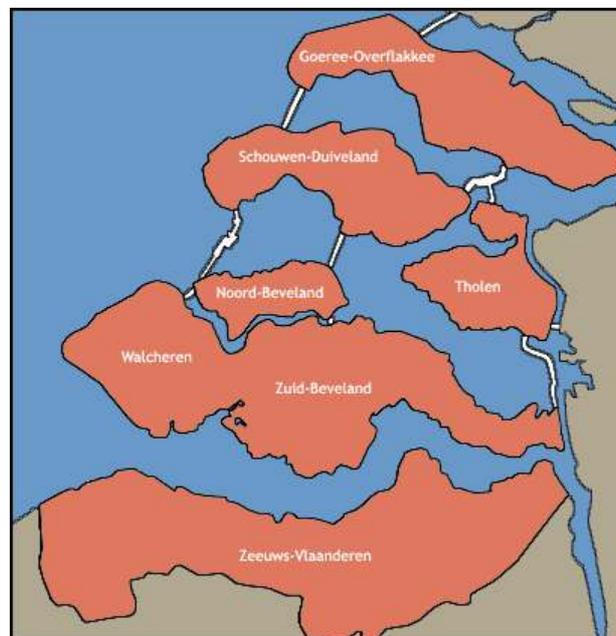


Figure 1: the province of Zeeland and its islands.

Over the centuries, the area changed rapidly. The Oosterschelde and Westerschelde, the main waters within the area, flooded the land, but also gave land back. When we look at old maps of this province, we see an area that looks very different then it is today.

Maps of Zeeland

Blonk (Blonk & Blonk – van der Wijst, 2010) distinguishes four main map types. The first one is the map of Jacob van Deventer, published in 1560. The second one is the Visscher-Roman map, published in 1656. The third one is a map from the Hattinga family, published in 1753. The last map type is the Krayenhoff map, dated 1806. These maps are base maps. All other maps of the Zeeland province are derivatives of one of these four. A short description of the four base maps is given in the section below.

Jacob van Deventer

Jacob van Deventer was born shortly after 1500 and died in 1575 in Cologne. He studied medicine and geography at the University of Leuven. Van Deventer became an important geographer and cartographer. First he worked for the German Emperor Charles V, later for his son, King Philip II of Spain. Jacob van Deventer is well known for his maps of the Dutch provinces and for his town maps.

The first version of the wall map of Zeeland can be dated around 1549. Although there is no year mentioned on the map, there are topographical indications for this date.

The map used in this research is dated 1560 and was published by William Silvius. In the corner above left, there are the coats of arms of the province of Zeeland, king Philip II and prince William of Orange. There are no roads on the map, but the watercourses are drawn. There are a lot of toponyms. Towns are drawn with their profile, while churches and cloisters are drawn with a little cross.

There is a discussion on the survey method Van Deventer has used. Fockema Andrea and Van't Hoff (1947, p. 25) points out that Van Deventer used the triangulation method. Koe-man thinks Van Deventer used a more simple method by Sebastian Münster.

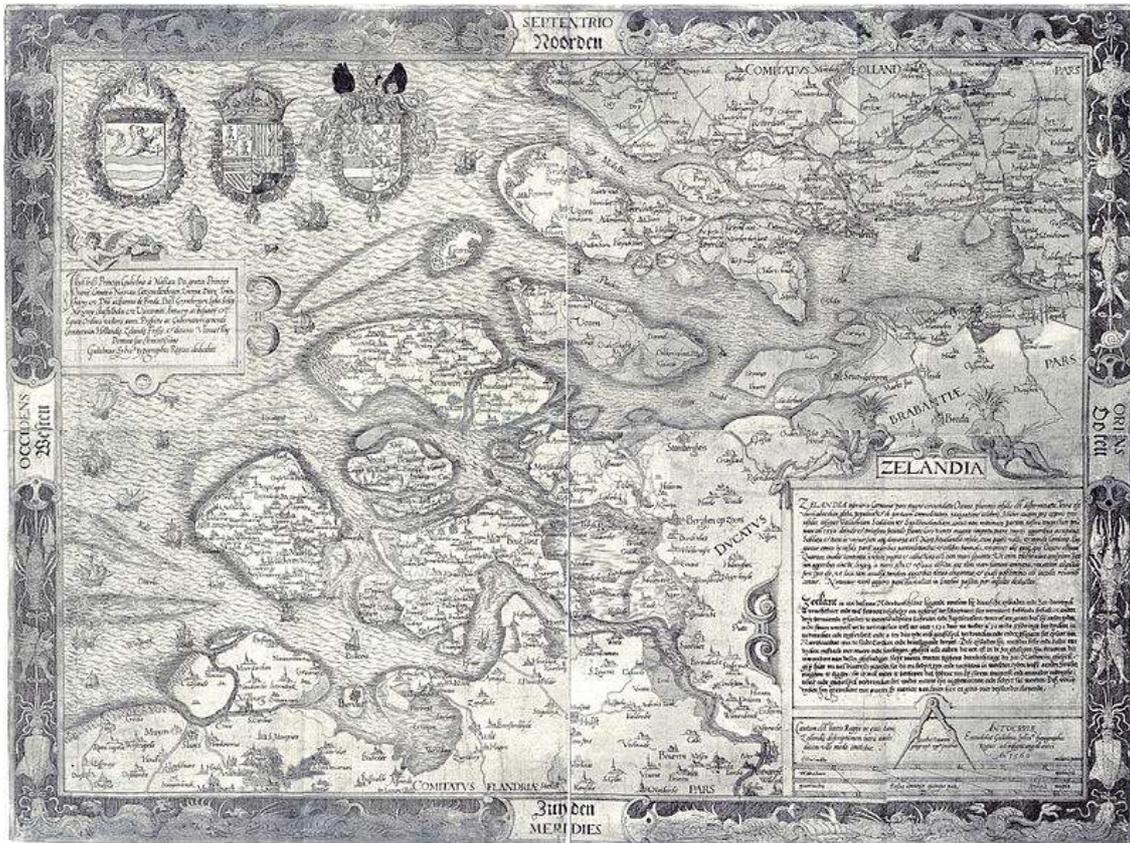


Figure 2: Map of the province of Zeeland by Jacob van Deventer (1560).

Visscher-Roman

A hundred years after the publishing of Van Deventer's wall map, a new map of Zeeland was needed. The commission for the map was given to Zacharias Roman in 1650. Zacharias Roman copied several maps and compiled his wall map. Roman was a bookseller and publisher in Middelburg, the capital of the province. For his map of Zeeland, he cooperated with Claes Jansz. Visscher, who was more experienced in copper engraving. Because the map was copied from other maps, with different scales and therefore different level of details, the wall map of Visscher Roman shows a great variance in topographical accuracy. Because no attention was paid to the earth's curvature, a geodetic inaccuracy is to be expected. The privilege (a kind of copyright) for this map was given to Zacharias Roman in 1656, so this year is also mentioned as publication date.

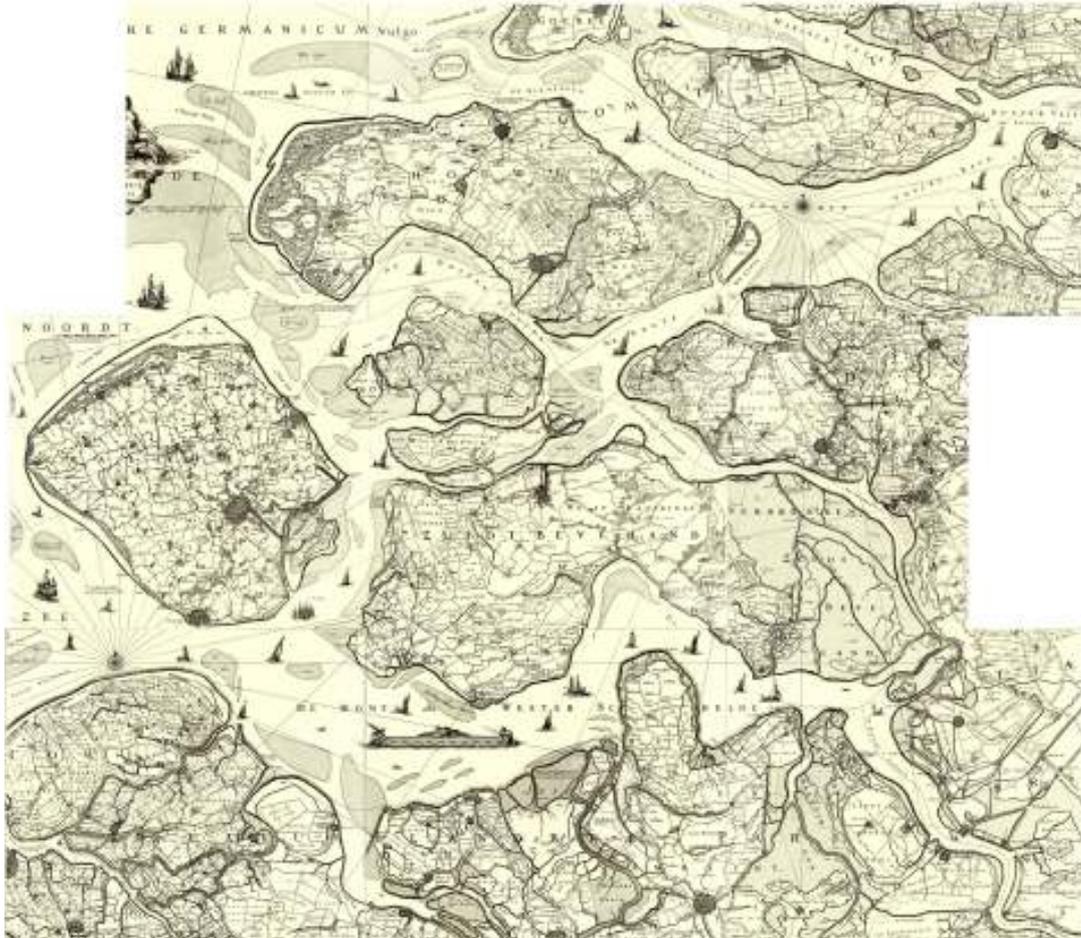


Figure 3: Visscher-Roman map of the province of Zeeland (1656).

Hattinga's

William Tiberius Hattinga was born in 1700. Like Jacob van Deventer, he studied medicines and geography and later mathematics. There he learned the triangulation method and developed a great interest in cartography. In 1730 and 1731 he got two sons: David William Carel and Anthony. They developed the same interest in cartography as their father.

The Hattinga family works, in commission of the States of Zeeland, on maps of the islands from 1744. The first map was of the island of Tholen. Later the other islands were mapped and in 1752 an *Atlas der Provincie van Zeeland* (Atlas of the province of Zeeland) was compiled. From these maps of the islands, which all were surveyed by the Hattingas themselves, a large map of the whole province was compiled. It is therefore to be expected that the accuracy of the maps of the islands is much better than the accuracy of the map of the province as a whole.



Figure 4: Hattinga map of the province of Zeeland (1753)

Krayenhoff

In the period 1795-1806 the Netherlands are known as the Batavian Republic. For the first time there is (more or less) a kind of nation state. This is the reason that there is a great demand for new accurate maps of the Republic. The commission for a new topographical map is given to lieutenant-colonel Baron C.R.Th. Krayenhoff. After Jacob van Deventer and W.T. Hattinga, the third cartographer who also studied medicine!

Krayenhoff started his project, where he surveyed the whole Republic by using the triangulation method, in 1801. After a false start, at first Krayenhoff used inaccurate instruments, the result was a network with 162 triangles. The used triangulation network was connected to the French network. In 1811 the project was finished. The province of Zeeland was mapped in 1806. The map was published by Covens & Mortier. Because of the used method, it is to be expected that the Krayenhoff map is the most accurate one of the four maps.



Figure 5: Krayenhoff map of the province of Zeeland (1806).

Used method

Introduction

For the analysis of the four maps, MapAnalyst was used. With this software it is possible to calculate the accuracy of maps relatively quick. The software is developed by the ETH Zürich and is free to download.² In this section a brief overview of MapAnalyst will be given. Only those functions used in this research project will be mentioned. For a complete description of MapAnalyst, see Jenny (2006 & 2010).

First step: setting the control points

MapAnalyst is based on the comparison of points on the old map with the same points in the real world. Therefore a set of points on the old map and in the modern reference map must be selected. MapAnalyst provides OpenStreetMap as the reference map. One can use an own reference map, but in the case of this research project, that was not necessary.

² <http://mapanalyst.cartography.ch/index.html>

As mentioned before, the landscape has changed often in this part of the Netherlands. Therefore, attention on the selection of the control points must be paid. Points on the coastlines cannot be used. The same goes for watercourses. In most cases churches were used as a control point, because one can be pretty sure that churches don't move very often.

Figure 6 shows the main screen of MapAnalyst, with the control points on the Van Deventer map and the reference map.

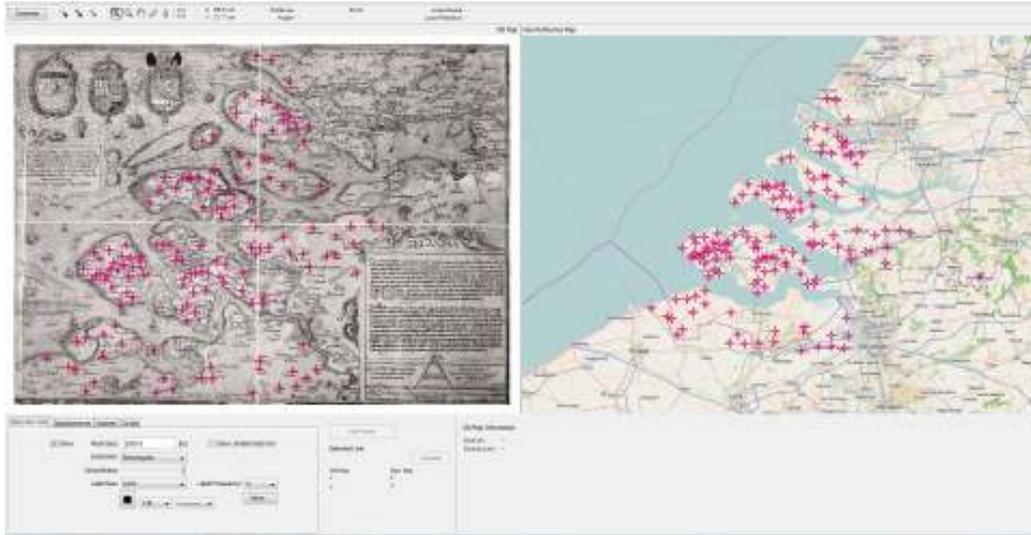


Figure 6: main screen of MapAnalyst, with the Van Deventer map and OpenStreetMap as the reference map.

Visualizing the analysis: distortion grids and vectors of displacement

The results of the analysis can be visualized in several ways. For this research the distortion grids and the vectors of displacement were used.

The distortion grid provides a good overview of the geodetic accuracy of the old map in general. Around the control points a grid is made. When the old map is as accurate as the reference map, the grid provides perfect squares. When the squares are reduced in size, the scale of the old map is reduced on that area of the map. When the squares are enlarged, the scale of the old map is also enlarged on that particular spot. In that way, one can point out areas of scale reducing and enlargement on the map. It provides a quality measurement for the map as a whole. Figure 7 shows the distortion grids for the four maps, subject to this research.

The quality of the specific points, i.e. the chosen control points, can be visualized with the vectors of displacement. Each control point is connected to a vector, which ends at the point where the control point should have been, if the old map was as accurate as the reference map. Figure 8 gives an example. The area of the circles around the control points is proportional to the inaccuracy of that point. But the main function is to make the vectors better visible, when projected on the old map. Where the distortion grid gives an overview for the map as a whole, the vectors of distortion gives information on the accuracy of the particular

points. This means, that for example groups can be distinguished with common direction and size of distortion. This can provide information, for example, on possible source maps.

Statistics of the analysis

MapAnalyst can also calculate some statistics. MapAnalyst calculates the scale in horizontal and vertical direction, the rotation of the old map, the mean position error (MPE) and its standard deviation (SD). Especially the last two statistics were used in this research. The mean position error provides a number for all control points on the map. Its unit is in meters. The lower this MPE, the more accurate the old map is. The SD provides the mean deviation for all points with respect to the mean position error. The lower this number, the more accurate the mean position error is.

Results

In this research project only the mean position error (MPE) and standard deviation (SD) were used. Table 1 gives for the four base maps the results of the calculations. Figure 7 shows the distortion grids for the maps.

<i>Map</i>	<i>Mean position error</i>	<i>Standard deviation</i>
Jacob van Deventer	813	575
Visscher-Roman	1516	1072
Hattinga	843	596
Krayenhoff	295	208

Table 1: results of the statistical calculations

The most accurate map, according to the table and the grid, is the Krayenhoff map. The MPE values are by far the lowest with Krayenhoff, while the distortion grid is almost a perfect rectangular. This could be expected. The Zeeland map of Krayenhoff is part of his large triangulation survey of the Netherlands.

As mentioned earlier, the Jacob van Deventer map is supposed to be the result of triangular surveys. The results of the accuracy analysis can confirm this. After Krayenhoff, it is the second most accurate map of the four analyzed. Although overall the distortions on the Van Deventer map are very low, the southern part shows relatively high distortions. This is visualized with vectors of displacement in figure 8. Maybe Van Deventer had used another map, maybe a map of the province of Vlaanderen to compile this part of his Zeeland map. This is for future research.

According to the cartobibliography, it is known that Roman compiled his wall map, as mentioned in the section on the Roman Visscher map. This map is clearly the most inaccurate one. When the vectors of displacement are analyzed, see figure 9, there are some patterns visible, of vectors with a common direction. With a few exceptions, one can see that there are

common directions of the vectors for each island. Therefore a conclusion can be that Roman used different maps for each island and compiled these, with the wall map as a result. The islands of Walcheren, Noord- and Zuid-Beveland and Schouwen-Duiveland are analyzed separately. The values of the MPE are given in table 2.

<i>Area</i>	<i>MPE</i>	<i>Deviation factor</i>
Walcheren	215	7,1
Bevelanden	362	4,2
Schouwen-Duiveland	279	5,4
<i>Zeeland</i>	<i>1516</i>	

Table 2: the mean position error for the islands and for Zeeland as a whole, for the Visscher Roman map.

The value for Zeeland is given to compare with. It is clear that the MPE of each island strongly differs from the MPE of Zeeland as a whole. This can be concluded by the deviation factor. This is the ratio of the MPE for Zeeland by the MPE of each island.

The same conclusions can be drawn for the Hattinga map, although less strong. Figure 10 shows the vectors of displacement. Table 3 shows the mean position errors for the islands and their deviation factor.

<i>Area</i>	<i>MPE</i>	<i>Deviation factor</i>
Walcheren	157	5,4
Bevelanden	152	5,5
Schouwen-Duiveland	212	4,0
<i>Zeeland</i>	<i>843</i>	

Table 3 the mean position error for the islands and for Zeeland as a whole, for the Hattinga map.

From both compiled maps, the Visscher Roman and the Hattinga map, is the last one the most accurate. This can be explained by the fact that Roman used an arbitrary set of maps to compile his wall map. The Hattinga's could use their own island maps, which they had made themselves. No doubt that these island maps were of a better quality then the maps Roman used.

For comparison, the MPE and deviation factors for the islands on the Van Deventer and Krayenhoff maps are given in table 4.

	Walcheren	Bevelanden	Schouwen-Duiveland	<i>Zeeland</i>
Van Deventer	307 (2,6)	382 (2,1)	280 (2,9)	<i>813</i>
Krayenhoff	150 (2,0)	315 (0,9)	276 (1,1)	<i>295</i>

Table 4 the mean position error for the islands and for Zeeland as a whole, for the Van Deventer and Krayenhoff map.

The deviation factors on the Van Deventer and Krayenhoff maps are much lower than on the Visscher Roman and Hattinga map. This can be explained by the usage of different techniques the mapmakers used. The conclusion that Van Deventer and Krayenhoff used their own surveys and the maps of Visscher Roman and Hattinga are compiled can be endorsed.

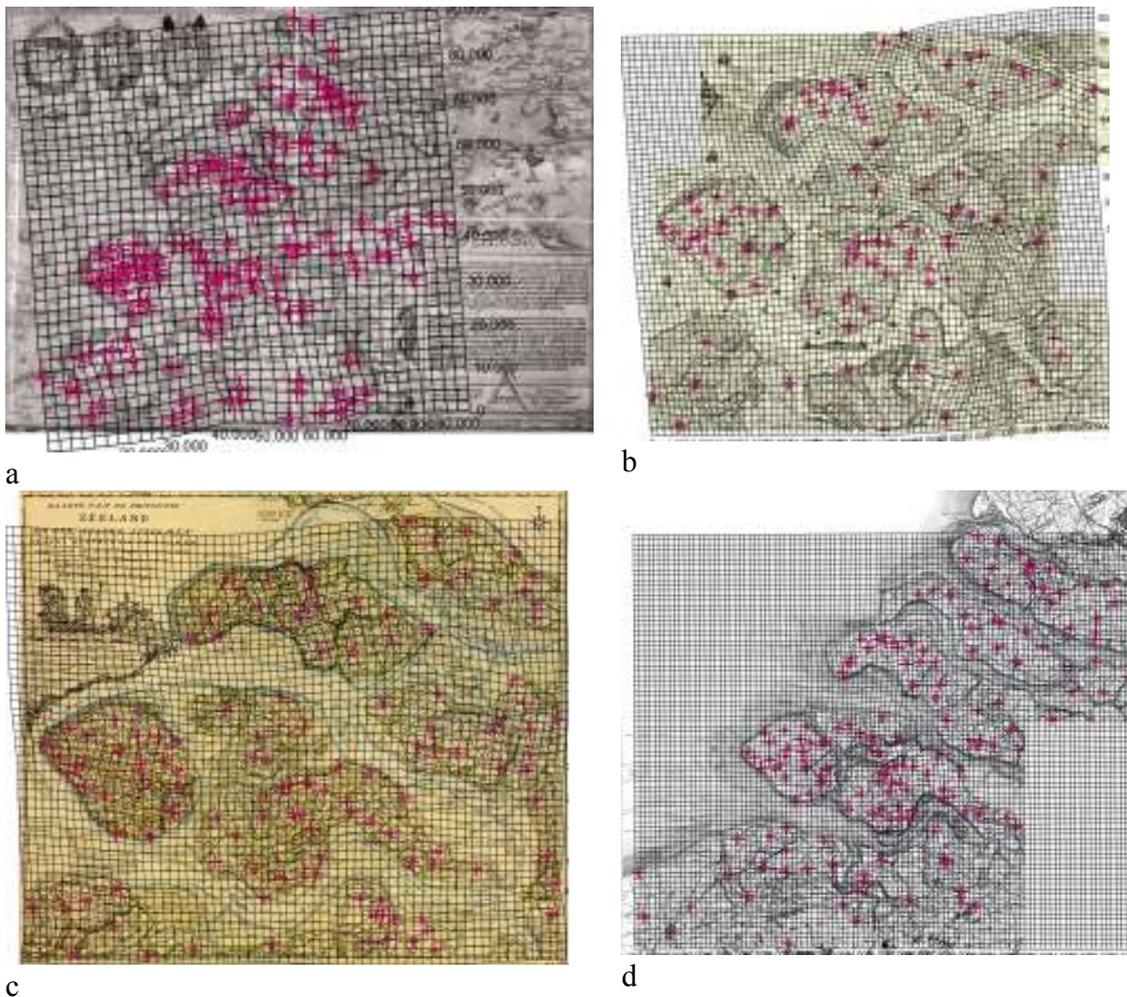


Figure 7: distortion grids for a) the Jacob van Deventer map, b) the Visscher-Roman map, c) the Hattinga map and d) the Krayenhoff map

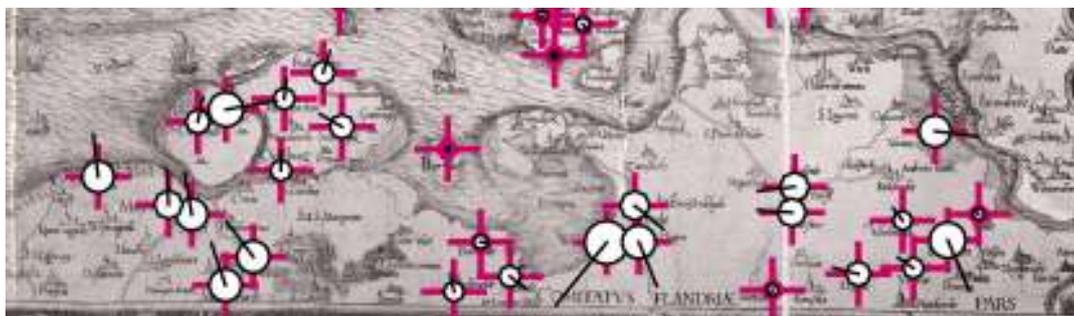


Figure 8: Vectors of displacement in the southern part of the Van Deventer map.

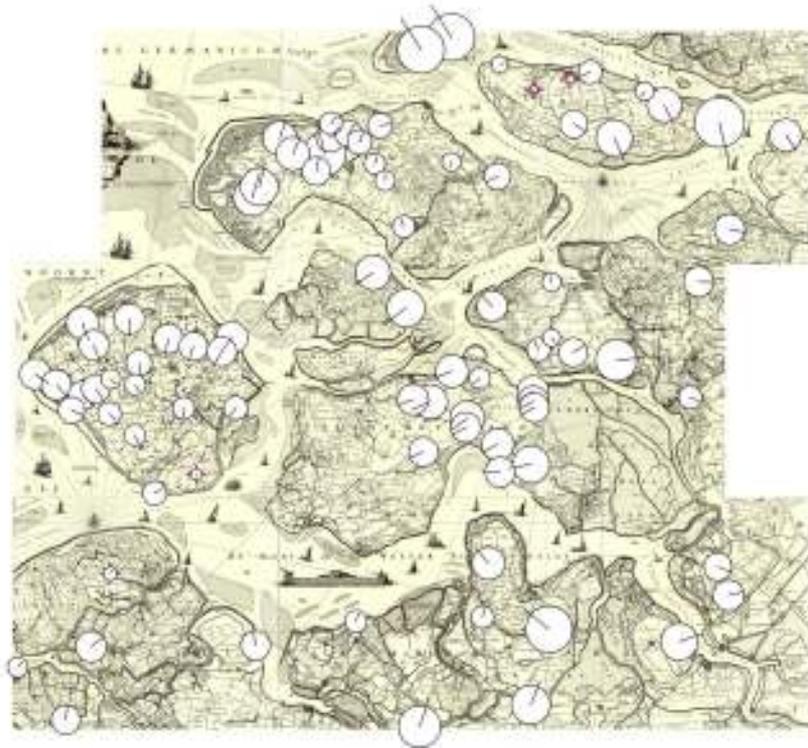


Figure 9: Vectors of displacement on the Visscher Roman map.

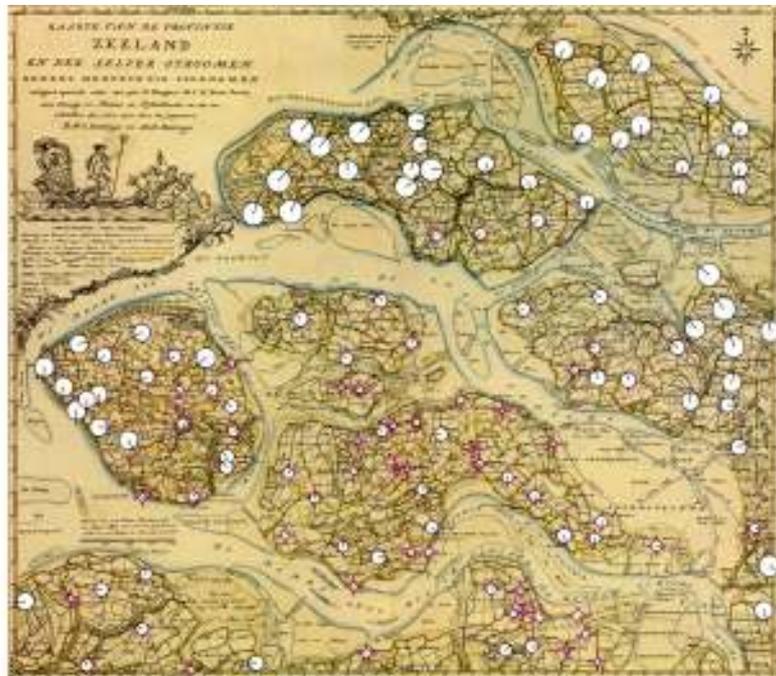


Figure 10: Vectors of displacement on the Hattinga map.

Conclusion

The improvement of the geometrical accuracy is not a chronological process. The fact that the Netherlands did not have a cartographic institution until the 19th century is the result of the lack of unity in this period. All provinces were operating independently. There was no so-called nation state. Krayenhoff was in the 19th century the first who made an accurate topographical map of the Netherlands. This accuracy is noticeable in the Zeeland map. Some 250 years earlier, Jacob van Deventer made maps of each of the provinces. Therefore he surveyed these provinces as a whole. For this reason, the Van Deventer map is the most accurate map of Zeeland, until the Krayenhoff map.

The maps of Visscher Roman and the Hattinga's are compiled from other maps, but there is a difference between them. Roman compiled his wall map from an arbitrary set of maps, which were more or less accidentally available. There was no attention for the quality of these maps. The Hattingas could compile their wall map from the maps they made themselves. They surveyed the islands themselves, which led to consistent maps of high quality.

As mentioned in the introduction, the cartobibliography of Zeeland is the first one in the Explokart series which includes an accuracy analysis.

MapAnalyst only shows patterns, but the interpretation is a work of man. Therefore, knowledge of the maps is essential in evaluating the results of an accuracy analysis. In this case some assumptions in the cartobibliography, that the Visscher Roman and Hattinga maps are compiled and Van Deventer and Krayenhoff are the results of own surveys, could be confirmed. On the other hand, by the analysis, new questions arise. For example in this research, what did Van Deventer do with the southern part of his Zeeland map? The inaccuracy differs very much from the rest of the map, so probably he copied this part from another map. But from which one?

Accuracy analysis to a cartobibliography can therefore be a valuable addition, which gives us a little more knowledge of the maps.

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