Nicolaus Copernicus as a Surveyor and Cartographer

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SUMMARY

Nicolaus Copernicus (1473–1543) is best known as an astronomer – the creator of the heliocentric model of the solar system and the author of the work "De Revolutionibus..." presenting his vision of the Universe. Copernicus' activity as a surveyor and cartographer is little known, and this subject is presented in this paper. Previous research shows that Copernicus' first cartographic work was a map of Warmia and part of Royal Prussia, made around 1510. Another cartographic work of Copernicus was a map of Livonia and Royal Prussia. Noteworthy is the cooperation of Copernicus with Bernard Wapowski in drawing up a map of the Kingdom of Poland and the Grand Duchy of Lithuania. These and other maps will be discussed in this paper, focusing on measurement methods, visualisation, and presumed accuracy.

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1. INTRODUCTION

Nicolaus Copernicus is best known as an astronomer – the creator of the heliocentric model of the Solar System and the author of the work De Revolutionibus, which details his vision of the Universe. On the other hand, Copernicus' activity as a surveyor and cartographer is little known, and this subject will be presented in this work. Previous research shows that Copernicus' first cartographic work was a map of Warmia and part of Royal Prussia, made around 1510. Copernicus' following cartographic work was a Livonia and Royal Ducal Prussia map. The cooperation between Copernicus and Bernard Wapowski in drawing up a map of the Kingdom of Poland and the Grand Duchy of Lithuania is worth noting. Unfortunately, none of the maps made by Copernicus has survived in the form of the original.

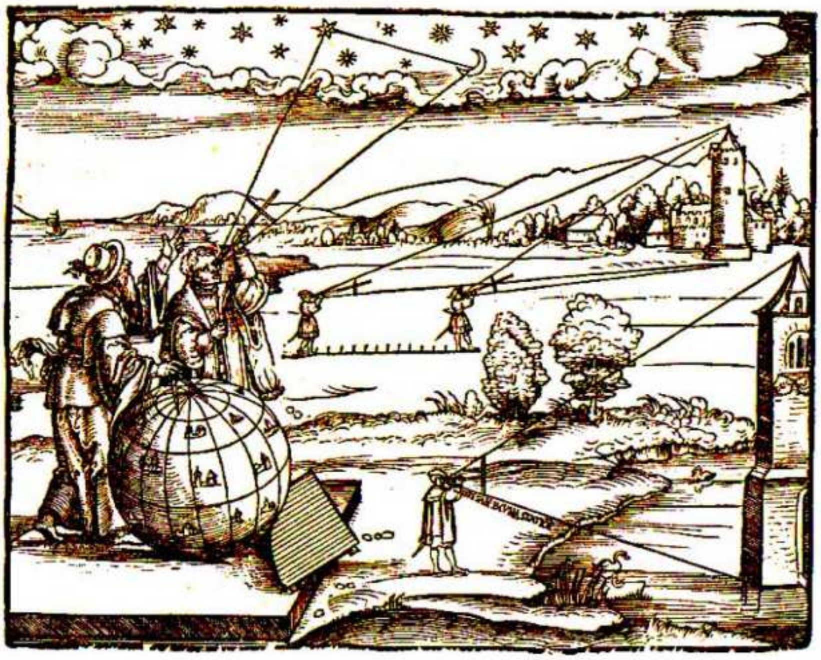

Fig. 1. Astronomical and geodetic measurements in the times of Copernicus (Beutler 2004).

Astronomical measurements and geodetic measurements were necessary to make the maps. (Fig. 1) illustrates the fact that surveying, positioning, navigation, and astronomy in the "glorious old days" essentially deal with measuring angles—the scale was ultimately introduced by one (or several) known distances between two places (as indicated by the symbolic measuring rod in the centre of the woodcut). A more detailed discussion of astronomical instruments, measurement methods, and cartographic projections used by Copernicus is discussed in the following chapters of this work.

2. NICOLAUS COPERNICUS - SURVEYOR

As far as geodesy is concerned, Copernicus himself expressed it in the introduction to De Revolutionibus (Michalski 1931), where he wrote that astronomy, the science "most valuable to the man who thinks nobly, is based on almost all the branches derived from mathematics: arithmetic, geometry, optics, geodesy, mechanics, and let us say, any of them that can be, all these constitute all this."

Birkenmajer's interpretation of this text is that Copernicus, writing about other branches of science related to astronomy, could have thought of physics (the modern approach), geography, and cartography, which he had to deal with in his life (Birkenmajer 1900).

From the numerous interpretations of Copernicus' discoveries from the point of view of their significance for the progress of modern geodetic ideas, the following words of Prof. Tadeusz Banachiewicz (1882-1954) should be quoted: "Our great man was also the first modern surveyor because he stated that the shape of the Earth depended on the force of gravity, that the Earth, like other celestial bodies, must have a round shape for the attraction of particles of matter (long before Newton)" (Piątkowski 1954).

Copernicus himself wrote about the action of the gravitational force in nature and its influence on the shape of the Earth as follows: "Gravity is nothing but the natural tendency that the Divine Providence of the Creator of the Universe has endowed the particles with so that they can be combined into a whole and a unity accumulating into a spherical shape" (Kołaczkowski 1972).

It should be emphasised that Copernicus gave the theoretical principle of modern geodesy and developed geodesy. In addition to astronomical observations, he made astronomical and geodetic measurements, namely latitudes and longitudes. For this purpose, he used simple instruments such as a spherical astrolabe, an equatorial instrument *(instrumentum parallacticum*), and a quadrant. Using these simple instruments, Copernicus achieved relatively high measurement precision when determining time about one minute and position about two to five arcminutes (Woszczyk 1973, Hurnik 2000, Poczobut-Odlanicki 1973). Copernicus determined the longitude difference between Cracow's and Frombork's meridians, and his observations were related to the meridian in Cracow. In this way, he introduced the domestic meridian instead of the hitherto used meridian passing through Alexandria or Toledo (Cichowicz 1956). Copernicus determined the latitudes for the following places: Bologna (1497), Rome (1500 or 1501), Frombork around 1515 with a high accuracy of 2' with the currently accepted value: Probably Olsztyn and Toruń, Riga and Dorpat (Cichowicz 1956, Poczobut-Odlanicki 1973).

3. NICOLAUS COPERNICUS - CARTOGRAPHER

The research conducted so far shows that the first cartographic work of Copernicus was a map of Warmia and part of Royal Prussia, made around 1510, probably in connection with the contestation of Polish and the Teutonic Knights regarding the border regions (Buczek 1963, Schnayder 1972). This is apparent from, among others, a letter from the Bishop of Warmia, Fabian von Lesseinen (of Łężany), who, on 17 May 1517, during a border dispute with the city of Elbląg over the western part of the Vistula Lagoon, instructed Canon Tideman Giese to bring him a map of the area, "*Topographicam eius descriptionem, quam doctor Nicolaus depinxit*."

As well as from a letter from the Bishop of Warmia, Maurycy Ferbera, who, in a letter of 10 July 1529 to Aleksander Sculteti, a canon of the Livonian bishoprics, confirms the receipt of the "Mappa sive description terrae Livoniensis", made at his request by Sculteti with the help of Copernicus.
This first map of Livonia, made with the participation of Copernicus, has not survived. It is known, however, that it fell into the hands of a canon and cartographer from Cracow, Bernard Wapowski. In a letter of 5 March 1533, he expressed his gratitude to the bishop of Chełm (Kulm), John Dantiscus, for the map, which he had received through the intermediary of the bishop of Frombork, Fabian Emmerich, who maintained close ties with Sculteti. Wapowski's letter also shows that this map, without a cartographic grid, was relatively accurate as far as the western part was concerned and not free from errors when it came to the part of the border with Russia and Finland. Polish historians of cartography, including K. Buczek and B. Olszewicz, based on indirect premises, assume that Copernicus provided the material for the map of the northern part in (Zierhoffer and Romer 1967) Tabula Sarmatiae — B. Wapowski, published in 1526. Copernicus's subsequent cartographic work was maps of Livonia and Royal Ducal Prussia, today Eastern Pomerania (Birkenmajer 1900, Schnayder 1972).
Noteworthy is the collaboration between Copernicus and Bernard Wapowski in drawing up a map of the Kingdom of Poland and the Grand Duchy of Lithuania on a scale of about 1:1,000,000, published in Kraków in 1526 (Fig. 2). The map was based on astronomical and geodetic measurements of Copernicus, especially of parts of Ducal Prussia. It was the oldest and best map of the Polish and Lithuanian lands, published in Poland, and counted among the most significant achievements of European cartography at that time. Its rich content, and high accuracy distinguished it as covering the northern and southeastern regions (Buczek 1963), (Poczobut-Odlanicki 1973, Schnayder 1972).

Fig. 2. A preserved fragment of Bernard Wapowski's map showing the central section of the Vistula and Warta rivers (Buczek 1963).

Such authors as Olaus Magnus, the author of the map of Scandinavia and the northern lands of Polish, published in Venice in 1539 (found in 1886 in the state library in Munich), Reticus – a student of Copernicus and publisher of De Revolutionibus, and author of the map of Prussia (1541), Zell, student of Reticus, author of the another map of Prussia, published in Nuremberg in 1542 (a copy was found in 1927 in the library in Venice), Henneberger – the author of the map of Prussia (1576), all of them used Copernicus' observations and cartographic materials.

The collection mentioned above of maps of Prussia from the years 1541, 1542, and 1576 shows that the map of Prussia prepared by Copernicus was an example and a source of cartographic information for the authors of the following map of the Polish northern lands (Schnayder 1972, (Poczobut-Odlanicki 1973).

The mention in Kaspar Schütz that Pregola quam Copernicus latine Praegoram Dixit flows from a swamp, etc., and another remark about the location of the sources of Bersha, placed there without specifying its origin and repeated in Ch. Hartknoch indicates, according to Birkenmajer, some lost geographical writings of Copernicus (Babicz 1973).
Copernicus' geographical and cartographic works were also used by his student and the first propagator of his heliocentric system, a professor at the University of Wittenberg, Joachim Rheticus, who was then 25. He came to Frombork in March 1539 to learn about the teachings of Copernicus. During his stay until August 1541, he was also interested in the geography of Prussia, which was expressed not only in the "Encomium Prussiae" attached to the "Narratio Prima" (1540) but also in the "*Tabula Chorographica auf Preussen und etliche umbliegende lender*", mentioned in a letter to Duke Albert in Königsberg, and finally in his Chorographia, illustrating the principles of mapping that he had arrived at in the course of his geographical interests (Staszewski 1961). The general views on geography expressed by Rheticus in the chorographia above can be taken as a reflection of Copernicus' views since it is commonly believed that "Copernicus was the spiritual father of Rheticus' Chorographia, and Rheticus himself was the Copernici viva vox. Rheticus emphasised in his chorographia the need for a close connection between geography and astronomy, "for if we do not know the longitude and latitude of a city, it is impossible to calculate eclipses or the movements of the sun, the moon, planets, and starry sky concerning it." He considered "the true beginning of geography" to be investigations "as if the earth could be considered the space of the sky". He saw the goal of geography as "high art" and "useful art" in "drawing up national maps according to reliable rules", i.e., by linking itineraries with geographical coordinates and drawing up chorographic tables. Then "such tables should be taken care of by some true and thorough mathematician, who, following in the footsteps of Ptolemy, may renew geography." Rheticus' chorography is closely related to these beliefs, but not as a description of the country in the Ptolemaic sense, but as a work giving "rules for drawing chorographic tables". If Copernicus, called by Rheticus "an excellent mathematician", put all his astronomical activity under the sign of mathematics, he could not fail to subordinate this queen of sciences to geography (Babicz 1973).
It is also assumed that Copernicus, together with Wapowski, helped the Italian cartographer Marcus Benevento in his work on the first modern map of Central and Eastern Europe (Tabula moderna Poloniae, Ungariae, Boemiae, Germaniae, Russiae, Lithuaniae), attached to the Geography of Ptolemy published in 1507. It was a reworking of the work of Nicholas of Cusa

from the mid-fifteenth century, but correctly written names and topographical details in the Polish lands and the area of the Chełmno land, Prussia, and Warmia confirm the possibility of the participation of Wapowski and Copernicus in the work on the publication of this map.

4. NICOLAUS COPERNICUS' ASTRONOMICAL INSTRUMENTS

In Copernicus's time, astronomical instruments were known and used: astrolabe, quadrants, triquetrum (equatorial triangle), astronomical ray and Jacob's staff, and gnomonic instruments. These instruments can be described in the work, created from analysing 185 manuscripts with treatises or astronomical tables in the Jagiellonian University Library (Rosińska 1972). Copernicus, fixated on the perfection of the ancient world, completely omits medieval instruments in his works and reconstructs the instruments used by the ancients (Woszczyk 1973). Since these instruments were not commonly used, he considers it necessary to recall their appearance and the rules for their use in De Revolutionibus. The following briefly describes these instruments in the order in which Copernicus describes them in his immortal De Revolutionibus.

4.1 QUADRANT

Quadrants are designed to measure the angular distances of objects whose frame of reference is the horizon plane and the zenith plane perpendicular to it. Therefore, measurements made with the quadrant refer to the values of angles between 0° and 90° included in this reference system.
The quadrant allowed the zenith distance of the Sun to be measured at the moment of its culmination on any given day. The central position of the shadow cast by the sunlit pointer, resulting from measurements taken at the moments of the summer and winter solstice (i.e., when the Sun is in the sign of Cancer and Capricorn, respectively) relative to the horizon, determined the latitude of the observation site. In this way, Copernicus determined the latitude of Frombork several times, calling this value the height of the pole above the horizon. He cites the results in De Revolutionibus +54°19' and +54°19.5' (Woszczyk 1973).

4.2 ARMILLARY SPHERE OR THE SO-CALLED ASTROLABE

An armillary sphere (also known as a spherical astrolabe) is an astronomical instrument, a celestial sphere model used to determine equatorial and ecliptic coordinates (right ascension and declination). It was used from antiquity to the 16th century, m.in. by Nicolaus Copernicus. The Copernican astrolabe, operating in the ecliptic coordinate system, consisted of six concentric circles (hoops) with scales marked with ink.
Copernicus made most of his astronomical observations with this instrument. Only 63 observations of Copernicus have survived, of which 51 were made in Warmia (mainly in Frombork), nine in Italy, and 3 in Kraków. Copernicus reduced all his observations to the Cracow meridian, which is very close to the meridian passing through Frombork. The accuracy of Copernicus' measurements was one minute for determining time and about five arc minutes for determining position (Woszczyk 1973).

4.3 TRIQUETRUM, i.e., INSTRUMENTS PARALLACTICUM

The triquetrum (Ptolemy's lineal) is an instrument for astronomical observations invented in antiquity and perfected by Claudius Ptolemy in the 2nd century. It was constructed of two intersecting arms suspended vertically. It was used to measure the angular distance of celestial bodies and their motion in the sky (Woszczyk 1973).

A triquetrum is a set of three wooden slats forming an isosceles triangle with a variable base. It is used only to determine the zenith distances of stars from them to determine the declination of stars (Woszczyk 1973). Also, in (Merczyng 1995), we find information that Copernicus used a triquetrum for astronomical observations.

4.4 CLOCKS IN THE TIME OF COPERNICUS

Measuring time is extremely important in astronomical observations. Let's consider how Copernicus solved this problem. He must have determined the time from his observations using a quadrant and probably some sundial. Perhaps it was a clock placed on one of the towers of the Frombork Cathedral, although no mention of it has survived. Later tradition attributed sundials in Toruń, Włocławek, and Frombork to Copernicus (Woszczyk 1973).

Ludwik Antoni Birkenmajer, an eminent researcher and a Copernicus, writes that "there is nothing to indicate that Copernicus had a mechanical clock, although in the 16th century they were no longer a rarity. However, later information shows that in the times of Copernicus, there was already a mechanical clock on the tower in Frombork, which Copernicus probably used to set up the armillary sphere in the first place (Birkenmajer 1900).

5. HOW NICOLAUS COPERNICUS DETERMINED LATITUDE AND LONGITUDE

There are many ways in which latitude can be determined through astronomical observations. One way Copernicus used was measuring Polaris' height above the horizon, which is almost coincidental with the pole.

Another way is to measure the height of the vertical angle from the horizon to the star or the Sun. If we know the body's position (because it has been catalogued) at the celestial pole, we can determine the latitude (Smith 1997).

In his work, Cichowicz discusses Copernicus' astronomical instrument called the quadrant and states that this instrument was used by Copernicus to determine the latitude of Frombork from the observation of the zenith distances of the Sun on the days of the spring and autumn equinoxes and obtained a reasonably accurate value (Cichowicz 1956) of 54°19' and 54°19.5' because the currently assumed latitude of Frombork is 54°21.5'.

Over the centuries, longitude has proved to be much more difficult to determine, as it is a function of time and involves the simultaneous comparison of two clocks, one located at a given point of the Earth and the other on the "zero" meridian. Nowadays, the role of the clock on the "zero" meridian (Greenwich) is fulfilled by radio time signals, which were, of course, unavailable in the old days.

That is why Ptolemy noted that lunar eclipses are perfect for this purpose. Copernicus also used lunar eclipses to determine the longitude of Frombork (Zajdler1977). The principle is that all eclipse phases are simultaneously seen at all points of the Earth, so they play the role of today's radio signals.

6. HOW MAPS WERE MADE IN COPERNICUS' TIME

The mapping principles were developed in ancient Greece and then described by Claudius Ptolemy in his Guide to Geography (127-155 CE), called Geography for short. This work, to a large extent, determined the development of cartographic sciences for fourteen centuries. Ptolemy's geography formed the basis for the world map and twenty regional maps. Ptolemy introduced the concept of geographic coordinates and used astronomical methods to determine the location of points on Earth (Sirko 1999).

For the construction of the world map, Ptolemy proposed two projections: a conical normal, tangent along the parallel of the island of Rhodes, and a modified conical projection, the so-called homomeric. At that time, the orthographic projection, attributed to Apollonius (about 240 BCE), was also known, as well as the stereographic representation. The stereographic projection was already known in antiquity. Its inventor is considered to be Hipparchus (180 – 126 BCE), who used it as a so-called planisphere for astronomical purposes. He was also known by Ptolemy (Szaflarski 1965).

The history of cartography is given, among others, in (Szaflarski 1965) and (Bagrow 2010). On the other hand, information about grids, such as straight, square grid, distance fidelity, Mercator, and Gall grids, is given in (Szaflarski 1965).

Marinus of Tyre (c. 120 BC) is considered to be the creator of the square grid, although it was known to Eratosthenes (about 200 BC) and Hipparchus (about 130 BC). Around the fifteenth century, it was used for nautical charts. The invention of the Mercator cylindrical grid resulted in the rapid removal of the square grid from these maps (Szaflarski 1965).

Thus, the maps' basis was the geographical coordinates of points (cities) determined from astronomical observations. The method of determining the latitude and longitude of any point is described in Chapter 5.

We can find out (guess) how maps were made in the times of Copernicus by analysing Bernard Wapowski's work on Grodecki's map from 1558 (Merczyng 1995). Merching Henry writes: "A few dozen of the principal points must have been determined in width and length by astronomical means, and the rest of the landscape, of course, already outlined by itineraries."

It goes on to say: The question arises as to what instruments the astronomical measurements were used. "There seems to be no doubt that for angular terms, these were no longer Copernicus's triquetra (movable triangles), one or probably portable astrolabes, i.e., circles divided into degrees and minutes, equipped with the so-called diopters, but naturally without optical glasses. "

"Concerning longitude, it is evident that these difficult measurements, as we have already mentioned, must have been made in such a way that observations were made using a lunar eclipse, which, after all, were more frequent than solar eclipses and were observed simultaneously in. Svizh and the specified point. To determine the time of eclipses, portable clocks had probably been used, the Nuremberg eggs, which already existed then, and which had previously been regulated according to the Sun in the given Sun."

7. HOW ACCURATE WERE MAPS IN COPERNICUS' TIME

None of the maps related to Copernicus have survived to our times, so we can infer the accuracy of his maps from evaluating other maps from this area and period. We now present the analysis results of two maps: a Map of Lithuania from 1613 by Prince Radziwiłł Fig. 3 and a map of Warmia by Johann Friedrich Enderson from 1755 (Fig. 5).

One of the simplest and most effective methods of assessing the mathematical accuracy of a map is the analysis of point location errors based on the measurement of distances between selected points on the archival map and reference material. With this method, you can calculate the absolute error (in meters) or the relative error (the ratio of absolute error to distance). In addition, the measurement points can result in a general distance error table or be used for isoline interpolation (Hooke & Perry 1976).

Comparing the position of some points on the old map with their current position, i.e., in the case of latitude, consists in calculating the differences:

$$\varepsilon_{\varphi} = \phi_{ref} - \phi_{map} \tag{1}$$

where ϕ_{ref} is the "error-free" latitude, i.e., the reference latitude, and ϕ_{map} is the latitude of a point on the old map.

An analogous expression can be written for longitudes, namely:

$$\varepsilon_{\lambda} = \lambda_{ref} - \lambda_{map} \tag{2}$$

The mean error of the latitude of any point on the old map will, therefore, be determined by the known formula proposed by Gauss:

$$m_{\phi} = \sqrt{\frac{\sum \varepsilon_{\phi}^2}{n}} \tag{3}$$

and the mean error of longitude is calculated using the analogous formula

$$m_{\lambda} = \sqrt{\frac{\sum \varepsilon_{\lambda}^2}{n}} \tag{4}$$

This method was used to evaluate the 1613 Map of Lithuania by Prence Radziwill and the Orphan by Henryk Merczyng (Merczyng 1995), who obtained the following values: $m_{\phi} \approx 12.5'$ a m_{λ} 39'. From the calculations repeated in this work, $m_{\phi} \approx 13.1'$ and $m_{\lambda} \approx 35.2'$ appear. This means that the calculations have been carried out correctly. As expected, the error of determining the longitude is much greater than that of the latitude due to the difficulty of measuring time.

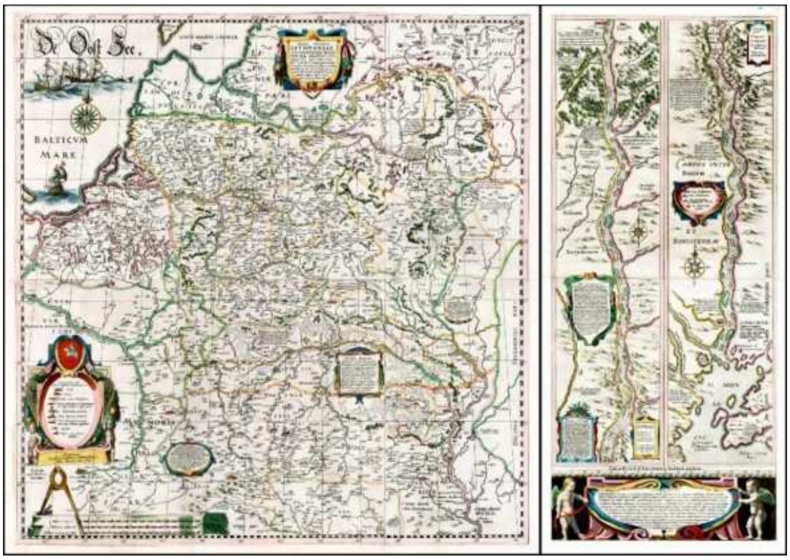

Fig. 3 Map of Lithuania by Prince Radziwiłł, edition from 1613, contains a Dnieper map (Lituania 2023).

The results of the analysis of the accuracy of the map of Lithuania are presented in the paper (Merczyng 1995) in tabular form. A much more appealing way is to give the errors of an old map in a linear measure in the form of an isoline.

To this end, having estimated the accuracy of the determination of latitude and longitude in a gradual measure, the equation (1) and (2) calculated the error of the location of the point on the map in the linear measure as follows:

$$\varepsilon_{\varphi}^{l} = \varepsilon_{\varphi} \times R \text{ and } \varepsilon_{\lambda}^{l} = \varepsilon_{\lambda} \times R \times \cos\phi \qquad (5)$$

where are errors in determining the coordinates ε_{ϕ}^{l}, $\varepsilon_{\lambda}^{l}$ ϕ and λ in a linear measure, R is the mean radius of the Earth, usually taken to be 6371 km.

Based on the linear deviations defined in this way, it is possible to calculate, from analogous formulas as (3) and (4), the average errors of the geographical coordinates in the linear measure and, finally, the error of the position of the point on the map in the linear measure will be $m_{\phi}^{l} m_{\lambda}^{l}$

$$m_P = \sqrt{\left(m_{\phi}^{l}\right)^2 + \left(m_{\lambda}^{2}\right)^2} \qquad (6)$$

According to this formula, errors in the location of the point on Prince Radziwill's Map of Lithuania were calculated, and their graphic image is shown in Fig. 4.

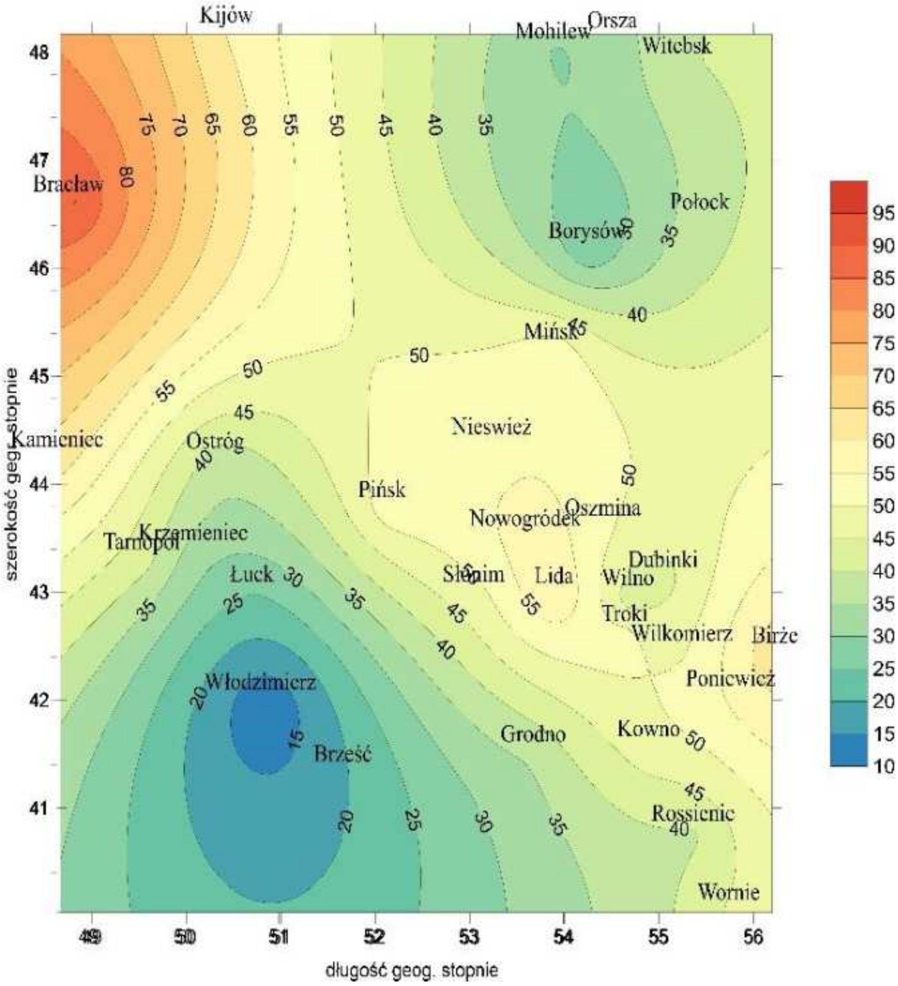

Fig. 4 The accuracy of the Map of Lithuania by Price Radziwill from 1613 in the form of an isoline of errors in the location of a point in (km).

Fig. 4 shows that the accuracy of the map ranges from 10 to 100 km. The smallest errors occur in the southern part of Lithuania in the vicinity of Volodymyr, while the largest errors occur in the north in the region of Bratislava. Explaining the causes of this phenomenon is not easy and has not been undertaken in this paper.

The following map analysed, i.e., the map of Warmia by J. F. Endersch, is burdened with slightly smaller errors than other maps from this period. The degree of accuracy of the map in question, expressed by the average error of the determination of the width, is 40" (Szeliga 1972), and the average error of the determination of the width is 1.5". Again, the accuracy of the λ-coordinate is twice as accurate as the accuracy of the ϕ-coordinate.

This is quite a good achievement because maps of similar accuracy were created a hundred years earlier, because the maps of K. Perthes' provinces, "younger" about 30 years than the map of Warmia and made in the same scale (1:225 000), are burdened with more significant errors. Also, a comparison of the accuracy of the map of Warmia with the map of East and West Prussia by J. W. Suchodolski from 1763 at a scale of 1:266 000 is in favour of the former (Pietkiewicz 1995, Szeliga 1972).

Fig. 5 Map of the Duchy of Warmia made by Jan Fryderyk Endersch (Wiki-2 2023)

8. SUMMARY

Nicolaus Copernicus, whose 550th birthday we are celebrating in Poland today, was an outstanding astronomer, geodesist, and cartographer. The following facts evidence the activity in this field.

A map, probably of Warmia and the western borders of Ducal Prussia, which the Teutonic Knights wanted to capture by recruiting Hans Liliental (Fabian von Losseinen, i.e., from Łężany) for this purpose. A letter from the Bishop of Warmia, Fabian von Lesseinen (from Łężany), who, on 17 May 1517, during a border dispute with the city of Elbląg over the western part of the Vistula Lagoon, instructed Canon Tideman Giese to bring him a map of the area made by Copernicus to the trial. The Bishop of Warmia, Maurycy Ferber, in a letter of 10 July 1529 to Aleksander Sculteti, a canon of the Livonian bishoprics, confirmed the receipt of the map terrae Livoniensis, made at his request by Sculteti with the help of Copernicus.

Polish historians of cartography, including K. Buczek and B. Olszewicz, based on indirect premises, assume that Copernicus provided material for the preparation of a map of the northern part in B. Wapowski's Tabula Sarmatiae, published in 1526.

Kaspar Schütz's mention that the Pregola flows out of a swamp, etc., and another one about the place of the sources of the Bersha, placed there without specifying its origin, according to Birkenmajer, indicates some misspelt geographical writings of Copernicus.

Copernicus' geographical and cartographic works were also used by his student and the first propagator of his heliocentric system, a professor at the University of Wittenberg, Joachim Rheticus, who was then 25.

The general views on geography expressed by Rheticus in Chorography can be taken as a reflection of Copernicus' views since it is commonly believed that "Copernicus was the spiritual father of Rheticus' Chorography.
The picture of Copernicus' cartographic activity, today reconstructed from fragments of facts in documents preserved to our times, could be incomparably more complete in the view of Jan Brożek (1585-1652) due to the materials he collected about the great astronomer, which were later lost. Nevertheless, what we now know about Copernicus' cartographic works and the circumstances in which they were created proves that they were connected with the efforts to draw up an accurate map of the country under the patronage of B. Wapowski.
To appreciate Copernicus' achievements, on the occasion of the 400th anniversary of the birth of Nicolaus Copernicus in 1873, the Municipality of Cracow established a foundation named after him and entrusted the Academy of Arts and Sciences with awarding prizes from the foundation's funds in five-year periods for scientific work in the field of astronomy and related sciences, i.e. astrophysics and geodesy, physical geography, terrestrial magnetism, and meteorology. The awarding of these awards was interrupted by World War II. Wishing to continue this tradition, the Cracow City Council resumed the prize in 1995 on the 500th anniversary of Nicolaus Copernicus' studies in Cracow. So far, the prize has been awarded six times, including three times to people associated with geodesy.

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