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Map Projection of Glavač's Map

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Stjepan Glavač



Croatian State Archives

- ▷ Varaždin, Croatia, December 13, 1627 –
† Trnava, Slovakia, August 4, 1680
- ▷ Jesuit, cartographer
- ▷ First professor of philosophy at the Jesuit Academy in Zagreb
- ▷ Author of the first detailed map of Croatia from 1673

ILLUSTRISSIMIS, SPECTABILIBUS AC MAGNIFICIS,
REVERENDISSIMIS, ADMODUM REVERENDIS, GENEROSIS AC NOBILIBUS
Scabris Regnorum Sclavoniarum, & c. Dominis Fastosis Gratiolissimis,
Felicitationem.

[illegible]

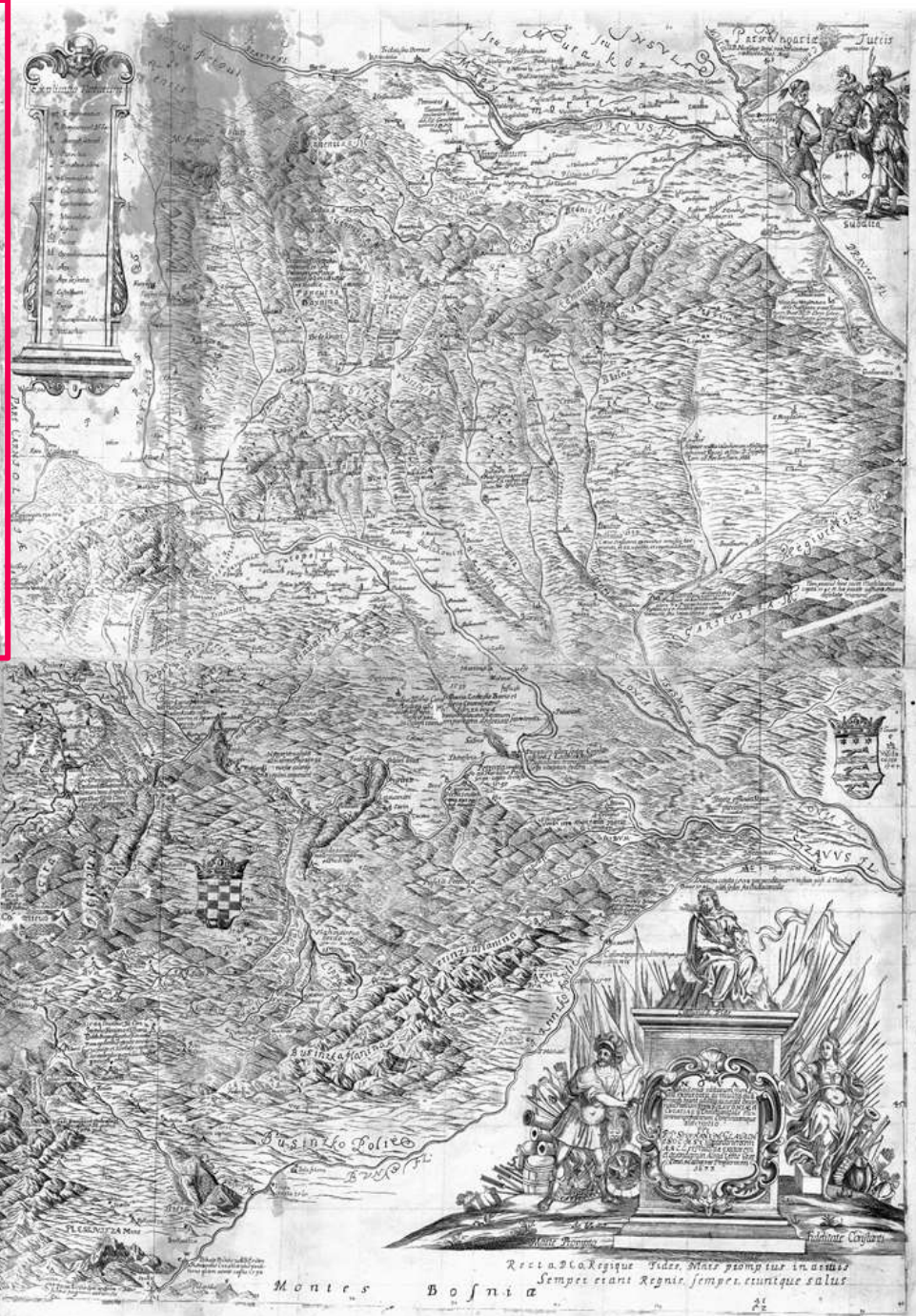
DD. VV.

Servus in Christo

Borghese Giovanni / Foto: F.E. - In Anelli: Ornella
Cagnoli / Foto: Lucio Cagnoli

ADMONITIO

Altre, fra queste, abbiamo una lettera di una signora che, nel 1860, aveva appena fatto il suo primo viaggio in Italia, e che, nel 1861, aveva fatto il suo secondo. La lettera è del 1860, e la signora si chiama Maria. La lettera è del 1860, e la signora si chiama Maria. La lettera è del 1860, e la signora si chiama Maria.



Re: a. B. La Regie: Tides, Mais promptur in a. m. s.
Semper etant Regnis, semper, eturque salus

Research on the map projection of Glavač's map

- ▷ formulas for rectangular coordinates in cylindrical projections

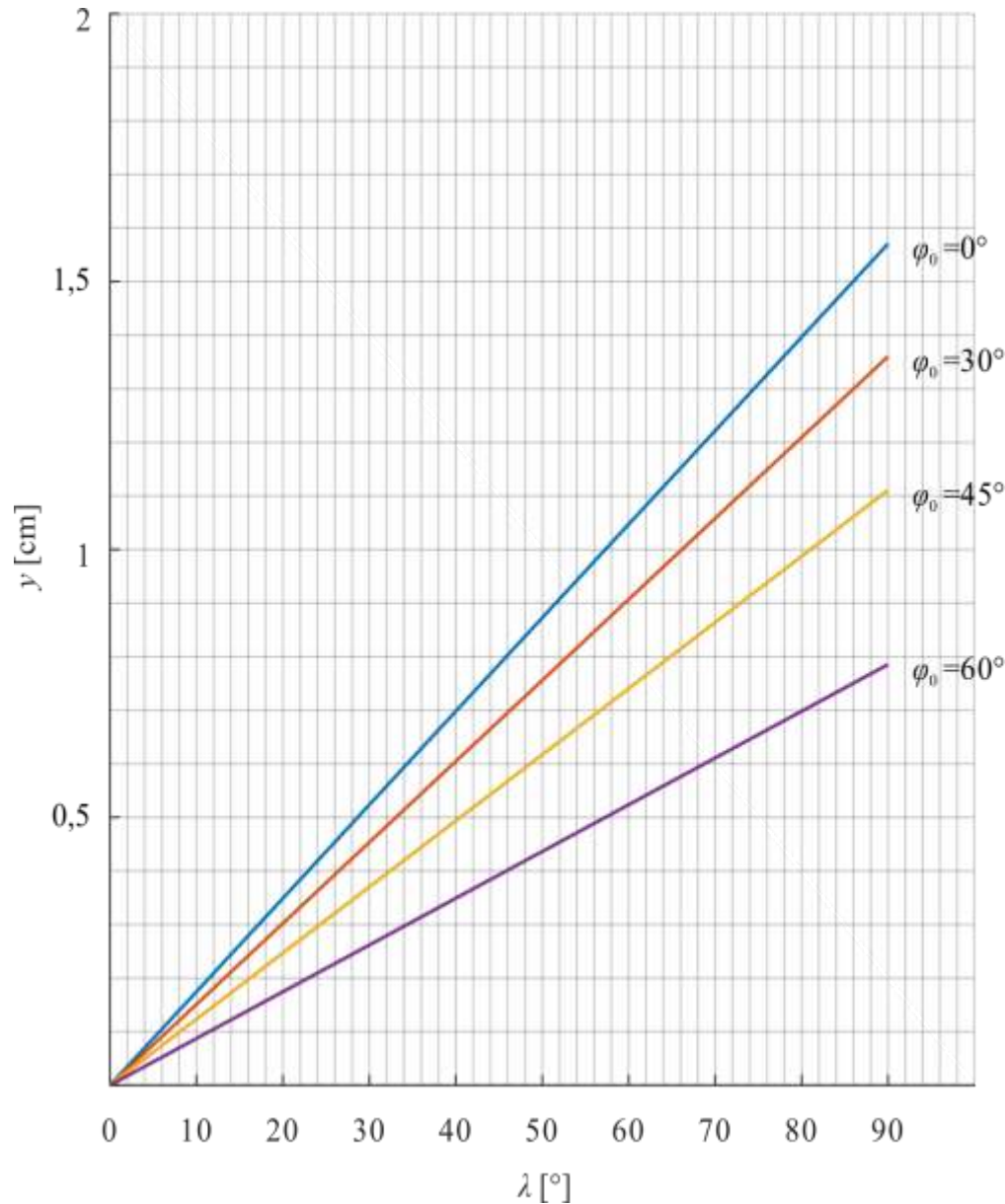
$$y = R \cos \varphi_0 (\lambda - \lambda_w)$$
$$x = R f(\varphi)$$

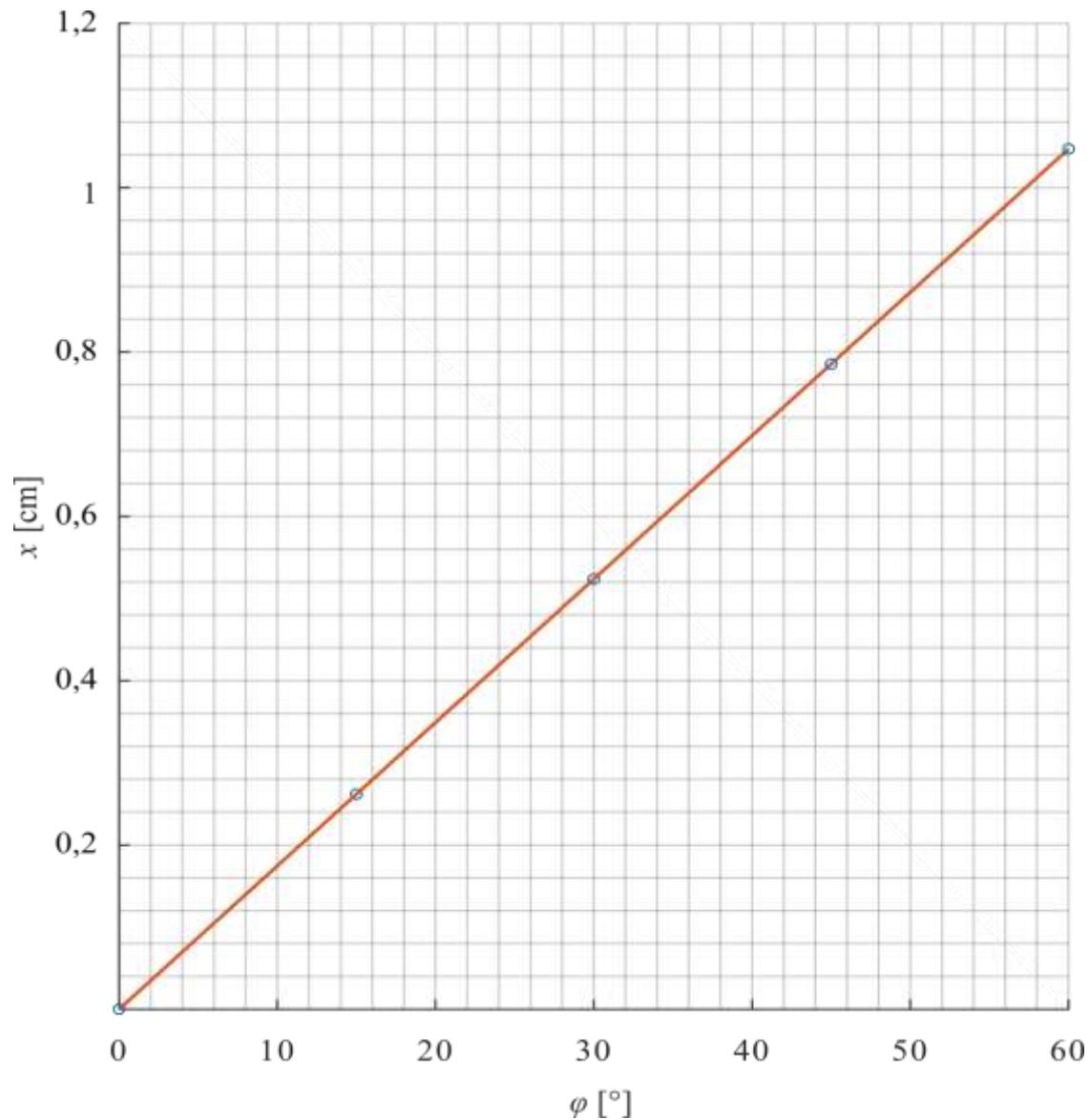
- ▷ for the Earth's sphere with radius $R=1$ and $\lambda_w=0$

$$y = \cos \varphi_0 \lambda$$
$$x = f(\varphi)$$

Dependency of the
ordinates y and longitudes
 λ in cylindrical projections

$$y = c \cos \varphi_0 \lambda$$

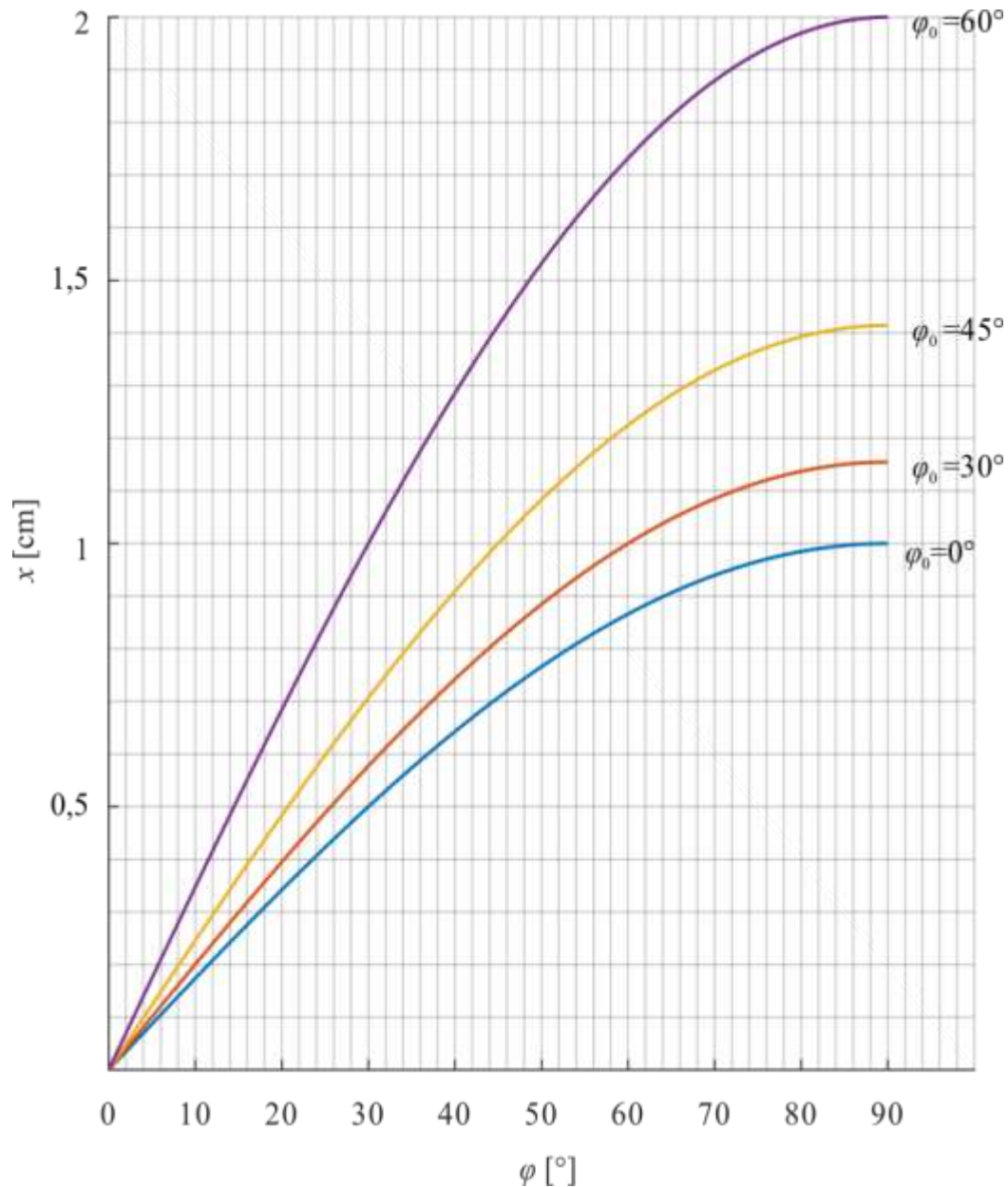




Dependency of the abscissas x and latitudes φ in equidistant cylindrical projections

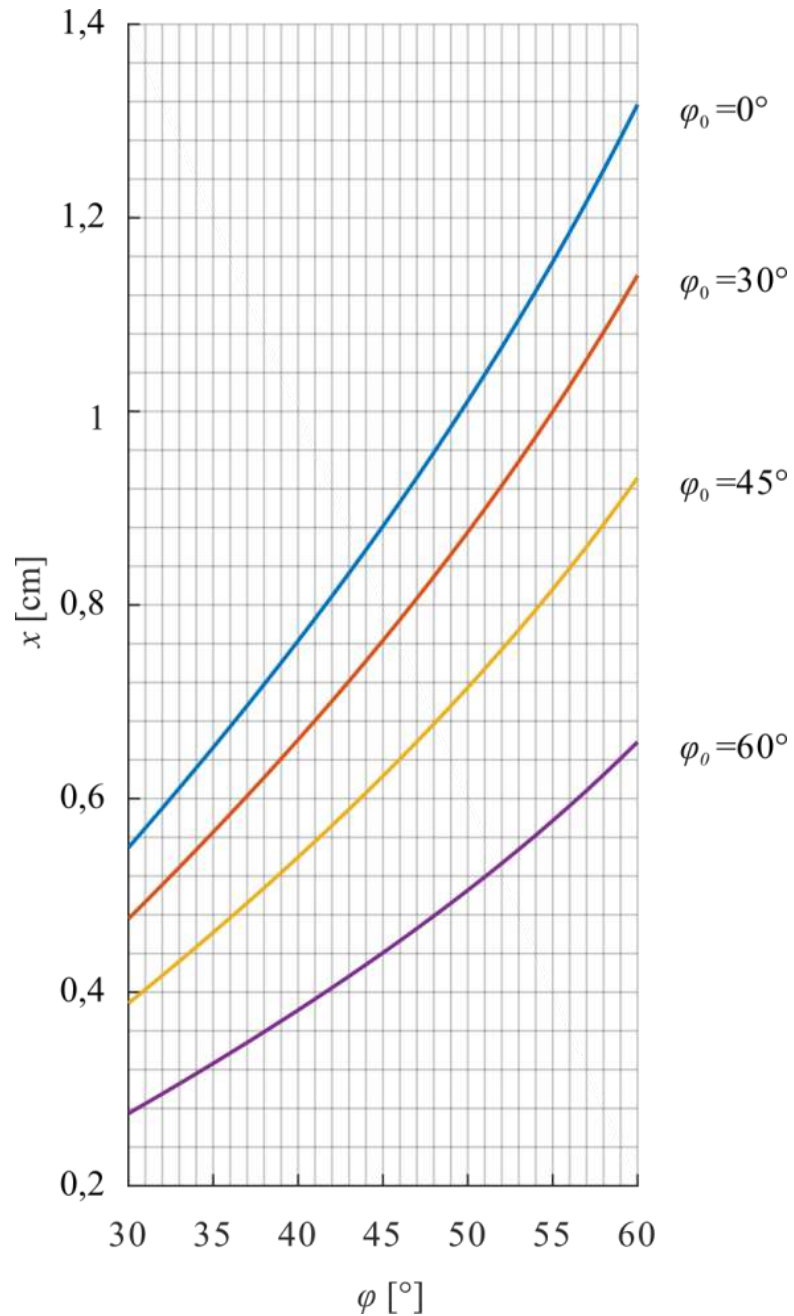
$$x = \varphi$$





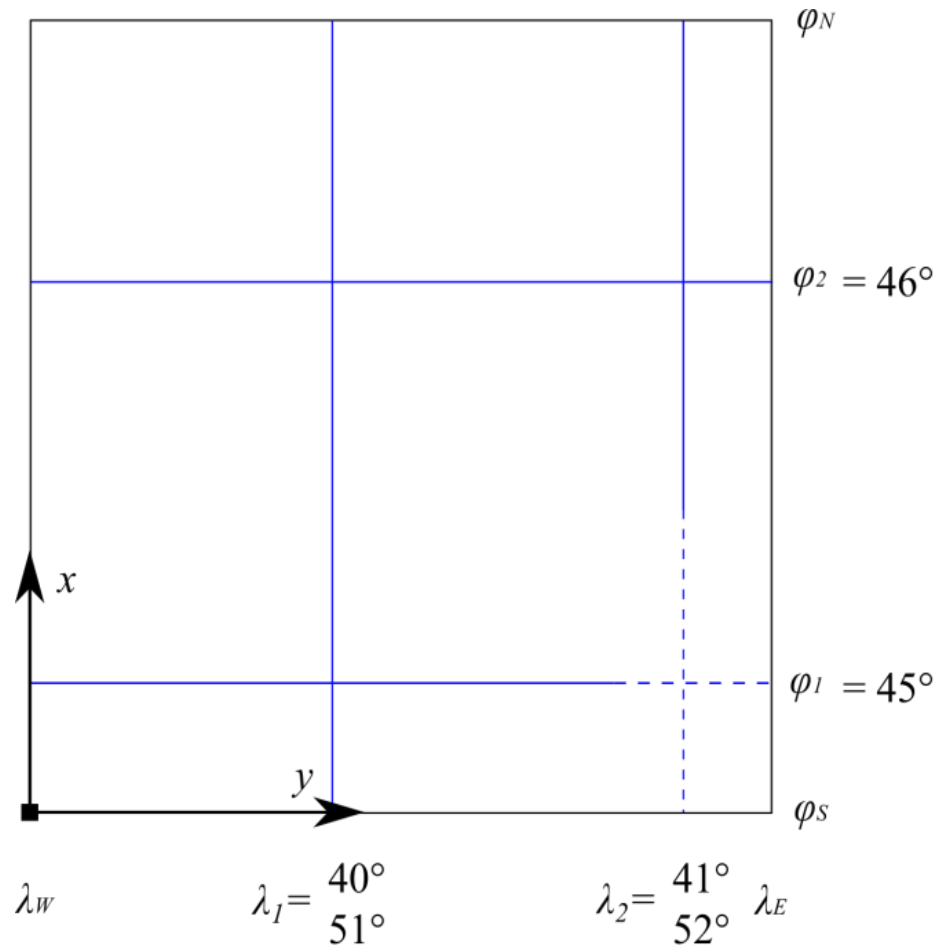
Dependency of the abscissas x and latitudes φ in equivalent cylindrical projections

$$x = \frac{\sin \varphi}{\cos \varphi_0}$$

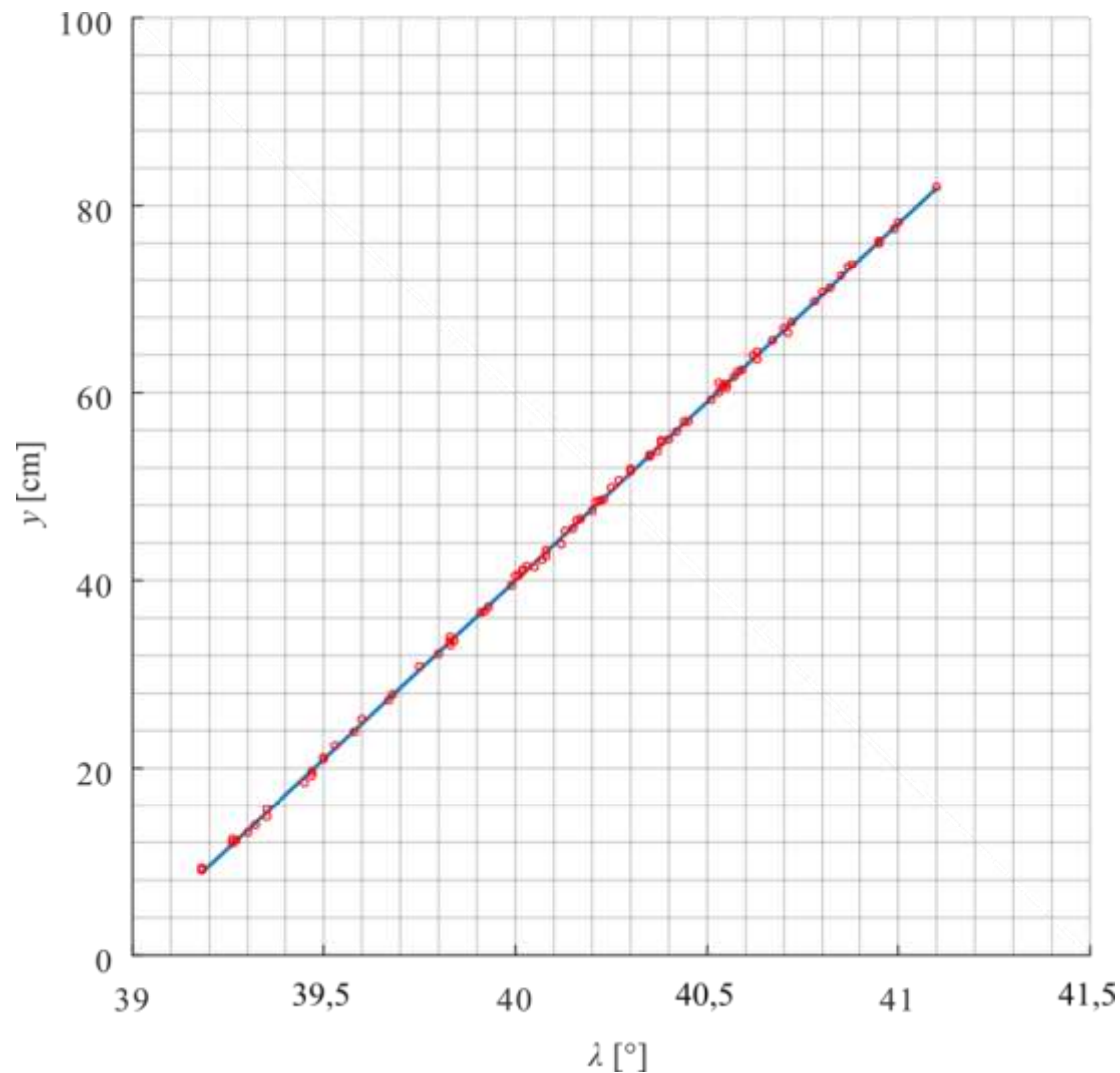


Dependency of the abscissas x and latitudes φ in Mercator projections

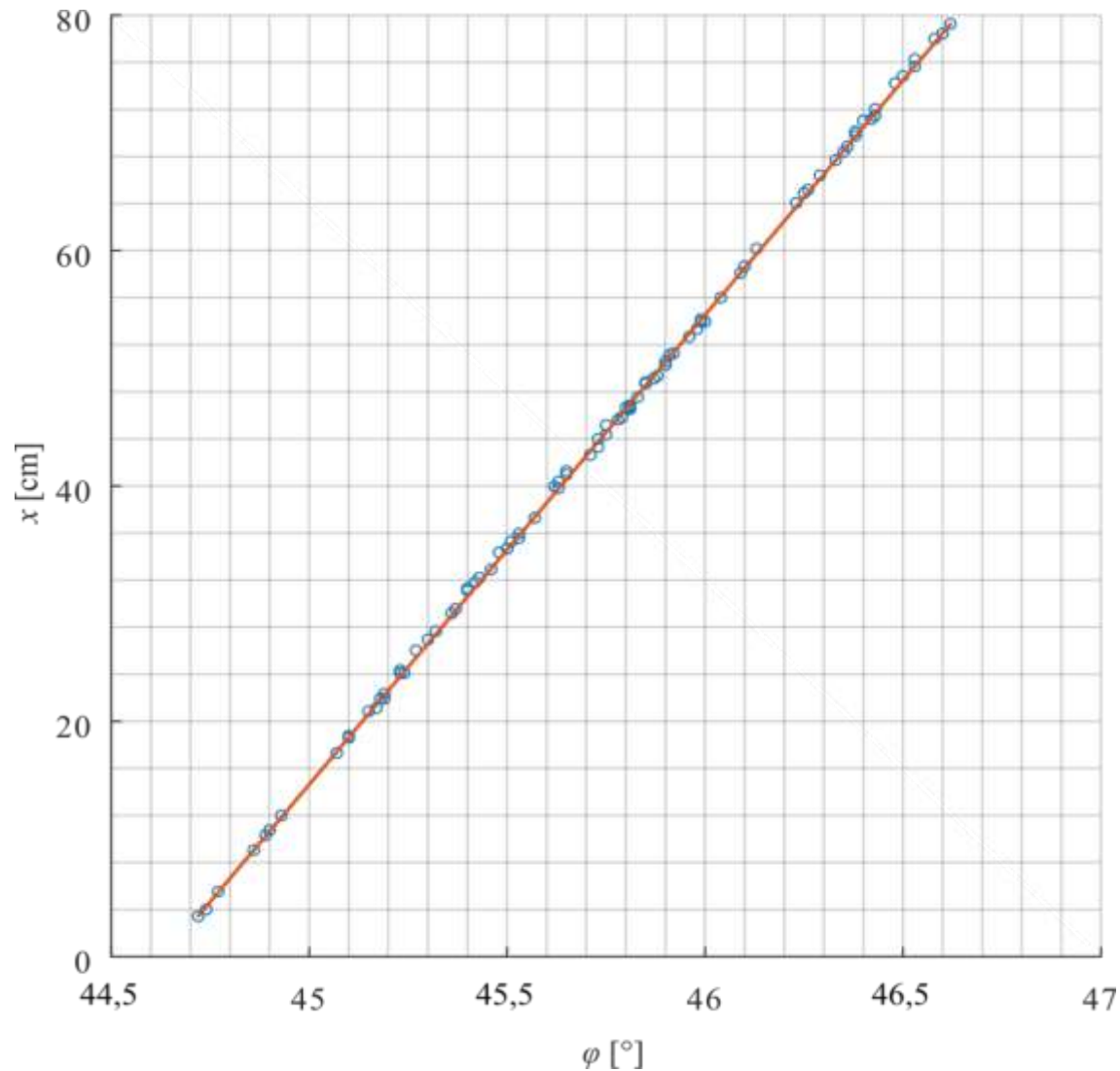
$$x = \cos \varphi_0 \operatorname{Intg} \left(45^\circ + \frac{\varphi}{2} \right).$$



Schematic view of the map graticule



Dependency of Glavač's ordinates y and longitudes λ is described with regression line $y=2181,4\lambda - 1482,9$ 



Dependency of Glavač's abscissas x and latitudes φ is described with regression line $x=2285,6\varphi-1780,4$



General equations of map projection of Glavač's map

$$y = \cos \varphi_s \frac{R}{M} (\lambda - \lambda_w) \cdot \frac{\pi}{180^\circ}$$

$$x = \frac{R}{M} (\varphi - \varphi_s) \cdot \frac{\pi}{180^\circ}$$

Calculated equations of regression lines

$$x = 2285,6 \left(\varphi - \frac{1780,4}{2285,6} \right)$$



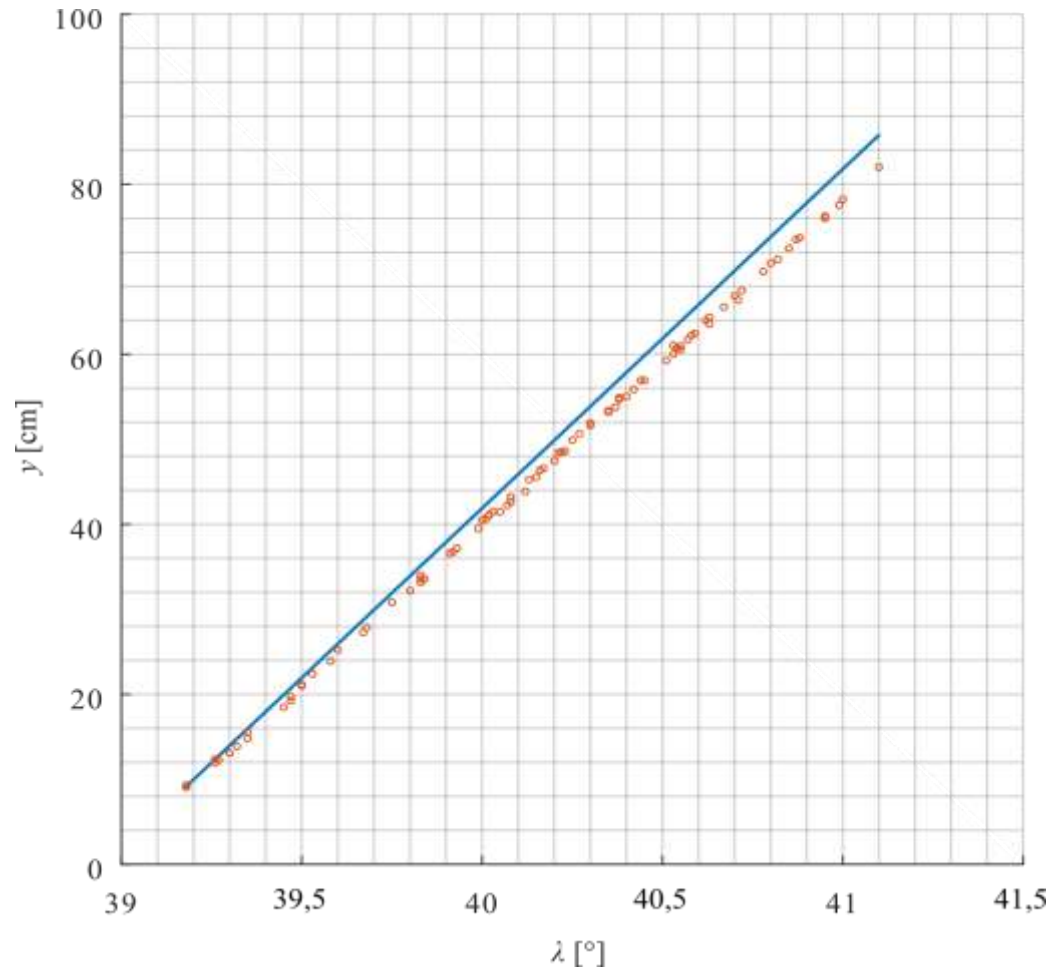
$$\begin{aligned} \varphi_s &= 44^\circ 38' \\ \frac{R}{M} &= 2285,6 \end{aligned}$$

$$y = 2181,4 \left(\lambda - \frac{1482,9}{2181,4} \right)$$



$$\begin{aligned} \lambda_w &= 38^\circ 57' \\ \varphi_0 &= 17^\circ \end{aligned}$$





Linear equation $y=2285,6\lambda -1553,8$ is slightly moved
from sets of points

General equations of map projection of Glavač's map

$$y = \cos \varphi_0 \frac{R}{M} (\lambda - \lambda_w) \cdot \frac{\pi}{180^\circ}$$

$$x = \frac{R}{M} (\varphi - \varphi_s) \cdot \frac{\pi}{180^\circ}$$

$$\begin{aligned} R &= 1 \\ M &= 1:1 \\ \varphi_0 &= 0^\circ \\ \varphi_s \text{ i } \lambda_w \end{aligned}$$



$$\frac{R}{M} = 2292,7$$

$$\cos \varphi_0 \frac{R}{M} = 2187,05 \quad (\cos \varphi_0 = 1)$$



$$\frac{2292,7}{2187,1} = 1,048$$

Result of the affine transformation between Glavač's map and the map *Kraljevinâ Dalmacije.....*, 1746.

	Whole map	Map sheets			Description of parameters
		2	3	4	
c_1 [cm]	-2,4	-2,5	-2,8	-2,2	Translation
c_2 [cm]	-1,0	0,8	1,3	1,0	
α	-5'	4'	-19'	-7'	Rotation angles
β	25'	21'	1'	24'	
p	1,047	1,046	1,058	1,042	Scale
q	0,987	0,987	0,980	0,987	

Calculating map scale using ratio $R/M = 2292,7$

Radius of Earth's sphere according to	Map scale
Snellius, 1617	1:268 000
Fernel, 1525; Picard, 1669	1:278 000
Riccioli, 1672	1:300 000

Map scale
between
1:265 000 and
1:300 000

Calculating map scale using factor 1,048

	Fernel, 1525.	Snellius, 1617.	Picard, 1669.	Riccioli, 1661.
Radius R [km]	6373	6150	6372	6917
Map scale of Glavač's map calculated using the Croatian and German mile	1:275 000	1:265 000	1:275 000	1:298 000

Conclusion

- ▷ Equidistant cylindrical projection with the equator as a standard parallel
- ▷ Horizontal map scale of Glavač's map should be increased for 1,048
- ▷ Several attempts to determine the Earth's dimensions, so several possible radii of the Earth's sphere were proposed in the late 17th century

Conclusion

- ▷ Ratio of the radius of the Earth's sphere and map scale is 2292,7
- ▷ More about Croatian mile you can find in an article:

Viličić, M., Lapaine, M. (2016): The Croatian Mile on Old Maps. *Cartography and Geoinformation*, Vol. 15, br. 25, str. 4-22. <https://hrcak.srce.hr/170966>

Thank you for attention!

Any questions?

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