Captured by Numbers

Nicolaas Struyck's quantitative geography in the *Inleiding tot de algemeene geographie* (1740)

Marieke Gelderblom | 5717035
Utrecht University | MSc History and Philosophy of Science
Thesis | 37,5 ECTS
July 2022

Supervisors:
dr. Emma Mojet
prof.dr.ir. Fokko Jan Dijksterhuis
dr. Steven Wepster

Table of contents

Introduction

This thesis is part of a history that describes how we have come to understand our world through numbers. It traces the establishment of quantitative descriptions as an appropriate form of worldly knowledge. In particular, it describes how and why Nicolaas Struyck saw numbers as the best way to understand the world. This scholar, who has been described as the 'most important Dutch mathematician of the 18th century,' tried to capture the world in numbers.[1] In this thesis I will investigate the quantitative practices of his *Inleiding tot de algemeene geographie* (1740).[2] The research question is as follows:

How and why did Struyck quantify empirical observation in his geography?

In this introduction I will present the most important concepts in the research question. First, I will introduce and reflect on my understanding of quantification, explaining what I believe it means 'to quantify' something. Then, secondly, I will look at the 18th-century Dutch Republic context of geography, especially the mathematical geography Nicolaas Struyck engaged in. In the third paragraph I will introduce the most important details of Struyck's life and work. Finally, I will present the overarching structure and argument of this thesis.

0.1 What is quantification?

Quantification has been presented as one of the main characteristics of the eighteenth century.[3] It emerges as part of the shifts during the Enlightenment and the corresponding intellectual and cultural shifts to toleration, secularization, classification of knowledge and popularization of science.[4] This 'mania for scientific classification' took several forms.[5] Quantification, in very general terms, is about 'capturing the world in numbers.' Nevertheless, what that entails and how that would proceed remains rather vague and intangible. There are several careful distinctions to make. Before I present my view on what quantification *is,* I consider it helpful to discuss what it *is not.* Roux introduced quantification as the arithmetical application of concepts, procedures and methods developed in mathematics to the objects of other fields of knowledge.[6] I want to deviate from her description in two ways. Firstly, I do

[1] The quote is obtained from Struik, *Geschiedenis van de wiskunde*, 189. (Dirk Jan Struik and Nicolaas Struyck are not related.)
[2] Struyck, *Inleiding*. The Inleiding consists of two parts; page numbers refer to the first part unless otherwise specified (resp. '91' vs. '91 (part II)'). Quotes from primary sources are translated to modern English (also. departing from the original abundant punctuation and capitalization), but the original Dutch is always provided in a footnote. All translations are my own.
[3] Klep and Stamhuis, 'The Statistical Mind in a Pre-Statistical Era', 15; Frängsmyr, Heilbron, and Rider, *The Quantifying Spirit in the Eighteenth Century*, 2.
[4] For an introduction to the Enlightenment in the context of the Dutch Republic, see Israel, *The Dutch Republic*, 1038–66.
[5] Israel, 1045.
[6] Roux, 'Forms of Mathematization (14th - 17th Centuries)', 324–25.

not consider quantification to be a strictly arithmetical process, but I also include practices that are not necessarily numerical (like ordering or systematizing). I will return to this point later. Secondly, as I see it, 'to quantify' something is not the same as 'to apply mathematics to it' or 'to abstract it through mathematics.' Speaking of application or abstraction seems to suppose that the object or phenomenon onto which mathematical concepts are imposed already has some sort of suitable shape or form. It supposes, in a sense, that the object or phenomenon is already receptive to mathematics. In my view that does not have to be the case. Like Porter writes, 'nobody ever argues that populations are inherently nonquantitative.' [7] Quantification can also apply to things that are by themselves not necessarily suitable for a mathematical description. Instead, I see quantification as this process of transformation: it can *make* these things receptive to mathematics.

In this thesis, I consider quantification to be the following: it is *a systematic process of transforming empirical data into meaningful numbers.* If we connect that to our research question, then this thesis will be about how and why Nicolaas Struyck converted empirical observations to meaningful descriptions of the world in numbers.

Such descriptions do not require any underlying conception of the reality of that object or phenomenon. It is very well possible to develop a quantified understanding of something that by itself is not necessarily mathematical at all. Quantification is only to conceive something as such.[8] In this sense I take quantification and mathematization to have distinct meanings. To quantify is to conceive something through mathematics, whereas to mathematize is also to embed these in an explanation or a model. Especially when it comes to geography, '[mathematization] was the thought that the world *was* mathematical and that this model could provide an explanation to everything that happened in the world,' using the words of Vermij.[9] Or, as Alberts put it: 'Mathematization is a conception of reality, in substance inspired by mathematical thinking and determined in this sense.'[10] In a mathematized worldview, laws underlie all of nature, the arts, and perhaps even humankind.[11] For a quantified conception they do not have to. One of the key points of this thesis is that I will argue that the latter applies to Struyck, who created a quantified, not mathematized geography. Mathematization thus concerns the world itself, whereas quantification 'only' relates to our conceptions or descriptions thereof. Though both are based on mathematical concepts and techniques, I consider quantification and mathematization to have very different implications.

[7] Porter, 'Making Things Quantitative', 38.
[8] See also Alberts, *Jaren van Berekening*, 13–33; Frängsmyr, Heilbron, and Rider, *The Quantifying Spirit in the Eighteenth Century*; Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data'.
[9] Vermij, *Kleine geschiedenis van de wetenschap*, 130.
[10] Alberts, *Jaren van Berekening*, 18.
[11] For a discussion of the mathematization of art, see Margócsy, *Commercial Visions*, 175–84.

Quantification can proceed in many ways. There is no one fixed way to transform something into meaningful numbers. Moreover, as I mentioned earlier, this often also involves processes that are not necessarily arithmetical. I find the interpretation by Frängsmyr, Heilbron & Rider particularly useful. They speak of 'the quantifying spirit of the eighteenth century' and describe this as 'the passion to order and systematize as well as to measure and calculate.'[12] Quantification is thus split into four parts: to order, systematize, measure, and calculate. This four-part division allows us to describe a broad range of developments. I have found this four-part distinction a particularly valuable tool for understanding developments in early modern geography. It allows us to look at quantification as a practice of working with data, in which fixed ways of collecting and combining numbers are used to create geographical knowledge. In this thesis, I will investigate how this worked out. To do this I will look at the practical aspects of collecting, organising, and summarising data, as well as the concerns for precise and standardized data, the intellectual methods of approximating values, and the techniques to present results.[13]

These practices thus shape the history of quantification but might equally well be seen as part of a history of statistics.[14] The two are closely related and cannot always be separated from each other. The history of statistics is diverse and encompasses several fields (including mathematical, civil, administrative, and economical branches). Nevertheless, we cannot yet really speak of statistics in the 18th century, since only after 1850 statistical methods of measurement and analysis began to assemble into a coherent body of knowledge.[15] Still the earlier practices of quantitative knowledge-making are relevant developments for this history of statistics. Advancing statistical methods relied on the idea that data was able to say something about the world in a meaningful way. That required a readily established trust in numbers, but also standardized measurement methods that allowed for statistical calculations and procedures. New practices of dealing with quantitative data on a large scale had to be developed and accepted before more theoretical statistics could begin to advance. Understanding this indispensable preparatory work is an important contribution to our insight in how we learned to work and reason with numbers. In this sense I see the history of quantification as an addition to and extension of the history of statistics, which by itself is too often focused on the origin and development of theoretical scientific statistics.[16]

---

[12] Frängsmyr, Heilbron, and Rider, *The Quantifying Spirit in the Eighteenth Century*, 2.
[13] The importance of looking at these practices for understanding quantification has also been argued for in Roux, 'Forms of Mathematization (14th - 17th Centuries)', 325; Klep and Stamhuis, 'The Statistical Mind in a Pre-Statistical Era'.
[14] Porter, 'Making Things Quantitative'; Klep and Stamhuis, 'The Statistical Mind in a Pre-Statistical Era'.
[15] Klep and Stamhuis, 'The Statistical Mind in a Pre-Statistical Era', 15; Mojet, 'Observing Disciplines', 44, 51–53; Stigler, *The History of Statistics*, 1.
[16] Klep and Stamhuis, 'The Statistical Mind in a Pre-Statistical Era', 29; Stigler, *The History of Statistics*, 3.

Moreover, in modern historiographical literature quantification is largely described in the context of the second half of the 18th century.[17] It is claimed that only after 1750 or even 1760 did 'a passion develop for the systematic collection and processing of observations of external reality.'[18] Developments in the first half of the eighteenth century are instead mainly regarded as preparatory work.[19] In this thesis, I want to extend this history further back. Perhaps Porter is right when he writes that 'only when uniform methods have been put in place is it possible to talk of adequate quantification.'[20] But these uniform methods will have to be introduced, developed, and become established. Although Porter might not perceive Nicolaas Struyck's attempt to understand the world through numbers as 'adequate quantification,' Struyck's undertakings help us to comprehend how quantitative practices developed into the 'passion' they would become. Struyck's work shows how quantification was contested and justified, and which values were ascribed to numbers. Looking closely at his early endeavours shows us how he made sense of, devised, and gave meaning to quantification. It thus makes the vague process of quantification concrete (as both a *how* and *why*) and informs us how the world was made receptive to a passion for numbers.

0.2 Geography and mathematics in the Dutch 18th century

Quantification, as the practice of translating the world into meaningful numbers, is not only an intellectual undertaking. It is also a social and political practice operating in a specific context. For this thesis, that context is the Dutch Republic in the first half of the 18th century.

The Dutch situation in the eighteenth century is not too rosy a picture. It is considered 'the age of decline' for the Dutch Republic, and it became clear that the English and French economies had begun surpassing the Dutch.[21] The state finances suffered a financial setback and the industrial economic downturn led to urban decline, although the elites remained wealthy and the upper middle class could retain its very comfortable lifestyle. The Republic thus remained a prosperous country, and its living standards remained the world's highest throughout the whole century.[22] Still, the de-urbanization also reduced the Republic's role as a centre of European intellectual and cultural

---

[17] Klep & Stamhuis, for example, describe the period between 1750-1850. Porter discusses little issues from pre-1800, and almost none pre-1750. And whereas Frängsmyr, Heilbron & Rider speak of a so-called 'quantifying spirit of the 18th century,' they also focus on the second half of this century. Klep and Stamhuis, 'The Statistical Mind in a Pre-Statistical Era'; Porter, 'Making Things Quantitative'; Frängsmyr, Heilbron, and Rider, *The Quantifying Spirit in the Eighteenth Century*.
[18] Klep and Stamhuis, 'The Statistical Mind in a Pre-Statistical Era', 15.
[19] These concern issues like the growing understanding and more widespread use of both mathematical and scientific instruments, like the barometer, thermometer, calorimeter, air pump, and telescope.
[20] Porter, 'Making Things Quantitative', 38.
[21] Israel, *The Dutch Republic*, 959, 998. Kennedy, *A Concise History of the Netherlands*, 204.
[22] Kennedy, *A Concise History of the Netherlands*, 230–31, 233; Israel, *The Dutch Republic*, 966–1018.

activity.[23] In an intellectual context, the period was characterized by a fundamental lack of interest in mathematics and empirical research, declining numbers of students, and too small provincial universities – though the relative freedom of the Dutch press fostered the publishing climate.[24] Next to that, the detached political structure of the Dutch Republic created a focus on local authorities and made large-scale statistical measurements less important for state affairs – and therefore they were not really undertaken. Government involvement in the registration of the causes of death, for example, started much later in the Netherland than in other European countries.[25] Therefore statistics in the sense of *statenkunde* did not really set off, and neither did it do much good to the pursuit of quantification. Moreover, the number of people that pursued a scientific search for quantitative knowledge was small and they operated relatively unorganized.[26] For practical knowledge, however, the situation was different. The developed Dutch trade economy still required a varied group of professionals with mathematical expertise, such as engineers, bookkeepers, and insurance agents. And although government involvement in death registration remained lacking, the calculating of life expectancies and corresponding premiums were of interest to life insurance companies. The government also gave out many state loans in an attempt to cover the enormous state debt (after wars with France), which encouraged the pursuit of actuarial mathematics.[27] In this particular type of political arithmetics (i.e. the early statistical undertaking concerned with the quantitative analysis of demographic data), Dutch scholars constituted the top of the field.[28] But mathematical practitioners were not a uniform community and mathematical practice varied by profession.[29] For some parts of society it was an advanced theoretical science, while others pursued it for practical incentives.

The type of mathematics that flourished most during the 18th century was 'mixed mathematics'.[30] This branch of mathematics solved the mathematical problems of a physical nature, combining mathematical theory with physical insight.[31] It was the counterpart to pure mathematics (primarily geometry and arithmetic), although both mixed and pure mathematics were generally studied by the same scholars and there was no sharp distinction in status and roles between them. Moreover, like pure mathematics could be either theoretical or practical, so could mixed mathematics

[23] Kennedy, *A Concise History of the Netherlands*, 234.
[24] Klep and Stamhuis, 'The Statistical Mind in a Pre-Statistical Era', 19; Kennedy, *A Concise History of the Netherlands*, 235; Israel, *The Dutch Republic*, 1044–45.
[25] Dijk, 'Doodsoorzakenclassificaties van 1750 tot 1900', 146.
[26] Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 144; Israel, *The Dutch Republic*, 1042.
[27] Kennedy, *A Concise History of the Netherlands*, 228; Israel, *The Dutch Republic*, 1015.
[28] Stamhuis, *'Cijfers en aequaties' en 'kennis der staatskrachten'*, 40. Stamhuis mentions Johan de Witt and Nicolaas Struyck in particular.
[29] Kent and Vujakovic, *The Routledge Handbook of Mapping and Cartography*, 145.
[30] Brown, 'The Evolution of the Term "Mixed Mathematics"', 81.
[31] Brown, 'The Evolution of the Term "Mixed Mathematics"'; Mulder, 'Pure, Mixed and Applied Mathematics'.

be of both types as well.[32] As a consequence, mixed mathematical knowledge was practised and valued in a theoretical setting, but also in a wide commercial and imperial context.[33] Next to that, the scope of mixed mathematics was quite fluid. It had traditionally included only six subfields ('mechanica, optica, astronomia, musica, geodesia, and logistica') but that domain expanded to more than twenty in the eighteenth century.[34] Examples are mapmaking, surveying, navigation, and geography. The latter, geography, was 'viewed as an important (if not *the* most important) part of mixed mathematics.'[35]

However, not all geography was mathematical. Geography in the Enlightenment was not understood as a single thing, but 'hovered uncertainly between humanity and science.'[36] The secondary literature remains opaque or even somewhat inconsistent when it comes to explaining what eighteenth-century geography actually entails.[37] Several traditions existed next to each other and the way geography was understood would vary between authors, times, and places.

A common non-mathematical conception of geography during the beginning and mid-18th century was that geography was mainly a supplement to history (though not necessarily natural history). History, at the time, was considered to deal with the particularities of a certain time and place, and to practise geography was to investigate where these were situated.[38] Geography in this sense was considered one of the 'eyes' of history (and by convention, it was the left; chronology being the right).[39] Geographers proceeded by comparing geographical descriptions in classic texts with the newest accounts of the world, with the intention to draw contrasts and parallels between the ancient and modern world.[40] Moreover, many scholars believed that one could get to know historical facts

---

[32] Note that these distinctions differ from the split between 'pure' and 'applied' mathematics, which would only emerge during the 19th century.
[33] Mulder, 'Pure, Mixed and Applied Mathematics', 33–34; Withers, *Placing the Enlightenment*, 196.
[34] Mulder, 'Pure, Mixed and Applied Mathematics', 33.
[35] Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 128.
[36] Rousseau and Porter, *The Ferment of Knowledge*, 286.
[37] Take, for example, Withers, *Placing the Enlightenment*. In acknowledgement of the discipline's vague status, definitions are generally avoided. Instead, it is defined negatively. Throughout the different essays in this single collection, geography is sometimes portrayed by contrasting it to history; at other times to astronomy; or it is opposed to cosmography, topography, and chorography. And in the cases when a more detailed attempt at the discipline's characterization has been undertaken, one essay might primarily discern between descriptive and mathematical geography; another between (inter-)national and local geography; and yet another between terrestrial and civil (or physical and social) geography. Overall, the literature remains rather opaque and somewhat conflicting. At the same time, there are also sources that speak of 'the stable definition of geography,' and doing so appears incomprehensible to me. Mayhew, 'The Effacement of Early Modern Geography', 388.
[38] Withers, *Placing the Enlightenment*, 178.
[39] Mayhew, 'The Effacement of Early Modern Geography', 399.
[40] Agnew and Livingstone, *The SAGE Handbook of Geographical Knowledge*, 116; Friedrich, 'Chorographica Als Wissenskompilationen', 83.

only by including geographical knowledge, like the place names, physical distances, countries, and cultures of the particular places they studied.[41]

This historical conception of geography existed next to, and sometimes overlapped with, a more descriptive one. Its purpose was to depict what the world was like for the sake of this worldly knowledge only.[42] This type of geography was thus characterized not by subject but as an activity, namely that of 'describing' the earth, albeit without a shared specification of how one should proceed therein. Geographical descriptions could generally take three different forms: textual, mathematical, and chorographical. The first type of geography enumerated facts of exploration and the countries in the world in prose. The texts adopted many of the medieval philological traditions to describe the natural and political phenomena that could be encountered in a particular place. The information was conveyed in narratives and intended to teach people about the world they were living in. By its very nature, this knowledge concerned singulars and particulars. The second type of descriptive geography tried to determine the mathematical properties of the globe through observations and calculations.[43] This was the type of geography that was considered part of mixed mathematics. It was centred around the earth's phenomena for as far as these could be measured, and usually concerned general theories rather than particular descriptions.[44] That also implied that human (socio-cultural) factors were often left out of these mathematical works, because these were considered too varied and random to measure.[45] The final, third branch concerned chorography. These descriptions of regionally localized situations were mainly set apart by the small scale on which they focused and often concerned local history and identity.[46]

Whereas textual geographic descriptions kept close ties to broader historical and philological traditions, the mathematical style of doing geography also included empirical insights. Mathematical geography thus somewhat departed from its earlier philological foundations, but the mathematical and non-mathematical traditions of geography also overlapped and intertwined. There was no strict separation. In practice, both continued to blend into each other.[47]

In all these guises geography was also perceived as an educational subject. It was taught in universities, but also in schools, coffeehouses, and other spaces of the public sphere.[48] Its audience

---

[41] Withers, *Placing the Enlightenment*, 178–79.
[42] Agnew and Livingstone, *The SAGE Handbook of Geographical Knowledge*, 116.
[43] Mayhew, 'The Effacement of Early Modern Geography', 388.
[44] However, until the late eighteenth century it would remain impossible to measure things like longitude precisely. See also Kent and Vujakovic, *The Routledge Handbook of Mapping and Cartography*, 135.
[45] Withers, *Placing the Enlightenment*, 136.
[46] Withers, 167; Mayhew, 'The Effacement of Early Modern Geography', 387; Friedrich, 'Chorographica Als Wissenskompilationen'.
[47] For more about this intertwinement, see also Dijksterhuis, 'The Mutual Making of Sciences and Humanities. Willebrord Snellius, Jacob Golius, and the Early Modern Entanglement of Mathematics and Philology'.
[48] Agnew and Livingstone, *The SAGE Handbook of Geographical Knowledge*, 116.

was wide and varied, ranging from experts to novices. Although the public differed between all these places, geography was considered relevant for all. During the 18th century, the discipline became embedded in society as a diverse cultural commodity. It was 'readily domesticated: learned at home by women as a genteel accomplishment, by men as a basis to commerce, by children as an educational accomplishment.'[49] Even geographical parlour games with cards and jigsaw maps were commonplace. All were believed to benefit from geographical knowledge.

Likewise, geographical boos and other writings also had a diverse but enormous audience. These works were commonly denoted as 'geographies' (singular: 'a geography'). Next to the many descriptions we have already encountered, geography was thus also considered a fixed mode of writing, a genre.[50] From the sixteenth until the eighteenth century, geography books were catalogues with headed paragraphs that conveyed information about all parts of the world.[51] They books could be geographical gazetteers and dictionaries, which piecewise ordered and summed up local knowledge about the world, or *mémoires*, offering textual explanations of the decisions behind the construction of given maps.[52] The most important genre for this thesis, however, is that of 'general geographies'. It studies the world as a whole, instead of through a regional approach. Nicolaas Struyck's *Inleiding tot de algemeene geographie* is such a general geography. This category of geography books will therefore be introduced in more detail in chapter 1.

Geographical knowledge was thus central to how the world came to understand itself in the Enlightenment. It was 'how the earth came to be known as a world.'[53] At the same time, geography's main challenge was that geographical descriptions often did not have a stable theoretical foundation. No one was able to see the entire earth for himself, so geographers were forced to trust others in one way or another. Before the 18th century, this was usually achieved by resorting to the classical literary heritage examined through philological study, but this was more and more challenged by Enlightenment critical thinking.[54] The alternative, trusting travellers' tales, was not much better.

> 'In early modern Europe, however, much of what went for geographical knowledge was exotic travel writing without much if any attention to what we would recognize as explicit conceptual claims or arguments. … How could you trust the stories brought back by travellers? What reliable conceptual basis could be given to such geographical knowledge?'[55]

[49] Withers, *Placing the Enlightenment*, 167–68.
[50] Mayhew, 'The Effacement of Early Modern Geography', 388.
[51] Mayhew, 388.
[52] Withers, *Placing the Enlightenment*, 182.
[53] Withers, 111.
[54] Agnew and Livingstone, *The SAGE Handbook of Geographical Knowledge*, 597.
[55] Agnew and Livingstone, 13.

The reliability of geography posed a significant problem. Many geographical understandings were subsequently based on ignorance or falsehoods, or on religious faith or fabulation only.[56] Some geographers only seemed to provide the public with astonishing readings, accepting the fact that these lacked coherence.[57] Consequently, the verification of geographical knowledge was a main concern at the time. This thesis is the search to how Nicolaas Struyck attempted to solve this problem.

0.3 Nicolaas Struyck (1686-1769)

Nicolaas Struyck has been described as 'the most important Dutch mathematician of the 18th century.'[58] He practised mathematics in a broad sense of the word, contributing to pure as well as mixed mathematics in the pursuit of his wide-ranging interests. Next to the mathematics of the earth and heavens, his principal activities concerned probability calculus, algebra, chronology, cartography, and entomology.[59] He is also known for his mortality tables and calculations on life annuities, though this fame is mainly restricted to insurance circles.[60] Next to that, Struyck's astronomical calculations (on comet orbits in particular) are regarded as valuable scholarly contributions.[61] Finally, Struyck is recognized as a demographer (though that is somewhat anachronistically) for his work on population statistics, or rather, political arithmetic.

When Struyck specified his occupation himself, he presented himself as a mathematician. This was the case, for example, when he had to register as a native burgher ('*poorter*') of Amsterdam in 1724 and specified his occupation as a 'mathesius'.[62] However, a reliable and complete biographical characterization of Nicolaas Struyck does not exist. Although he has been included in the most important Dutch biographical encyclopaedias, these lemmas usually consist of a few brief sentences.[63] They generally only mention that Struyck was a famous practitioner and teacher of mathematics, that he contributed to various mathematical disciplines, and list the most important books he had written. Only two attempts for a more thorough characterization of his life and work have been undertaken up

[56] Rousseau and Porter, *The Ferment of Knowledge*, 292–94.
[57] Hermans, 'Johan Lulofs en zijn tijdgenoten', 93.
[58] Struik, *Geschiedenis van de wiskunde*, 189. Dirk Jan Struik and Nicolaas Struyck are not related.
[59] Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 126.
[60] Pearson, *The History of Statistics in the 17th and 18th Centuries*; Hogendijk, 'Lijfrentes in de zeventiende en achttiende eeuw'; Stamhuis, 'Levensverzekeringen 1500-1800'. Ibid. for an introduction to life annuities and life insurance.
[61] Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*; Molhuysen and Kossmann, 'Nicolaas Struyck'.
[62] Amsterdam citizens that were registered as '*poorters'* had more rights than other citizens. Membership could be obtained by birth (which applied to Struyck), marriage, or payment for those from outside Amsterdam. See also Pearson, *The History of Statistics in the 17th and 18th Centuries*, 329; Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 131.
[63] Aa, 'Nicolaas Struyck'; George Hendrik de Rivecourt and Kobus, 'Nicolaas Struyck'.

FIGURE 1: THE ONLY EXISTING PORTRAIT OF NICOLAAS STRUYCK, ALSO PRINTED ON THE OPENING PAGES OF THE INLEIDING (1740). IN HIS LEFT HAND HE KEEPS A DOCUMENT CONTAINING A PARABOLIC COMET PATH. ENGRAVING ON PAPER BY JACOBUS HOUBRAKEN AFTER JAN MAURITS QUINKHARD, 1738. 'PORTRET VAN NICOLAAS STRUYCK (1686-1783) — CENTRAAL MUSEUM UTRECHT'.

to now.[64] Many details about Struyck's life therefore remain unknown or uncertain, and sources sometimes contradict each other.

Struyck was born in Amsterdam on 21 May 1686 and he died in the same city on 20 May 1769.[65] He was the second son of Geertruy Wesdorp and Nicolaas Struyck Nicolaaszoon, both devout Lutherans. Struyck provided his own family tree in one of his books, when he discussed 'the duration

[64] Van Haaften created a detailed bibliographical overview of his activities in 1925. Next to that, we find the most detailed account in Zuidervaart's discussion of 18th-century astronomy, where he also includes details about Struyck's life, scholarly views and contacts (though, obviously, mainly in the context of Struyck's astronomy. See also Haaften, *Nicolaas Struyck*; Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*, 108–25.

[65] Though somehow the (mistaken) birthday 19 May has also come to circulate among Struyck's biographical descriptions.

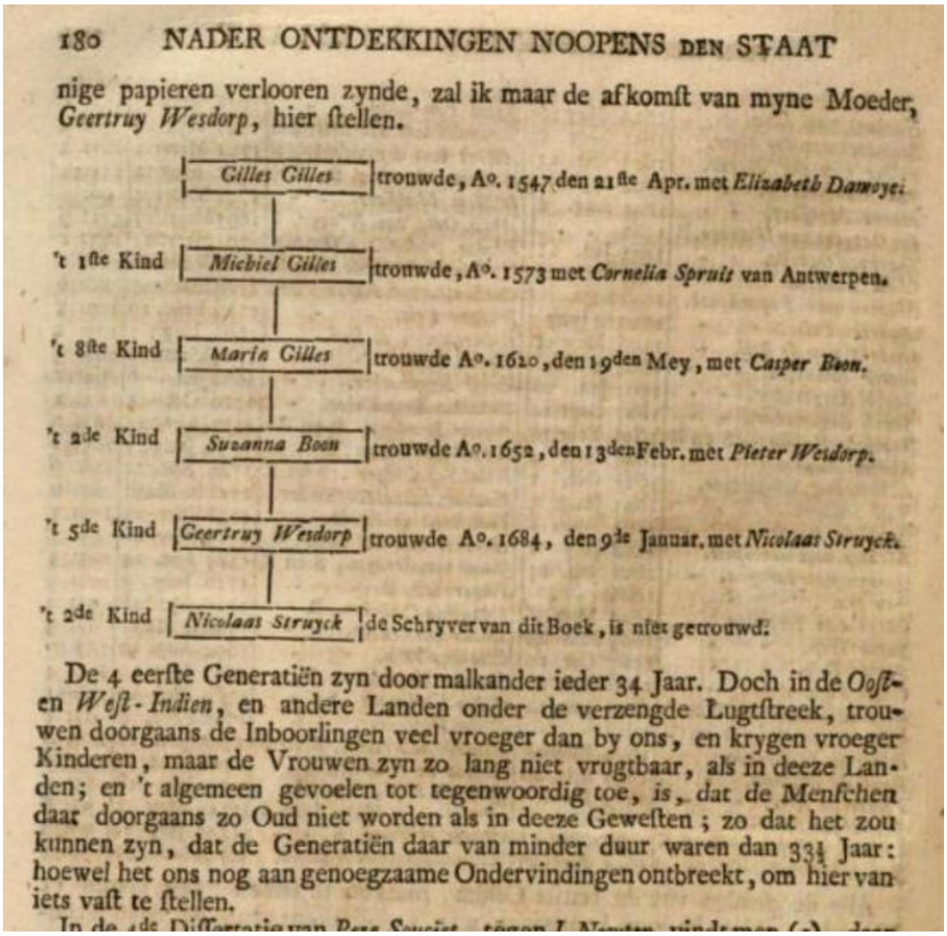
of generations' in an attempt to trace the origins of humanity.[66] It can be found in figure 2. Like his parents, Nicolaas had remained a devoted churchgoer his entire life. His father had been a prosperous goldsmith, his grandfather a silk merchant, and his great-grandfather a sailor.[67] It was a line of practical occupations, but also of tradesmen with mathematical experience. There were no academic mathematicians or other scholars in the family, but their practical skills should not be underestimated.[68] The family name Struyck was also sometimes spelt as Struijck or Struick. Yet, Nicolaas did not continue it. He never married and had no children himself. At his death, he left 4 houses to his second cousins.[69] The rest of his large inheritance of 20,000 Dutch guilders went to the welfare fund of the Amsterdam Lutheran church, not to family.[70] The rest of his possessions were sold. The advertisement in a newspaper in 1769 makes clear what scientific properties he possessed:

> 'On Monday and Tuesday the 10th and 11th of July, at the home of the deceased on the Agterburgwal, behind the Zwaan Brewery: an excellent collection of (...) books; as well as maps and manuscripts, drawn insects and various instruments, among which four skilfully crafted cometaria or tools for determining the true course of the comets around the sun &c. &c.; bequeathed by Mr Nicolaas Struyk [sic], in life a member of several science societies and a distinguished mathematician here [in Amsterdam].'[71]

Little is known about Nicolaas' youth or the education he received. It has been claimed that he revealed a great love for mathematics at a young age, though the evidence for this is scarce.[72] Nevertheless, the quality of Struyck's later writings reveals that he must have been thoroughly schooled. Struyck's mathematical abilities were highly developed, he was clearly up-to-date with the work of the most important scholars of his time, and he spoke multiple languages.[73] Judging by Struyck's later correspondence and the sources he consulted for his books, he was able to read in Dutch, Latin, English, French, German, and perhaps Italian.

---

[66] Struyck, *Vervolg*, 180.
[67] Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*, 109.
[68] Some sources describe the Rotterdam mathematician Anthonie Struick (1742-1771) as Nicolaas' brother, but this is untrue. We find this fact in Aa, 'Nicolaas Struyck'. It is refuted in Molhuysen and Kossmann, 'Nicolaas Struyck'; George Hendrik de Rivecourt and Kobus, 'Nicolaas Struyck'.
[69] Haaften, *Nicolaas Struyck*, 10.
[70] Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 126.
[71] Dutch: 'Op Maandag en Dingsdag den 10 en 11 July, zal men t'Amst. ten huize van den overledene op de Agterburgwal, agter de Brouwery de Zwaan verkopen: een uitmuntende Verzameling (...) Boeken; als mede Kaarten en Manuscripten, getekende Insecten en verscheide Instrumenten, onder welke uitmunten vier kunstig vervaardigde Cometaria of Werktuigen, om den waren loop der Cometen om de Zon te bepalen &c. &c.; nagelaten door den Heer Nicolaas Struyk, in leven Lid van verscheide Societeiten der Wetenschappen en voornaam Mathematicus alhier.' Krogt, 'Advertenties Voor Kaarten, Atlassen, Globes e.d. in Amsterdamse Kranten 1621-1811', 248.
[72] Aa, 'Nicolaas Struyck', 982.
[73] Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*, 110.



180 NADER ONTDEKKINGEN NOOPENS DEN STAAT

nige papieren verlooren zynde, zal ik maar de afkomſt van myne Moeder, *Geertruy Wesdorp*, hier ſtellen.

Gilles Gilles trouwde, A°. 1547 den 21ſte Apr. met *Elizabeth Damoye*.

't 1ſte Kind *Michiel Gilles* trouwde, A°. 1573 met *Cornelia Spruit* van Antwerpen.

't 8ſte Kind *Maria Gilles* trouwde A°. 1610, den 19den Mey, met *Casper Boon*.

't 2de Kind *Suzanna Boon* trouwde A°. 1652, den 13den Febr. met *Pieter Wesdorp*.

't 5de Kind *Geertruy Wesdorp* trouwde A°. 1684, den 9de Januar. met *Nicolaas Struyck*.

't 2de Kind *Nicolaas Struyck* de Schryver van dit Boek, is niet getrouwd.

De 4 eerſte Generatiën zyn door malkander ieder 34 Jaar. Doch in de *Ooſt-* en *Weſt-Indien*, en andere Landen onder de verzengde Lugtſtreek, trouwen doorgaans de Inboorlingen veel vroeger dan by ons, en krygen vroeger Kinderen, maar de Vrouwen zyn zo lang niet vrugtbaar, als in deeze Landen; en 't algemeen gevoelen tot tegenwoordig toe, is, dat de Menſchen daar doorgaans zo Oud niet worden als in deeze Geweſten; zo dat het zou kunnen zyn, dat de Generatiën daar van minder duur waren dan 33¼ Jaar: hoewel het ons nog aan genoegzaame Ondervindingen ontbreekt, om hier van iets vaſt te ſtellen.

FIGURE 2: FAMILY TREE OF THE FAMILY ON NICOLAAS STRUYCK'S MOTHER'S SIDE. HE PROVIDES THE TREE TO DETERMINE THE AVERAGE GENERATION LENGTH, WHICH HE USES AS A TIME RECKONING TOOL. STRUYCK, *VERVOLG*, 180 (PART II).

When he was growing up, Struyck used to catch butterflies with his father. From an early age on he had a strong entomological interest and underheld a small collection himself. Not without results, because in 1718 he published six folio volumes with drawings of insects and other naturalia.[74] Some of Struyck's drawings can be found in figures 3-7. Although his drawings were for sale, he had created them for his own enjoyment and not for money. In 1740, he recalled that collecting insects 'used to be a big part of my hobbies.'[75] Struyck most likely worked from dead specimens that he had obtained through his large correspondence network (which would also provide him with data from empirical observations). The drawings might appear scientifically precise, but Struyck took plenty of artistic liberties. The insects that he presents together could usually not be found in the same natural environment. It could be that his experience with collecting natural specimens inspired how he

[74] Zuidervaart, 109.

[75] Dutch: '… die [i.e. insecten] weleer een groot deel myner Liefhebbery uitmaakten.' Struyck, *Inleiding*, 88; Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 127.

Figure 3: Metropolian Museum of Art (NY): A Dragonfly, 1715. Drawn with pen and black ink, watercolor, over touches of graphite. The size is 13.2 x 19.1 cm.

Figure 4: J. Paul Getty Museum: Four Beetles and a Moth, 1715. Drawn with pen and black ink, watercolor, gouache, gold paint with white gouache heightening, and pen and brown irongall ink. The size is 43.7 x 28.6 cm.

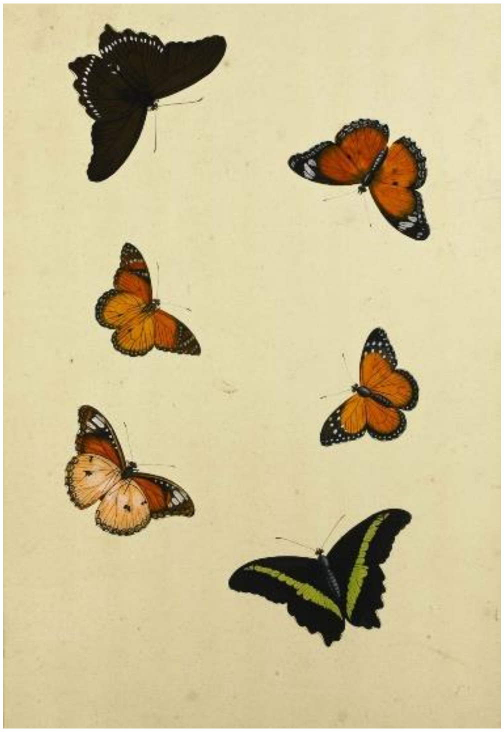


Figure 5: Dutch private collection: A study of Six Moths, 1715. Drawn with graphite, gouache and watercolor on laid paper. Size is 45.0 x 28.3 cm.

Figure 6: Metropolian Museum of Art (NY): A Caterpillar and Two Moths on a Branch and Two Butterflies, early/mid 18th century. Drawn with Pen and black ink and watercolor over touches of graphite. Size is 23.9 x 20.2 cm.

FIGURE 7: IV AFBEELDING IN STRUYCK'S INLEIDING, SHOWING SEVERAL NATIVE AND NON-NATIVE BUTTERFLIES ["IN- EN UITLANDSCHE DAG- EN NAGT-KAPELLEN"]. IN BETWEEN PAGE 88 AND 89 (QUOTE ON PAGE 89).

proceeded in his mathematical work and in the quantification of geography. Zuidervaart claimed that 'he no longer chased butterflies, but devoted his time to collecting empirical data, with the aim of discovering lawlike patterns in them.'[76] Although Struyck would never publish a substantial work about insects, he remained interested in their collection throughout his life.

How Struyck exactly earned his money remains somewhat mysterious. In any case he was no academic and has never been connected to a university. Neither did he have a patron. He only started to capitalize on his scientific knowledge later in his life (after ca. 1750). Before that, 'he did not live *off* science, but *for* science, unhampered, but at the same time unsupported by any (royal) protection whatsoever.'[77] From his inheritance we know he possessed quite a fortune at the end of his life, but it is unclear which activities provided him with this wealth.[78] Judging by his (grand-)father's occupation, much seems to indicate that he lived off investigating the family fortune as a financially independent scientific *amateur*, not uncommon at the time. Early in life, Struyck tried various jobs in the Amsterdam

[76] Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 127.
[77] Zuidervaart, 131.
[78] Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*, 126.

trade business, like the men of his family before him. He worked as a 'bone weigher' and in the exchange business, as well as several similar jobs.[79] At several stages in his life (but not continuously) Struyck taught all sorts of mathematics, including bookkeeping, astronomy, and navigation. The administrative and recording skills he obtained through these practical occupations did not go unused, and like insect collection, might have inspired his quantification practices.

Moreover, his teaching reputation was outstanding. Struyck cared about passing on knowledge and did so skilfully. Having studied with him was something to brag about, as was done by one of his former students who hoped to find students himself through a newspaper advertisement in 1762:

> 'Coenraad Holman, living on the waters between the Old and New Bridge in Amst., who has enjoyed the education of the famous Sir Nicolaas Struyck for nearly 5 years, Member of the Royal Societies of London and Paris, and of the Dutch Academy of Sciences, who for 10 years held lectures in Arithmetic, Geometry, Algebra etc. and Bookkeeping. Now presents his service to teach these sciences to everyone in these sciences, to everyone's satisfaction.'[80]

There is a receipt signed by Struyck for lessons he provided in 1735: five florins for a month's lessons in accountancy, nine for the candle, pens and ink, and six for the fire.[81]

Finally, Struyck also earned money through his writings. His books and other essays were well-read and he acquired great fame in the Netherlands.[82] But his books are also described as 'often dealing with important subjects, which are not mentioned in the title and therefore usually remain unnoticed.'[83] A complete overview of Struyck's writings can be found in Van Haaften's biography,[84] but his most important publications are the following:

- The '*Uytreekening'*:
  Uytreekening der kanssen in het speelen, door de arithmetica en algebra, beneevens een Verhandeling van looteryen en interest, Amst. 1716, reprint 1720, 8°. Published under his initials N.S. only. Inspired by Jacob Bernoulli and Abraham de Moivre; Struyck also provides new solutions to problems posed by Christian Huygens in 1657.[85]

---

[79] Zuidervaart, 110.
[80] Dutch: 'Coenraad Holman, woonende op 't Water tusschen de Oude en Nieuwe Brug t Amst., welke byna 5 Jaaren de Onderwyzing heeft genooten van den beroemden Heer Nicolaas Struyck, Lid der Koninglyke Societeiten van Londen en Parys, en van de Hollandsche Maatschappy der Weetenschappen, welke 10 Jaaren Collegie heeft gehouden in de Rekenkonst, Geometria, Algebra &c. en 't Boekhouden. Presenteerd zyn Dienst om in deeze wetenschappen te onderwyzen, tot ieders genoegen.' Krogt, 'Advertenties Voor Kaarten, Atlassen, Globes e.d. in Amsterdamse Kranten 1621-1811'.
[81] Pearson, *The History of Statistics in the 17th and 18th Centuries*, 330.
[82] Van der Aa, ABWN.
[83] Frederiks and van den Branden, 'Nicolaas Struyck'.
[84] Haaften, *Nicolaas Struyck*.
[85] A discussion of this work can be found in Hald, *A History of Probability and Statistics and Their Applications before 1750*, 394–96.

- The ‘*Inleiding’*:
  Inleiding tot de algemeene geographie, beneevens eenige sterrekundige en andere verhandelingen, Amst. 1740, 4°, in two parts. Struyck’s magnum opus and the main subject of this thesis.
- The ‘*Vervolg*’:
  Vervolg van de beschryving der staartsterren, en nader ontdekkingen omtrent den staat van ‘menschelyk geschagt, benevens eenige sterrekunidge, aardrijkskundige en andere aanmerkingen, Amst. 1753, 4°, in two parts.
  Sequel to the previous book, which was praised for showing ‘how the application and use of mathematics is conducive to the attainment and extension of knowledge of the course of the heavenly bodies.’[86]
- *Nieuwe kaart van het land der Angrianen, met kartons voorstellende een gedeelte der westkust van Indostan, Biseroek, en Soendadoerga*, 1757. Copper printed, scale approx. 1:470.000, size 24-26 cm.[87]
  Most likely the only map Struyck ever created himself, but nevertheless it demonstrates that he was capable of doing so.
- *Inleiding tot het Koopmans Boekhouden* together with Gerrit la Borde, Amst. 1768, folio. Originally intended to update Abraham de Graaf’s *Instructie van het Italiaans boekhouden*, but the authors believed a more substantial revision of the content was required.

Struyck combined practical and theoretical mathematics. He valued and possessed advanced knowledge of mathematical theory, but also emphasized the importance of practical, local utility.[88] Although he considered ‘mathematics, celestial science and other sciences’ as ‘much more sublime’ than practical subjects, he also believed that ‘no work that will benefit the common good can be underestimated.’[89] On the one hand, he published an advanced work on probability theory, which Hald described as ‘the only mathematical work written by Struyck’ (obviously not recognizing mixed mathematics as part of mathematics).[90] On the other hand, Struyck also wrote about ‘inferior’ but useful topics like bookkeeping. He seemed to consider geography as taking up a position in between. Nevertheless, in many of the prefaces to his books he stressed that he wanted to spread mathematical ideas among his fellow countrymen, and that he hoped to foster society and advance the common good.[91] In general, Struyck kept close ties to the Amsterdam society around him.

---

[86] George Hendrik de Rivecourt and Kobus, ‘Nicolaas Struyck’.
[87] L’Honoré Naber, *Inventaris der verzameling kaarten, berustende in het Algemeen Rijksarchief*, 62.
[88] Struyck, *Uytreekening*, aan den lezer; Struyck, *Inleiding*, voorreden, 4.
[89] Dutch: ‘Het dunke niemant te laag, dat wy, der Wiskunde toegewyd, een Opstel uitgeven over 't Koopmans Boekhouden. Want behalve dat ons hierin geen Voorbeelden van Wiskundigen ontbreken, kan men ook geen arbeid, die voor 't gemeen belang voordeling zyn kan, beneden iemants waarde schatten. De Wiskunde, de Hemelloopkunde en andere Wetenschappen zyn, 't is waar, veel verhevener, maar ook op verre na zo gangbare munt niet, inzonderheid in onze Stad, als 't Boekhouden.’ Struyck and Graaf, *Inleiding tot het Koopmans Boekhouden*.
[90] Hald, *A History of Probability and Statistics and Their Applications before 1750*, 395.
[91] Struyck, *Inleiding*; Struyck, *Vervolg*; Struyck and Graaf, *Inleiding tot het Koopmans Boekhouden*.

Struyck's activities yielded him scientific recognition. In 1749 he became a fellow of the Royal Society of London, in 1755 of the Académie Royale des Sciences. The (recently established) Hollandsche Maatschappij der Wetenschappen was the last but could not stay behind, so included him as a member in that same year. It appears that the Royal Society based their decision primarily on Struyck's *Inleiding*, given the admittance year and the fact that they possessed a copy of Struyck's *Inleiding* in their library in 1839, but none of his other writings.[92]

Maintaining international ties was not always easy for the Amsterdam-bound Struyck. He wrote all of his books in Dutch, which limited his audience. It has been argued that 'his fame would have been greater had he written in the language of the learned.'[93] Moreover, Struyck was not used to travelling and never left the city for long. But he read profusely, judging by the many references to books and papers in foreign journals. He also maintained a vast (international) correspondence network, and through these letters he could stay in touch with all parts of the world. Among his correspondents, we find many great scholars.[94] Struyck also had the habit of welcoming travelling scholars in his home in Amsterdam, continuing to do so until his death.[95]

Being so Amsterdam-bound meant that Struyck had never seen most of the phenomena he described in the *Inleiding* and *Vervolg*. He relied on the data he could obtain through this correspondence network or requested his contacts to send him the observations he was missing.[96] In this sense, Struyck was a prototypical eighteenth-century geographer. Although fieldwork and exploring were vital to produce geographical data, a 'geographer' at the time referred to a scholar who did not explore at all. Instead, a typical geographer's world consisted of the desk in his hometown, and he practised geography through the textual compilation of the work of others. It was believed that only those who did not travel had the time and capacity to reflect and compare. [97]

His character is vividly described by the Dutch philosopher Frans Hemsterhuis (1721-1790), writing to his close companion Amalia von Schmettau from the Hague on 24 September 1779, ten years after Struyck died:

---

[92] Library, *Catalogue of the Scientific Books in the Library of the Royal Society*, 768.
[93] Aa, 'Nicolaas Struyck', 982.
[94] These include Leonard Euler (1707-1783), Edmund Halley (1656-1742), Pierre Bouguer (1698-1758), Nicolas Louis de la Caille (1713-1762), César-François Cassini (1714-1784), Joseph-Nicolas de l'Isle (1688-1768), Charles-Joseph Messier (1730-1817), Willem Jacob 's-Gravesande (1688-1742), Frans Hemsterhuis (1721-1790), Alexandre-Guy Pingré (1711-1796), Charles-Joseph Messier (1730-1817) and many others. Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 146.
[95] Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*, 116.
[96] Some examples are described in Zuidervaart, 112. A register of Nicolaas Struyck's correspondents is provided by Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 146.
[97] Agnew and Livingstone, *The SAGE Handbook of Geographical Knowledge*, 45; Withers, *Placing the Enlightenment*, 179.

> ‘I knew Mr. Struyk [sic] in Amsterdam, one of the most famous mathematicians in Europe. There are only a few branches of mathematics that are not in his debt. He died at the age of 78. He was a small man, with a slender figure; about that, he was very vain, as he told me himself. Apart from his knowledge of the things of life, of the arts, of the sciences, his spirit did not exceed the strength of a child of the age of 5. He was afraid of everything. He never went out unless accompanied by a friend. A little rascal in the streets would put him to flight at the slightest threat. His maid could make him pale and tremble instantly with a tale of ghosts or phantoms. He wrote several good works. His greatest work is a Geography, or Universal Cosmology. It must contain a chart of the universe; the book contains two excellent treatises on comets, two others on life annuities and on chances and magic squares,[98] a natural history of five butterflies he had, a catalogue of all eclipses, and another of all volcanoes.’[99]

Hemsterhuis does not seem fully informed. Struyck died at the age of 83, not 78. Moreover, this description does not do justice to the content of Struyck’s *Inleiding*, as we will see in the next chapter. Nevertheless the letter provides a unique insight into Struyck’s character. Hemsterhuis acknowledges that Struyck was a great mathematician and recognized geographer. Apart from that, his description of Struyck could hardly have used less favourable terms.

We can thus conclude that Nicolaas Struyck thus acquired a respectable reputation in his own time. He was accepted into the most prestigious international societies, a recognized teacher and could generously support his living. Still, he remains relatively unknown to modern historians of science. Partly this could be caused by Struyck writing in Dutch. Moreover, Struyck did not leave behind any great theoretical advancements. Van Haaften brought up that it could also be caused by the dispute Struyck had with Kersseboom about population statistics and life annuities, in which most people (unsubstantiatedly and unfairly) picked Kersseboom’s side.[100] This mistaken ‘lost dispute’ might have led to a neglect of Struyck’s scholarly activities.

---

[98] The reference to chances and magical squares Hemsterhuis refers to Struyck’s essay on demography, titled *Conjectures on the state of the human race*. It is not so much about these topics as it is about civil geography, as we will see in chapter 3.

[99] French: ‘J’ai connu beaucoup Mr. Struyk à Amsterdam, un des plus celebres mathematiciens de l’Europe. Il y a peu de branches des mathematiques qui ne lui aient des obligations. Il est mort à 78 ans. C’etoit un petit homme, d’une mince figure; avec cela il etoit fort vain à ce qu’il m’a dit lui même. Son sçavoir faire dans les choses de la vie, dans les arts, dans les sciences, ne passoit pas les forces de l’âge de 5 ans. Il avoit peur de tout. Il ne sortoit jamais qu’accompagné d’un ami. Un petit polisson dans les rues le mettoit en fuite par la moindre menace. Sa servante pouvoit le faire palir et trembler dans l’instant par un conte de revenants ou de spectres. Il a ecrit plusieurs bons ouvrages. Son grand ouvrage est une Geographie ou Cosmologie Universelle. Cela doit contenir le tableau de l’Univers; le livre contient deux excellents traités sur les comètes, deux autres sur les rentes viagères et sur les chances et les quarrés magiques, une histoire naturelle de cinq papillons qu’il avoit, un catalogue de toutes les eclypses, et un autre de tous les vôlcans.’ Hemsterhuis, *Lettres à Diotime, tome 2: 1779*, 115–16.

[100] Van Haaften writes: ‘This is surely one of the principal reasons why Struyck’s work has faded into the background.’ Kersseboom, *Eenige aanmerkingen op de gissingen over den staat van het menschelyk geslagt,*

0.4 Research structure and argument

Although Struyck remains relatively unknown, he has not been forgotten. The different aspects of his scholarly activities have received some interest from modern historians but remain relatively isolated from each other. The little research that has been conducted focussed on singular facets of his wide-ranging activities, without thoroughly connecting one area to another. It concerns primarily astronomy and population statistics. I will call these fields 'heavenly geography' and 'civil geography' (which exist next to 'terrestrial geography', the geography of earthly phenomena), because this terminology expresses the centrality of geography in all Struyck's scholarly work that this thesis argues for.

Earlier research has described Struyck's astronomical contributions which primarily focus on comet orbits.[101] The efforts can be largely ascribed to Zuidervaart, who introduced the most detailed account Nicolaas Struyck's life currently in existence alongside it.[102] Next to that, Zuidervaart also connected part of Struyck's astronomy findings with some remarks about his population statistics in an essay that presents Struyck as a collector of empirical data in the context of learned societies.[103] Although this essay is said to be about 'the parts that testify to Struyck's early statistical activities,' it only considers Struyck's comet and population statistics – not his geography.[104] My approach in this thesis will put Struyck's geography central, and I will argue that this new perspective uncovers the coherence in all Struyck's scholarly activities. Next to these writings, several other scholars have occupied themselves with Struyck. One might have become familiar with Struyck's early writings on probability theory through Pearson, or with Struyck's actuarial mathematics, life annuities and population statistics, as described by Hogendijk as well as Stamhuis.[105] Struyck's population statistics is the only area in which he is also acknowledged in an international context.[106] That is caused by this part of Struyck's writings being posthumously made available to an international audience in 1912, when Johan Adriaan Vollgraff partially translated Struyck's writings into French. Although it concerned only a selection of Struyck's works, the translation was titled *Les oeuvres de Nicolas Struyck qui se*

---

uitreekening van de lyfrenten en 't aanhangsel op beide, begreepen in het boek, genaamt Inleiding tot de algemeene geographie door Nicolaas Struyck onlangs te Amsterdam uitgegeeven...; Haaften, *Nicolaas Struyck*, 44.

[101] Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*.

[102] Zuidervaart.

[103] Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data'.

[104] Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*; Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 129.

[105] Pearson, *The History of Statistics in the 17th and 18th Centuries*, 329–47; Hogendijk, 'Lijfrentes in de zeventiende en achttiende eeuw'; Stamhuis, 'Levensverzekeringen 1500-1800'.

[106] Peculiarly, Struyck's name pops up surprisingly often in the introduction of modern articles about population statistics in the field of gerontology and geriatrics. See also Leeuwen, 'The Era of the Guilds'.

rapportent au calcul des chances, à la statistique, etc. traduits du Hollandais par J.A. Vollgraff.[107] It contains the *Uytreekening,* as well as two of Struyck's essays on population statistics and life annuities, but none of Struyck's geographical or astronomical writings.[108] Our overview of the existing literature about Struyck's work is completed with a brief essay about Struyck's cartography by Van de Brink.[109]

Surprisingly absent among the scholarly efforts to study Struyck's activities is a thorough discussion of his geographical writings. The *Inleiding,* Struyck's magnum opus, has only been studied for its essays about astronomy, population statistics, and life annuities. Geography seems to have felt between two stools, perhaps because it was not yet a unified discipline and Struyck considered himself primarily a mathematician. I believe that this neglect is unjustified. This thesis will therefore put Struyck's *Inleiding* central*,* as the mathematical geography book it is. I intend to show three things:

1. My primary aim for this thesis is to demonstrate that Struyck approached geography through a particular 'quantitative method'. I will investigate how and why this quantification proceeded. With this very concrete example of one way how eighteenth-century quantification could proceed, I hope to illuminate the vague and intangible nature of quantification.
2. Secondly, I will argue that Struyck's quantitative method for geography applies to all fields he considered geography. In particular, it connects Struyck's civil and heavenly geography, which have previously only been studied in relative isolation from each other (in the guise of population statistics and life annuities; and astronomy). I will demonstrate that geography was central to all his scholarly activities and that this understanding is indispensable for a comprehensive account of Struyck as a scholar.
3. Thirdly, I will argue that Struyck's quantitative geography set him apart from his contemporaries. I will show that it was not the obvious approach at the time and that his contemporaries proceeded in unmistakably distinct ways. The comparison will show that Struyck's quantification was not mathematization.

The first point will be addressed in the first two chapters. Chapter 1 will present Struyck's *Inleiding tot de algemeene geographie,* as well as its structure, content, and purpose. The book will be presented as part of a tradition of 'general geography' as introduced by Bernard Varenius. Against this background chapter 2 will then introduce Struyck's geographical approach as his 'quantitative method'. Whereas this method is first presented for terrestrial phenomena considered 'typically'

[107] Vollgraff, *Les oeuvres de Nicolas Struyck (1687-1769)*; Molhuysen and Kossmann, 'Nicolaas Struyck'; Alberts and Beckers, 'Tussen Tannery En Klein', 179; Hogendijk, 'Lijfrentes in de zeventiende en achttiende eeuw'.
[108] The essay is about the seventh and eight essay attached to the *Inleiding*, called *Conjectures on the state of the human race* and *Calculations of life annuities*. Their content is discussed in chapter 3 of this thesis.
[109] Brink, 'De kartering van de Salomonseilanden. Een kaartkritiek van Nicolaas Struyck'.

geographic, chapter 3 will then extend this to Struyck's civil and heavenly geography. I will thus argue for the second point of my argument in this chapter. Finally, the argument will be completed in chapter 4, where Struyck's *Inleiding* will be compared to two other geographical books closely connected in space and time.

The argument contributes to the existing literature in four ways. Firstly, I hope to create a more comprehensive understanding of Struyck as a mathematician. Approaching Struyck's scholarly activities through his geography connects the historical research that has been previously conducted. Secondly, I want to give geography a place in the history of quantification and statistics. These histories usually reserve a large role for civil or administrative themes, often in the context of a political or governmental body, but I believe relevant developments are not limited to these matters. Struyck's work shows how these developments are inspired by quantification in other fields, like geography. Thirdly, connected to this, this argument will also enrich these histories by extending them further back to the first half of the 18th century. Looking closely at Struyck's quantitative method informs us how the world was made receptive to the 'passion for numbers' which has been described in the historiographical literature. Finally, I hope to contribute to our understanding of how authority was transferred from humanist philological traditions to new (mathematical) ways of working with empirical data. Struyck's quantitative method combined various sources and used, processed, and produced their data in multi-faceted ways. By investigating these, hopefully this research can support the newly emerging field of data history.[110]

[110] Chadarevian and Porter, 'Introduction: Scrutinizing the Data World'; Aronova, Oertzen, and Sepkoski, 'Introduction: Historicizing Big Data'; Sepkoski, 'Data in Time'; Mojet, 'Observing Disciplines'.

Chapter 1: An introduction to general geography

As the book's title gives away, Nicolaas Struyck wrote the *Inleiding tot de algemeene geographie* as an introduction to the discipline of general geography. This 'general geography' was a type of systematic geography, and 'a general geography' was a learned work that proceeded according to the standards of this discipline. The popular genre was founded by the geographer Bernard Varenius, who opposed this type of mathematical general geography to the more descriptive 'special geography' in his *Geographia Generalis* (1650). Ninety years later, Struyck continued working in like spirits.

I will begin this chapter by explaining how Varenius' influential geographical shaped the discipline of general geography. Then I will introduce Struyck's *Inleiding tot de algemeene geographie*, as well as the motivations and aims Struyck had for pursuing general geography. In the final, third, section I will show how Struyck defined and classified the discipline of geography, and how he structured the chapters of his book accordingly. Overall, this chapter thus intends to introduce the structure, content, and purpose of the *Inleiding* in the tradition of general geography. This contextualizes the research question.

1.1 Bernard Varenius' influential *Geographia Generalis*

Bernard Varenius (1622-1650) was a German geographer who later moved to Amsterdam and Leiden, where he died at an early age. Modern historiographers mainly see him as a revolutionizer of physical geography in particular, although the field was not regarded as a recognizable component of geography at the time.[111]

Varenius' most important geographical writing is the Latin *Geographia Generalis* (1650), which he intended as an introductory textbook for beginning university students. In the work, Varenius incorporated the ideas of Kepler, Galileo, and (especially) Copernicus to geography. He was the first geographer to adopt a heliocentric perspective in his works. He also based his geography on the new philosophical and scientific views of Descartes. Taken together, it made the *Geographia Generalis* the first book to move beyond medieval geographies based on a study of classical authors.[112] The work is often regarded as the intellectual divide that separated ancient and medieval geography from modern geography, 'distinguishing the era when a modern geography could emerge on a truly scientific footing.'[113] In his book, Varenius criticized that most geographies had largely developed into regional

[111] Unwin, *The Place of Geography*, 66–67; Vos, 'Beknopte geschiedenis van de fysische geografie en haar toepassingen', 24.
[112] Warntz, 'Newton, the Newtonians, and the Geographia Generalis Varenii', 165, 170, 173.
[113] Agnew and Livingstone, *The SAGE Handbook of Geographical Knowledge*, 26.

descriptions (what was called ‘chorography’).[114] The criticism was widely adopted and the book’s direct impact can hardly be overstated: ‘to the world of learning generally, and in the popular mind in Holland and elsewhere, Varenius came to be known within a decade as "THE Geographer."’[115] That status would not be altered for over a century. The revolutionary work set the standard for geography until well into the eighteenth century, and his ideas were respected and adopted by men like Newton and Alexander von Humboldt.[116]

Although Varenius had passed away quickly after the book’s publication, the original text would be thoroughly edited multiple times and by various editors. Next to the text as intended by Varenius, three other influential editions circulated around in Struyck’s time. The first major editing was conducted by Isaac Newton in 1781 and printed in Canterbury. The title page of his *Geographia Generalis* can be found in figure 8. Newton wanted to solve the scarcity of Varenius’ book since he considered it a necessary read for the Cambridge students he was teaching. He made many substantial revisions to the work, amended and corrected it, and added details and tables where he saw fit.[117] In 1712 James Jurin would update and refine the work again, which indicates that the book was still considered important academic study material at this time.[118] The first non-Latin edition appeared in 1734, after Dugdale and Shaw translated Jurin’s edition into English.[119] Only then Varenius’ ideas became available for a non-academic (though educated) British audience – not so much earlier than Struyck would present them to the Dutch general public in 1740. Dugdale and Shaw would keep updating English editions up to a fourth version in 1765.[120]

Most of all, this history of continuous revisions shows that Varenius’ *Geographia Generalis* was highly influential and still considered relevant at the time Struyck worked on his *Inleiding*, even though Varenius published his *Geographia Generalis* 90 years earlier. We know from the *Inleiding*’s references that Struyck must have possessed at least two copies: the original by Varenius as printed by Elsevier in Amsterdam (from either 1650, 1664, or 1671) and the edition edited by Newton, printed in Canterbury

---

[114] Unwin, *The Place of Geography*, 67.
[115] Warntz, ‘Newton, the Newtonians, and the Geographia Generalis Varenii’, 174.
[116] Varenius had a large influence on Humboldt’s geography, and according to Unwin, Humboldt’s *Kosmos* ‘sought to represent the whole material world in the tradition of the *Geographia generalis* of Varenius.’ Unwin, *The Place of Geography*, 76. See also Zondervan, ‘De richting in de beoefening der aardrijkskunde vóór A. von Humboldt en C. Ritter’, 752; Warntz, ‘Newton, the Newtonians, and the Geographia Generalis Varenii’, 170; Rebok, ‘The Influence of Bernhard Varenius in the Geographical Works of Thomas Jefferson and Alexander von Humboldt’.
[117] Warntz, ‘Newton, the Newtonians, and the Geographia Generalis Varenii’, 177–80.
[118] Baker, ‘The Geography of Bernhard Varenius’, 53.
[119] Warntz, ‘Newton, the Newtonians, and the Geographia Generalis Varenii’, 166, 182–83; Baker, ‘The Geography of Bernhard Varenius’, 53.
[120] Baker, ‘The Geography of Bernhard Varenius’, 53.

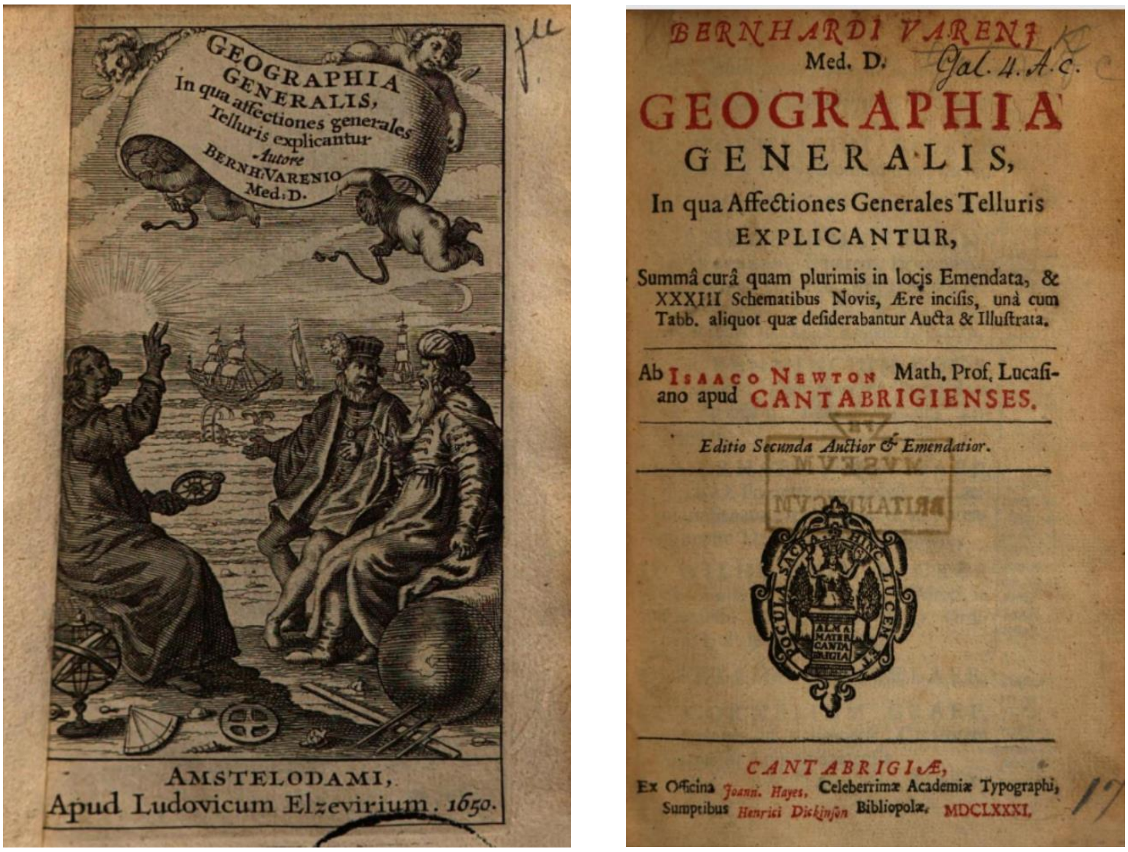


FIGURE 8: FRONT PAGES OF BERNARD VARENIUS' *GEOGRAPHIA GENERALIS*, THE EDITIONS THAT NICOLAAS STRUYCK MUST HAVE POSSESSED. THE LEFT IS THE LATIN EDITION FROM 1650, THE RIGHT IS THE VERSION EDITED BY NEWTON FROM 1681. *BERNHARD VARENIUS (1622-1650)*, 25.

(1681).[121] In fact, Struyck found the book so important that he would publish a Dutch translation in 1750 (but more about that in chapter 4).

Varenius' main purpose of the book is to strengthen the theoretical basis and scientific reputation of geography. He believed the discipline lacked reliable proven foundations. Instead, it was ignorant, unreliable, and lacked coherence. Therefore he wanted to provide general principles for the field, based on the most advanced knowledge of his time. In practice that implied that he reduced the manifold geographical phenomena to mathematical principles: mathematics was considered an authoritative discipline, appropriate to serve as this foundation.[122] The mathematical basis is evident if we look at Varenius' definition of geography:

[121] As becomes clear from Struyck's footnotes. Struyck, *Inleiding*, 113.
[122] *Bernhard Varenius (1622-1650)*, 25.

> 'Geography is that part of mixed mathematics, which explains the affections of the earth and its parts depending on quantity, viz. its shape, place, motion, magnitude, celestial appearances, and other related properties.'[123]

Varenius wanted to establish the discipline as firmly as possible. Next to promoting geography as a mathematical subfield, he also cited more than 300 scholars in the *Geographia Generalis*, of which about half from classical antiquity. In his attempt to lay new foundations for the field, he also carefully built on existing scholarly work. He pointed out the classical foundations of his results to strengthen their value, and he argued that these themes had a long scholarly tradition. The main purpose of this use of old and new materials was 'for laying reliable foundations for future application and in presenting a systematised concept of geography.'[124]

Next to a theoretical mathematical foundation, Varenius also gave geography its own systematic and methodological approach. He believed that once these were in order, geography could be easily taught and learned. Varenius' motive was thus also didactical (and it has been argued that the book's didactic design made it so easy to add and update new editions).[125] Moreover, he believed general geography had a practical use for both students, merchants and explorers travelling and trading worldwide.

The most innovative aspect of Varenius' new general geography was that he no longer structured the discipline by looking at a geographical object's position or placement, but organized it thematically. The chapters of Varenius' *Geographica Generalis* are split between rivers, mountains and mines; not per region or country. Varenius thus systematically arranged his book based on the similarity of phenomena, instead of plainly enumerating physical phenomena per region (like descriptive and chorographic geography). He justified this new style by introducing a divide between two types of geography, *Geographia Generalis* and *Geographia Specialis*.[126] The first, which he practised himself, was general geography. This looked at the complete earth, how it is constituted, and its division into parts. It concerned knowledge based on mathematical, geometrical, or astronomical laws; therefore the subject matter is largely restricted to the earth's physical conditions.[127] The second type, which he did not practice, was special geography. This field instead described individual regions and countries. It concerned all phenomena where people are involved, whose unpredictable behaviour

---

[123] Latin: 'Geographia dicitur Scientia mathematica mixta, quae Telluris, partiumque illius affectiones à quantitate dependentes, nempe figuram, locum, magnitudinem, motum, caelestes apparentias, atque aliis proprietates affines docet.' Varenius, *Geographia Generalis*, 1.
[124] *Bernhard Varenius (1622-1650)*, 230.
[125] *Bernhard Varenius (1622-1650)*, 227, 229.
[126] Unwin has argued that Varenius' division was inspired by Ptolemy's classical distinction between geography and chorography. See also Unwin, *The Place of Geography*, 67.
[127] For this reason Varenius is often considered as the founder of physical geography, though he himself did not consider that a criterium. See also Baker, 'The Geography of Bernhard Varenius'..

makes it difficult to establish general laws. Special geographic knowledge is therefore not based on mathematics and laws, but on observation and experience of travellers and traders.

Despite the strict division, Varenius stressed that general and special geography were not completely opposed to each other. Regional knowledge yielded the information that was also required to understand the world on a larger scale. This information helped to formulate structured hypotheses and theories in general geography. And on the other hand, one should also consider the foundations posed by general geography in special geography. These two branches were thus mutually interdependent.

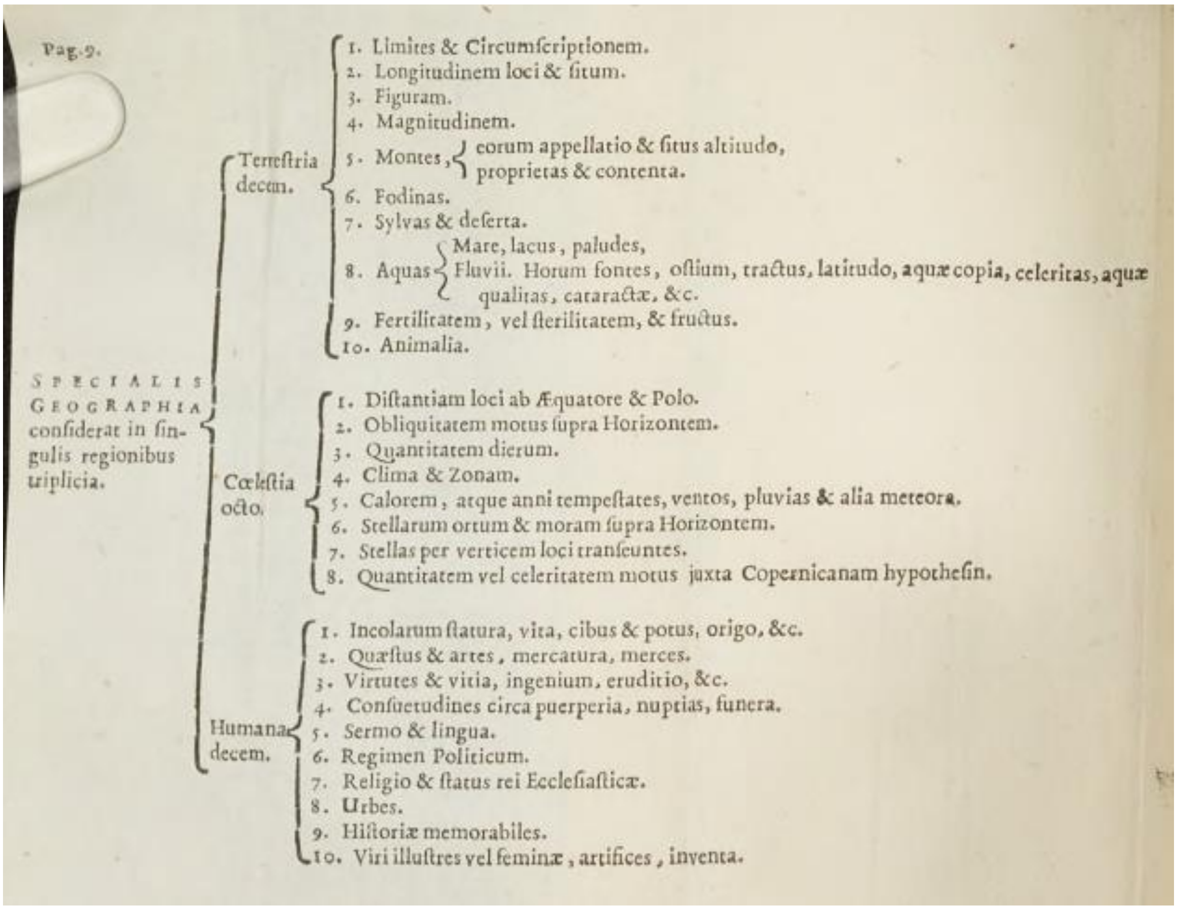
Varenius then classified both types of geography into their subcomponents. He also arranged the book's chapters according to this division and points out which chapters concern which theme. Obviously, the content of the book *Geographica Generalis* only concerns topics of the first type. His division is as follows:

- General geography (*Geographia Generalis*):
    - The absolute (chapter 1-11),
    - The relative (chapter 12-30),
    - The comparative (chapter 31-40).
- Special geography (*Geographia Specialis*)
    - The celestial,
    - The terrestrial,
    - The human.

A more detailed schematical representation as provided by Varenius can be found in figure 9).[128] This figure shows the high level of detail in which he classified and systematized geography, and how the book's chapters move from the general to the specific.

[128] Varenius, *Geographia Generalis*, 2–3, 11.

- GENERALIS GEOGRAPHIA in tres Partes in hoc libro divisa est, quæ sunt
  - PARS ABSOLUTA, divisa in Sectiones sex.
    - SECTIO PRIMA, de præcognitis capita duo.
      - Cap. I. De Prolegomenis.
      - Cap. II. De quibusdam necessariis ex Geometria.
    - SECTIO SECUNDA, affectiones totius Telluris explicat capitibus V.
      - Cap. III. De Telluris Figura.
      - Cap. IV. De ejus dimensione & magnitudine.
      - Cap. V. De ejus motu.
      - Cap. VI. De ejus loco in Systemate Mundi.
      - Cap. VII. De ejus substantia & materia.
    - SECTIO TERTIA, in qua Terræ Constitutio & partes explicantur capitibus quatuor.
      - Cap. VIII. De Divisione Terræ per Aquas.
      - Cap. IX. De Montibus in genere.
      - Cap. X. De Montium differentiis.
      - Cap. XI. De Sylvis, desertis, & fodinis.
    - SECTIO QUARTA, HYDROGRAPHIA in qua Aquarum constitutio & proprietates explicantur, capitibus VI.
      - Cap. XII. De Divisione Aquarum.
      - Cap. XIII. De Oceano & Mari.
      - Cap. XIV. De Motibus maris, inprimis de Fluxu & Refluxu.
      - Cap. XV. De Fluviis.
      - Cap. XVI. De Lacubus, stagnis & paludibus.
      - Cap. XVII. De aquis mineralibus.
    - SECTIO QUINTA.
      - Cap. XVIII. De mutatione locorum aridorum in Aquosa & contra.
    - SECTIO SEXTA, de Athmosphæra.
      - Cap. XIX. De Athmosphæra & Aëre.
      - Cap. XX. De Ventis in genere.
      - Cap. XXI. De Ventorum differentiis & in specie.
  - PARS RESPECTIVA explicans affectiones cælestes capitibus.
    - Cap. XXII. De affectionibus cælestibus in genere.
    - Cap. XXIII. De latitudine loci & elevatione poli.
    - Cap. XXIV. De Divisione Telluris in Zonas.
    - Cap. XXV. De longitudine dierum & divisione Telluris in Climata.
    - Cap. XXVI. De luce, calore, & tempestatibus anni.
    - Cap. XXVII. De Umbris & divisione incolarum respectu umbrarum.
    - Cap. XXVIII. De comparatione Affectionum cælestium in diversis locis, ubi de Antœcis, Periœcis & Antipodibus.
    - Cap. XXIX. De Diversitate Temporis in diversis locis.
    - Cap. XXX. De diverso ortu Solis, Lunæ, &c. atque aliis apparentiis.
  - PARS COMPARATIVA, affectiones illas considerans, quæ ex comparatione unius loci ad alium oriuntur.
    - Cap. XXXI. De longitudine locorum.
    - Cap. XXXII. De situ locorum ad invicem.
    - Cap. XXXIII. De distantia locorum mutua.
    - Cap. XXXIV. De Horizonte visibili.
    - Cap. XXXV. De arte Nautica in genere & navium structura.
    - Cap. XXXVI. De onere navibus imponendo.
    - Cap. XXXVII. De Directoria artis Nauticæ parte prima, Cognitio intervalli.
    - Cap. XXXVIII. Secunda parte Cognitio plagarum.
    - Cap. XXXIX. Tertia pars de Histriodromia, sive via navis.
    - Cap. XL. Quarta pars de loco navis in itinere.



Pag. 9.

SPECIALIS GEOGRAPHIA conſiderat in ſingulis regionibus triplicia.

Terreſtria decem.
1. Limites & Circumſcriptionem.
2. Longitudinem loci & ſitum.
3. Figuram.
4. Magnitudinem.
5. Montes, eorum appellatio & ſitus altitudo, proprietas & contenta.
6. Fodinas.
7. Sylvas & deſerta.
8. Aquas: Mare, lacus, paludes, Fluvii. Horum fontes, oſtium, tractus, latitudo, aquæ copia, celeritas, aquæ qualitas, cataractæ, &c.
9. Fertilitatem, vel ſterilitatem, & fructus.
10. Animalia.

Cœleſtia octo.
1. Diſtantiam loci ab Æquatore & Polo.
2. Obliquitatem motus ſupra Horizontem.
3. Quantitatem dierum.
4. Clima & Zonam.
5. Calorem, atque anni tempeſtates, ventos, pluvias & alia meteora.
6. Stellarum ortum & moram ſupra Horizontem.
7. Stellas per verticem loci tranſeuntes.
8. Quantitatem vel celeritatem motus juxta Copernicanam hypotheſin.

Humanæ decem.
1. Incolarum ſtatura, vita, cibus & potus, origo, &c.
2. Quæſtus & artes, mercatura, merces.
3. Virtutes & vitia, ingenium, eruditio, &c.
4. Conſuetudines circa puerperia, nuptias, funera.
5. Sermo & lingua.
6. Regimen Politicum.
7. Religio & ſtatus rei Eccleſiaſticæ.
8. Urbes.
9. Hiſtoriæ memorabiles.
10. Viri illuſtres vel feminæ, artifices, inventa.

Figure 9: Varenius' classification of geography and the corresponding chapters in the Geographia Generalis. Varenius, 8, 9.

The distinction between general and special geography arose from Varenius' intention to present geography as a mathematical discipline. At least in general geography, most things could be proven by mathematical, geometrical, or astronomical laws, according to Varenius.[129] Proofs were conducted by logical argument or demonstration. However, in special geography 'almost everything is explained without demonstration, being either grounded on experience and observation, which is the testimony of our senses, nor can they be proven in any other way.'[130] Varenius believed that any reliance on observation and experience should be avoided because these did not constitute appropriate foundations.[131] Although Varenius regarded special geography as an interesting subject on its own, it belonged not so properly to geography.

Varenius' methodological approach to general geography led to a focus on physical geographical phenomena, since he believed that these could be described mathematically. Varenius

---

[129] Varenius, 5.

[130] Latin: '… in Speciali autem Geographia omnia fere sine Demonstratione explicantur (ex cepris caelestibus affectionibus, quae demonstrari possunt) quo experientia & observatio, hoc est sensum testimonium illa confirmat, neque possunt alio modo probari.' Varenius, 6.

[131] See also Unwin, *The Place of Geography*, 67. Baker, 'The Geography of Bernhard Varenius', 59.

substantiated all his claims with a coherent (and often enumerated) logical structure. For example, when Varenius writes that 'the reasons for the Copernican Hypothesis are these,' this is followed by an enumeration of eight arguments, then their respective counterarguments, and finally his answers to those.[132] The outcome is the most important, because in the end Varenius collects statements to inform the reader about the most recent and accurate knowledge of what the world was like.

Next to Varenius' general geography there existed also several other geographical styles in the century leading up to Struyck's *Inleiding.* Scholars like Johann Hübner and Philipp Clüver also published extremely popular and often reprinted books, but their writings look nothing like Varenius' general geography. Take Hübner's *Kurtze Fragen aus der alten und neuen Geographie* (1693).[133] The book was translated into many European languages including Dutch, went through 40 editions and was still used in schools in the 1760s, but its views on geography and organisational structure differed completely from Varenius. Hübner's pedagogic method was to write in a question-and-answer format, meant to engage students' thinking. Moreover, local contexts were always the starting point for his descriptions. What later authors would call the 'Hübner method' referred to a textual structure that organised content 'from "West" to "East", from "evening" to "morning."'[134] In 1749, the German teacher and librarian Johann Jacob Schatz commented:

> 'The vast majority [of writers] keep the order with Mister Hübner and discuss 1) the planiglobe, 2) Europe, 3) Portugal, 4) Spain, 5) France, 6) Great Britain, 7) the Netherlands, 8) Switzerland, 9) Italy, 10) Germany etc. and then also the remaining realms and parts of the world.'[135]

Another type of geographical genre is Philipp Clüver's *Introductio in Universam Geographiam* (1624). The six-volume book remained a standard work through the mid-18th century, and mainly contained short descriptions of countries with a focus on human and historical considerations. Moreover, it still placed the earth at the centre of the universe – whereas Varenius adopted the heliocentric model.[136] Although Clüver devoted some pages of his massive work to mathematical geography, his descriptive style was completely disconnected from Varenius' general geography.

These various styles of practising geography existed next to each other during Struyck's lifetime. We know Struyck must have been aware of these different traditions since he possessed and commented on geographical books that fit all of these traditions, even though he practiced general geography himself. In particular, he is unusually critical about his French copy of Hübner's geography,

---

[132] Varenius, *Geographia Generalis*, 49–55.
[133] Hübner, *Kurtze Fragen Aus der Neuen und Alten Geographie*.
[134] Withers and Fischer, 'Geographical Education in the Eighteenth-Century German-Speaking Territories', 22.
[135] John Jacob Schatzen, *Examen Geographicum* (Frankfurt und Leipzig, 1776 edition), 8. Quote obtained from Withers and Fischer, 22.
[136] *Bernhard Varenius (1622-1650)*, 59.

which he brings up in several places throughout the *Inleiding*.[137] Nevertheless, the criticism also indicates that he at least found the book relevant enough to correct it. Still, most other geographic writings did not address geography in a systematic fashion comparable to Varenius. Instead of looking for the discipline's foundations or thoroughly investigating its classification, they remained little more than educational textbooks or encyclopaedic place and country descriptions. Their purpose and approach to geography are incomparable to Varenius' intentions – and clearly did not have as much influence on Struyck's *Inleiding*. At the same time, that does not mean that Struyck pursued general geography with the same intentions as Varenius. In the next paragraph I will describe how Struyck's geographical treatise came about, trace his motivations for it, and compare these to Varenius'.

1.2 Introducing Struyck's *Inleiding*

Like Varenius Struyck called his book a 'general geography' – or, in Dutch, an *'algemeene geographie*'. The full title is *Inleiding tot de algemeene geographie, benevens eenige sterrekundige en andere verhandelingen* (1740; see also figures 10, 11). It was his first major work and one of the first comprehensive geographical handbooks in Dutch.[138] Still Struyck himself regarded his work as only an introduction to the discipline, 'because there are still many things that I leave for others to investigate; either to find or to improve.'[139]

[137] See Struyck, *Inleiding*, 15, 44–49, and 323 (part II).
[138] See also Hermans, 'Johan Lulofs en zijn tijdgenoten'. Hermans argues that Lulofs', not Struyck's, should be regarded as the geographical handbook. We will come back to this in chapter 4.
[139] Struyck, *Inleiding*, voorreden.


INLEIDING
TOT DE
ALGEMEENE
GEOGRAPHIE,
BENEVENS EENIGE
STERREKUNDIGE
EN ANDERE
VERHANDELINGEN.
DOOR
NICOLAAS STRUYCK.
TE AMSTERDAM,
By ISAAK TIRION,
MDCCXL.

FIGURE 10: THE TITLE PAGE OF STRUYCK'S *INLEIDING TOT DE ALGEMEENE GEOGRAPHIE*. STRUYCK, *INLEIDING*.

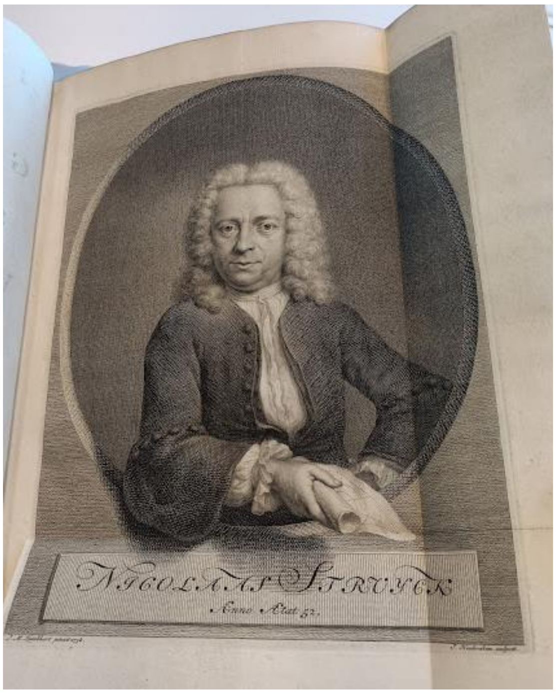


FIGURE 11: PORTRAIT OF NICOLAAS STRUYCK AS A FOLD-OUT IN THE *INLEIDING TOT DE ALGEMEENE GEOGRAPHIE*. STRUYCK.

Very generally, the book consists of a preface, table of contents and two separately paginated sections (each an '*afdeeling*'). The first of these composes the *Inleiding tot de algemeene geographie, of aardryks-beschryving* (note that this title differs slightly from the book's title page: he added the term '*aardryks-beschryving'*). Struyck provided a coherent geographical handbook of 176 pages. Its chapters cover wide-ranging themes, such as the terrestrial and civil distribution of the entire earth, but also contain more specific discussions of planets and stars, mountains, mines, continents, seas, peoples, animals, and even seafaring. In this first part of the book, Struyck step by step uncovers the whole (physical) world and the universe beyond. The second part of the book is not such a coherent whole. It is also twice as long. The 392 pages contain nine disconnected essays about actuarial, chronological, demographical, and astronomical topics on various themes.

The two parts of the *Inleiding* were available to the public from early 1740 onwards, but most of the work had been written and printed in fragments during the previous years already. Struyck remarks that most essays had been printed before the first part of the *Inleiding* could go to press (except for the final essays, which was an appendix ['*aanhangsel'*]).[140] Whenever Struyck first started thinking about writing a geographical handbook is unclear, but Van Haaften claimed that Struyck

[140] Struyck, voorreden.

started working on the book in 1732 and Zuidervaart even argued that 'Struyck presented the result of some twenty years of scholarship.'[141] Van Haaften also brings up that the individual editions of the work differ from each other, since bookbinding was not mass production. Some of the manuscripts he looked at included an additional tenth essay that was not included in the introduction, titled *Appendix to the research on several sun and moon eclipses*.[142] Overall, most of the book seems to originate from the second half of the 1730s and the earliest full manuscript circulated amongst Struyck's friends in spring 1737.[143] Struyck writes in the preface that the essays were printed the first.[144] Several essays were 'finished printing by 15 April 1738' and whenever Struyck mentions the time of writing, it is usually 'the current year 1738.'[145] The rest of the book also includes several observations from 1739 and the preface dates from November of that year. In general, its fragmented printing process mostly indicates that the *Inleiding* is a compilation of evolving thoughts in various degrees of coherence.

When it comes to Struyck's motivation he expressed to have written *Inleiding* first and foremost because he wanted to extend our insight into the 'general knowledge of the whole earth'.[146] He believed that the book's power was its universality, and to obtain this he compiled, extended, and generalized existing particular knowledge of local situations. This search for generality was remarkable for the time. Struyck did 'not only investigate the towns and cities of particular empires and states,' but in his search for universality, he went beyond the usual aim of geographers.[147] Struyck saw such broad geographical-theoretical knowledge as a prerequisite to understanding our world and how humans have lived in it. Expanding this knowledge will therefore help us grasp the past, present and future. Like many of his contemporaries, Struyck saw geography (together with chronology) as auxiliary disciplines to history, calling them 'the eyes of history.'[148] Struyck saw geographical knowledge as valuable on its own, but believed it was equally relevant for related scholarly inquiries.

[141] Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 129; Haaften, *Nicolaas Struyck*, 4, 56. Zuidervaart argues that Struyck's correspondence indicates that he conceived his plan to publish about comets in 1722. I think this intention only does not point to a plan for the *Inleiding* as a whole. Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*, 112.

[142] Haaften, *Nicolaas Struyck*, 4.

[143] Zuidervaart found that Struyck already discussed an early manuscript with a befriended surveyor, Gerrit Spinder, in 1737, its most important parts being in place by then. Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*, 460.

[144] Struyck, *Inleiding*, voorreden.

[145] For an essay printed in 1738, see Struyck, 360 (part II). The occurrences of 'the current year 1738' are mentioned at several places throughout the book, but see for example Struyck, 99, 142, 360 (part II).

[146] Struyck, *Inleiding*, voorreden.

[147] George Hendrik de Rivecourt and Kobus, 'Nicolaas Struyck', 982.

[148] At the time, geography and chronology are seen these essential auxiliary disciplines because most historical writings order their subjects either geographically or chronologically. See also Grafton, 'The Identities of History in Early Modern Europe: Prelude to a Study of the Artes Historicae', 45.

This 'general knowledge of the whole earth' was not intended for fellow scholars, but for all his fellow countrymen. For that reason he wrote the book in Dutch, not the academic Latin. In practice, however, the book would remain inaccessible for a large part of the Dutch people, since only literate and educated laymen would be able to understand the book (even more so because Struyck also assumed quite some prior knowledge of arithmetic and geometry).[149] Moreover, he emphasized the book's relevance for merchants, statesmen, theologians, and physicists, though he did not explain if this were theoretical or practical.[150] Nevertheless, he believed the book would lead to intellectual improvement for all individual readers and that this would then advance the Dutch people as a whole. He believed it contributed to the commonweal by enlightening (the educated part of) society. Struyck wrote for an audience that, according to himself, was already familiar with the discipline of geography. It had been discussed 'even in several Dutch books.'[151] He argued that these books had already convinced his readers of geography's usefulness, necessity, and pleasure. The problem was that these geographical writings remained limited in scope to a discussion of the Dutch Republic only, so the Dutch people remained deprived of broader knowledge of the world. Struyck, therefore, took up this teacherly task.

Next to an educational motive, Struyck also had practical and philosophical motivations for his treatise. The practical value was to be found in issues like regents determining the rent price for tenants wishing to rent a house for life.[152] Likewise Struyck's writings on life annuities, or cartography and navigation provide solutions for practical problems of everyday or professional life. Besides these more hands-on topics, Struyck also intended to investigate deeper insights. He claimed to strive for 'the true Knowledge of Mathematics only,' and emphasized that all criticism that helped to achieve this goal was welcome ('because no man can know everything').[153] Exemplary in this sense are Struyck's mathematical calculations to predict all sun and moon eclipses for the coming 25 years: Struyck hoped that other mathematicians would continue to improve his advancements and extend the precise mathematical predictions to future times.

The final type of insights geographical knowledge contributed to, according to Struyck, were insights about God. Geography 'shows us with what remarkable wisdom the world has been

---

Dutch: 'Met regt noemt men de Geographie en de Chronologie de Oogen van de Historien …' He ascribes this expression to Pierre Le Lorrain (better known as the abbot of Vallemont), a French physician who also wrote about history. Struyck, *Inleiding*, 4.

[149] According to Israel, about three quarters of the Dutch male population was literate in the middle of the 18th century, whereas only half of the women could read. Israel, *The Dutch Republic*, 686.

[150] Struyck, *Inleiding*, 4.

[151] Struyck, voorreden.

[152] Struyck, 371 (part II).

[153] Dutch: '… want een Mensch kan alles niet weeten … beogende maar alleen de waare Kennis van de Wiskonst.' Struyck, voorreden.

created.'[154] Struyck maintained that nature and 'natural reason' show that there is one God that created and maintains the world.[155] For him the search for more knowledge was ultimately a search to understand 'the great wisdom of the Creator,' who operates with 'such an exquisite order' and 'so much usefulness.'[156] Understanding and conveying this knowledge is yet another goal Struyck hopes to achieve in the *Inleiding*. Struyck's theological position was not uncommon for the time. The mainstream Dutch Enlightenment scholar never questioned religious belief directly, but combined a conventionally pious belief that God is omnipresent with his empirical findings and enthusiasm for classification.[157] Still, Struyck's theological views had a large influence on his view of geographical knowledge, especially on its boundaries. No geography could ever be complete, he believed, since some geographical insights remained reserved for the Creator. In short, we have seen that Struyck saw geographical knowledge as indispensable in many situations.

Still he valued geography for very different reasons than Varenius, who intended to promote geography as a reliable scholarly discipline by bringing back the general principles and theories into the field. Struyck, on the other hand, was much less concerned with establishing such a proper foundational framework for geography. Instead, intended to advance Varenius' framework futher by contributing novel practical and philosophical insights. But he aimed for his fellow countrymen instead of the academic world, and published in his mother tongue instead of the scientific lingua franca. Yet, both geographers also share some of their motivations. Struyck and Varenius both had educational goals. But whereas Varenius' didactic efforts were aimed at easing student learning through a new accessible systematic and methodological approach, Struyck wanted to educate and advance the general public with general knowledge. More than mathematical predictions, Struyck strove for geographical generalities. With this knowledge of how and why Struyck created his general geography, it is time to look at the book's structure and content. In the next paragraph I will therefore elaborate on Struyck's ideas about geography as a discipline and how this impacted the *Inleiding*'s scope and structure.

[154] Dutch: '… en boven dit alles, zoo leid [sic] dezelve ons op om te zien met welk een wonderlyke wysheid dat de Aarde gemaakt is.' Struyck, 4.
[155] Dutch: 'De natuurlyke reden leert aan alle Menschen, dat 'er één God is, die alles geschapen heeft en onderhoud …' Struyck, 51.
[156] Dutch: '… de groote Wysheid van den Schepper, … die in zulk eene uitsteekende order, met zoo veel nut …' Struyck, 56.
[157] Israel, *The Dutch Republic*, 1041.

1.3 Defining and classifying the discipline of geography

Before Struyck began describing the world, he described the discipline of geography itself. Despite the audience's familiarity with the discipline, he regretted the lack of agreement on the field's scope.[158] Geography's limitations apparently were a cause of confusion in his time, because several authors applied strict definitions of the discipline while others included almost anything.[159] Struyck wrote that he intended to take a position in the middle. According to Struyck,

> 'geography is a description of the earth as well as its parts, appearance, place, magnitude, and movement; together with the celestial appearances that are related to it.'[160]

Note that this definition is extremely similar to Varenius' definition of geography that we discussed in paragraph 1.1. The fact that Struyck does not provide any references (to Varenius or any other scholar) indicates that Varenius' view on geography had become common knowledge at the time. The main difference between their definitions is that Struyck did not explicitly define geography as a part of mathematics. However, throughout the rest of the book, Struyck left no doubts that he perceived it as such. He continuously described his peers as mathematicians or astronomers (or incidentally using poetic expressions like 'admirers and connoisseurs of the heavenly orbits').[161] Moreover, likewise similar to Varenius, Struyck also commented on geography's roots, arguing that 'arithmetic, geometry, and astronomy are the foundations on which everything rests.'[162] Finally, note that with this definition Struyck restricted all geography to measurable phenomena: he is only concerned with the part of the world that can be properly captured in numbers.

The Dutch words Struyck used to refer to the discipline of geography alternated. In the above definition he used the term *geographie,* but in general he switched between the words *geographie, aardrykskunde* and *aardryks-beschyving*.[163] He used those interchangeably and sometimes provides more than one at a time, like in *Inleiding tot de algemeene geographie, of aardryks-beschryving.*[164] Next to that he describes of the book's title in the preface as: 'I call my book *Introduction to the General Knowledge of the Earth.*'[165] He thus used the terms 'knowledge of the earth' instead of the word

---

[158] Struyck, *Inleiding*, 1.

[159] Even as late as in 1921, similar remarks about the disciplines unclear boundaries would be made. A. van Deursen writes in his handbook on geography: 'This statement by Nicolaas Struyck can be repeated in our days: opinions about the scope of geography still differ.' (Dutch: 'Deze uitspraak van Nicolaas Struyck kan nog in onze dagen herhaald worden: nog steeds verschillen de meeningen over den omvang der aardrijkskunde.'). Deursen, *Aardrijkskunde*, 13.

[160] Dutch: 'De Geographie is eene beschryving van de Aarde, en derzelver deelen, gedaante, plaats, grootheid en beweging; als ook van de Helemsche Verschyningen, die daar toe betrekkelyk zyn.' Struyck, *Inleiding*, 1.

[161] Struyck speaks of 'Wiskonstenaars' and 'Sterrekundigen' throughout the book. In this instance he, mentioned 'Liefhebbers en Kenders van de Hemelsloop.' Struyck, 301 (part II).

[162] Dutch: 'De Reekenkonst, de Meetkonst, en de Sterrekonst, zyn de gronden daar alles op rust.' Struyck, 2.

[163] Compare Struyck, 1–4.

[164] Struyck, 1.

[165] Struyck, voorreden.

'geography.' Apparently he saw these as synonyms – to Struyck, geography is the discipline that studies, describes, and provides knowledge about the earth.

After providing his definition of geography, Struyck subsequently split the discipline into its components and sub-components. Struyck intended this division as both an organisational classification of the discipline of geography and a way to structure the chapters of his book. The proposed structure is highly similar to Varenius', as introduced in paragraph 1.1.[166] Like Varenius, Struyck's main divide is between general and special geography, which are then split into three subcategories. Struyck classifies and explains the discipline's components as follows:

- General geography (*algemeene geographie)*: describing the earth and her regional properties in general.
  - The absolute (chapters 2-11): on the size, shape, and movement of the earth's body.
  - The relative (chapter 12): on the coincidences that happen to the earth because of celestial bodies (i.e. latitude, longitude, climatic zones).
  - The comparative (chapter 13): on the comparison of properties of different parts of the earth.
- Special geography (*bijzondere geographie*): describing the condition and location of each place individually.
  - In relation to the earth: on the boundaries and location of particular sites, mountains, forests, deserts, waters, plants, and animals.
  - In relation to the heavens: on a particular site's distance to the equator or poles, its day length, etc.
  - In relation to the people: on the number of people in particular countries or cities, their governance, religion, habits, rituals, language, history, etc.[167]

Struyck indicates to which part of geography each chapter corresponds. Only three chapters do not fit into the division: the 1st, about geography's definition and this division itself, the 14th on seafaring, and the 15th on logarithms. Since the book is about general geography, there are no chapters about topics Struyck regards as special geography. Nevertheless, he claims to have blended some special geography into the general, 'touching upon the issues concerning people only in passing.'[168] As for the rest, he does not intend to discuss particularities but wants to confine himself to broader, worldwide properties instead. This is not because these are uninteresting, but the book would have become too voluminous otherwise, says Struyck.[169] Note that he thus excluded special geography for different

[166] Varenius, *Geographia Generalis*.
[167] This classification is described textually; the ordering on different 'levels' is therefore mine. See Struyck, *Inleiding*, 2.
[168] Dutch: 'Van de byzondere Geographie zal ik onder de algemeene laaten invloeien; dog om de kortheid van 't geen, 't welk de Menschen betreft, de meeste zaaken niet eens aanroeren, en van eenige maar als in 't voorbygaan iets melden; want dit alles na te vorschen zou een veel grooter werk vereischen.' Struyck, 2.
[169] Struyck, 2.

reasons than Varenius, who believed that special geography could not be studied with proper methods (because they rested on 'unreliable' observation and experience).

The latter part of the book consists of nine essays. Struyck introduces these as follows: 'Of several remarks which appeared in [the first part of the *Inleiding*] I have made special treatises, because they ran a bit wide, which are added in the end.'[170] They concern the following nine titles:

1. Introduction to the general knowledge of comets.
1. Observations on the course of Jupiter.
2. Considerations on the size of the earth, as found by ancient and modern men.
3. Investigation of the lunar atmosphere.
4. Investigation of a few sun and moon eclipses, serving to elucidate the histories and chronologies – to which a list of the historical sun and moon eclipses is added that the chronologists do not report or which they have not yet investigated using tables, and which are calculated here.
5. Short description of all the comets, collected from the histories up to our time, together with the tables needed to calculate comets.
6. Conjectures on the state of the human race.
7. Calculations of life annuities.
8. Appendices to the calculations of life annuities.

These essays depart from the established structure of a general geography and therefore provide particularly valuable insights into Struyck's own vision and approach. Struyck made frequent references to some of the essays in the first part of the *Inleiding*, like the third and the seventh essay. Other themes are less required for grasping the rest of the book. The level of detail of much of the advanced astronomical work, for example, went beyond the relevance to the rest of the *Inleiding*. Here, Struyck had the space to provide the detailed tables and calculations without having to depart from the broader narrative. Moreover, many of the essays raise the issue of using geography for dating historical events. He believed that our knowledge of events like the fall of Troy should be informed by astronomical observations of the heavenly bodies which he considered geography. Likewise our understanding of demographic structures informs time reckoning by informing us of the length of a generation. To do so he combined both ancient and more modern scholars, such as the work of Virgil's '*Eneas'* as translated by 'Joost van Vondel' [sic] with that of Isaac Newton.[171] Struyck thus used the essays to put into practice what he claimed in the preface, using geography (and chronology) as 'the

[170] Dutch: 'Van verscheide Aanmerkingen, die daar in voorkwamen, heb ik voegzaamheidshalven, om dat ze wat breed uitliepen, byzondere Verhandelingen gemaakt, die agter geplaatst zyn.' Struyck, voorreden.
[171] Struyck, 17–18.

eyes of history.'[172] I will introduce some of these essays in more detail in chapter 3, which is about Struyck's civil and heavenly geography.

To sum up, this paragraph outlined what Struyck considered proper general geography. He largely Varenius' influential definition and classification and likewise regarded the discipline as a mathematical field based on arithmetic, geometry, and astronomy. But Struyck's conception of the phenomena which could be captured by numbers was broader than Varenius', as is shown by the content of the essays. Overall, Struyck contributed to an established discipline, but also made clear choices where to place his own accents. The next paragraph will briefly sum up the most important findings of this chapter.

1.4 Conclusions

In the previous paragraphs I have introduced the discipline of general geography in the tradition of Varenius' *Geographia Generalis*. The influential handbook was published about 90 years before *Inleiding* but still very influential. Struyck possessed two editions and Varenius' ideas clearly also shaped Struyck's views of the discipline – although he was also aware of the various co-existing styles of practising geography, like those of Hübner of Clüvier. Still, we should not see the *Inleiding* as yet another translated and updated edition of Varenius' book. Despite the resemblance, both authors wrote for very different audiences and with very different purposes. And although Struyck adopted Varenius' overall plan of geography, he mentions him only three times in the *Inleiding*, two of which are to correct some of Varenius' results.[173]

Unlike Varenius' academic audience, Struyck wrote the *Inleiding* in his native language for his fellow Dutch countrymen. Struyck's goal was to educate them in 'the general knowledge of the world.' He wanted to provide both practical and philosophical geographical knowledge, to advance individuals and contribute to the commonweal. But apart from this didactic purpose, Struyck also saw extending the available geographical theories also as valuable by itself. He believed it would help us understand the world's past, present, and future, as well as the ways of God. It took Struyck several years to develop his ideas in full. He compiled and printed the material for his book piece by piece. To discover the world's generalities, Struyck looked at geography as a mathematical discipline based on arithmetic, geometry, and astronomy. He based the book's chapters on the common disciplinary classification of general geography, restricting its scope to measurable phenomena.

To sum up, this chapter has introduced the structure, scope, and purpose of the *Inleiding* in the broader tradition of general geographies. It provided the background to Struyck's geography,

[172] Struyck, 4.
[173] Struyck, 112, 113.

which is necessary to answer our research question. Having contextualized the book in this chapter, I will describe it in a more internal manner in the next chapter about its content and the peculiarities of Struyck's approach.

Chapter 2: Struyck's 'quantitative method'

In the previous chapter I introduced Nicolaas Struyck's *Inleiding tot de algemeene geographie* as part of a broader, established tradition of general geography. Although Bernard Varenius had published his *Geographia Generalis* 90 years before Struyck's *Inleiding,* Struyck adopted much of his ideas. Moreover, I also presented Struyck's ideas about geography and his motivations for writing the *Inleiding,* as well as the scope and structure of the book. I will now elaborate on that discussion in this chapter by taking a closer look at *how* Struyck approached geographical phenomena. Struyck treated these subjects in his own, specific style. This chapter will outline what his geographical approach entailed for terrestrial geographical subjects – or rather, the phenomena that are unmistakably considered general geography, judged by the standards presented in the previous chapter and also commonly seen so today. The general investigative practice based on compiling and comparing other scholars' data is what I call Struyck's 'quantitative method'. This method will be introduced and explained in this chapter. It is a first answer to the question *how* Struyck quantified empirical observations in his geography. This answer will be extended in chapter three, where I argue that this method not only applies to the terrestrial phenomena of this chapter, but also characterizes Struyck's contributions to civil and heavenly geography.

This chapter will place two of the *Inleiding's* sections central: the chapter on mountains and the essay on the measure of the earth. The two cases are illustrative of Struyck's approach throughout the *Inleiding*: both demonstrate how quantitative calculations constitute the foundations of Struyck's systematic and quantitative geographical understanding. Broadly speaking, his quantitative method proceeds as follows. Struyck approaches a geographical phenomenon by investigating the ways it could be measured. He compiles observation data from fellow scholars, verifies their values through mathematical reasoning and conversion into a single unit system, compares their results, and judges what the problem's outcome should be. Often he ends a discussion with a critical reflection and what I call 'data criticism' on the original observations. I will end this chapter by arguing that Struyck uses this method primarily to explain how geographical knowledge had been acquired and developed.

2.1 Mountains and mountain height

Struyck's discussion of mountain heights is an illustrative example of the way Struyck employed quantification to study geographical phenomena.[174] Topics like these stirred the imagination of geographers at the time. As Agnew and Livingstone write: 'In the eighteenth-century Europeans began to look at the natural world around them with a new curiosity. Mountains began to seem objects of

[174] Struyck, 55.

potential beneficial interest rather than obstacles frequently to be avoided.'[175] Struyck's 17-page exposition on mountains composes the fifth chapter of the *Inleiding*. He begins it with the definition of a mountain, which he characterized as 'a height on earth, that exceeds far above the places around it.'[176] It might seem a somewhat unusual definition, but recall that the Amsterdam-based Struyck had probably never encountered a mountain in his lifetime. After this introduction, the rest of the chapter is split into four parts:

1. The arrangement of the mountains
2. The diversity of the mountains
3. The height of the mountains
4. On burning mountains

In the first section, Struyck listed the positions of all the main mountain chains (*keetens*) that can be found in each continent. In this section Struyck also meticulously discusses that their positioning is by no means coincidental but a consequence of the Creator's purposes. The second part of the chapter is devoted to the diversity of mountains and only consists of six concise, enumerated statements, such as: '4. Several mountains burn and smoke; others are without fire.'[177] The third part on the height of mountains is much longer. I will elaborate on this section in more detail in the coming paragraphs, discussing how Struyck develops his discussion of mountain heights. Finally, Struyck discusses burning mountains as a special type of mountain. For each continent he enumerates where its burning mountains can be found, often with (eyewitness) accounts of their eruptions.

The first and second parts of the chapter do not provide any references, which might indicate that Struyck reproduced established or conventional geographical descriptions. These parts of the chapter proceed according to what Struyck considered a standard way of doing general geography: we find highly similar descriptions in Bernard Varenius' geography.[178] The same goes for the final, fourth, section on burning mountains. But here Struyck does update Varenius' writings with the results of his own literature study, using new and more recent data. His sources for these updates mainly consist of recent travel accounts and of the philosophical transactions of the Royal Society. In one paragraph, he unexpectedly turns to the first person, careful to emphasize that he now presents his own opinion. That is when he writes that 'the mountains are not just placed there by chance … to me, this seems to be a delusion and, in this way, one runs the risk of erasing the high respect one owes to the Supreme

[175] Agnew and Livingstone, *The SAGE Handbook of Geographical Knowledge*, 359.
[176] Dutch: 'Een hoogte op de Aarde, die ver boven de plaatzen, die daar omtrent zyn, uitsteekt.' Struyck, *Inleiding*, 54.
[177] Dutch: 'Verscheide Bergen branden en rooken; andere zyn zonder vuur.' Struyck, 56.
[178] Varenius, *Geographia Generalis*, 135.

Being from one's thoughts.'[179] Struyck critically argues against colleagues who have presented such views ('I do not know how Thomas Burnet dares to say such a thing').[180] So, when it comes to God, Struyck is careful to stress that he involves his personal views in the argumentation. He operates differently than in the rest of the chapter, where he mainly adopts established geographical writings (such as by Varenius) or extends these by incorporating new source literature. Overall, Struyck mainly operates as a compiler in sections one, two and four.

Conversely, Struyck takes up a different role in the third section. Half of the chapter consists of a discussion of mountain heights in general and for particular mountains. Struyck begins by describing the results that the ancient Greeks obtained, creating an overview of the knowledge they already possessed. He provides what 'perpendicular height' (*perpendiculaare hoogte*) they determined for several Greek mountains.[181] Amongst others, this includes the mountain Pelion ('now Petras, in Macedonia'), whose height supposedly amounts to 10 stadia. Next to providing the result in this ancient measurement unit, Struyck also gives its size in modern measures: 9/40 German miles, or 6850 Parisian feet. Struyck also uses the Westerkerk's tower in Amsterdam as a reference object to interpret ancient sizes. This allows him to conclude that the 17th-century scholar Riccioli 'is far off the mark if he believes that [the ancients found] mountains on earth of 457 stadia high,' since that would equal 1280 times the height of this church tower.[182] By converting the abstract value to a size that Struyck and his readers can interpret, Struyck can judge Riccioli's statement as absurd. Later in this section Struyck will use other references for similar purposes, such as the earth's radius or the highest pyramid near Cairo.

Struyck then proceeds with a discussion of contemporary methods to determine mountain heights: 'At first sight, measuring the height of the mountains on earth does not appear difficult for a mathematician; but several difficulties arise.'[183] He presents two possible methods and their drawbacks, one based on geometry and another on barometer measurements. The first is the geometrical approach, which is based on angle measurement from the foot of the mountain. However, from afar the earth's slight bend between the observer and the mountain peak will always cause a mountain to seem somewhat higher than it actually is. The method will therefore result in an overestimation. Moreover, an observer conducting the angle measurement faces several practical difficulties, such as finding a suitable plain to observe from.

[179] Dutch: 'De Bergen zyn niet maar by geval ter neergezet ... dit schynt my toe eene waanwysheid; en op deeze wys loopt men gevaar, om uit zyne gedagten uit te wissen, de hooge Eerbied, die men aan 't Opper-Weezen schuldig is.' Struyck, *Inleiding*, 55.
[180] Dutch: '… ik weet niet, hoe dąt Thomas Burnet zulks durft zeggen.' Struyck, 55.
[181] Struyck, 57.
[182] Dutch: 'Ricciolus is ver het spoor byster, als hy meent, dat op de Aarde De en Bergen zyn, die de hoogte hebben van 457 stadien.' Struyck, 57.
[183] Dutch: 'De hoogte van de Bergen, op de Aarde, te meeten, schynt in den eerste opslag, voor een Wiskonstenaar, niet moeielyk; maar verscheide zwaarigheden doen 'er zig in op.' Struyck, 57.

Oever van de Zee. Verſcheide voornaame Wiskonſtenaars, als de Heeren *Halley*, *Caſſini*, *Mariotte*, *Fueillée*, en *Scheuchzer*, hebben Tafels opgemaakt, om door het daalen van de Barometer, of door de hoogte van de zelve, de perpendiculaare hoogte der Bergen, boven de oppervlakte der Zee, te vinden: Ik zal die hier laaten volgen; de duimen en voeten zyn Paryſche maat:

Hoogte van 't Quikzilver in de Barometer.	De hoogte, boven de oppervlakte der Zee, in voeten, volgens					
Duimen.	*Halley*	*1 Caſſini*	*Mariotte*	*Feuillée*	*Scheuchz.*	*2 Caſſini.*
28	0	0	0	0	0	0
27	921	798	771	853	790	780
26	1876	1740	1571	1992	1610	1614
25	2869	2826	2403	3420	2465	2514
24	3902	4056	3266	5136	3356	3492
23	4979	5430	4171	7150	4285	4554
22	6104	6948	5113	9442	5256	5772
21	7282	8610	6100	12022	6264	7038
20	8517	10416	7140	14890	7617	8430
19	9828	12366	—	18046	8454	9972
18	11184	14460	—	21490	9633	11682
17	12631	16698	—	25222	10879	

FIGURE 12: TABLE WITH RATIOS BETWEEN BAROMETER MERCURY HEIGHT BAROMETER AND THE CORRESPONDING MOUNTAIN HEIGHT, AS FOUND BY VARIOUS SCHOLARS. STRUYCK, *INLEIDING*, 58.

A second method based on barometer readings will therefore provide better measurements, according to Struyck. Or rather, he believes that it will develop into a promising strategy in the future. At the present moment the method still has large drawbacks. The main problem is that scholars disagree about the correct ratio between the height of mercury in a barometer and the corresponding mountain height. To find the correct value, Struyck compiled the ratios as proposed by 'several distinguished mathematicians', which he obtained from their writings.[184] He converted all these values into the same unit (i.e. Parisian feet) and presented the resulting ratios in a single table. This table can be found in figure 12 and provides ratios by Edmond Halley (1656 – 1742), Jacques Cassini (1677 – 1756), Edme Mariotte (1620 – 1684), Louis Feuillée (1660 – 1732), and Johann Jakob Scheuchzer (1672 – 1733).[185]

Most of all, Struyck wants to trace the aspects one should take into consideration for determining the appropriate mathematical method for making mountain height measurable in general. Instead of discussing what can be concluded from this table, he continues by asking how these mathematicians could obtain these ratios and what that means for our knowledge of the measurability

[184] Struyck, 58.

[185] Barometers had been used in experimental and empirical investigations since the middle of the 17th century. Its basic identity, as an instrument for various purposes, had been established before the beginning of the 18th century. However, there was no universal agreement that barometers showed the pressure of the air (though there seemed to be a consensus that it had something to do with the weight of the air). See also Golinski, 'Barometers of Enlightenment'.

of mountains in general. He is not so much interested in the knowledge that arises from these particular values, or which of these particular ratios works the 'best'. Instead, Struyck discusses how several scholars proceeded to obtain their results, writing that 'Feuillée's table is based on an observation that he did in Peru, near Lima; there he found the height of a mountain, through geometry, to be 877 Parisian feet; at the top of the mountain the mercury was 26 inch [*duim*], 6 ½ line [*linie*] high, and at the foot of the mountain 27 inch, 5 lines.'[186] In an equal level of detail, Struyck describes the observations that enabled Halley and Scheuchzer to arrive at their ratio.[187] In these discussions Struyck focuses on the values the scholars recorded to have observed and how they calculated with them – not so much on the specific methodological details of their undertakings, or the measurement errors that might have permeated their work. He evaluates the procedure of their mathematical analysis, not the practical measurement undertakings. Struyck believes the latter is only singular, or particular; while the former is general. However, Struyck traces Halley and Scheuchzer's work, but never discusses how the other two scholars arrived at their ratios. Also the difference between Cassini 1 and Cassini 2 remains unclear. He wants to investigate which considerations to take into account, not necessarily to provide a complete overview of all methodological approaches that have been used to obtain the numbers.

Struyck accepts these scholars' observation practices and the values they recorded to have observed without any hesitance. But that does not hold for the values in the table, which result after he converted the ratios to a single unit. Struyck compares and criticizes the different ratios, concluding that: 'it appears to me that he [i.e. Scheuchzer] sets the mountains much too low, and Feuillée much too high.'[188] Struyck could not discover what caused their disagreement but he suggests that the weight of the air might differ per location and that clouds could change the air's condition.

At no point in the section does Struyck hint at a conclusion about what the true ratio between the values would be. He even leaves it in the middle which of the proposed proportions might be the closest, or which one works the most accurately. It is clearly not his objective to end the paragraph with a description of the 'correct' way to use a barometer to determine mountain heights. Instead, analysing the possible mathematical evaluation techniques was valuable by itself. Still, Struyck believes that something like a 'best ratio' exists, and he is hopeful that scholars will come closer to this value in the future. Struyck concludes that 'many more and more accurate observations are required,

---

[186] Dutch: '… de Tafel van Feuillée is gegrond op een Waarneeming, door hem in Peru gedaan, by Lima; daar vond hy de hoogte van een Berg, door de Meetkonſt, 877 Paryſche voeten; op den Top van den Berg was 't Quikzilver hoog, 26 duim, 6 linie, en onder aan den voet van den Berg, 27 duim, 5 linien.' Struyck, *Inleiding*, 58.
[187] Struyck refers to Johann Jakob Scheuchzer as 'Jan Jacob Scheuchzer' in this chapter.
[188] Dutch: '… maar het komt my voor, dat hy de Bergen veel te laag stelt, en Feuillée veel te hoog.' Struyck, *Inleiding*, 59.

De Heer *Scheuchzer* heeft van de volgende Bergen de hoogte bepaald, door het daalen van 't Quikzilver in de Barometer; dog my dunkt, dat dezelve te laag zyn gesteld:

Bergen in Zwitzerland.	Paryſch. voet.	duim.		linie.	
Guppen ob Schwanden, in 't Canton Glariis	3971	23	:	4	(t)
Joch, in 't Landſchap Engelberg . .	5926	21	:	4	
St. Bernards Berg	4365	22	:	11	
De Capucynen, op den Berg van St. Gothard	5255	22	:	0	
Op den Top van den Berg	6264	21	:	0	
Zur Dauben, op de Berg Gemmi . .	6012	21	:	3	
Mullenen, aan de Voet van Gemmi . .	1962	25	:	7	
Stella, in de Schamzer Valley . . .	9585	18	:	1½	

Figure 13: Table with the heights of several Swiss mountains, as found by Scheuchzer. Struyck, 60.

especially of the high mountains in Peru and Chile, before anything certain can be concluded.'[189] He believes that more observations will lead to more comparison material, and therefore to more reliable conclusions.

In the final part of this section, Struyck continues by listing the height of some specific mountains. He obtained the values from the writings of other scholars. These include results on Swiss mountains by Scheuchzer (presented here in figure 13). Again, Struyck remarks that he believes Scheuchzer's method will have resulted in values that are too low. But although Struyck believes the numbers are inaccurate, that does not stop him from reproducing them. In total Struyck presents the height of about 20 mountains that appear to be randomly selected, with data from various sources. The paragraph concludes with several arguments for the variability of mountain height over time, which are mainly based on (eyewitness) accounts of collapsing mountains.

Overall, Struyck's discussion of mountain heights was primarily about the question: how to measure a mountain? He discussed possible strategies to determine this height. The essay is primarily about the question of how appropriate quantification could proceed. He sought a general method that was applicable to all mountains. Struyck evaluated two strategies in detail and assessed their drawbacks. Most of all, he pinpointed to what he believed was the most effective method (barometer readings) and what would be required to develop this method even further (namely, determining the true ratio between mercury and mountain height). He compiled and enlisted the ratios that had been proposed in the literature and (incompletely) elaborates how these came about. The summit of the discussion is the table in figure 12, which provides the different ratios in one single measurement unit. Since Struyck is now able to compare the proposed values, he can judge and criticize them. Although

[189] Dutch: '… dog veel meer, en nog netter Waarneemingen worden vereischt, en wel voornaamentlyk van de hooge Bergen in Peru en Chili, eer dat men iets zekers hier uit kan besluiten.' Struyck, 59.

he does not pick the true or best ratio, he appears hopeful: Struyck believed such a true ratio exists and can be discovered by increasing the number and accuracy of observations. Overall, we can thus summarize Struyck's strategy as follows. He first compiled data obtained by other scholars. Then, he converted their numbers to some common standard and unit system, creating an overview by putting all data next to each other in a table. With this overview he was now able to compare these values. Finally, based on this comparison he then criticized the numbers that seemed implausible. He was less concerned with which numerical result would be the best (since the data and thus the result is variable) than he was with explaining how the current knowledge came about. That held for the procedure through which the data had been translated into this result, for which he indicated how an appropriate mathematical analysis would proceed, but it also held for the reconstruction of what ancient scholars had already known and how our knowledge had developed since then.

2.2 The size of the earth

Let us now move away from mountains and turn to a second case. Among the essays that comprise the second part of the *Inleiding,* Struyck included a piece named *Treatise of the size of the earth, as it has been found by the old and contemporary*.[190] While the previous case was valuable because it provided a prototypical example of Struyck's general approach to geographical subjects, this case is worthy of elaboration for other reasons. It describes a problem that Struyck identified as crucial for all his geographical writing, and the solution he proposed to solve this problem. Consequently, Struyck required the essay as an indispensable piece of his reasoning in many of the chapters. Of the nine essays attached at the end of the *Inleiding*, this is the one Struyck refers to the most, the first time no later than on page 4.

The 15-page essay on the size of the earth discusses older and more recent estimates, including how these values have been obtained and how accurate they are. But more than determining the earth's actual dimensions, the essay is primarily concerned with the methodological approaches to measure the earth as proposed throughout the ages. Struyck introduced the essay in the preface as: 'The following treatise leads us to the knowledge *of the old measures*.'[191] To create this wide-ranging overview, Struyck had to compare and assess measurements in multiple unit systems (both ancient and modern). He realized that if he wanted to compare multiple observations, these need to be in the same unit.

Appropriate unit conversion was a core problem for Struyck's mathematical conception of geographical descriptions. As we have seen in the previous section, combining material from various

[190] Dutch: 'Verhandeling van de Grootte der Aarde, Zoo als die door de Oude en Hedendaagse gevonden is.' Struyck, 53 (part II).
[191] Dutch: 'De volgende Verhandeling leid ons op tot de kennis *van de Oude Maaten*.' Struyck, voorreden.

sources is part of Struyck's standard approach to geographical subjects. But it was also a difficult problem, because the unit use of his time was extremely unstructured. Struyck resented the confusing variety of different measurement units and their unsystematised use. He writes, frustratedly: 'I do not think that anyone ever determined the true size of the geometrical foot.'[192] Moreover, his fellow geographers apparently used various units interchangeably, 'so that this causes great confusion.'[193] Struyck stressed that this held for modern and ancient measures alike, so that units failed to create 'a representation of how large or vast something is, in relation to another determined quantity.'[194] It is an unusually early plea for unit systematics. Most similar expressions mainly occurred later in the 18th century, and actual steps to collaboratively deal with the issue were undertaken only towards the end of this century.[195]

Like in the chapter on mountains, Struyck began this essay by reciting what ancient scholars thought about this topic. But to be able to interpret these correctly, one should be able to compare their foreign values to known ones. Struyck wrote that 'the greatest difficulty for determining the size of the earth … is to unravel from these writers what length the measures were in previous times, compared to any of those we know today.'[196] The strategy that Struyck proposed to solve this issue is the following. He took a common length known and then compares its ancient measurement to its modern value. But then, which magnitude should he take? Since distances between cities were likely to have changed, these did not suffice. Struyck instead agreed on the side length of 'the largest pyramid', which is 'currently still seen near Cairo.'[197] But even now this promising magnitude is set, there are still some more hurdles.

First, Struyck needed an accurate modern measurement for the pyramid's sides. The 'renowned traveller' (though no mathematician) Jean de Thévenot claimed this length to be 682 Parisian feet in 1664. However, Struyck argued that since then the standard length of the Parisian foot has changed in the meantime, so this would now equal 686 Parisian feet. How exactly Thévenot obtained his value is unclear, but Struyck subsequently compared it with a second value provided by the English mathematician John Greaves, 'who to accurately measure the sides of the pyramids

---

[192] Dutch: '… dog ik vind niet dat iemand ooit de waare grootte van de Geometrische voet bepaald heeft.' Struyck, 4.
[193] Dutch: '… zoo dat hier een groote verwarring is.' Struyck, 4.
[194] Dutch: 'Om een verbeelding te maaken, hoe groot of uitgestrekt iets is, ten opzigt van een andere bepaalde grootheid, zoo gebruikt men Maaten.' Struyck, 4.
[195] Heilbron, 'The Measure of Enlightenment'. For reference, only in 1792, the French astronomers Jean-Baptiste-Joseph Delambre and Pierre-François-André Mechain undertook an attempt to produce a standard meter for the Académie des Sciences. Withers, *Placing the Enlightenment*, 120.
[196] Dutch: 'De grootste zwaartigheid, om de Grootte der Aarde, volgens 't gevoelen der Ouden, te bepalen, is, om uit de Schryvers te ontwarren, hoe lang dat de Maaten in voorige tyden geweest zyn, in vergelyking van een der hedendaagse, die bekend is …' Struyck, *Inleiding*, 53 (part II).
[197] Dutch: '… dat ieder zyde van de grootste Pyramide, die nog tegenwoordig by *Cairo* gezien word, de lengte had van 800 voeten, of 1½ Stadie, dat is net een Stadie van *Babylon*.' Struyck, 53 (part II).

through triangles, using an excellent tool … in the same way that mathematicians measure inaccessible distances.'[198] Greaves also found a length of 686 Parisian feet. A third measurement is provided by Jean Mathieu de Chazelles using a measuring cord. De Chazelles arrived at a different length, namely 690 Parisian feet. According to Struyck, De Chazelles believed 'some should be subtracted to find the real length,' but it is unclear how much exactly. In the end, Struyck subtracted 5 feet and concludes that the pyramid side's length can be set at 685 Parisian feet.[199]

Struyck might not have employed the most thorough methods to arrive at this outcome. It seems unfounded to subtract 5 feet. When Struyck would have subtracted only 4, all sources would agree (especially since he indicated that the exact value that should be subtracted was unknown anyway). But regardless of how thoroughly Struyck determined the value, he could now continue with his calculation. He equaled the length of 685 Parisian feet to Herodotus' ancient value of '800 Herodotian feet.'[200] The Herodotian foot was his principal ancient measure, because its ratio to many ancient measures was already known. Through this intermediate step Struyck could therefore compare the pyramid's side in modern Parisian feet to various other ancient measurement units. However, unlike the (more or less) critical analysis of three modern measuring attempts as presented in the previous paragraph, Struyck did not question how Herodotus arrived at his estimate. He is not even suspicious of the roundness of the number. The whole of Struyck's subsequent reasoning rests on this one measurement by Herodotus, but he accepted it unproblematically.

Struyck continued by presenting an overview of the resulting conversions between different ancient measurement units. This is largely a chronologically ordered textual examination where two different units are compared using ratios (e.g. 'the old foot of *Rhodus* is to the foot of *Herodotus* as 7 to 8 …').[201] To maintain the overview between these multiple ratios, Struyck described their proportion in abstract 'parts' ('*deelen*') starting by equalling 1 Parisian foot to 1440 of these parts.[202] From these parts, it becomes clear that Struyck was often sloppy in his exactness: the aforementioned 7:8 ratio later turns out to be 1079:1233, which is very close but not equal.[203] The resulting unit conversion

[198]Dutch: 'De Engelsche Wiskonstenaar *Greaves,* die naukeurig [sic], door driehoeken, de zyden van de Pyramiden gemeeten heeft, met een uitsteekend werkuig … op die wys als de Wiskonstenaars de ongenaakbaare afstanden bepaalen.' Struyck, 54 (part II).
[199] His complete reasoning is as follows: 'Mr. Chazelles measured the sides [of the pyramid] with a rope on an uneven ground which was somewhat higher in the middle, and set the value at 690 Parisian feet, of which he said that something should be taken away to have the true length; now, if we take away 5 feet, so one finds ... 685 of these present Parisian feet.' Dutch: 'Mr. Chazelles heeft met een koord de zyden gemeeten, en vond die op een oneffen grond, die in 't midden wat hooger was, 690 Parysche voeten, waar van hy zeid, dat iets afgenomen moet worden, om de waare lengte te hebben; neemen wy nu 5 voeten daar af, zoo vind men ... 685 van deeze tegenwoordige Parysche voeten.' Struyck, 54 (part II).
[200] Struyck, 55.
[201] Struyck, 57 (part II).
[202] The number 1440 appears to have been chosen at random but might just be the easiest to calculate with.
[203] To give an indication of the difference between these ratios: the fractions 7/8 and 1079/1233 differ only in the fouth decimal. Struyck, *Inleiding*, 58 (part II).

58 *Verhandeling van de*

	Deelen.		Egipt. voet.
De Egiptische, de Babylonische Konings voet van *Samos*	1644	— — — —	600
De Persiaansche voet, die van *Drusus* en *Almamon* —	1479⅓	— — — —	540
De Siciliaansche, daar *Diodor*. de Pyr. mede beschryft (*k*)	1409	— — — —	
De oude Griekse van *Hercules* — — —	1370	De lengte van de Stadie van 600 voeten.	500
De Griekse van *Herodotus* — — —	1233		450
De oude voet van *Rhodus* — — — —	1079	— — — —	
Die van *Archimedes* en *Albategnius*, of de Roomse palm	986⅔	— — — —	360
De Griekse van *Xenophon*, van *Delphos*, en van *Aristoteles*	739⅓	— — — —	270
De Roomse voet — — — —	1315	een Stadie van 625 voet is	500

FIGURE 14: TABLE WITH RATIOS BETWEEN VARIOUS ANCIENT MEASURING UNITS. STRUYCK, 58 (PART II).

ratios were not only presented in text, but also in a schematical overview that can be found in figure 14. In the table Struyck presented the ratios in the earlier mentioned 'parts' as well as in Egyptian feet. Note that these two values presented a similar but not exactly equal ratio, as can be seen by comparing the different rows (e.g., for the top two rows, 1644:600 does not equal 1479 1/3: 540).

Having worked out the conversion rates between ancient and modern units, Struyck continued by listing several ancient estimates of the earth's size (next to, strangely enough, the size of France and Babylon). According to Struyck, 'one can see that all the foremost astronomers and geologists of old times are sufficiently consistent and that they calculated the circumference of the earth to be ... 7096 1/2 Dutch miles.'[204] Struyck defended their methods:

> 'The accusation against the great men of ancient times, that they have estimated the earth's size in an uncommonly crude way, is due to expire at once, and one should acknowledge that they have had a better idea than one previously thought.' [205]

In the final part of the essay Struyck dedicated only one brief paragraph to 'the contemporary method to determine the size of the earth,' in which he briefly describes the triangulation efforts of Willebrord Snellius, Petrus van Musschenbroek, and Jean Picard.[206] These three scholars set the circumference of the earth at respectively 6840, 7083 1/3, and 7098 Dutch miles. Struyck could compare the three values because he had converted them into the same unit (obtaining them from the original source in various other units). He did not mention which of these three estimates is the best. Instead of determining a true or most accurate modern estimate, Struyck focused on the methods and calculations required to obtain these values. He ended the essay with the following conclusion:

[204] Struyck, 65 (part II).
[205]Dutch: ''t Verwyt tegens die groote Mannen van den Ouden Tyd, als of zy op een ongemeene ruwe wys de Grootte van de Aarde opgeeven, komt dan t'eenemaal te vervallen, en ment moet bekennen, dat zy een beter denkbeeld daar van gehad hebben, als men tot nog toe gemeend heeft.' Struyck, 65-6 (part II).
[206] Struyck, 66-7 (part II).

> ‘So in the end one can see, and who would ever have thought it, that by present-day measurements the earth’s circumference is found to be only 1 1/2 Dutch miles larger than the ancient Egyptians determined, which is only 1/4732 of the entire circumference.’[207]

In other words, the main conclusion Struyck drew from the essay is that current measurements of the size of the earth show that ancient scholars also already provided remarkably reliable estimates.

Let me briefly summarize the findings of this paragraph. Struyck wrote this essay to discuss the size of the earth. But this ‘size of the earth’ was more than a numerical value for the globe’s dimensions. Instead, Struyck used the essay to investigate ‘the various sizes that were used across the earth.’ He intended to equate the unit systems of different times and different places, so that he would also be able to equate observations from these different times and places. Moreover, he created an overview of unit conversions that was relevant for many subjects throughout the *Inleiding.* He had to deal with the variability of units time and again throughout the book’s chapters, so by transferring this problem to an essay at the back of the book, he could outsource one step of his reasoning. It saved him the repetitive discussion of this important step in his reasonings. That he so often referred to this essay is therefore not surprising. Next to dealing with a crucial step in Struyck’s reasoning, the essay is also interesting for its geographical content, the size of the earth. When we look at how Struyck tries to find a strategy to determine the dimensions of the globe, we recognize that he follows largely the same structure as for mountain heights. He compiled, converted and compared numbers to determine which values he considered plausible (and to criticise those he did not). In both cases, he is looking for a way to measure the subject under discussion. To Struyck, geography is about the question: how to measure the earth? He wanted to find a general mathematical method that could transform observations into a numerical result. Moreover, he described how the present knowledge related to that of ancient times. In both these ways he was investigating how our geographical knowledge had developed. After these two examples about mountains and the earth’s size, in the next paragraph I will trace Struyck’s general way of discussing geographical topics and introduce this characteristic procedure as Struyck’s ‘quantitative method’.

2.3 Struyck’s quantitative method step by step

As I have already suggested, Struyck proceeded along similar lines in both the essay on the size of the earth and the chapter on mountains, and in fact does so throughout the whole *Inleiding*. The examples demonstrate the procedure he employed for transforming the empirical observations, which he had

[207] Dutch: ‘Dus ziet men eindelyk, en wie zou zulks ooit gedagt hebben, dat door de hedendaagse afmeetingen, de Aarde maar 1 1/2 Hollandsche myl in den omtrek grooter gevonden word, als de oude Egiptenaaren die bepaald hebben, 't welk maar 1/4732 van den geheelen omtrek verscheelt.‘ Struyck, 67 (part II).

gained access to through other scholars' writings, into geographical knowledge claims. This inquisitive process is what I call Struyck's 'quantitative method.'

The overlap between the two presented cases points us to the most important parts of Struyck's general approach. He approached any geographical problem by investigating the ways it could be measured and saw geographical knowledge as the result of the subsequent quantitative comparison. The crux to determining whether geographical measurements made sense, according to Struyck, was to verify how much these agreed with similar, comparable, results. Struyck therefore started by compiling all sorts of sources, combining ancient and modern data. He converted the obtained values into one shared unit or ratio, so that he could get in a position to compare the different outcomes. Through calculations or some other type of mathematical reasoning he then verified how much the data made sense. As we have seen in the previous paragraphs, he put the data in tables or else created some other kind of overview (recall figures 12 and 14). From there he would evaluate the different options and determine the desired result. The comparison allowed him to judge which values he considered plausible. He believed he could judge data by looking at their coherence and comparability. In some places he even says so quite explicitly: 'If one compares this history with the other comet writers [sic] that have been printed so far, one will be able to see which one best to rely on.'[208] Still Struyck was often not necessarily after a specific numerical outcome. Instead of picking one best result, he critically analysed all values through some sort of source criticism, or rather, data criticism. In his data criticism Struyck indicated which observations he considered reliable and which he did not. He preferred to focus on examining this mathematical method of analysis rather than indicating which value was the best outcome of this analysis. To summarize it very bluntly: compiling, converting, and comparing allowed him to evaluate the data, after which he posed his data criticism.

Quantification, to Struyck, thus was the process of gaining access to data sources that could then be translated into meaningful numbers. It was a systematic procedure for creating geographical knowledge; a mathematical method to equate and judge data. In this sense, Struyck's quantitative method was a transformative process for handling data and reshaping it into knowledge, not one that created data by itself. Struyck conducted little observations himself but had gained access to large amounts of written sources of both ancient and more recent times. At the same time, the method was based on the idea that empirical experience constitutes the basis for our understanding of the world – only Struyck was not the one who saw it for himself. So, to come back to our research question, Struyck's quantitative method was intended to transform empirical observations into meaningful numbers. But these were observations others had conducted, and that he now transformed into

[208] Dutch: 'Indien men deeze Historie met de andere Comeet schryvers, die tot nu toe gedrukt zyn, vergelykt, dan zal men kunnen zien waar dat men 't best staat op kan maaken.' Struyck, 166 (part II).

meaningful geography. Discussing how Struyck quantified empirical observations, then, is to discuss how Struyck processed the observations that had been conducted by other scholars.

Very generally this processing followed the strategy as I have just described. However, I want to provide some more nuances to the method. To start with, I want to point out that the conversion often entailed a more fundamental shift than equating only the data's units. As we have seen in the previous examples, Struyck was concerned with the careful comparison between different data sources, but omitted a critical take on which values he adopted as input for this comparison. He rarely questioned whether these had been obtained through reliable measurement methods in the first place. Instead, he just replicated the values of earlier scholars unhesitantly and uncritically. However, sometimes such methodological reflections were unavoidable. The wide-ranging source data expressed large varieties, especially when it concerned both ancient and contemporary sources. That became problematic when two scholars might have attempted to measure the same thing, but measured two incomparable concepts in practice. The concept that represented the distance between the earth and the moon, for example, was neither evident nor did it have one shared conception over the ages (this distance is a particularly effective example, so it will come back throughout this and the next paragraphs). While scholars in Struyck's time determined the distance between the two spherical centres, the ancient scholar Posidonius looked at 'how high the moon was above the region of the clouds.'[209] To use and compare both types of data, Struyck thus had to verify what method Posidonius had used by closely looking at his text. Frequently, the variety among Struyck's source data thus concerned a more fundamental conceptual issue than 'only' that of confusing unit systems.

Secondly, this processing of the data sometimes also required more mathematical methods than only an arithmetical conversion. To return to the previously mentioned distance between the earth and the sun, Struyck there combined arithmetical with geometrical reasoning. He wanted to show how contemporary astronomers had been able to conclude that the sun is 'far away from the earth,' namely, 20626 ½ times the earth's radius, which 'shows clear enough from the observations of all astronomers.'[210] Despite using this word choice, he seemed aware that no astronomer had actually 'observed' this value, but that it was already the result of some previous processing. Struyck defined various angles and made a sketch, providing a geometric argument to show his readers how the provided value arose from performing a sequence of calculations (figure 15). The desired distance was half of the longest diameter of the ellipse that the earth moves around the sun, so in figure 15 that is

[209] Dutch: 'Possidonius stelde de Maan boven 't gewest der Wolken, twee millioenen Roomsche stadien.' Struyck, 24.

[210] Dutch: 'Dat de Zon ver van de Aarde is, blykt genoeg uit de Waarneemingen van alle Sterrekundigen.' Struyck, 6.

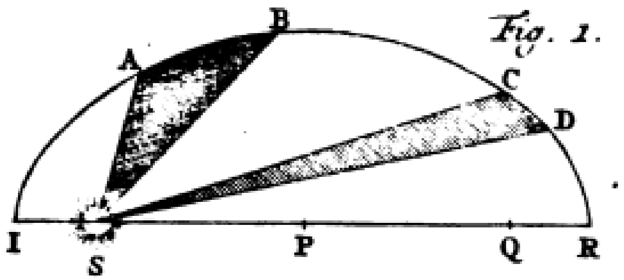


FIGURE 15: THE DIAGRAM THAT STRUYCK USED FOR DETERMINING THE DISTANCE BETWEEN THE SUN AND THE EARTH. IN THE FIGURE, A, B, C, D ARE THE (MOVING) EARTH AND S IS THE SUN. STRUYCK, AFBEELD. II (BETWEEN P. 16 AND 17).

half of IR.[211] This reasoning did not comprise a rigorous proof, but served to prepare the data so that he could successfully compare it later.

Not only the converting process can be nuanced, but also Struyck's data criticism, because it was not always fully based on the data comparison only. Struyck always took the recipient of the data criticism into account. Commenting on the ratios for mountain height, he corrected Scheuchzer and Feuillée but remained silent about Cassini and Halley. Concerning Edmond Halley we see this reluctance more often, like in Struyck's discussion on some of Halley's calculations on comet paths.[212] The excerpt is one of the scarce cases where Struyck provides a highly detailed account of the calculations he undertook to verify Halley's results. In most other cases he only outlines the bigger picture of his calculations, like when he checked how Thévenot, Greaves and De Chazelles obtained the pyramid side length. Struyck must have meticulously checked all Halley's steps. He works his own way through Halley's observations, 'calculating according to his numbers' but not following Halley's way of calculating.[213] Nevertheless Struyck does still not arrive at completely the same results that Halley obtained. But instead of criticizing him, Struyck tries to account for the difference. He writes that 'if neither of us has conducted miscalculations, the difference will probably arise from the fact that the two of us did not use the same tables.'[214] Struyck admired Halley and did not want to doubt his work when there could also be other explanations.[215] To other scholars, Struyck is not always so forgiving. Just like Halley, Johannes Hevelius also studied comet paths. He described five comets, which Struyck equally (in his own words) 'put to the test.'[216] Struyck recalculated Hevelius' values and

[211] Struyck, 14.
[212] Struyck, 178.
[213] Dutch: 'Volgens zyn getallen reeken ik …' Struyck, 178.
[214] Dutch: '... en zoo 't geen reekenfouten in een van beide zyn dan zal dit verschil waarschynelyk voortkomen, dat wy beide de zelfde Tafels niet gebruikt hebben.' Struyck, 178.
[215] Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*, 109.
[216] Dutch: '*Johannes Hevelius*, heeft … niet meer als van vyf Comeeten kunnen vinden de Maanden, in welke dezelve te zien waren; maar als men die ter toets brengt, dan vind men, dat maar van één de Maand bekend is, … de andere vier moet men verwerpen.' Struyck, *Inleiding*, voorreden.

concluded that four of the five comet observations should be outright rejected. No caveats for miscalculations or contrasting tables here. Although Struyck employed his quantitative method because the data comparison enabled him to pose data criticism, he did not only base his critical comments on the numbers but also took the criticism's recipient into account.

2.4 (Re)construct knowledge

Struyck's quantitative method was a way to obtain and justify general geographical knowledge, the goal of the *Inleiding*. But the book was not just a collection of the most accurate measurements about the world, and Struyck did not want to provide only the most accurate or current knowledge. Rather, Struyck used his quantitative method to explain how this knowledge had been acquired and developed. In one guise we have already encountered this focus in the previous paragraph, since in his quantitative method Struyck focused on the required mathematical analysis and data criticism instead of pointing to a definite outcome or 'best estimate'. He focused on the strategy to obtain and justify geographical knowledge, emphasizing the process rather than the outcome. In this paragraph, I will take this point further. I will argue that Struyck's quantitative method enabled him to put the contributions of different times and places on par, which he used to reconstruct knowledge development from ancient to his own time. Overall, we should thus not see the *Inleiding* as a book about our world, but about what we know and have known of that world.

In the previous paragraphs we have already seen that Struyck made good use of a wide range of sources. He regarded his study of the earth as a continuation of a long-standing tradition that started with the most eminent Greek philosophers and stretched to contemporary scholars – and even beyond. Throughout the *Inleiding*, Struyck often referred to men like Pliny, Posidonius, Johannes Hevelius, and Newton within a single paragraph.[217] He took all these predecessors seriously regardless of how long ago they had obtained their results, and he considered all their observations worthy of comparison with each other. Through his quantitative method he indeed could look at their results in similar ways by converting their numerical data into comparable values. This way of equating sources would not have been possible in descriptive geographies, like those in the style of Hübner. The generality of quantification enabled Struyck to compare ancient data with contemporary results in a way that would otherwise not have been possible.

However, the *Inleiding* relied on ancient accounts in more ways than only making use of their data. The historical observations served as a source, but Struyck combined his own calculations with a philological reconstruction of the geographical knowledge of ancient times. When discussing mountain height, Struyck started by presenting the results that the ancient Greeks obtained. From there he

[217] Struyck, 24.

moved on to modern scholars. In the essay on the size of the earth, the central place for ancient results was even more apparent. The main purpose of the essay was to reconstruct classical knowledge. In the *Inleiding* Struyck usually began his geographical discussions by summing up the knowledge and estimates that were around in ancient times. Only after treating its classical conception, he would also introduce contemporary estimates. An antiquarian conception thus formed the principal understanding of an issue, and from there Struyck investigated how scholars arrived at their modern viewpoint. Let us return to our recurring example of the moon's distance and size, now accepting that it is measured as the distance between the earth and the moon's centres. Struyck began his discussion by noting that Posidonius estimated this at 51096 German miles, as we know through Pliny.[218] Struyck then mentioned that this is reasonably close to the contemporary observations, which the most eminent astronomers have set at 51380 German miles – referring to calculations in Newton's *Prinicipia*, Hevelius' *Tabula Selenographica in qua Lunarium*, and David Gregory's *Astronomiae physicae et geometricae elementa*.[219] Struyck primarily used the modern result to assess and praise the accuracy of the historical estimate, though he also rendered it obsolete. But the modern result's primary use thus was to enable the evaluation of the ancient value – Struyck did not so much value for what it told us about the world. Still, it is clear he considered contemporary knowledge as superior to ancient knowledge. Since then our knowledge had progressed. We have seen this too in paragraph 2.2, where Struyck ended the essay on the size of the earth similarly: modern measurements by Snellius and others took up only a minor part of the essay and were primarily meant to establish the accuracy and competence of the ancient measurement, not so much relevant for their own sake.

One reason for reconstructing ancient knowledge and including obsolete classical observations might be because the old and new results granted authority to each other. Classical scholars still possessed authority in eighteenth-century geography, and a long scholarly tradition indicated that a subject was worthy of study.[220] Newton, Hevelius and Gregory's results thus became more relevant, since they continued to advance our knowledge of issues that had been studied for centuries. At the same time, Posidonius' results are only considered relevant and judged against the background of these modern estimates. Struyck judged his efforts to be of such remarkably high quality only because his values approached Newton and Gregory's modern contributions. Struyck's use of the old and the new mutually enhanced each other.

Like the developments from the past to the present, Struyck also stretched these to the future. He frequently indicated how geographical insights would continue to advance, like the ratios of

[218] Struyck, 24.
[219] Dutch: '*Posidonius* stelde de Maan, boven het gewest der wolken, twee millioenen Roomsche stadien … dat is 50000 Duitsche mylen.' Struyck, 24–25.
[220] Unwin, *The Place of Geography*, 70.

mountain height. He believed these would only improve with future measurements. Moreover, the current uncertainty in measurements now was no reason for Struyck to exclude them. We see this, for example, in his discussion of the number of stars in the universe. He wrote: 'Concerning the distance between fixed stars, which one cannot know with any certainty up to now; the way of the earth around the sun is too small to make a noticeable difference in view. The eminent mathematician Christiaan Huygens determined through assumptions, of which one likewise cannot be sure, that the star Syrius … is 27663 times as far from the sun than the earth.'[221] Struyck pointed the value's uncertainty out, but it did not stop him from printing it. One only arrives at knowledge in stages, as he argued.[222] The improvement of observations, and therefore of our numerical estimates, will also continue to develop in the future. Struyck was hopeful that more and better measurements would continue to improve our understanding: 'The number of fixed stars is impossible to determine; the longer one's used telescope, the larger the number he will find.'[223] He was convinced that knowledge could and would progress in the future, just like it had in the past. To Struyck, the scholarly efforts of different times could be seen as a continuation that build on earlier knowledge.

In conclusion, Struyck thus believed knowledge could change and, in particular, that it progressed. His quantitative method allowed him to connect and synthesise sources of various times and places. Through quantitative comparison he could draw a line from ancient observations to contemporary measurements and to the observations of the future. We have seen that modern results often served to judge the accuracy of ancient estimates, and that the old and the new mutually grant authority to each other. Struyck believed that we gain more insights through critical evaluation and data criticism. Although the mathematical analysis method remains fixed, more and better observations will improve the accuracy of the result, according to Struyck. I have argued that the *Inleiding* was not intended as a collection of the most accurate measurements about the world, and that Struyck did not want to provide only the most accurate or current knowledge. Instead he wished to explain how this knowledge had been acquired and developed. Any overview of now accurate results will inevitably become obsolete, because current observations would be replaced with better ones in the future. In that sense it is not surprising that he focused on the quantitative methods of evaluation that would remain constant.

---

[221] Dutch: 'Wat de afstand van de Vaste Sterren aangaat, die kan men tot nog toe met geene zekerheid weeten; de weg van de Aarde om de Zon is te klein, om een merkelyk verschilzigt te maaken. De voortreffelyke WIskonstenaar, *Christiaan Huigens*, besloot door onderstellingen, daar men evenwel niet zeker op kan gaan, dat de Ster Syrius … 27664 maal verder van de Zon is, dan de Aarde.' Struyck, *Inleiding*, 5.
[222] Dutch: '… men komt maar in trappen tot de weetenschap.' Struyck, 166 (part II).
[223] Dutch: 'De menigte van de Vaste Sterren is onmogelyk te bepaalen; hoe langer Verrekykers dat men gebruikt, hoe grooter getal dat men ontdekt …' Struyck, 5.

2.5 Conclusions

In the previous paragraphs I have outlined Struyck's quantitative method in the study of geography. The first part of our research question, which asked how Struyck quantified empirical observation, is thus answered: through his quantitative method. Through this systematic inquisitive process, Struyck attempted to capture the world in numbers and investigated how appropriate quantification would proceed. His approach is a transformative process to discover generalities, translating source data into geographical knowledge. Struyck believed observations and experience were an indispensable basis for this understanding, but he sought universal knowledge instead of singular findings. He began by compiling his fellow scholars' empirical data as well as collecting the values that had been described in ancient literary accounts. He converted the data so that he would be able to compare it. Then he investigated how much the data agreed and weighed the different values against each other. Through this evaluation Struyck could attain truly general knowledge about the world that rose above the singularity of mere observations. To him, geographical knowledge was thus the result of quantitative comparison. Reasoning as well as observation and experience took up a central role in his geography, though he combined his own revisions and improvements with readily established geographical writing. Overall, he developed a systematic way of evaluating data and transforming it into geographical knowledge.

The chapter on mountains and mountain height is exemplary of how Struyck addressed geographical topics in the *Inleiding*. He was largely concerned with the question of how to measure a mountain and he investigated possible strategies. By converting various ratios between barometer mercury height and mountain height into one single unit system, he was able to compare and judge these proposals. He did not pick which of these ratios was the best but believed these would continue to improve in the future. He primarily wanted to show his readers how our current knowledge had come about and how a methodological, mathematical assessment of these (future) values ought to proceed. In the second paragraph, we have seen that Struyck searched for a similar quantitative evaluation method to measure the earth. But more than investigating the earth's dimensions, the essay was important because it explained how one could convert ancient measures into modern ones. This was a central part of Struyck's reasoning throughout the whole book since his quantitative method was principally based on comparing sources from different times and places. Finding the right mathematical calculations so that this widely varying data could be equated was one of Struyck's primary concerns.

Struyck appears to have seen quantification primarily as a way to attain the 'general knowledge of the world' he desired. The process led to universal knowledge in two aspects. First, the quantitative method was a way to rise above the particularity of singular observations. It could generalize the empirical experiences of different observers. Secondly, it was a way to also connect these empirical observations with a philological study of classical sources. These different sources were not so different for Struyck, to whom all empirical data was presented in written form. In the final paragraph I have argued that Struyck used this general knowledge not to describe our world, but to describe what we know and have known of that world. Struyck was interested in how knowledge developed. This shows in his quantitative method, which is primarily a strategy to obtain and justify (i.e., develop) geographical knowledge. Moreover, the method relies on the comparison of ancient and modern data and presents ancient estimates next to contemporary ones. But Struyck did not only use ancient data, he also reconstructed the classical understandings of these scholars. He believed that our geographical insights had progressed from the past and would continue to improve in the future. Struyck did therefore not so much point to the most accurate, current measurements of the earth, but demonstrated how our knowledge had come about. Since observations would be replaced anyway, it made much more sense to focus on the fixed mathematical evaluation strategy thereof.

In this chapter I have demonstrated Struyck's approach toward geography, but restricted the discussion to those subjects that unquestionably belong to general geography. I have introduced this approach as Struyck's 'quantitative method,' with which I referred to his general investigative practice based on compiling and comparing other scholars' data. In the next chapter, I will show that this method was not restricted to terrestrial geography only, but that he approached heavenly and civil phenomena in much the same way.

Chapter 3: Civil and heavenly geography

The previous two chapters have focused on those parts of Struyck's work that have not been studied by modern historians. It concerned the earthly phenomena of the terrestrial world, like mountains; topics we still see as 'typically geographical' in our present times. However, in the *Inleiding* Struyck did not only write about the terrestrial world. His definition of geography also mentioned 'the celestial appearances that are related to it,' as we have seen in chapter 1. And, as we will see in this chapter, he likewise considered descriptions of the civil world to be part of the scope of geography. Apart from terrestrial geography Struyck's geography thus also contained a heavenly and civil component. As we will see later, these cannot simply be seen as standard subfields of geography. At the same time, the topics concern the two parts of Struyck's work that have been relatively well-researched, though in the guise of astronomy and population statistics. They are usually presented separate from each other, two fields that were connected mainly by the scholar performing it. Still, these are considered to have yielded Struyck's most successful scholarly contributions. In this chapter I will connect these rather isolated islands of historical literature to each other as well as to my present research. The chapter thus relies on and engages with work by Pearson, Stamhuis, Hald, Zuidervaart and others.[224] I will demonstrate that Struyck's terrestrial, civil, and heavenly geography are closely connected and that his quantitative method equally applied to all these fields of inquiry. A full investigation of how Struyck quantified empirical observations, which is the first part of our research question, should therefore also analyse his approach to these non-terrestrial aspects of geography. Finally, I argue that studying Struyck's geography and the corresponding quantitative method is therefore indispensable for a comprehensive understanding of Struyck as a scholar.

The first paragraph introduces Struyck's chapter about the division of the earth. He regarded a division by landmass as just as significant as a division 'by government'. He argued that the content of both could be measured alike, whether this regards numbers of the relative size of a place by area or population. Struyck thus studied 'the civil' in the same way he studied 'the terrestrial. I will argue that contrary to the common conception, he considered population statistics (or 'political arithmetic') an inherent part of geography (despite not explicitly including civil geography in his definition of geography). With that established, I will then introduce how Struyck approached this civil geography in more detail. I will demonstrate that here, too, he followed his quantitative method to evaluate and justify his conclusions. The same goes for his heavenly geography and astronomical calculations, which

[224] Hogendijk, 'Lijfrentes in de zeventiende en achttiende eeuw'; Stamhuis, 'Levensverzekeringen 1500-1800'; Pearson, *The History of Statistics in the 17th and 18th Centuries*; Hald, *A History of Probability and Statistics and Their Applications before 1750*; Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data'; Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*.

are the topic of the third paragraph. Astronomy was commonly regarded as a discipline distinct from geography, though closely tied to it, especially in general geography. Varenius similarly adopted astronomy as part of geography, as we have seen in chapter one. In the end, it even seems reasonable to assume that practices that were already established in astronomy informed Struyck's quantitative method in its broader conception. However, before we get to that, we should get our feet back on the ground and look at Struyck's division of the earth.

3.1 The civil like the terrestrial: Struyck's *Division of the earth*

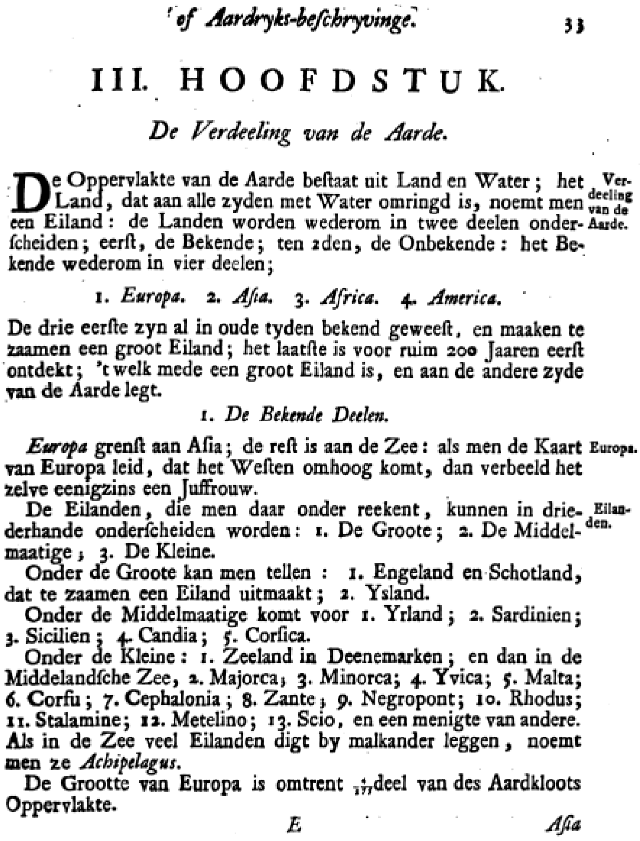
A full understanding of the world did not only concern the earth's mountains and waters, but also the plants, animals and humans that could be encountered on it, according to Struyck.[225] This paragraph will demonstrate that Struyck studied civil geography similar to how he studied terrestrial geography: through numbers. It will investigate the third chapter of the *Inleiding* on 'divisions of the earth', in which the terrestrial and civil aspects of geography come together.[226]

In all divisions of the earth, the first step is to split between water and land, says Struyck. That meant he could save all topics related to water for chapter 9 (titled *On water*), and fully focus on the distribution of the earth's land in the present chapter. Struyck described two approaches to do so. The first of these was a division of the earth by landmass, the second a division based on civil organisation.

He began the chapter by describing the division by landmass (see also figure 16). Roughly the divide comes down to:

- The known parts:
    - Europe,
    - Asia,
    - Africa,
    - America.
- The unknown parts:
    - The Arctic countries,
    - The Southland.

[225] Although Struyck spends about 10 lines on plants in the two-page chapter *On the forests, marshes, deserts, and plants.* He is somewhat more interested in animals. The chapter *On animals* takes up 7 pages, but almost exclusively deals with insects (not surprisingly, since he was a passionate hobby entomologist, as has also been described in the introduction). Struyck, *Inleiding*, 85–86, 87–94.
[226] Struyck, 53.


of Aardryks-beſchryvinge. 33

III. HOOFDSTUK.

De Verdeeling van de Aarde.

De Oppervlakte van de Aarde beſtaat uit Land en Water; het Land, dat aan alle zyden met Water omringd is, noemt men een Eiland: de Landen worden wederom in twee deelen onderſcheiden; eerſt, de Bekende; ten 2den, de Onbekende: het Bekende wederom in vier deelen; Verdeeling van de Aarde.

1. *Europa.* 2. *Aſia.* 3. *Africa.* 4. *America.*

De drie eerſte zyn al in oude tyden bekend geweeſt, en maaken te zaamen een groot Eiland; het laatſte is voor ruim 200 Jaaren eerſt ontdekt; 't welk mede een groot Eiland is, en aan de andere zyde van de Aarde legt.

1. *De Bekende Deelen.*

Europa grenſt aan Aſia; de reſt is aan de Zee: als men de Kaart van Europa leid, dat het Weſten omhoog komt, dan verbeeld het zelve eenigzins een Juffrouw. Europa.

De Eilanden, die men daar onder reekent, kunnen in drie-derhande onderſcheiden worden: 1. De Groote; 2. De Middelmaatige; 3. De Kleine. Eilanden.

Onder de Groote kan men tellen: 1. Engeland en Schotland, dat te zaamen een Eiland uitmaakt; 2. Ysland.

Onder de Middelmaatige komt voor 1. Yrland; 2. Sardinien; 3. Sicilien; 4. Candia; 5. Corſica.

Onder de Kleine: 1. Zeeland in Deenemarken; en dan in de Middelandſche Zee, 2. Majorca; 3. Minorca; 4. Yvica; 5. Malta; 6. Corfu; 7. Cephalonia; 8. Zante; 9. Negropont; 10. Rhodus; 11. Stalamine; 12. Metelino; 13. Scio, en een menigte van andere. Als in de Zee veel Eilanden digt by malkander leggen, noemt men ze *Achipelagus.*

De Grootte van Europa is omtrent 1/77 deel van des Aardkloots Oppervlakte.

E *Aſia*

FIGURE 16: FIRST PAGE OF CHAPTER 3, THE DIVISION OF THE EARTH. STRUYCK, *INLEIDING*, 53

In his discussion, Struyck first enumerated the known landmass of the world and divided these areas into regions and their islands. The result was simply a description of what physical landmass there is to be found in that part of the earth. For each of these parts, Struyck discussed its geographical boundaries, enumerated the corresponding islands (the large, medium, and small ones), and provided its size as a fraction of the earth's area. Whenever the number of islands would be too large to enumerate, he stuck to the ones he considers the most important. Often Struyck indicated when and by whom the islands were discovered, thus giving the historical background of a place. We learn that Europe's size is 4/275th of the earth's area, Asia 4/55th, Africa 4/75th, and America about 22/275th (or, says Struyck, so is the parts that had already been discovered).[227] All in all, the known countries now take up about 1/4th of the earth's area. From that result but without any explanation, Struyck guessed that the earth is 1/3rd land and 2/3^{rds} water.[228] Despite putting a number on it, Struyck did not see this

[227] These estimates are quite close to the percentages we now ascribe to the sizes of these respective continents, which indicates that Struyck ascribed similar boundaries to these continents as we presently do.
[228] Struyck, *Inleiding*, 33–37.

ratio as fixed, since land can be taken by the raging of the sea or flooded after heavy storms or earthquakes.[229]

So far, our introduction to Struyck's division of the earth by the physical criteria of landmass. Let us move to a division based on social criteria, namely 'the distribution of the earth, from the government originally.'[230] This 'government' (*regeering*) is some sort of division based on a place's civil organisation, which could refer to a housefather (*huisvader*) and his family, a city, a country, or some other unit. Struyck continued in the same spirit as for landmass. He wrote that there are three known types of government: monarchies, aristocracies, and democracies. These categories, he says, are not mutually exclusive but can also mix with each other. For example, the last two both apply to republics and commonwealths.[231] Nevertheless, he considered them important for accurately describing the places of the earth. As he did for landmass, Struyck again divided the earth into different regions, beginning with Europe, then Asia, Africa, and America. Next, all regions are then split further into countries or communities.

In general, Struyck divides Europe into nine parts: the kingdom of Great Britain, the kingdoms of the northern kings, Russia, France, Germany, Poland, Spain, Italy, and Turkey (he presents the Netherlands as a part of Germany, though a part that does not fall under the reign of the German emperor).[232] Three belong to the north of Europe, three to the middle, and three to the south. Struyck himself claims that this is the division 'as is usual' in such divisions by government.[233] Indeed, we recognize a similar structure to what is now known as the Hübner method (which I have described in paragraph 1.1), although Struyck arranges the countries in a different order. Like Hübner and other special geographers, Struyck provided a brief discussion of each country's most important characteristics. These characteristics are usually physical landmarks, such as mountains, rivers, or the lack of rain in Cairo. He also included the names of big cities, European settlers, and indigenous tribes. And, finally, he mentioned socio-cultural rarities, like a country's people living in tents or when 'this

---

[229] Dutch: 'op eenige plaatzen neemt het Land af, door het woeden van de Zee, en op andere plaatzen neemt het zelve wederom toe.' Struyck, 38.
[230] Struyck, 38.
[231] Dutch: 'De regeringen zyn van driederlei zoort: 1. De Monarchale, of daar een Perzoon eigenwillig het Gebied voert; 2. De Aristocratische, daar de Voornaamste uit het Volk, of den Adel regeeren; 3. De Democratische, daar het Volk alleen het bewind der zaaken in handen heeft; dog de voornoemde Regeeringen vind men ook door malkander gemengd: de twee laatste zoorten noemt men Republicquen, of Gemeenebesten.' Struyck, 38.
[232] Dutch: '… ook behooren niet onder den Keizer, de Gemeenebesten van de Vereenigde Nederlanden en Zwitzers; die worden ieder door hun eigen volk geregeerd.' Struyck, 43.
[233] Struyck, 43.

country is not healthy for Europeans.'[234] In these descriptions he proceeds similarly to how Hübner and Clüver pursue geography, in a style common for descriptive or special geography.[235]

However, just like in previous examples, Struyck also went beyond these established geographical writings, contributing new analyses of data he had compiled himself. He wrote that the names, boundaries, and population size of countries and cities could change over time. 'Who desires to investigate this, has to resort to the histories; and to see an example thereof, one need only look at the change in the number of houses that has taken place in 100 years,' says Struyck.[236] Noteworthy is that he thus makes explicit that he sees population statistics as the strategy to study this descriptive division by government. In a three-page long footnote he discussed this number, as well as that of mills, for several cities and villages in the province of Holland (figure 17).[237] Again, he proceeded by compiling and comparing data for various places, using this to judge and verify his statements. In all places the number of houses in- or decreased over these 100 years. Struyck therefore argued that these 'histories' indicate that the population size per place is variable, which he regards as proof that the division by government is not fixed. 'All places are not fixed in one single state; the rulers rise and fall, the greatest and most popular cities often change into ruins and deserted places, and from modest beginnings others sometimes grow to a considerable size.'[238] He concluded that people did not remain in the same place, nor remained organized by fixed civil structures.

Providing a division of the earth 'by government' into regions, then countries, cities and villages was not strange or unusual. Quite the opposite: at the time it was an established, common way to describe the different regions of the earth like this, embarked upon by many geographers.[239] Struyck's division into regions and countries followed the typical structure most of these descriptive geographers adhered to.[240] He reproduced quite some descriptive geography as it could be found in the corresponding literary genre of geographical dictionaries (*geographische woordenboeken*), adopting and building on established geographical writings in ways similar to what we saw in the previous chapter.[241] But these descriptions by place remained primarily a custom that belonged to the textual traditions of *descriptive* geography, not to the mathematical style of general geographies.

---

[234] Dutch: 'Guinée … dit Land is voor de Europeanen niet gezond.' Struyck, 47.
[235] Cf. Hübner, *Kurtze Fragen Aus der Neuen und Alten Geographie*; Clüver, *Introductio in universam geographiam*.
[236] Dutch: 'Die dit begeert te onderzoeken, moet zyn toevlugt tot de Historien ncemen: en om hier van een voorbeeld te zien, behoeft men zyn oog maar te slaan op de verandering, die in 100 Jaaren tyd, in 't getal der Huyzen … is voorgevallen.' Struyck, *Inleiding*, 39.
[237] Struyck, 39–42.
[238] Dutch: 'Maar alles blyft niet in eenen stand; de Heerschappyen gaan op en onder; de grootſte en volkrykste Steden veranderen dikwils in Puinhoopen en eenzaame Plaatzen; en van geringe beginzelen, wassen andere zomtyds aan tot een merkelyke grootte.' Struyck, 39.
[239] Withers, *Placing the Enlightenment*, 167; Mayhew, 'The Effacement of Early Modern Geography', 387.
[240] Withers and Fischer, 'Geographical Education in the Eighteenth-Century German-Speaking Territories', 22.
[241] Struyck, *Inleiding*, 42.

40 *Inleiding tot de algemeene Geographie,*
beeldingen of Kaarten, die in groote menigte voorhanden zyn; dog alle niet van ééne waarde: door de nieuwe ontdekkingen vind men

'T Zuiderquartier.

	In 't Jaar 1632. In de Steeden.	In 't Jaar 1732. In de Steeden.	In 't Jaar 1732. op 't Platte Land en de Dorpen.	De Steeden vermeerdert.	De Steeden verminderd.
1 Dordregt	3386	3954	7545	568	
2 Haarlem	6490	7963	2155	1473	
3 Delft	4842	4870	4368	28	
4 Leyden	8374	10891	9357	2517	
5 Amfterdam	16051	26035	3065	9984	
6 Gouda	2452	3974	2311	1522	
7 Rotterdam	5048	6621	3445	1573	
8 Gornichem	1609	1398	405	—	211
9 Schiedam	1383	1504	206	121	
10 Schoonhoven	661	558	1884	—	103
11 Den Briel	1082	940	2442	—	142
12 's Gravenhage	3160	6163	778	3003	
13 Woerden	675	397	770	—	278
14 Oudewater	618	562	120	—	56
15 Geertruidenberg	433	456	440	23	
16 Heusden	652	537	1376	—	115
17 Naarden	474	480	1147	6	
18 Weefp	347	494	194	147	
19 Muiden	163	190	15	27	
20 Vianen	—	483	646		
21 Afperen	180	147		—	33
22 Woudrichem	166	158	1088	—	8
23 Heukelom	107	113	—	6	
24 Goerée	206	162	128	—	44
25 Vlaardingen	548	691	559	143	
26 Geervliet	169	96	1937	—	73
27 Sevenbergen, enz.	—	—	384	—	
28 Clundert	134	120	167	—	14
	59410	79957	46932		

De Huizen van Sevenbergen zyn niet uitgedrukt in 't bezonder, maar met die op het Platte Land te zaamen; ook niet die van de Clundert, die ik op 120 ftel.

In

FIGURE 17: STRUYCK ARGUES THAT THE POPULATION SIZE OF CITIES AND COUNTRIES IS SUBJECT TO CHANGE. THOSE THAT WANT TO INVESTIGATE THIS, SHOULD RESORT TO THE 'HISTORIES' (HISTORIEN). AS AN EXAMPLE, STRUYCK COMPARES THE NUMBER OF HOUSES IN THE CITIES AND VILLAGES. STRUYCK, 40.

These general geographies were instead meant to discuss the measurable parts of the earth. Changeable humans and their variable civil organisations did not have a place therein – that branch of geography was usually regarded as special, not general geography.[242] Struyck disagreed. Instead, he attempted to measure the variability of human civil organisation itself. His investigation led to the three-page long footnote described above. Through population statistics, Struyck could create a place

242 Withers and Fischer, 'Geographical Education in the Eighteenth-Century German-Speaking Territories', 22.

for civil geography in his mathematical conception of geography – an idea that had not yet met much support among geographers. Population statistics, or, 'political arithmetic' was not considered a part of geography. It would not be until the 19th century that geographers started to explore this social realm and developed a vocabulary to encompass it in their field.[243]

All in all, this chapter leads to some important conclusions. It shows that there is not one 'distribution of the earth' for Struyck. He described the distribution of the world's landmass just like he described the distribution of its people, contrary to common practices for general geographies. Consequently, this paragraph has shown that Struyck regarded civil geography as just as much part of geography as terrestrial geography. Moreover, he approached both through parallel methods, namely, through quantified measurements. Struyck made clear that he believed the way to measure civil geography was by studying demographic characteristics and population statistics. In the end this shared method led to a shared conclusion: Struyck believes both are subject to change. Land can be taken or given to the sea, like the number of people living in one place can grow or reduce. In both cases, this fact is revealed to us by comparing numbers (namely, the changing proportion of the earth's surface, or the number of houses per place), according to Struyck. Nevertheless, the did not fully develop his thoughts on sophisticated demographic measurement strategies in this chapter, but elaborated on them later, in the essay with C*onjectures on the state of the human race*. That will be the topic of the next paragraph.

3.2 Civil geography

So far we have established that Struyck did not see civil geography as a field separated from geography but as an inherent part of it. He elaborated on the topic in two essays attached to the *Inleiding.* As we have seen, neither social descriptions nor population statistics had an established place in general geography. However, the study of demographic characteristics was still part of a wider investigation of population structure and related measurements of birth and death. This type of population statistics rested on the pioneering ideas put forward by William Petty (1623 – 1687).[244] Petty had tried to solve all kinds of problems using wide demographic data, usually resulting in rather speculative conclusions. His friend John Graunt (1620 – 1674) did so too, although he expressed somewhat more careful reasonings. The topics he studied were mainly death and birth (or rather, baptism) rates. In the Netherlands, Johan de Witt (1625 – 1672) was the first to continue in like spirits. He used similar

[243] Agnew and Livingstone, *The SAGE Handbook of Geographical Knowledge*, 359.
[244] For more on Petty, Graunt and De Witt, see also Pearson, *The History of Statistics in the 17th and 18th Centuries*, 330–47; Stamhuis, 'Levensverzekeringen 1500-1800'; Klep and Stamhuis, 'The Statistical Mind in a Pre-Statistical Era'.

mortality data primarily to advance life annuity calculations.[245] Struyck adopted this approach. Like De Witt, Struyck investigated primarily mortality rates and used those for the calculations of life annuities. Neither of the Dutchmen engaged much in Petty and Graunt's search for wider political or religious conclusions.

Struyck was aware of his predecessors' pioneering efforts in *political arithmetic*, as they had called the field. Struyck himself did not mention that term (which is why I will not adopt it either). His essays are titled C*onjectures on the state of the human race* and *Calculations of life annuities.*[246] Struyck had a thorough knowledge of the earlier publications and also reflected critically on them, especially when it came to De Witt's work. Struyck pointed out that the value of annuities should be calculated from life tables based on observations, not from mere hypotheses as had been done by De Witt.[247] He similarly used and commented on Graunt's *Natural and Political Observations*. However, Struyck's knowledge of Petty's ideas was based on only the parts that had been published in the *Philosophical Transactions*. Still, even more than these political arithmeticians, Struyck seemed to relate his undertaking to the much older observations by the Italian geographer Riccioli (1598 – 1671), the Scottish politician William Maitland (1525 – 1573) and English mathematician Edmond Halley (1656 – 1742). Especially this last one uses mortality data ('observations') in a way Struyck approves of and wishes to follow. He thus particularly wanted to advance the empirical basis of life annuities – after he had worked on the mathematical theory behind life annuities earlier in his book *Uytreekening*.[248]

The Dutch context was not too favourable for the required type of demographic observation. The fragmented Republic did not have a central administration, which meant that Struyck just had to work with whatever records there were available. He could not usually consult many administrative records: 'There are not enough observations of all the regions as examples.'[249] It meant that Struyck largely had to rely on what other scholars had already written.[250] Like Struyck did not base his

---

[245] Life annuities heavily rely on the collection of demographic data. This data was used to create mortality tables, whose mortality rates were then used to determine the appropriate premium. The annuities were periodic payments as compensation for money lent to a person or institution – usually the Dutch government, in this case. The annuitant receives a regular fixed payment until the corresponding 'life' ended. That life did not necessarily have to belong to the person receiving the money, but could also be someone else (for example, a young child). See also Hogendijk, 'Lijfrentes in de zeventiende en achttiende eeuw', 139; Stamhuis, 'Levensverzekeringen 1500-1800', 141; Pearson, *The History of Statistics in the 17th and 18th Centuries*, 340; Hald, *A History of Probability and Statistics and Their Applications before 1750*, 369.

[246] In other cases he just spoke of 'measurements of the people.' For example, see Struyck, *Inleiding*, 328 (part II), 385 (part II).

[247] Struyck, 345 (part II) and following pages.

[248] Struyck, *Uytreekening*, 124–29.

[249] Dutch: 'Men heeft geen Waarneemingen genoeg van alle Gewesten tot voorbeelden.' Struyck, *Inleiding*, 328 (part II).

[250] The only exception in which Struyck does provide relatively large amounts of new source data is when he discusses the administrative records of Broek in Waterland, of which Struyck is also often credited in the secondary literature. However, since Struyck obtained the data through his friend Mr. Jacob Oostwoud, who again has it from 'a distinguished man who lived there,' we ought to qualify even this as primarily a form of

terrestrial geographical writings on his own observations or measurements of the terrestrial phenomena he described, he similarly could not perform his own observations of demographic records – and setting up such records himself was even less realistic. In one of the few cases where he had been able to obtain his own data, he proudly remarked:

> 'The foregoing tables and accounts are not based on assumptions, but on actual experience, as drawn from the annuity records, by order of the gentlemen of the government: I have faithfully treated them, and could show the copies thereof.'[251]

Moreover, the passage makes clear that Struyck regards the consult of demographic records as obtaining knowledge through 'actual experience' (*wezentlyke ondervindingen*). To Struyck, the empirical phenomenon to be observed is thus the record itself – not the people described by this record. He uses like terminology for demographic records more often.[252] Struyck does not study people, he studies records. Moreover, he held that seeing administrative records provided direct observations – though he usually had to do without.

At the same time, the lack of Dutch administrative records also meant that he could only provide uncertain conjectures. That did not stop him. Although civil geography did not yet serve any purpose and most things were still quite obscure now, Struyck believed that the best thing to do was to still discuss those matters, since it might 'encourage others, who, after more observations, could still bring many new discoveries.'[253] He was confident that our knowledge and so our certainty would only improve in the future: 'It seems to me, that one will discover plenty of wonders in them, that will educate us.'[254] Also in civil geography, he believed that more observations would lead to more comparative material and thus to more knowledge, which would advance the field. The more numbers, the better.

Currently, his best justification for his 'uncommon' civil geography was the following. He began the *Conjectures of the state of the human race* by demonstrating that 'it is not useless to examine these things: one often examines with great difficulty things that can serve no purpose.'[255] Struyck brought

---

compiling – although the data had never appeared in print before. Struyck, 381 (part II); Beets and van Poppel, 'Nederlandse Geboortepatronen in Historisch Perspectief'; Pearson, *The History of Statistics in the 17th and 18th Centuries*, 342.

[251] Dutch: 'De voorgaande Tafels en Reekeningen steunen niet op onderstellingen, maar op wezentlyke ondervindingen, als zynde getrokken uit de Boeken der Lyfrenten, op order van de Heeren der Regeering: Ik heb dezelve getrouwelyk behandeld, en zou de Copyen daar van kunnen vertoonen.' Struyck, *Inleiding*, 369 (part II).

[252] For example, likewise in Struyck, 345 (part II). There, Struyck equally ambiguously justifies calculations for life annuities as: '… daar nogtans door de ondervinding bleek aan eenige duizenden van Lyven.'

[253] Dutch: '… zoo zal dit ligtelyk andere aanmoedigen, die, na meer Waarneemingen, nog wel veel nieuwigheden daar door konden te voorschyn brengen.' Struyck, 328 (part II).

[254] Dutch: 'Het schynt my toe, dat men hier nog wonderlyke zaaken in ontdekken zal, die ons zullen opleiden.' Struyck, 328 (part II).

[255] Dutch: 'Dit na te gaan, is niet onnut: men onderzoekt dikwils, met groote moeite dingen, die nergens toe kunnen dienen.' Struyck, 321 (part II).

up two examples of great labour and time expenditure that he considers futilely spent – implicitly arguing that studying population statistics is at least more valuable than wasting time on these irrelevant things. The first example concerned Claas Kammers, who counted the number of chapters, verses, words and letters in the Old and New Testaments.[256] Struyck considered these as completely useless numbers. The second example was about magic squares and the number of forms that these could take (see figure 18). Struyck believed that the many scholars who attempted these laborious calculations had wasted their time – although he also admits that it does show us what wonderful properties numbers possess. In the end, Struyck argued that his conjectures are more valuable than these subjects, because at least civil geography gives us insight into God's creation and teaches us 'to see a part of the great wisdom, that the Creator of the universe has seen fit to use for maintaining the human race.'[257]

Struyck started his own investigation of how our human race was maintained. The following paragraphs will describe how he proceeded, again according to his quantitative method. He started by estimating the number of people in the whole world. He compiled the data as it had been accounted for by earlier scholars (primarily by Botterus and Vossius) and presented it neatly in one table (see figure 19). Their numbers vary enormously. Using the overview, Struyck then judges the estimates and critically evaluates the numbers: 'The first, from Botterus, given his estimate of Europe, is a much better estimate than that by Vossius, as will be shown in the following.'[258] This verification consisted of a calculation of the area one person ('big or small') would have according to that estimate for the population size of Europe.[259] So, argued Struyck about Botterus' numbers, 'if all the land of Europe was equally divided among 100 million people, each one would have a piece of it 9 morgen, or a square piece, each side of which is 74 rods, *Rhynlansche maat*.'[260] In a modern measure that would equal about 77,8 squared meters.[261] Struyck considered it therefore a fair guess for Europe's population size, but he judges Botterus' total of 900 million people on earth as much too large, 'as the conjecture for Asia and America seems to be much too large.'[262] To sum up, Struyck thus partakes in his usual procedure as we have become acquainted with in the previous chapter. Likewise he again does not tell

[256] Struyck, 321 (part II).
[257] Dutch: '… om een gedeelte van de overgroote Wysheid te zien, die de Schepper van 't Heel-Al heeft believen te gebruiken tot onderhouding van 't Menschelyk Geslagt.' Struyck, 328 (part II).
[258] Dutch: 'Het eerste uit Botterus, wegens Europa, is veel beter gegist als dat van Vossius, gelyk in 't vervolg nader zal blyken.' Struyck, 323.
[259] Struyck, 324 (part II).
[260] A 'morgen' was a unit of land measurement. Dutch: 'Indien al het Land van geheel Europa onder het getal van 100 millioenen Menschen gelyk verdeeld wierd; dan zou ieder daar een stuk van kunnen hebben, groot 9 morgen, of een vierkant stuk, daar van ieder zyde lang is 74 roeden, Rhynlandsche maat.' Struyck, 324 (part II).
[261] Pearson, *The History of Statistics in the 17th and 18th Centuries*, 336.
[262] Dutch: '… hoewel ik niet geloof dat daar zoo veel Menschen zouden gevonden worden, alzoo my de gissing van Asia en America te groot voorkomt.' Struyck, *Inleiding*, 324 (part II).

De Reken-Konſtenaars ſtellen voor, om in een Vierkant, 't welk in andere kleine vierkanten verdeeld is, zoodanig, dat op ieder zyde evenveel vakken komen, alle de geheele getallen, van de Eenheid af, vervolgens in ieder vak te ſchryven, zoodanig, dat als de Horizontaale, Verticaale, en Diagonaale reien opgeteld worden, dat dan de Zommen altyd gelyk zyn; dit noemt men een betooverd Vierkant:

7	11	14	2
6	10	15	3
12	8	1	13
9	5	4	16

Moſchopule (*a*), *Agrippa* (*b*), *Bachet* (*c*), *Frenicle* (*d*), *Arnauld* (*e*), *Preſtet* (*f*), *Poignard* (*g*), *La Hire* (*h*), en *Sauveur* (*i*) hebben veel moeite aangewend, om de waare hoedanigheden daar van aan te wyzen. Mr. *Frenicle* heeft een Vierkant van 16 ruiten, als hier nevens te zien is, op 880 manieren vertoond (*k*); maar ik heb gevonden, dat hy op ver na het getal nog niet ontdekt heeft, zoo als men dit vierkant geduurig anders, en anders kan ſtellen. Verſcheide nieuwe Uitvindingen over de betooverde of konſtige Vierkanten heeft *Pieter Karman*, Burgermeeſter van de Ryp, gedaan; hoe men dezelve kan maaken door vouwen, verſchuiven, en andere manieren; ook, hoe veelmaal de getallen in dezelve verplaatſt kunnen worden, zoodanig, dat die evenwel de eigenſchap behouden ...

FIGURE 18: STRUYCK'S DISCUSSION OF A MAGICAL SQUARE AS EXAMPLE OF IRRELEVANT RESEARCH ON NUMBERS. STRUYCK, 322 (PART II).

Om dan ter zaak te komen, zoo is de eerſte aanmerkenswaardige zaak, die ons, in opzigt van ons onderzoek, voorkomt, hoe groot ten naaſtenby het getal moge zyn der Menſchen, die omrrent deezen tyd te gelyk op de Aarde leeven; dog dit is zeer bezwaarlyk om uit te vinden: hoe wonderlyk veel dat voornaame Schryvers daar in verſchillen, zal ik door een voorbeeld aanwyzen. De eerſte Colom heeft *Ricciolus* meerendeels uit *Botterus* (*l*), de tweede heeft *Hubner* uit *Voſſius* (*m*), de derde is uit een Geographiſche Tafel (*n*), en de vierde heeft *Robus* uit *Voſſius* (*o*). 't Getal der Menſchen.

	Millioenen.	Mill.	Mill.	Mill.
Spanjen — — — — —	10	2	6	2
Vrankryk — — — — —	19 of 20	5	20	5
Italien, Sicilien, en andere Eilanden	11	2	11	3
Groot-Brittannien — — — —	4	3	8	2
Duitsland, het bovenſte deel —	20	} 5	20	5
De Nederlanden, of 17 Provincien	4		5	2
Sweeden, Denemarken, en Noorweg.	} 8	1	8	1
Moſcovien in Europa — — —		$4\frac{1}{2}$	16	3
't Europ. Turkyen, Griekenland, &c.	16	$5\frac{1}{2}$	16	$5\frac{1}{2}$
Poolen en Pruiſſen — — —	6	$1\frac{1}{2}$	7	$2\frac{1}{2}$
In Europa is de Zom 99, dog hy ſteld	100	30	117	31
In Aſia — — — — —	500	300		
In Africa — — — — —	100	} 100		
In America — — — —	200			
Op de geheele Aarde — — —	900	430		

FIGURE 19: TABLE WITH VARIOUS POPULATION ESTIMATES. 'THE FIRST COLUMN RICCIOLUS LARGELY GOT FROM BOTTERUS, THE SECOND HUBNER GOT FROM VOSSIUS, THE THIRD IS FROM A GEOGRAPHICAL TABLE [BY C. SPECHT OF UTRECHT], AND THE FOURTH ROBỤS GOT FROM VOSSIUS.' STRUYCK, INLEIDING, 323 (PART II).

his readers what the most reasonable estimate would be. Also in his civil geography, an accurate conclusion on the issue's outcome is not one of Struyck's main concerns.[263] First and foremost, Struyck wanted to compile, compare and assess the measurements of people that are currently in existence.

Struyck's main aim of the essay was to investigate if the number of people on earth increases, decreases, or remains stationary. He believed that it must be the latter, 'which is also not at all implausible, considering that if the people increased too much in number, the land would become too full, and many would not be able to make a living, and if it decreased too much, the earth would become empty, which both seems to be against the Creator's intention.'[264] Unlike his normal approach, he here starts off with this conclusion. Still he brings up a method to investigate its correctness: the truth of this statement 'will be disclosed at first glance if, in a year, about as many are born in a place as die there; which I will now examine.'[265]

By comparing the births and deaths of a place within one year, you should be able to spot an overall in- or decrease. In the absence of global or national records, this problem required finding general rules based on the extrapolation of one place and one year. Struyck realized that his population measurement strategy would only work when birth and death were indeed the only variables involved in in- or decreasing population size. One should therefore only measure suitable places, 'in which the influx of foreigners and the number of those leaving is very small compared to all the people found there.'[266] Apart from the place, the investigated time period was also crucial. Struyck argued that the number of births usually exceeded that of deaths, but once in a while disease (like pest epidemics), fires, war, departing Reformists, or other 'unusual deaths' cause a sudden rise in death numbers.[267] Consequently, the ratio between births and deaths thus remained stable in the long term.[268]

---

263 Similarly, the accuracy and trustworthiness of the original data are, again, not Struyck's main concerns. Pearson critically remarked on this: 'I have not succeeded in finding the original statements in Botterus, and Ricciolus takes his numbers from what a certain Nicolovius says that Botero says! The second authority for the population of the world is Isaac Vossius, but Struyck only cites two writers: Hubner, writing in 1707, and Rabus in 1688, who both profess to be citing Vossius, but they do so with numbers which do not accord.' Pearson, *The History of Statistics in the 17th and 18th Centuries*, 334.

264 Dutch: '... dit komt ook niet onaanneemelyk te vooren, als men bedenkt, dat wanneer het volk al te veel in 't getal aangroeide, zoo zou het Land te vol worden, en veele niet aan de kost kunnen komen, en indien het te sterk verminderde, zoo zou de Aarde leedig worden, 't welk beide tegen het oogmerk van den Schepper schynt te stryden, blyft dan na genoeg het zelfde getal van Menschen op de Aarde.' Struyck, *Inleiding*, 328 (part II).

265 Dutch: 'Zoo zou het in de eerste opslag wel schynen of daar in een Jaar ten naastenby zoo veel gebooren wier den als daar sterven; 't welk ik nu zal onderzoeken.' Struyck, 328 (part II).

266 Dutch: 'Ik verstaa daar door zulke plaatzen, waar in de toevloed der Vreemdelingen, en 't getal van die daar uittrekken, zeer weinig is ten opzigt van al het Volk dat daar in gevonden word.' Struyck, 328 (part II).

267 Struyck, 328-9 (part II). Likewise baptism numbers were not completely accurate, since some children died before they were baptized.

268 Earlier Struyck argued against a fixed civil organisation structure (as described in paragraph 3.1). He believed the distribution of people over the earth must change. That does not necessarily contradict the current statement that the total number of people on the earth is stationary: even if the total number of people remains fixed, their spatial distribution could still change.

Besides piously motivated, his frantic attempts to prove a constant world population might also have other roots. Struyck investigated demographic data partly to geographically describe the world, but also to improve the calculations of life annuities.[269] A stationary population was a prerequisite for finding the general mortality laws Struyck was after.[270] It gave Struyck a strong incentive if he wanted his actuarial theories to be taken seriously.

In any case, Struyck believed that birth and death rates held the clue. Struyck again looks at several villages, this time by combining data from Graunt, Halley and Maitland as well as his own observations of Dutch administrative records. He looked at records for cities like London, Vienna, Breslau (now Wroclaw), Paris, Hamburg, Enkhuizen and Gouda. Compiling and comparing data between multiple cities is his solution to the difficulties involved with extrapolating from only one place and time. A detailed account of his undertakings has been provided by Pearson and Stamhuis, but in very general terms it entailed the following.[271] Struyck claimed that for all parts of Europe, the birth and mortality rates express similar regularities. Moreover, these numbers relate to the total number of people in that country in similar ways. He tries to discover the fixed ratios that help him determine the total population size. Struyck thus investigated individual places to discover the patterns that hold more widely, although he admits that 'so far this proportion is hard to find.'[272] Nevertheless, such general knowledge remained Struyck's goal. We see the same desire for generalities in his subsequent analysis of the demographic structure of these cities. He was not only interested in population size in total, but also as split by age, gender, and religious community. For all these characteristics he kept looking for generalities that were present in all cities. He estimated the ratio between boys and girls, for example, by comparing the baptism rates of several cities (see figure 20). Next to the numbers as compiled from the records of several cities, he also included a column that 'shows the number of girls who, according to the number of boys, should be baptised if the fixed ratio always was that 49 girls

---

[269] In fact, his calculations for life annuities would not remain unfruitful. An example of an important insight for life insurance derived by Struyck (though principally in the *Vervolg*, not the *Inleiding*) was that contemporary widows' funds charged premiums that were too low to pay off the pensions promised – often leading to their bankruptcy. These premiums were age-related. Van Leeuwen summarizes: 'A couple both aged 40 paid a one-off deposit of 70 guilders plus 30 guilders annually. In return, the wife was promised an annual widow's pension of 200–300 guilders. Struyck calculated that an annual premium of not 30 but 100 guilders would be necessary to sustain such payments.' Leeuwen, 'The Era of the Guilds', 44–45. See also Stamhuis, 'Levensverzekeringen 1500-1800', 145; Pearson, *The History of Statistics in the 17th and 18th Centuries*, 342.

[270] Stamhuis, *'Cijfers en aequaties' en 'kennis der staatskrachten'*, 23; Stamhuis, 'De Ontwikkeling van de Actuariële Theorie Tot de 17e En 18e Eeuw', 161.

[271] Pearson, *The History of Statistics in the 17th and 18th Centuries*, 337–47; Stamhuis, 'Levensverzekeringen 1500-1800', 141.

[272] Dutch: '… dat het getal der Huwelyken, ook van die gebooren worden en sterven, nagenoeg eene evenredigheid houd, met her getal der Menschen, die in een geheel Land zyn; maar deeze evenredigheid is tot nog toe bezwaarlyk om te vinden.' Struyck, *Inleiding*, 332 (part II).

	Jongens	Meisjes	Meisjesna de order	Verschil
Coppenhagen . .	2651	2439	2498	+ 49
Breslaw . . .	5105	4913	4811	— 102
Leipzig . . .	1771	1657	1669	+ 12 (g)
Dresden . . .	4240	4046	3995	— 51
Weenen . . .	2185	2057	2059	+ 2
Te zaamen	15952	15112	15032	— 80

FIGURE 20: TABLE WITH THE NUMBER OF CHILDREN BAPTIZED BETWEEN 1717 AND 1725 FOR VARIOUS CITIES. STRUYCK, 337 (PART II).

would be baptised against 52 boys.'[273] The final column demonstrates how far his general rule ('*regel*') is off. Moreover, not only does Struyck's strategy to compile, convert and compare thus result in such general knowledge in civil geography, but Struyck also engages in his usual data criticism. By comparing the data he had compiled he judges whose values to use. Frequently he remarks things like: 'For the year 1714, according to Mr. Maitland, the number of deaths in Hamburg was about 3.000; Erdman Neumeister, pastor of St. Jacob's Church in Hamburg, thought that in 1716 there were about 240.000 souls in that place; but this is too much.'[274]

It goes too far to go into all details now, but I think Struyck's general attitude and approach are clear. Even the way he combines the analysis of empirical observations with the reconstruction of philological knowledge proceeds similarly (reproducing ancient Egyptian death and population estimates). This general image resonates with the image of Struyck that has been presented in the secondary literature. Hald writes:

> 'Among political arithmeticians Struyck stands out as critical and sober-minded. He has a sceptical attitude about the accuracy of data collected by others ... He criticizes the existing birth and death registers in several countries ... and warns against uncritical use of statistical ratios.'[275]

Zuidervaarts speaks about Strucyk's population statistics in like terms, writing that Struyck obtained 'a real taste for the empirical study of populations.'[276] He emphasizes that Struyck criticized De Witt because he believed that these calculations should not only be based on mathematical equations, but on empirically obtained mortality tables. Struyck used these to test his estimates, 'derive a

273 Dutch: 'De derde Colom met Cyffers verbeeld het getal van de Meisjes, die, ingevolge van 't gestelde getal der Jongens, gedoopt zouden moeten worden, indien altyd die order plaats greep, dat geduurig 49 Meisjes gedoopt wierden tegen 52 Jongens.' Struyck, 337 (part II).
274 Dutch: 'Voor het Jaar 1714 waren de Dooden in Hamburg, volgens Mr. Maitland omtrent 3.000; Erdman Neumeister, Pastor in St. Jacobskerk te Hamburg, meende, dat, omtrent het Jaar 1716, in die plaats wel 240.000 Zielen waren; dog dit is te veel.' Struyck, 336 (part II).
275 Hald, *A History of Probability and Statistics and Their Applications before 1750*, 396.
276 Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 140.

number of general conclusions,' and 'contrasted [his] results with figures he had found in recent literature.'[277] In his own time Struyck's mortality tables were also heavily criticized by the mathematician Willem Kersseboom (1671-1771), who accused him of plagiarism. Kersseboom's accusations are now generally regarded as unfounded, but at the time that was not immediately clear.[278] Kersseboom's tables, not Struyck's, were used until well into the 19th century. The dispute has most likely contributed to Struyck remaining relatively unknown today. Nevertheless, the existing literature on Struyck's civil geography thus describes him as the terrestrial geographer we have encountered in the previous chapters: a critical compiler of quantitative material.

The previous sections have demonstrated that the 'civil geographer' Struyck was a compiler, evaluating and synthesizing others' numerical data. He believed that places could be understood and compared to each other through numerical descriptions of their people. Ultimately, he hoped this would lead him to general knowledge that reached beyond the administrative records of one particular place. How he counted population depended on the data he had at hand: it could be the number of persons, houses, 'habitable places', households (*huisgezinnen*), or parishes. He also investigated how he could extrapolate birth, death or marriage rates to find general patterns to estimate the total population. At the same time Struyck was well aware that these administrative records were not very reliable source data. He was hesitant to regard his civil geography as more than mere conjectures. But he had good hope for the future and hoped that these conjectures would provoke others to collect more data. With more data, they would be better equipped to establish new theories.

Overall, these conclusions strongly remind us of those in the previous chapters. Compiling, converting and comparing data was again central to Struyck's approach. He worked on civil geography according to his quantitative method. We should therefore not separate Struyck's demographic understanding from the rest of his geographical writings, but see it as embedded in it.

3.3 Heavenly geography

Like Struyck measured the earth in its terrestrial and civil aspects, so did he wish to measure the heavens above it. Although his contributions turned out unsuccessful in the long term, Struyck was 'certainly the most important of all Dutch comet researchers in the eighteenth century.'[279] In five essays attached to the *Inleiding*, he described cometary orbits, the lunar atmosphere, and sun and moon eclipses. The essay was 'a compilation of evidently years of hard work.'[280] In this paragraph I will relate Struyck's astronomical undertakings to the rest of his geography.

[277] Zuidervaart, 141.
[278] The argument between Kersseboom and Struyck has been described in detail by Haaften, *Nicolaas Struyck*, 17–42; Haaften, 'Kersseboom En Zijn Geschriften. I', 679–89.
[279] Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*, 108.
[280] Zuidervaart, 113.

The fact *that* Struyck adopted astronomy as a part of geography is not too surprising. Both fields were considered as part of mixed mathematics, though generally two clearly distinct parts.[281] Their common descriptions characterized them as being about different subject matters. Geography was about the globe, whereas astronomy concerned the celestial bodies, including the earth's position relative to the stars and to the other planets. However, in practice, geography and astronomy were closely related and commonly taught together in lectures or books.[282] As a consequence, the disciplines were closely intertwined or even blended into each other.

Struyck became acquainted with the calculations for cometary orbits through the illegally printed edition of Newton's *Principia* that circulated in Amsterdam around 1714. Newton had shown that the paths of 'unpredictable' comets were, in fact, equally predictable orbits as those of planets. Moreover, he had demonstrated that a cometary orbit close to the sun could be approximated with a parabola.[283] Most likely Struyck came across Halley's *Synopsis* shortly after this, through which he learned of Halley's calculations of cometary orbits based on historical sources.[284] Struyck was much inspired by this idea. Halley had presented a list of 24 cometary orbits and used it to describe how some appearances must actually have been the same comet.[285] Already in 1722, Struyck expressed his intention to publish an extension of Halley's tables and find even more periodic comets. He mentioned his desire in a letter to the French astronomer Joseph-Nicolas de l'Isle (1688 – 1768), the first with whom Struyck started corresponding about comets.[286] He also requested (and received) data on some comets that had been observed in China, of which apparently notes were kept in the Parisian libraries.

These efforts resulted in the five essays in the *Inleiding*. Struyck primarily wanted to determine the 'Newtonian' orbital coordinates that could describe their parabola-shaped orbits. To do this, he analysed historical observation data in a way that resembled Halley.[287] Struyck believed that several of these observations must have described the appearance of the same comet, because he thought the total number of comets did exceed a hundred (and there had been more comet sightings).[288] He hoped

[281] Brown, 'The Evolution of the Term "Mixed Mathematics"', 81.
[282] Withers, *Placing the Enlightenment*, 195.
[283] Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 134. At the same time, Struyck was not entirely convinced that comets had a fixed orbit. He also expresses that some scholars think that comets reach closer to the sun with every orbit, and will eventually 'fall into it and serve as food for it.' He has not yet made up his mind about the issue. Dutch: '… dat de Comeeten allenks de Zon naderen in ieder omloop; en dat die na verloop van een langen tyd daar in zullen vallen, en als tot voedzel van de zelve verstrekken.' Struyck, *Inleiding*, 5 (part II).
[284] Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 133.
[285] Zuidervaart, 134; Struyck, *Inleiding*, 4 (part II).
[286] Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*, 112.
[287] Zuidervaart, 112.
[288] Struyck, *Inleiding*, 23-4 (part II).

to detect new periodic comets, adding to Halley's 24, by spotting similarities in their orbital coordinates. For this reason he attempted to describe all comets by their coordinates, writing that

> '… if this were done according to the proposition of a parabolic path for all the comets of which we have accurate observations, then, when one of these same comets would be seen again, one would be able to discover that same [comet's] orbit by a single observation of the place in longitude and latitude, or at most by two [observations]; and one could even assure oneself whether it was that [periodic] comet that had been taken as the subject of his investigation.'[289]

That strategy had not yet worked out when he published the essays. Most historical sources had not described comet appearances in enough detail to determine the required orbital coordinates.[290] However, Struyck still suggested eight new periodic comets in the essay, albeit based on 'just' the periodicity in their appearance and not their orbital coordinates.[291]

Also in his heavenly geography, Struyck did not usually work from his own observations. Although he possessed a telescope and described his own findings sometimes, his astronomical writings principally rested on all kinds of written sources.[292] He relied on what he had encountered in books and publications but also requested specific material, like in his correspondence with De l'Isle. This way he was able to compile an enormous amount of data. He used these sources to describe the comet appearances described in classical literature and traced all comet appearances up to those found by astronomers of his own time. Connecting such wide-ranging material is not easy but required many deliberate calculations. He found a way to bridge their great differences by converting the data found in descriptions into orbital coordinates. These coordinates described the comets a way through which they could be compared. Through that comparison, Struyck then hoped to determine which appearances must have been one and the same comet. We recognize, again, his quantitative method. For one thing, these historical observations thus served as a source for contemporary astronomy, but he also combined these calculations with a philological reconstruction of the astronomical knowledge of ancient times. Struyck recounted what 'the wise men of the old times' thought about comets and

---

[289] Dutch: '… indien dit uitgevoerd was van alle de Comeeten, daar men de nette waarneemingen van heeft, volgens de stelling van een Parabolische weg, wanneer een van de zelve wederom gezien wierd; zoo zou men door een enkelde Waarneeming van de plaats in lengte en breedte; of ten hoogsten door twee, de omloop van dezelve kunnen ontdekken, en zig zelfs verzeekeren, of het wel die Comeet was, dewelke men tot een grond van zyn onderzoek nam.' Struyck, 24 (part II).

[290] Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 135.

[291] Of these eight, there were only three comets that Struyck surely believed to return. For three others he considered this probable. The return of the last two was more a suggestion than a statement that could be defended with some confidence. Zuidervaart, 118.

[292] Struyck brings up that he owns a 7-feet reflecting Newtonian telescope made by George Hearne, as well as a 26-feet binocular. He occasionally describes his own observations, such as of the moons of Jupiter on 30 August 1724. Struyck, *Inleiding*, 22–27.

explained how they combined their observations with superstition.[293] According to Struyck, reliable knowledge only developed when scholars like Tycho Brahe, Johannes Kepler, Hevelius and Newton started looking at comets 'more seriously.'[294] The essays not only tell what astronomical knowledge we have now, but also how it had been developed over time.

Since comets only appeared ever so often, all astronomers had to rely on written accounts of earlier observations to some extent. Combine that with the fact that the role of mathematics was large and firmly established in astronomy: it is no wonder that calculating based on historical data was an obvious and omnipresent practice in astronomy.[295] Astronomers had long realized that observations became more valuable if they were combined. In this sense, Struyck's style fit well into established astronomy. It even seems reasonable to assume that it were these astronomical practices that inspired his distinct quantitative approach in general.

However, Struyck's heavenly geography was quite uncommon in his exceptionally critical attitude towards other astronomers' findings, as well as his plea to consult the observations as described in the original sources. He took the goal of data criticism very seriously:

> 'On the whole, I find 174 errors or mistakes in Johannes Hevelius' 12th book on the description of the comets. I do not say this to obscure the fame of that excellent observer and great astronomer, but to show that one should consult the comet writers with caution, and rather seek what one needs in this respect in the [works of the] historians themselves.'[296]

Struyck spotted these errors by comparing Hevelius with Riccioli, Keckermann, Newton and many other scholars. He argues what aspects are and are not 'in agreement with the other writers of the time.'[297] Most of these comments question their reconstructions of the time and day they claim that certain comets had been seen in ancient times. Struyck is keen to criticize his peers and predecessors and uses quantitative comparison to justify his remarks. Modern literature likewise recognizes Struyck for his 'unusually critical' attitude and for producing the 'first critical study of the historical sources about comets ever published.'[298] The extent of his data criticism was thus unprecedented.

---

[293] Struyck, 1-2 (part II).
[294] Struyck, 2-4 (part II).
[295] Stigler, *The History of Statistics*, 5–6.
[296] Dutch: 'In 't geheel vind ik 174 misslagen of verdigtzelen in 't 12de Boek van de Beschryving der Comeeten, door Joannes Hevelius: Ik zeg dit niet om den roem van dien voortreffelyken Waarneemer en grooten Sterrekundigen te verduisteren; maar om aan te toonen, dat men de Comeetschryvers met omzigtigheid moet gebruyken, en liever, 't geen men des aangaande noodig heeft, by de Geschiedschryvers zelfs zoeken.' Struyck, *Inleiding*, 9 (part II).
[297] Dutch: '… en dit laatste komt met de andere Schryvers van dien tyd overeen.' Struyck, 9 (part II).
[298] Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*, 116; Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 135.

In the end, Struyck failed in finding more periodic comets. No wonder, because we now know that his entire undertaking was impossible in practice.[299] Struyck never realized it, but his estimate of the number of comets was much too small. Had he known that there were not a hundred comets, but a multiple thereof, then he might have realized that it was impossible to spot periodic comets in the way he attempted, neither through orbital coordinates nor periodicity.

In this paragraph I have argued that Struyck looked at the heavens by compiling, converting and comparing quantitative data in a highly critical way. These practices were not as unconventional in astronomy as they were in many other fields, so it might very well be that this had been a source of inspiration for Struyck's more general approach. In any case, I have demonstrated that Struyck measured the heavens and the world underneath it in similar ways, both through his quantitative method. His astronomical efforts were therefore not separated from, but well-connected to his other geographical activities. They should be interpreted as part of a wider attempt to describe the world, in its terrestrial, civil and astronomical aspects.

3.4 Conclusions

Overall, this chapter has related the terrestrial, civil and heavenly components of Struyck's geography. In the first paragraph we have seen that Struyck wanted to describe the world by its terrestrial as well as its civil characteristics. He investigated the distribution of land over the earth just like he investigated the distribution of people, and both divisions were quantified in parallel ways. Contrary to the common conception, civil geography was thus an inherent part of Struyck's geography. He investigated this civil geography and demographic characteristics in the chapter on divisions of the earth, but also the essay of *conjectures on the state of the human race*, which I demonstrated in the second paragraph. Struyck employed his quantitative method for civil geography in ways similar to how he used it for terrestrial geography. Moreover, in the third paragraph we have seen that likewise it was the practice through which he approached the heavenly geography. For this reason I have argued that Struyck's astronomical and demographic contributions should not be interpreted as two disunited islands. It makes much more sense to approach these as heavenly and civil geography, which together with terrestrial geography form the discipline Struyck regarded as 'geography'.

In chapter 2 I have introduced Struyck's quantitative method as the centrepiece of my interpretation of the *Inleiding*, or, of that part of Struyck's work that had not been researched by modern historians. I have presented it as a first answer to how Struyck quantified empirical observations, our research question. In this chapter, I have extended this answer. I have demonstrated

[299] Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 135.

that his quantitative method is not only the key element of Struyck's terrestrial geography, but that it likewise aligns with his approach to civil and heavenly geography, including what other historians have written about this earlier (although their research framed it as population statistics and astronomy). My present thesis thus connects and extends their earlier research to Struyck's contributions. It provides a framework to see their contributions not as disconnected efforts, but as part of a larger whole. Consequently, I think understanding Struyck's inquisitive approach is indispensable for any comprehensive account of Struyck as a scholar. His quantitative method unified all scholarly activities he considered geography (terrestrial, civil, and heavenly).

In the end, his quantitative method not only unified Struyck's geography. It is also what made it unique. In the next chapter I will argue that it was not the obvious method at the time and that his contemporaries proceeded in unmistakably distinct ways. The comparison shows how Struyck's aims and ideas about using numbers differ from others around him, and help us understand why he believed numbers were so valuable.

Chapter 4: Nicolaas Struyck and his contemporaries

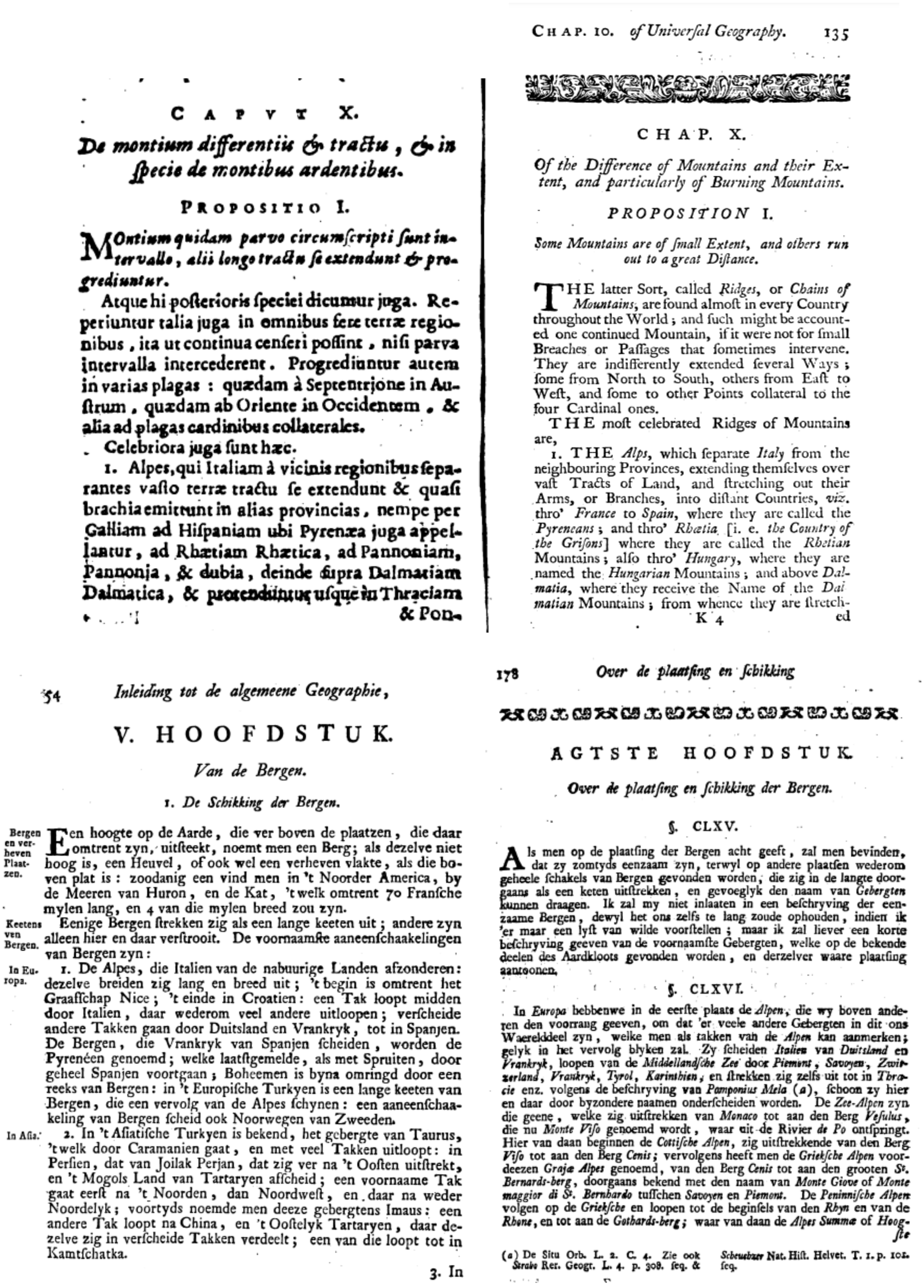
In the previous chapters we have largely focused on Struyck's own activities. I have introduced the scope, structure and content of the *Inleiding*, and explained how Struyck approached these subjects through his distinct quantitative method. But Struyck was not the only scholar in the Dutch Republic interested in geography in the early modern period, and there are several other general geographies that take an approach like the *Inleiding*. In this chapter I will therefore investigate how Struyck's approach in the *Inleiding* coincides and deviates from the two most significant similar works of his place and time. In this chapter I will argue that doing so points out the most important characteristic of Struyck's mathematical geography: that it was an attempt to *describe* the world, not *explain* it. He looked for general descriptions of phenomena, not the laws underlying them. This is the difference between quantification and mathematization, as introduced earlier in paragraph 0.1. The comparison unveils why Struyck believed quantification was a worthwhile undertaking. It thus answers the second part of our research question, which is *why* Struyck engaged in the quantification of empirical observations.

The first scholar that Struyck will be compared to is Bernard Varenius' *Geographia Generalis* (1650, Amsterdam), which I have already introduced in chapter 1.[300] The compassion with Varenius' non-empirical and logically-deductive style is a helpful starting point to highlights the differences between their respective mathematization and quantification of geography. Secondly, I will compare the *Inleiding* to Johan Lulofs' *Inleiding tot eene natuur- en wiskundige beschouwinge des aardkloots, tot dienst der Landgenooten* (1750, Leiden), which is much closer to Struyck's own time and geographical approach.[301] Still it is clear that in the mid-eighteenth century, there was not one single way to pursue geography in its 'mixed mathematical' sense.

Before we begin I want to emphasize how highly similar all three books were. The parallels between the books by Varenius, Struyck and Lulofs really cannot be missed. For all works, the first page of the chapter on mountains has been put next to each other in figure 21. Next to Varenius' original Latin, the English translation of 1734 has been included as well, to ease the comparison and because this edition is closer in time to Struyck and Lulofs' publications. The overview shows that all authors begin with a general introduction and then list the most important mountain ridges, beginning with Europe and the Alps. The descriptions that follow are likewise fairly similar to each other, and the three books clearly belong to the same geographical genre. The differences that will be pointed out in this chapter therefore highlight the different ways of pursuing general geography.

---

[300] Varenius, *Geographia Generalis*.
[301] Lulofs, *Inleiding tot eene natuur- en wiskundige beschouwinge des aardkloots ...*



CAPUT X.

De montium differentiis & tractu, & in ſpecie de montibus ardentibus.

PROPOSITIO I.

Montium quidam parvo circumſcripti ſunt intervallo, alii longo tractu ſe extendunt & progrediuntur.

Atque hi poſterioris ſpeciei dicuntur juga. Reperiuntur talia juga in omnibus fere terræ regionibus, ita ut continua cenſeri poſſint, niſi parva intervalla intercederent. Progrediuntur autem in varias plagas: quædam à Septentrione in Auſtrum, quædam ab Oriente in Occidentem, & alia ad plagas cardinibus collaterales.

Celebriora juga ſunt hæc.

1. Alpes, qui Italiam à vicinis regionibus ſeparantes vaſto terræ tractu ſe extendunt & quaſi brachia emittunt in alias provincias, nempe per Galliam ad Hiſpaniam ubi Pyrenæa juga appellantur, ad Rhætiam Rhætica, ad Pannoniam, Pannonia, & dubia, deinde ſupra Dalmatiam Dalmatica, & protenduntur uſque in Thraciam & Pon-

CHAP. 10. *of Univerſal Geography.* 135

CHAP. X.

Of the Difference of Mountains and their Extent, and particularly of Burning Mountains.

PROPOSITION I.

Some Mountains are of ſmall Extent, and others run out to a great Diſtance.

THE latter Sort, called *Ridges*, or *Chains of Mountains*, are found almoſt in every Country throughout the World; and ſuch might be accounted one continued Mountain, if it were not for ſmall Breaches or Paſſages that ſometimes intervene. They are indifferently extended ſeveral Ways; ſome from North to South, others from Eaſt to Weſt, and ſome to other Points collateral to the four Cardinal ones.

THE moſt celebrated Ridges of Mountains are,

1. THE *Alps*, which ſeparate *Italy* from the neighbouring Provinces, extending themſelves over vaſt Tracts of Land, and ſtretching out their Arms, or Branches, into diſtant Countries, *viz.* thro' *France* to *Spain*, where they are called the *Pyreneans*; and thro' *Rhætia* [i. e. *the Country of the Griſons*] where they are called the *Rhetian* Mountains; alſo thro' *Hungary*, where they are named the *Hungarian* Mountains; and above *Dalmatia*, where they receive the Name of the *Dalmatian* Mountains; from whence they are ſtretch-

K 4 ed

54 *Inleiding tot de algemeene Geographie,*

V. HOOFDSTUK.

Van de Bergen.

1. *De Schikking der Bergen.*

Bergen en verheven Plaatzen. Een hoogte op de Aarde, die ver boven de plaatzen, die daar omtrent zyn, uitſteekt, noemt men een Berg; als dezelve niet hoog is, een Heuvel, of ook wel een verheven vlakte, als die boven plat is: zoodanig een vind men in 't Noorder America, by de Meeren van Huron, en de Kat, 't welk omtrent 70 Franſche mylen lang, en 4 van die mylen breed zou zyn.

Keetens van Bergen. Eenige Bergen ſtrekken zig als een lange keeten uit; andere zyn alleen hier en daar verſtrooit. De voornaamſte aaneenſchaakelingen van Bergen zyn:

In Europa. 1. De Alpes, die Italien van de nabuurige Landen afzonderen: dezelve breiden zig lang en breed uit; 't begin is omtrent het Graafſchap Nice; 't einde in Croatien: een Tak loopt midden door Italien, daar wederom veel andere uitloopen; verſcheide andere Takken gaan door Duitsland en Vrankryk, tot in Spanjen. De Bergen, die Vrankryk van Spanjen ſcheiden, worden de Pyrenéen genoemd; welke laatſtgemelde, als met Spruiten, door geheel Spanjen voortgaan; Boheemen is byna omringd door een reeks van Bergen: in 't Europiſche Turkyen is een lange keeten van Bergen, die een vervolg van de Alpes ſchynen: een aaneenſchaakeling van Bergen ſcheid ook Noorwegen van Zweeden.

In Aſia. 2. In 't Aſiatiſche Turkyen is bekend, het gebergte van Taurus, 't welk door Caramanien gaat, en met veel Takken uitloopt: in Perſien, dat van Joilak Perjan, dat zig ver na 't Ooſten uitſtrekt, en 't Mogols Land van Tartaryen afſcheid; een voornaame Tak gaat eerſt na 't Noorden, dan Noordweſt, en daar na weder Noordelyk; voortyds noemde men deeze gebergtens Imaus: een andere Tak loopt na China, en 't Ooſtelyk Tartaryen, daar dezelve zig in verſcheide Takken verdeelt; een van die loopt tot in Kamtſchatka.

3. In

178 *Over de plaatſing en ſchikking*

AGTSTE HOOFDSTUK.

Over de plaatſing en ſchikking der Bergen.

§. CLXV.

Als men op de plaatſing der Bergen acht geeft, zal men bevinden, dat zy zomtyds eenzaam zyn, terwyl op andere plaatſen wederom geheele ſchakels van Bergen gevonden worden, die zig in de langte doorgaans als een keten uitſtrekken, en gevoeglyk den naam van *Gebergten* kunnen draagen. Ik zal my niet inlaaten in een beſchryving der eenzaame Bergen, dewyl het ons zelfs te lang zoude ophouden, indien ik 'er maar een lyſt van wilde voorſtellen; maar ik zal liever een korte beſchryving geeven van de voornaamſte Gebergten, welke op de bekende deelen des Aardkloots gevonden worden, en derzelver waare plaatſing aantoonen.

§. CLXVI.

In *Europa* hebbenwe in de eerſte plaats de *Alpen*, die wy boven anderen den voorrang geeven, om dat 'er veele andere Gebergten in dit ons Waerelddeel zyn, welke men als takken van de *Alpen* kan aanmerken; gelyk in het vervolg blyken zal. Zy ſcheiden *Italien* van *Duitsland* en *Vrankryk*, loopen van de *Middellandſche Zee* door *Piemont*, *Savoyen*, *Zwitzerland*, *Vrankryk*, *Tyrol*, *Karinthien*, en ſtrekken zig zelfs uit tot in *Thracie* enz. volgens de beſchryving van *Pomponius Mela* (*a*), ſchoon zy hier en daar door byzondere naamen onderſcheiden worden. De *Zee-Alpen* zyn die geene, welke zig uitſtrekken van *Monaco* tot aan den Berg *Veſulus*, die nu *Monte Viſo* genoemd wordt, waar uit de Rivier *de Po* ontſpringt. Hier van daan beginnen de *Cottiſche Alpen*, zig uitſtrekkende van den Berg *Viſo* tot aan den Berg *Cenis*; vervolgens heeft men de *Griekſche Alpen* voordeezen *Grajæ Alpes* genoemd, van den Berg *Cenis* tot aan den grooten *St. Bernards-berg*, doorgaans bekend met den naam van *Monte Giove* of *Monte maggior di St. Bernhardo* tuſſchen *Savoyen* en *Piemont*. De *Peninniſche Alpen* volgen op de *Griekſche* en loopen tot de beginſels van den *Rhyn* en van de *Rhone*, en tot aan de *Gothards-berg*; waar van daan de *Alpes Summæ* of *Hoogſte*

(*a*) De Situ Orb. L. 2. C. 4. Zie ook *Strabo* Rer. Geogr. L. 4. p. 308. ſeq. & *Scheuchzer* Nat. Hiſt. Helvet. T. 1. p. 102. ſeq.

FIGURE 21: THE CHAPTER ON MOUNTAINS IN DIFFERENT GEOGRAPHICAL WORKS. NOTE THE HIGHLY SIMILAR STRUCTURE AND CONTENT THAT THE BOOKS SHARE. LEFT TO RIGHT, TOP TO BOTTOM (SO STARTING AT THE LEFT TOP): VARENIUS (ORIGINAL LATIN EDITION, FIRST AMSTERDAM EDITION, 1650), VARENIUS (ENGLISH TRANSLATION BY DUGDALE AND SHAW, 1734), STRUYCK (1740), LULOFS (1750).

4.1 Bernard Varenius **(1622-1650)**

As we have seen in chapter 1, general geography would not have existed were it not for Bernard Varenius. He introduced the split between general and special geography with the intention to provide new, mathematical, foundations for geography. We have also already seen that Struyck was heavily influenced by his ideas and adopted many of the common standards of general geography. Still Struyck did not adopt Varenius' ideas one-to-one. The books were published ninety years apart (1650 resp. 1740), written in different languages (Latin resp. Dutch) and aimed at different audiences (academics resp. the general public). Instead of intending to assert new foundations for the field, Struyck wanted to advance his countrymen with general knowledge of the whole world. What I did not yet discuss in chapter 1 is how these books also took up different approaches to pursue mathematical geography. They might treat largely the same subjects, but they did not discus these in like ways. Now that we have become familiar with the details of Struyck's quantitative method in chapters 2 and 3, we can compare it to Varenius' style.

Struyck adopted and extended much we also recognize in Varenius' geography. That holds for the structure and content of descriptive sections, like the descriptions of mountain ridges we saw in figure 21, as well as for numerical data. We see this in figure 22, which shows both their tables of the latitude and longitude of several places on earth. Struyck's table is designed similarly to that of Varenius, but also contains his own revisions and improvements. He added missing data (e.g. Aleppo), corrected values (e.g. Avignon), and extended the table by adding the North/South or East/West distinction (in the penultimate column). In the final columns, Struyck describes where he compiled the newly obtained data, though not for all rows. Struyck thus had improved Varenius' book, but that did not mean that he saw it as a complete replacement for Varenius' original. On the contrary: after he finished his *Inleiding,* he started working on a Dutch translation of Varenius' geography. It was published in 1750 and titled *Volkomen samenstel der aerdryksbeschryving in het algemeen, verklarende de Natuur en Eygenschappen der Aerde.*[302] The third part of the book contained supplements of which the first 64 pages are notes by Struyck.[303] The translation indicates that Struyck still considered Varenius' geography to be relevant for the general (non-Latin) Dutch public, even though it already had access to his own geography.

[302] Varenius, *Volkomen Samenstel Der Aerdryksbeschryving*. The translated edition had been the the 'last and most improved' version by Dugdale and Shaw. In a newspaper in 1749 the book was advertised as: 'The widely acclaimed Newton and others used this work to teach the students at their high schools.' Krogt, 'Advertenties Voor Kaarten, Atlassen, Globes e.d. in Amsterdamse Kranten 1621-1811', 197.

[303] Krogt, 'Advertenties Voor Kaarten, Atlassen, Globes e.d. in Amsterdamse Kranten 1621-1811', 197; Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*, 111, 459–60.

of *Aardryks-beschryvinge.* 145

Tafel der Breedte en Lengte van eenige Plaatzen.

A

		graad. min.		graad. min.		
Abbeville . . .	C	50 : 7	N	0 : 27	W	L
Agde . . .	D	43 : 19	N	1 : 8	O	
Agra, in 't Mogolsland	C	26 : 43	N	74 : 24	O	(a)
Aix, in Provence .	C	*43 : 31	N	* 3 : 12	O	
Alby . . .	C	*43 : 55	N	* 0 : 12	W	
Alencon . . .	C	48 : 25	N	2 : 15	W	
Aleppo, in Syrien .	C	35 : 45	N	35 : 0	O	L
Alexandrien, in Egipten	C	31 : 11	N	27 : 56½	O	
Algiers . . .	C	36 : 49½	N	7 : 15	W	
Almerie, in Spanjen .	F	*36 : 51	N			
Amiens . . .	C	*49 : 55	N	* 2 : 12	W	
Amsterdam . .	C	52 : 23	N	2 : 39	O	L
Angers . . .	C	47 : 29	N	2 : 54	W	
Antibes . . * .	C	*43 : 34	N	* 4 : 48	O	
Antwerpen .. .	C	51 : 13½	N	2 : 10	O	
Archangel, in Moscovien .	.	64 : 34	N	36 : 37	O	(b)
Arica, in Peru . .	F	18 : 27	Z	73 : 31	W	
Arles . . .	C	43 : 34	N	2 : 21	O	L
Arras . . .	C	50 : 18	N	0 : 24	O	
Avignon . . .	C	*43 : 57	N	2 : 32	O	
Avranches . . .	C	48 : 41	N	3 : 43	W	
Aurillac . . .	C	*44 : 55	N	0 : 7	O	
Auxerre . . .	F	47 : 46	N	1 : 10	O	(c)

B.

Barcelona . .	C	41 : 26	N	0 : 7	W	
Basel . . .	C	47 : 55	N	5 : 15	O	
Bayeux . . .	C	49 : 16	N	3 : 3	W	
Bayonne . . .	C	*43 : 30	N	* 3 : 49	W	laHire en L
Beauvais . . .	C	49 : 26	N	0 : 15	W	
Berlyn	C	52 : 33	N	11 : 7	O	
Bezancon . . .	C	47 : 18	N	3 : 30	O	
Beziers . . .	C	43 : 20	N	0 : 53	O	

T 2 Boca

(a) *P. Gaubil.* heeft de Breedte 26 graad., 48 min.
(b) Comm. Acad. Petrop., tom. 3, pag. 464.
(c) *La Hire* heeft de Breedte 47 graad., 35 min.

658 *Geographia Generalis*

TABULA LONGITUDINIS ET LATITUDINIS LOCORUM.

Nomina locorum.	Latitudo. gr.	min.	Longit.	
Adrianopolis Thraciæ.	43	0	53	
Ænipontum.	46	55	35	
Ætna mons Siciliæ.	38	20	39	
Agra in Megoris regno.	34	38	87	7
Alba Græca, sive Belgrado in Hungaria.	47	40	45	
Alexandria Ægypti.	30	58	60	30
Algerium Africæ.	32	30	22	
Amstelodamum.	52	26	26	30
Ancona.	43	40	38	30
Angola Africæ Austr.	9			
Antiochia Syriæ.	37	0	75	15
Antverpia.	51	16	26	
Alepo Syriæ.				
Aquileja Italiæ.	45	12	34	
Aquinum, D. Thomæ.	41	56	38	30
Aquisgranum.	50	48	27	30
Aden Arabiæ.				
Ostium Araxis fl.	46	0	81	0
Arbela.	35	52	89	
Ostia Argentei fluvii.	35			
Argentoratum.	48	44	27	50
Ariminum.	43	50	35	
Armusa, Ormus.	27	24	95	57
Aromata promontor. Africæ, hodie Guardafur.	14	20	88	40
Ascalon.	32	27	67	20
Athenæ.	37	15	53	0
Avenio, Avignon.	43	52	23	0
Augusta Vindelic.	48	21	33	0
Aurasicum, Aurange.	43	30	26	30

Aureæ

Figure 22: Tables on latitude and longitude, the left by Varenius and the right by Struyck. Varenius, *Geographia generalis*, 658; Struyck, *Inleiding*, 145.

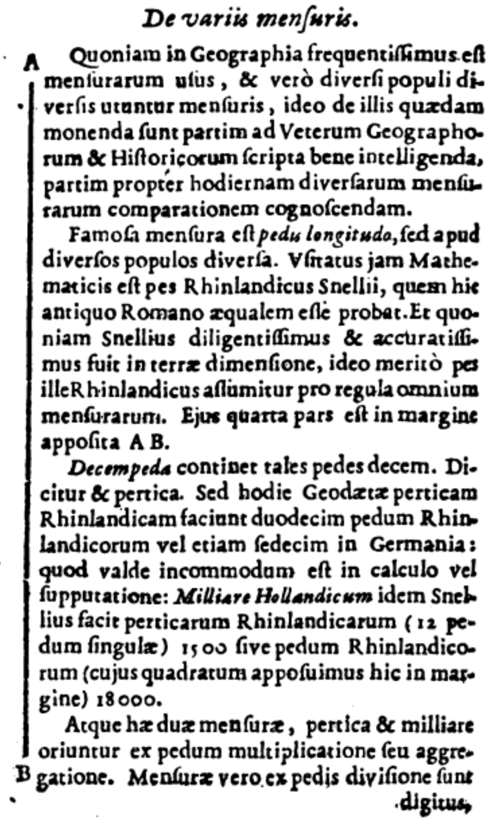
The *Inleiding* and the *Geographia Generalis* might thus look similar in design and content, but nevertheless Struyck and Varenius discussed geographical topics in distinctly different styles. Their divergence entails more than an updating of work after 90 years of new results. As I described in paragraph 1.1, Varenius' book provides knowledge about the earth and a justification for that knowledge through reasoning and arguments. These are presented in a coherent (and often enumerated) logical structure to substantiate certain claims. For example, when Varenius writes that 'the reasons for the Copernican hypothesis are these,' this is followed by an enumeration of eight arguments, then their respective counterarguments, and finally his answers to those.[304] It is a logically-deductive justification for his claim, not using any empiricist basis. Recall that Varenius argued that any reliance on observation and experience should be avoided in geography, because he believed these did not constitute appropriate foundations. The opposite is true for Struyck. The *Inleiding* is primarily founded on empirical observations, though he is investigating the appropriate ways to justify those. Through his quantitative method he intended find a way to combine observation, experience as well as mathematical, geometrical, or astronomical laws. The difference is not too surprising, because only

[304] Varenius, *Geographia Generalis*, 49–55.

since the turn of the eighteenth century, 'observation' as a first-hand experience had become a common practice.[305] Moreover, where Struyck focused on investigating the appropriate mathematical strategy for analysis, Varenius concentrated on results. Varenius wanted to inform his reader about what the world was like and why it was like that. He used historical data, but only because it still informed his modern insights. Struyck, on the contrary, wanted to describe what we know and have known about the world. He saw the reconstruction of historical knowledge also as a goal by itself. Nevertheless, both accounts were comprehensive in applying a method that provides general knowledge that holds for the whole world.

Because of these different conceptions, Struyck had to deal with different problems than Varenius. The issue of measurement units as described in paragraph 2.2 was a big frustration to Struyck, but only a small complication to Varenius. Struyck undertook a complicated historical recalculation to find a common measure, attempting to find common ground between old and new values so that he could refer back to the important essay in the rest of his book. He wanted to reconstruct the ancient units, as well as solve the problems arising from equating old and new observations. Varenius was much easier off. He simply enlisted a multitude of mainly contemporary units and put them next to the Rhineland foot of Snellius (which 'is deservedly taken as the standard for all other measures, because Snellius was very diligent and accurate in measuring the dimensions of the earth').[306] He accepted the established conversion as one of his premises but did not question the appropriate methodology to convert various measures. It was a much shorter and more practical solution. Such problems resulting from working with empirical observations were much less of a problem for him than they were for Struyck. Varenius accepted one solution as a premiss and continued his logical reasoning with it. Moreover, Varenius thus uses a concrete length, whereas Struyck investigated abstract ratios (undefined 'parts') to compare the different units. In fact, Varenius even provides a very concrete printed line segment AB of this length in the margin (see figure 23). To

[305] Daston and Lunbeck, *Histories of Scientific Observation*, 85.
[306] Varenius, *Geographia Generalis*, 16.



De variis mensuris.

A Quoniam in Geographia frequentissimus est mensurarum usus, & verò diversi populi diversis utuntur mensuris, ideo de illis quædam monenda sunt partim ad Veterum Geographorum & Historicorum scripta bene intelligenda, partim propter hodiernam diversarum mensurarum comparationem cognoscendam.

Famosa mensura est *pedis longitudo*, sed apud diversos populos diversa. Usitatus jam Mathematicis est pes Rhinlandicus Snellii, quem hic antiquo Romano æqualem esse probat. Et quoniam Snellius diligentissimus & accuratissimus fuit in terræ dimensione, ideo meritò pes ille Rhinlandicus assumitur pro regula omnium mensurarum. Ejus quarta pars est in margine apposita A B.

Decempeda continet tales pedes decem. Dicitur & pertica. Sed hodie Geodætæ perticam Rhinlandicam faciunt duodecim pedum Rhinlandicorum vel etiam sedecim in Germania: quod valde incommodum est in calculo vel supputatione: *Milliare Hollandicum* idem Snellius facit perticarum Rhinlandicarum (12 pedum singulæ) 1500 sive pedum Rhinlandicorum (cujus quadratum apposuimus hic in margine) 18000.

Atque hæ duæ mensuræ, pertica & milliare oriuntur ex pedum multiplicatione seu aggre-
B gatione. Mensuræ vero ex pedis divisione sunt

digitus,

FIGURE 23: VARENIUS' DISCUSSION OF MEASUREMENT UNITS. NOTE THE LINE SEGMENT AB IN THE LEFT MARGIN. VARENIUS, GEOGRAPHIA GENERALIS, 16.

Varenius, converting various measures is relevant as a brief list of practical results, but it is not part of the necessary groundwork for the rest of his book.

Another large difference is what domains both authors considered proper geography. Varenius had defined general geography as the discipline that dealt with the physical world which could be grasped through mathematics, and in which human factors had no place.[307] The ‘human geography’ only had a place in special geography in his classification, because he believed it could not be measured and was not universal. Although it could still inform our knowledge of individual regions, he did not consider it suitable for a global scale. Varenius himself rather provided knowledge about the physical world, detached from the human place in it. As Baker put it, ‘he held pure geography to be a matter apart from political and social consideration.’[308] As we have seen in chapter 3, Struyck does not agree with this view. Even though he adopted the split between general and special geography and likewise

[307] Several scholars have elaborated on this topic. For a more detailed discussion, see also Baker, ‘The Geography of Bernhard Varenius’; Unwin, *The Place of Geography*; Warntz, ‘Newton, the Newtonians, and the Geographia Generalis Varenii’; Hermans, ‘Johan Lulofs en zijn tijdgenoten’.
[308] Baker, ‘The Geography of Bernhard Varenius’, 51.

focused on the former, he regards civil geography as proper geography as well. His solution was to use population statistics to quantitatively approach civil geography. As I have also argued in paragraph 3.1, Struyck's views on the legitimacy of civil geography were not common among geographers.

To sum up, despite that Varenius and Struyck's books appear much alike, there are also large distinctions between their approaches to mathematical geography. Varenius saw geography as a mathematical model to look at the world. All phenomena he studied ought to fit in here and be explained by it. He tried to reduce nature to its corresponding underlying mathematical laws and explain the world through this logically-deductive model. The empirical only had a minor function. Varenius thus wanted to mathematize the world (in the sense mathematization has been described in paragraph 1.1). Struyck, on the other hand, did not attempt to embed all phenomena in such a mathematical model. He quantitatively described empirical observations, but he did not explain what laws led to the occurrence of certain phenomena. Although he tried to measure the world in a way so that these numbers could describe it as a coherent whole, he did not explain why these things happened by referring to their underlying mathematical relations. Instead of these explanations, he used his quantitative method primarily to find universal descriptions of the world. This comparison thus shows that Struyck quantified, not mathematized.

We should, however, realize that Varenius' book is about a century older than the *Inleiding*. Although Varenius' logically-deductive style highlights that Struyck did not look for such mathematical models, it is not too surprising that Struyck's approach differs from Varenius'. The use of empirical observations had become more central in all sciences. I will now compare the *Inleiding* to a book much closer connected in time. In the next paragraph, the *Inleiding* will be held against its most neighbouring counterpart, a general geographical work of the mid-eighteenth century that we have not yet encountered earlier in this thesis.

4.2 Johan Lulofs (1711-1768)

A scholar who cannot be overlooked when it comes to early modern Dutch geography is Johan Lulofs. Together Struyck and Lulofs were considered the internationally top scholars in geography at the time – albeit only for a brief period of time, before advancements in German geography started to surpass the Dutch.[309] The men knew each other and corresponded about their work, for example sharing their astronomical observations. Nevertheless, Struyck and Lulofs generally operated in different circles: Lulofs was a prototypical academic while Struyck had no formal ties with academia. Lulofs was also 25

[309] Dutch: 'Van nu af aan staan onder de beoefenaars der wetenschappelijke aardrijkskunde de Nederlanders een tijdlang bovenaan, zooals de namen en werken van een Nicolaas Struyck, Johannes Lulofs, Nicolaas Witsen ons bewijzen.' Zondervan, 'De richting in de beoefening der aardrijkskunde vóór A. von Humboldt en C. Ritter', 754.

years younger than Struyck. When Struyck published the *Inleiding* at the age of 52, the 27-year-old Lulofs had just started to accelerate his academic career. He became a professor in mathematics and astronomy in Leiden in 1742, where he succeeded ‘s Gravesande and had Musschenbroek as his close colleague.[310] The academic work took up much of his time. His busy schedule meant a delay for the geography book he had been working on since 1740. Instead of the three years he initially intended to spend writing, he would be editing the book for ten years. The resulting *Inleiding tot eene natuur- en wiskundige beschouwinge des aardkloots, tot dienst der Landgenooten* (1750) is generally regarded as his main work.[311] It is still relatively well-mentioned in historiographical literature but it could acquire this moderate fame only because it would be translated into German in 1755 (something Struyck’s *Inleiding* would not experience). This reputation developed primarily because Kant, who produced the most important geographical writings of the second half of the 18th century, knew of the translation and mentioned Lulofs’ work in his writings.[312] For the rest, Lulofs own reputation is quite like that of Struyck, in the sense that, according to Vermij, ‘it has gone downhill with Lulofs’ reputation [since his own time] and presently he is nearly forgotten.’ Vermij suggests that this might be because Lulofs did not do any great discoveries and had not developed ground-breaking new theories.[313]

The starting year of Lulofs’ writing in 1740 coincides with the publication of Struyck’s *Inleiding*. That might or might not be a coincidence. In any case, Lulofs argued Struyck’s work should be improved.[314] His writing was motivated by the lack of a decent handbook on the topic, ‘in general, and in particular one for our fellow countrymen.’[315] This last comment indicates that he did not think Struyck’s *Inleiding*, with its exact same purpose, sufficed. Lulofs had read the work and already referred to him halfway the first page, where he commented that ‘Mr. Struyck's work, which has been quoted several times, contains many useful things.’[316] He was much less praiseful about Varenius, whom he named as one of the writers he has ‘not dared to make use of, because … I found that they either themselves tried to mislead the reader with false, at least unfounded, stories, or were deceived by

---

[310] Hermans, ‘Johan Lulofs en zijn tijdgenoten’, 91; Zuidervaart, *Van ‘konstgenoten’ En Hemelse Fenomenen*, 136.
[311] Lulofs, *Inleiding tot eene natuur- en wiskundige beschouwinge des aardkloots ...* The translation of Lulofs’ term ‘*natuurkundig’* is open to multiple interpretations, as the Dutch term could refer to scholarly activities physics, natural history, and natural philosophy at the time.
[312] Hermans, ‘Johan Lulofs en zijn tijdgenoten’, 100; Unwin, *The Place of Geography*, 71.
[313] Vermij, ‘Johannes Lulofs als vertegenwoordiger van het newtonianisme in de Republiek’, 137.
[314] In 1741, Lulofs published *Inleidinge tot de waare natuur- en sterrekunde*, the translation of a work by John Keill. Although it was broadly annotated, he never mentioned Struyck. Zuidervaart interprets this as a sign of rejection by Lulofs. Zuidervaart, *Van ‘konstgenoten’ En Hemelse Fenomenen*, 141.
[315] Dutch: ‘… dat 'er in het algemeen en inzonderheid onzen Landgenooten, (schoon het meermaalen aangehaalde werk van den Heer Struyck veele nuttige dingen behelst,) nog eene Natuur- en Wiskundige Beschouwing van onzen Aardkloot ontbrak.’ Lulofs, *Inleiding tot eene natuur- en wiskundige beschouwinge des aardkloots ...*, voorreden.
[316] Dutch: ‘… schoon het meermaalen aangehaalde werk van den Heer Struyck veele nuttige dingen behelst …’ Lulofs, voorreden.

others.'[317] Still it is questionable how serious we should take his statement, because Lulofs provides about 100 references to Varenius' *Geographia Generalis* in Lulofs' book.

Like Struyck, Lulofs thus wanted to write for his fellow countrymen. Lulofs motivated this by writing that 'many Dutch people are animated with an admirable virtue and love for the natural and mathematical sciences.'[318] However, it is not entirely clear who his audiences included exactly. Struyck had used the term to refer to the educated layman, as we have seen in chapter 1. But whereas Struyck's use of his mother tongue had been the obvious choice, Lulofs spent much time defending his choice, as if his audience would not find it so obvious.[319] Moreover, historiographical literature has described Lulofs' *Inleiding* as a scholarly handbook intended for academics and accepted by the academic community as such.[320] According to Hermans,

> '[Lulofs' *Inleiding*] is revolutionary in more than one sense, among other things because it was written directly in Dutch and not in Latin, something that can be called exceptional for scientific writings in Lulofs' time. Nicolaas Struyck's *Inleiding tot de Algemeene Geographie* had also been written in Dutch, but this work aimed at educated laymen more than scholars.'[321]

So, when it comes to audience, it appears that Lulofs' book also aimed for academics next to (or even instead of) the general Dutch public. In any case it is safe to conclude that his readers were more thoroughly educated than Struyck's.

In his geography Lulofs argued that he wanted to explain the earthly phenomena through mathematics and physics. Like Varenius and Struyck, it is an undertaking he characterizes as mathematics.[322] Unlike them, however, he does not describe his efforts in terms that denote it as 'geographical' at any place in the book. He thus framed his undertaking differently than Varenius and Lulofs, and did not explicitly mention that he attempted to write a general geography. Still Lulofs adopted the practices common to 18th-century general geography as we have come to know them in the previous chapters. Like Struyck he adopted Varenius' classification of geography as the basis for the book's chapter structure (see figure 24). Lulofs first deals with what he calls the natural history of

[317] Dutch: '… ik heb van veelen [schrijvers] geen gebruik durven maaken, om dat ik na een ryp onderzoek bevond, dat zy of zelve den Leezer met valsche, ten minsten ongegronde vertelselen zogten te misleiden, of van anderen bedroogen waren; om welke reden men Varenius, Kircherus en diergelyke Schryvers doorgaans, met eenige omzigtigheid zal aangehaald vinden.' Lulofs, voorreden.

[318] Dutch: '… daar veelen onzer Nederlanderen met een pryslyke zugt en liefde tot de Natuur en Wiskunde zyn bezield.' Lulofs, voorreden.

[319] Lulofs apologized for his lack of 'linguistic neatness and elegance' and his use of artificial Dutch words. Moreover, he claimed to have introduced plenty of artificial Dutch words since only their Latin counterparts existed – and included a dictionary with translations at the end. Lulofs, voorreden.

[320] Hermans, 'Johan Lulofs en zijn tijdgenoten', 7; Vos, 'Beknopte geschiedenis van de fysische geografie en haar toepassingen', 25.

[321] Hermans, 'Johan Lulofs en zijn tijdgenoten', 7.

[322] Lulofs, *Inleiding tot eene natuur- en wiskundige beschouwinge des aardkloots ...*, voorreden.

LYST

DER

HOOFDSTUKKEN.

EERSTE DEEL.

XVIII.

LYST DER HOOFDSTUKKEN.

TWEEDE DEEL.

BERICHT AAN DEN BOEKBINDER.

De Plaat van de Opdragt moet gezet worden agter de Tytel.
De Plaaten Tab. I. tot XV. agter bladz. 648.

IN-

FIGURE 24: THE TABLE OF CONTENT OF LULOFS' *INLEIDING TOT EENE NATUUR- EN WISKUNDIGE BESCHOUWINGE DES AARDKLOOTS, TOT DIENST DER LANDGENOOTEN* (1750), IN WHICH WE RECOGNIZE VARENIUS' INFLUENCE. LULOFS, *INLEIDING*.

the earth, and secondly treats the phenomena influenced by the sun and other celestial bodies. That he called called this a mathematical investigation of the earthly sphere instead of a general geography indicates that the academic status of geography was still somewhat uncertain.

Experiment and observation played a similar role for Lulofs as they did for Struyck: they were the basis of all knowledge about the world. Both scholars operated as a compiler and based their writings on a diverse and wide range of sources. Among these, Lulofs also included Struyck. Lulofs credited Struyck's discussion on measurement units in the *Inleiding*, although he did not agree with all Struyck's calculations: 'I have more than one reason not to settle for Mr Struyck's shrewd thoughts.'[323] Lulofs' main two points of criticism concern Struyck's readings of classical sources. He argues that Struyck misinterprets Hipparchus and Pliny's texts. According to Lulofs, Hipparchus' estimate of the earth's circumference had been 277.000 stadia, not 275.000; and he corrected the value of a stadium of Eratosthenes to 570.746 Parisian feet. Apparently, Lulofs had more criticism, but 'to preserve brevity, I will skip the other things of lesser importance here.'[324] Next to Lulofs' opinion of Struyck, this

[323] Dutch: 'Ik hebbe meer dan ééne reden, om in de schrandere gedagten van den Heer Struyck niet te kunnen berusten,' Lulofs, 64.
[324] Dutch: 'Andere dingen van minder belang gaa ik voorby, om de kortheid te bevlytigen.' Lulofs, 65.

issue also illustrates how Lulofs and Struyck employed similar ways of quantitative comparison for source criticism (which he also applied to Struyck's conclusions).

The depth of their mathematical analyses, however, is a major difference. For Struyck, the converting and comparison of his quantitative method were not always thoroughly substantiated, but Lulofs supplemented his arguments with extensive mathematical proofs. For example, where Struyck describes the earth as an imperfect sphere (based on observational data and a brief recalculation thereof), Lulofs extends on this and related topics, such as 14 pages of mathematical reasoning to find the exact ratio between the two diameters. His arguments are mathematically much more rigorous. Lulofs is also more explicit in the steps of his geometrical proofs than Struyck, though like Struyck he does not do so when he recalculates ancient estimates. This is not caused by Struyck being unable to develop these mathematical reasoning (because he was an excellent mathematician himself), but rather appears to originate from the different intended audiences.[325]

Not only was Lulofs much more thorough in his mathematical depth, but he was also much more focused on finding mathematical explanations for the earthly phenomena. As early as the first page he remarked that she wanted to investigate the size, movements, characteristics, and conditions of the earth, but that these cannot be investigated directly:

> 'Most of the phenomena which occur in our Earth, and which are objects of physical and mathematical contemplation, are so closely interwoven with their form that it is almost impossible to conceive of them, much less to explain their origin in a convenient manner, unless one immediately investigates the true form with which the earth is endowed. We shall therefore begin our consideration with this.'[326]

He thus looked at the physical manifestations of these phenomena only to be able to study them in a more abstract fashion later. He mentioned that he did not only want to *conceive of them*, but also *explain their origins.* This quote as well as his way of discussing the various geographical topics show that Lulofs wanted to do more than only describe the earth. He wished to create a mathematical framework to also explain the earthly characteristics and phenomena. In this sense, Lulofs' approach is more resembling to Varenius' than to Struyck's. Varenius and Lulofs tried to create a mathematical counterpart of the physical world that can serve as explanatory model for the encountered

[325] For example, both mentioned to have knowledge of the new 'fluxie-theory' by Newton and argue that the reader's mathematical ability plays a role in the choice to do or do not use it in a proof.
[326] Dutch: 'De meeste verschynselen, die zig in onzen Aardkloot op doen, en voorwerpen zyn van eene Natuur- en Wiskundige beschouwinge, zyn zo naauw verknogt met deszelfs gedaante, dat men 'er bynaar geen denkbeelden van kan maaken, veel minder derzelver oorsprong op eene gevoegelyke wyze verklaaren, zo men niet aanstonds onderzoek doed naar de waare gedaante, waar mede de Aarde voorzien is. Wy zullen derhalven onze Beschouwinge daar mede aanvangen.' Lulofs, *Inleiding tot eene natuur- en wiskundige beschouwinge des aardkloots ...*, 1.

phenomena, whereas Struyck only wanted to describe it through numbers. Lulofs (like Varenius) created a mathematized geography, whereas Struyck developed a quantified geography.

A final difference between Struyck and Lulofs concerns the place of civil geography in their books. Lulofs forcefully argued against including anything about the inhabitants of the earth in any mathematical description of the earth.[327] Later he called any distribution by government too arbitrary to contribute to his mathematical purposes:

> 'Some of those who have written about general geography are used to present a division of the world as have it originated by government; but I feel that this should be left to those who describe either the special geography or the political and civil histories of the earth; for I, intending a natural history and a mathematical contemplation of the earth, will set aside as far as possible that arbitrariness, which would exceed our present purposes.'[328]

To Lulofs, civil geography lacked the mathematical rigour to fit in his geography. Humans were too arbitrary. The reluctance to include this subject fit Lulofs' (and Varenius') search for a mathematized model: humans could not be explained by laws of nature, these scholars argued. Struyck, on the other hand, did not attempt to find any such explanatory laws. He only wanted to describe humans like he described the earth, and that was something population statistics could do very well.

We can conclude that Struyck and Lulofs created two very similar books, which were created around the same time and place and written in the same language. The men were in contact with each other and Lulofs knew of Struyck's *Inleiding*. Both also collected and compared empirical observational data, which they used as the basis for their mathematical geography. Nevertheless, their geographies still differed from each other in significant ways. Lulofs' book was much more mathematically rigorous and aimed at a more thoroughly educated public than Struyck's. But the most important point is that Lulofs wanted to find mathematical explanations for the phenomena he investigated. He wanted to account for these phenomena and excluded topics that were too arbitrary for such a mathematical explanation. In other words, Lulofs mathematized, not quantified. Struyck, on the other hand, did not desire to explain but only described regularities. The difference comes down to the distinction between mathematization and quantification. What this tells us about Struyck's quantitative geography will be discussed in the following paragraph.

---

[327] Lulofs, voorreden.

[328] Dutch: 'Zommigen der geenen, die over de Algemeene Aardklootskunde geschreeven hebben, zyn gewoon over de verdeelinge van deze, zo als dezelve uit de Regeering oorspronkelyk is, te handelen; doch ik oordeele, dat men dit diende over te laaten aan die geenen, die of de byzondere Geographie, of de Staatkundige en Burgerlyke Geschiedenissen des Aardkloots beschryven; daar ik, een Natuurlyke Geschiedenisse en een Wiskundige Beachouwinge des Aardkloots voor hebbende, het willekeurige, dat ons bestek te verre zoude te buiten gaan, zo veel doenlyk is, zal ter zyden zetten.' Lulofs, 141. Twentieth-century geographers still mention this as one of the main characteristics that makes Lulofs' work more academic than Struyck's. Hermans describes Lulofs choice to delete human and animal subjects as 'a great improvement' for the academic nature of the discipline. See Hermans, 'Johan Lulofs en zijn tijdgenoten', 94.

4.3 Conclusions

In this chapter we have examined Varenius' and Lulofs' geography and compared it to Struyck's *Inleiding.* The comparison makes clear that a particular quantitative approach is not self-evident, not even for other works closely connected in time and space. Although Varenius, Struyck, and Lulofs build on each other's work, their books have unmistakably distinct characters. Comparing these geographies that are so closely related to each other, shows how Struyck's geography differed from his contemporaries. It is particularly interesting to see how his quantification differed from the others' mathematization.

The difference is most apparent for Varenius, who carried out geography through logically-deductive reasonings that relied on empirical observations as little as possible. He wanted to reveal what the world was like and explain why it was like that, and to do that he was mainly after the explanations for geographical phenomena. The same goes for Lulofs, although he compared empirical observations in ways that resemble Struyck's approach. Still, Lulofs embedded these in a rigorous mathematical framework and wished to 'explain their origin in a convenient manner.' We do not see any such desire to explain in Struyck's geography. Struyck wanted to spot the world's regularities, describe those things that were universal, and investigate how we had come to know this. He wanted to universalize and generalize experience and regarded numbers as a way to do so. The comparison emphasizes that unlike Varenius and Lulofs, he sought descriptions, not explanations.

To Struyck, the value of quantification was in the opportunity to verify observations and transform empirical singularity into general statements about the world. He was not interested in the height of one particular mountain, but in mountain height in general. Through quantification he could surpass singularities and achieve comprehensiveness. Nevertheless, Struyck provided descriptions, not explanations. This answers the final part of our research question. We now know why Struyck quantified empirical observations: because it allowed him to find general regularities and universal descriptions of the world. Struyck's quantification was not mathematization.

Conclusions

In this research I have addressed Nicolaas Struyck and his quantitative geography in the *Inleiding tot de algemeene geographie*. The previous four chapters discussed various aspects of his quantification, or, his way of translating the empirical world into meaningful numbers. This conclusion will re-evaluate the most important findings and come back to the overarching argument of this thesis, which primarily focused on putting geography at the centre of all Struyck's scholarly activities. I have argued that Struyck approached geography through a particular 'quantitative method', that this was central to all fields he considered geography and that his quantification differed from mathematization. Finally, I will end this section by pointing out the aspects I have not addressed in so much detail and providing some suggestions for further research.

Throughout this thesis we have gotten to know Nicolaas Struyck as scholar who discovered the world through his books, not through his experience. He wanted to share the geographical knowledge he had been able to compile with a wider Dutch public, which was his main reason for creating the *Inleiding.* This geographical treatise published in 1740 was not only Struyck's major work, but also one of the first comprehensive geographical handbooks in Dutch. He proceeded by compiling, converting, and comparing source data, which allowed him to evaluate it and pose data criticism. This is what I have called Struyck's 'quantitative method'. It was a transformative process for handling data and reshaping it into universal geographical knowledge, which Struyck did with an exceptionally critical attitude. Struyck employed quantification as a firmly principled method to obtain universal geographic knowledge about the world. His quantitative method was a way to generalize the singular empirical experiences of different observers. It was thus not so much a strategy to structure information or deal with information overload, as proposed by Stamhuis and Klep, who describe quantification primarily as a strategy that arose from the expanding quantity of available information in the 18th century.[329] All in all, we can now answer our research question, *how and why did Struyck quantify empirical observation in his geography?* This thesis has shown that Struyck quantified empirical observations through his quantitative method, which he systematically employed to provide general knowledge of the earth and to describe how that knowledge had developed.

Struyck used his quantitative method to be able to compare between modern and historical data. These types of sources were not so different for Struyck, who obtained access to all his data through writings. He not only used ancient data, but he also tried to reconstruct classical conceptions of geographical knowledge. This way his quantitative method connects newly emerging mathematical practices of working with empirical observations with the established philological study of literary

[329] Klep and Stamhuis, 'The Statistical Mind in a Pre-Statistical Era', 65–66.

sources. Struyck used, processed, and produced their data in multi-faceted manners. The way these traditions overlapped, shared practices, and transferred authority in the mid-eighteenth century describes a pivotal development for the quantification of geography and for data history more general.

Moreover, Struyck investigated civil and heavenly geography like he investigated terrestrial geography, namely, through his quantitative method. These topics concern the two parts of Struyck's work that have been relatively well-researched, though in the guise of astronomy and population statistics. I have argued that these rather isolated islands of historical literature can be connected and extended by putting Struyck's geography and his quantitative method central, which unified all scholarly activities he considered part of geography. Struyck's civil geography was not separated from his terrestrial geography but incorporated as a part of it. In other words, the distinction between his statistical and geographical contributions does not exist in a strict sense. For one thing, I therefore believe quantitative geography should obtain a place in the history of quantification and statistics, which is all too often focused on demographics or theoretical developments only. Relevant developments are not limited to these matters, but Struyck's work shows how these developments are inspired by and connected to quantification in other fields. Related to this point, this thesis thus also presents a new perspective on Nicolaas Struyck as mathematician, namely, a perspective that primarily characterizes his mixed mathematical activities as geographical. I believe that any comprehensive account of Struyck as a scholar should be based on a thorough understanding Struyck's quantitative geographical approach.

I have argued that the main way in which Struyck's general geography differed from that of his contemporaries was in the search for quantified but not mathematized knowledge. Struyck used mathematics to describe, not explain. He did not seek a mathematical model that could provide explanations for everything that happened in the world. Although he tried to capture the world in numbers, he also considered it variable over time in ways that could not always be predicted (e.g. as we have seen for the distribution of landmass and people). Similar variability applied to humans too, which were generally considered as too arbitrary to be captured in laws – but could still be described through numbers. The distinction between quantification and mathematization and the corresponding analysis of how these lead to different geographical conclusions for different scholars, is a valuable contribution to the history of developing eighteenth-century mixed mathematical practices, in geography but possibly also in many related fields.

All in all, we have seen that eighteenth-century quantification could go many ways. This thesis has extended the depth and precision of this vague concept by looking very closely at one of the ways in which it could proceed. It showed how Struyck made sense of, devised, and gave meaning to quantification. Moreover, I have demonstrated how Struyck's quantification was more complex than straightforward data collection, measurement, or ordering, as well as how it was distinct from mathematization. Although Struyck's case is only one example of how quantification could proceed, its analysis was a fruitful tool to illuminate the vague and intangible nature of this key characteristic of the eighteenth century. Struyck's quantification therefore helps us to understand how the world was made receptive to the 'passion for numbers' that has been described in the historiographical literature.[330] Even if they did not involve advanced approximating and averaging, the earlier practices of quantitative knowledge-making are undeniably of great importance to the history of statistics, which should more often extend its sight further back into the early 18th century.

In this final section I would like to extend our own sight too, but instead to the future. A topic that would particularly benefit from additional research are the people and developments that might have inspired Struyck's geography and quantitative method. In chapter 3 I have hinted that his strategy might have roots in more common astronomical practices, but it would be worthwhile to investigate the connections in more detail. The same goes for the numerical comparison skills and practices that Struyck learned from working as a bookkeeper. Furthermore, I have compared the *Inleiding* with other similar Dutch general geographies, but not included a more international perspective. Especially the works of Edmond Halley are known to have been a strong influence on Struyck's ideas, and because of the remarkable parallels Struyck has been described as 'the Dutch Halley'.[331] After Struyck finished the *Inleiding* he even sent Halley a letter to inform him, but he never received a reply.[332] A thorough account of their connections and the similarities between their activities would therefore be very welcome.

Next to this, additional geographical data histories would be very welcome, to which my approach for quantification as a transformative data practice might prove fruitful.[333] Struyck's case demonstrates how the distinction between data and knowledge has been perceived historically and what practices were involved in working with geographical data. He studied mortality records similar to how he studied barometer measurements, not adjusting the performed analysis by his quantitative methods. Of special attention are Struyck's efforts to equate historical and modern data. It would be interesting to see how the combination of using observational and philological data fitted in the broader, changing relationship between historia and scientia. Moreover, I have not addressed any practical or social aspects of compiling data. The difficulties in obtaining reliable measurements obviously limited the collection of secure data. Struyck got much of his source data through books, but

330 Frängsmyr, Heilbron, and Rider, *The Quantifying Spirit in the Eighteenth Century*; Klep and Stamhuis, 'The Statistical Mind in a Pre-Statistical Era'; Rousseau and Porter, *The Ferment of Knowledge*.
331 Zuidervaart, 'Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data', 130.
332 Zuidervaart, *Van 'konstgenoten' En Hemelse Fenomenen*, 113.
333 Chadarevian and Porter, 'Introduction: Scrutinizing the Data World'; Aronova, Oertzen, and Sepkoski, 'Introduction: Historicizing Big Data'; Sepkoski, 'Data in Time'.

also received or requested material through his correspondence, obtained it from newspapers, and even sent his friends to collect demographic records for him. Looking more closely at how was able to obtain and access his data would therefore be worthwhile.

It may be clear that there is still much to uncover when it comes to quantification, eighteenth-century mathematical geography and the ‘most important Dutch mathematician of the eighteenth century’. At the very least, I hope that this thesis has demonstrated that the study of Struyck’s geography as the connection between these themes is of an unquantifiable value.

Bibliography

Aa, A.J. van der. 'Nicolaas Struyck'. In *Biographisch woordenboek der Nederlanden*. Vol. 2. 17. DBNL, 1874. https://www.dbnl.org/tekst/aa__001biog21_01/aa__001biog21_01_0970.php.

Agnew, John, and David Livingstone. *The SAGE Handbook of Geographical Knowledge*, 2022. https://uk.sagepub.com/en-gb/eur/the-sage-handbook-of-geographical-knowledge/book227938.

Alberts, Gerard. *Jaren van Berekening: Toepassingsgerichte Initiatieven in de Nederlandse Wiskunde-Beoefening 1945-1960*, 1998. https://ir.cwi.nl/pub/20354.

Alberts, Gerard, and Danny Beckers. 'Tussen Tannery En Klein: Polariteit in de Geschiedschrijving van Wiskunde in België En Nederland'. *Studium* 6, no. 3/4 (2013): 173–86.

Aronova, Elena, Christine von Oertzen, and David Sepkoski. 'Introduction: Historicizing Big Data'. *Osiris* 32, no. 1 (2017): 1–17.

Baker, J. N. L. 'The Geography of Bernhard Varenius'. *Transactions and Papers (Institute of British Geographers)*, no. 21 (1955): 51–60. https://doi.org/10.2307/621272.

Beets, Gijs, and Frans van Poppel. 'Nederlandse Geboortepatronen in Historisch Perspectief'. *Demos* 31, no. 4 (2015): 4–7.

Bernhard Varenius (1622-1650). Brill, 2007. https://brill.com/view/title/13751.

Brink, Paul van de. 'De kartering van de Salomonseilanden. Een kaartkritiek van Nicolaas Struyck'. *Bulletin van de vakgroep kartografie* 16 (15 September 1988): 7–11.

Brown, Gary I. 'The Evolution of the Term "Mixed Mathematics"'. *Journal of the History of Ideas* 52, no. 1 (1991): 81–102. https://doi.org/10.2307/2709583.

Chadarevian, Soraya de, and Theodore M. Porter. 'Introduction: Scrutinizing the Data World'. *Historical Studies in the Natural Sciences* 48, no. 5 (2018): 549–56.

Clüver, Philipp. *Introductio in universam geographiam*. Bunonis, 1624.

Daston, Lorraine, and Elizabeth Lunbeck. *Histories of Scientific Observation*. University of Chicago Press, 2011.

Deursen, A. van. *Aardrijkskunde*. Noordhoff, 1921.

Dijk, J. P. van. 'Doodsoorzakenclassificaties van 1750 tot 1900'. *GEWINA / TGGNWT* 5, no. 4 (26 January 2012): 145–57.

Dijksterhuis, Fokko Jan. 'The Mutual Making of Sciences and Humanities. Willebrord Snellius, Jacob Golius, and the Early Modern Entanglement of Mathematics and Philology'. *The Making of the Humanities, From Early Modern to Modern Disciplines* 11 (2012): 73–92.

Frängsmyr, Tore, John L. Heilbron, and Robin E. Rider. *The Quantifying Spirit in the Eighteenth Century*. University of California Press, Berkeley, 1990.

Frederiks, J.G., and F.J. van den Branden. 'Nicolaas Struyck'. In *Biographisch woordenboek der Noord- en Zuidnederlandsche letterkunde*, 767. Amsterdam: L.J. Veen, 1891 1888.

Friedrich, Markus. 'Chorographica Als Wissenskompilationen'. *Sammeln, Ordnen, Veranschaulichen: Zur Wissenskompilatorik in Der Frühen Neuzeit* 2 (2003): 83.

George Hendrik de Rivecourt, Willem, and Jan Christiaan Kobus. 'Nicolaas Struyck'. In *Biographisch Woordenboek van Nederland*, Part II (I-S):982. Arnhem, Nijmegen, 1886.

Golinski, Jan. 'Barometers of Enlightenment'. In *British Weather and the Climate of Enlightenment*, 108–36. Chicago,: University of Chicago Press, 2007.

Grafton, Anthony. 'The Identities of History in Early Modern Europe: Prelude to a Study of the Artes Historicae'. In *Historia: Empiricism and Erudition in Early Modern Europe*, 41–74. Transformations. Cambridge, Mass.: MIT Press, 2005.

Haaften, M. van. 'Kersseboom En Zijn Geschriften. I'. *De Economist* 74, no. 1 (1 December 1925): 667–94.

———. *Nicolaas Struyck*. Nijhoff, 1925.

Hald, Anders. *A History of Probability and Statistics and Their Applications before 1750*. John Wiley & Sons, 2005.
Heilbron, J. L. 'The Measure of Enlightenment'. In *The Quantifying Spirit in the Eighteenth Century*, 207–42. University of California Press, 1990. https://doi.org/10.1525/9780520321595-009.
Hemsterhuis, François. *Lettres à Diotime, tome 2: 1779*. Edited by Jacob van Sluis. 2. Berltsum: Van Sluis, 1779.
Hermans, Willem Frederik. 'Johan Lulofs en zijn tijdgenoten: een bijdrage tot de kennis van de physisch-geografische denkbeelden in de 18e eeuw' LXXI, no. 2 (1954).
Hogendijk, J. P. 'Lijfrentes in de zeventiende en achttiende eeuw'. *Nieuw archief voor wiskunde. Serie 5*, 5, 11, no. 2 (June 2010): 138–44.
Hübner, Johann. *Kurtze Fragen Aus der Neuen und Alten Geographie*. Gleditsch, 1726.
Israel, Jonathan Irvine. *The Dutch Republic: Its Rise, Greatness and Fall, 1477-1806*. The Oxford History of Early Modern Europe. Oxford: Clarendon Press, 1995.
Kennedy, James C. *A Concise History of the Netherlands*. Cambridge Concise Histories. Cambridge: Cambridge University Press, 2017. https://doi.org/10.1017/9781139025447.
Kent, Alexander, and Peter Vujakovic. *The Routledge Handbook of Mapping and Cartography*. Routledge, 2018.
Kersseboom, W. *Eenige aanmerkingen op de gissingen over den staat van het menschelyk geslagt, uitreekening van de lyfrenten en 't aanhangsel op beide, begreepen in het boek, genaamt Inleiding tot de algemeene geographie door Nicolaas Struyck onlangs te Amsterdam uitgegeeven...* Jan van den Bergh, 1740.
Klep, Paul, and Ida Stamhuis. 'The Statistical Mind in a Pre-Statistical Era: The Netherlands 1750–1850', 2002.
Krogt, Peter van der. 'Advertenties Voor Kaarten, Atlassen, Globes e.d. in Amsterdamse Kranten 1621-1811', Summer 2021. https://explokart.eu/wp-content/uploads/sites/3/Advertenties_1621-1811.pdf.
Leeuwen, Marco H. D. van. 'The Era of the Guilds: Mutual Insurance 1550–1800'. In *Mutual Insurance 1550-2015: From Guild Welfare and Friendly Societies to Contemporary Micro-Insurers*, 17–82. London: Palgrave Macmillan UK, 2016.
L'Honoré Naber, S. P. *Inventaris der verzameling kaarten, berustende in het Algemeen Rijksarchief*. Nijhoff, 1914. https://resolver.kb.nl/resolve?urn=MMUBL07:000001063:00088.
Library, Royal Society (Great Britain). *Catalogue of the Scientific Books in the Library of the Royal Society*. R. and J. E. Taylor, 1839.
Lulofs, Johannes. *Inleiding tot eene natuur- en wiskundige beschouwinge des aardkloots ...* Verbeek, 1750.
Margócsy, Dániel. *Commercial Visions: Science, Trade, and Visual Culture in the Dutch Golden Age*. University of Chicago Press, 2014.
Mayhew, Robert J. 'The Effacement of Early Modern Geography (c. 1600–1850): A Historiographical Essay'. *Progress in Human Geography* 25, no. 3 (2001): 383–401.
Mojet, E. 'Observing Disciplines: Data Practices in and between Disciplines in the 19th and Early 20th Centuries', 2022. https://dare.uva.nl/search?field1=keyword;value1=mojet;docsPerPage=1;startDoc=2.
Molhuysen, P.C., and Fr. K. H. Kossmann. 'Nicolaas Struyck'. In *Nieuw Nederlandsch Biografisch Woordenboek*, 10:987–88. Leiden: A. W. Sijhoff, 1937.
Mulder, Henry Martyn. 'Pure, Mixed and Applied Mathematics. The Changing Perception of Mathematics through History'. *Nieuw Archief Voor de Wiskunde (4)* 8 (1 January 1990): 27–41.
Pearson, Karl. *The History of Statistics in the 17th and 18th Centuries: Against the Changing Background of Intellectual, Scientific and Religious Thought: Lectures by Karl Pearson Given at University College London During the Academic Sessions 1921-1933*. Macmillan, 1978.
Porter, Theodore M. 'Making Things Quantitative'. *Science in Context* 7, no. 3 (ed 1994): 389–407.

Rebok, Sandra. ‘The Influence of Bernhard Varenius in the Geographical Works of Thomas Jefferson and Alexander von Humboldt’. In *Bernhard Varenius (1622-1650)*, 259–70. Brill, 2007.

Rousseau, George Sebastian, and Roy Porter, eds. *The Ferment of Knowledge: Studies in the Historiography of Eighteenth-Century Science*. Cambridge University Press, 1980.

Roux, Sophie. ‘Forms of Mathematization (14th - 17th Centuries)’. *Early Science and Medicine* 15, no. 4/5 (2010): 319–37.

Sepkoski, David. ‘Data in Time’. *Historical Studies in the Natural Sciences* 48, no. 5 (1 November 2018): 581–93.

Stamhuis, Ida H. *‘Cijfers en aequaties’ en ‘kennis der staatskrachten’: statistiek in Nederland in de negentiende eeuw*. Rodopi, 1989.

———. ‘De Ontwikkeling van de Actuariële Theorie Tot de 17e En 18e Eeuw’. In *Studies over Zekerheidsarrangementen. Risico’s, Risicobestrijding En Verzekeringen in Nederland Vanaf de Middeleeuwen*, 157–74, 1998.

———. ‘Levensverzekeringen 1500-1800’. In *Studies over Zekerheidsarrangementen. Risico’s, Risicobestrijding En Verzekeringen in Nederland Vanaf de Middeleeuwen*, 141–74, 1998.

Stigler, Stephen M. *The History of Statistics: The Measurement of Uncertainty before 1900*. Harvard University Press, 1990.

Struik, Dirk Jan. *Geschiedenis van de wiskunde*. Het Spectrum, 1990.

Struyck, Nicolaas. *Inleiding tot de algemeene geographie, benevens eenige sterrekundige en andere verhandelingen*. By Isaak Tirion, 1740.

———. *Uytreekening der kanssen in het speelen, door de arithmetica en algebra, beneevens een Verhandeling van looteryen en interest*, 1716.

———. *Vervolg van de beschryving der staartsterren, en nader ontdekkingen omtrent den staat van’t menschelyk geslagt*. by Isaak Tirion, 1753.

Struyck, Nicolaas, and Abraham de Graaf. *Inleiding tot het Koopmans Boekhouden*. Jan Morterre, 1768.

Unwin, Tim. *The Place of Geography*. Routledge, 2013.

Varenius, Bernhardus. *Geographia generalis: in qua affectiones generales telluris explicantur*, 1650.

———. *Volkomen Samenstel Der Aerdryksbeschryving in Het Algemeen, Verklarende de Natuur En Eygenschappen Der Aerde*. Translated by Nicolaas Struyck. Haerlem: J. Bosch, 1750.

Vermij, Rienk. ‘Johannes Lulofs als vertegenwoordiger van het newtonianisme in de Republiek’. *GEWINA / TGGNWT* 22, no. 3 (7 February 2012): 136–50.

———. *Kleine geschiedenis van de wetenschap*. Uitgeverij Nieuwezijds, 2006.

Vollgraff, Johan Adriaan. *Les Oeuvres De Nicolas Struyck (1687-1769) Qui Se Rapportent Au Calcul Des Chances, À La Statistique Générale, À La Statistique Des Décès Et Aux Rentes Viagères, Tirées Des Oeuvres Complètes*. Amsterdam, 1912.

Vos, Willem. ‘Beknopte geschiedenis van de fysische geografie en haar toepassingen’. Wageningen: De Dorschkamp, 1982.

Warntz, William. ‘Newton, the Newtonians, and the Geographia Generalis Varenii’. *Annals of the Association of American Geographers* 79, no. 2 (1989): 165–91.

Withers, Charles W. J. *Placing the Enlightenment: Thinking Geographically about the Age of Reason*. University of Chicago Press, 2008.

Withers, Charles W. J., and Luise Fischer. ‘Geographical Education in the Eighteenth-Century German-Speaking Territories’. *Paedagogica Historica*, 1 February 2021, 1–27.

Zondervan, H. ‘De richting in de beoefening der aardrijkskunde vóór A. von Humboldt en C. Ritter’. *Tijdschrift van het Kon. Nederlandsch Aardrijkskundig Genootschap* XII, no. 2 (1895): 741–56.

Zuidervaart, Huib J. ‘Early Quantification of Scientific Knowledge: Nicolaas Struyck (1686–1769) as Collector of Empirical Gathered Data’. In *The Statistical Mind in a Pre-Statistical Era: The Netherlands, 1750–1850*, edited by Paul Klep and Ida Stamhuis, 125–48. Amsterdam: Aksant, 2002.

———. *Van ‘konstgenoten’ En Hemelse Fenomenen*. Erasmus Publishing, 1999.