Intermediate reference frame for Uzbekistan topographic maps

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Before 1995-2000

CS42

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Now

CS42

Triangulation tower

Bench Mark

In the future

PZ90(SC95)

WGS84

Central Asian triangulation measurement were produced in Tashkent coordinate system (1875). This works are based on the Bessel –ellipsoid (1841), \( a = 6377397 \text{m.} \), \( \alpha = \frac{1}{299.14} \).

The measurement and calculated the longitude for 900 points (rms= ± 0°.25).

In 1950 about 50% of the European triangulation networks and about 20% of other continents networks (also Russia and Uzbekistan) were based on the Bessel ellipsoid.

\[ \lambda = -4^h 37^m 10.80^s \quad 1891 \]
\[ \varphi = 41^0 19' 31'' .48 \quad 1895-1896 \]
Origin: Sablino, Russia. 1930.

Bessel reference ellipsoid

\[ a = 6377397.155m \]
\[ b = 6356078.963 \]
\[ f = 1 : 298.3 \]
\[ \Delta X = 382 m \]
\[ \Delta Y = 151 m \]
\[ \Delta Z = 574 m \]
\[ \Delta \alpha = 739.845 \]
\[ \Delta f = 0.10037483 \]

Origin: Bugry, Russia. 1942.

Krasovsky reference ellipsoid

\[ a = 6378245 m \]
\[ b = 6356863 \]
\[ f = 1 / 298.3 \]
\[ B_0 = \phi_0 - \xi_0 = 59^0 46' 18'\,71 - 0'\,16 = 59^0 46' 18'\,55 \]
\[ L_0 = \lambda_0 - \eta_0 \sec B_0 = 30^0 19' 38'\,55 + 3'\,54 = 30^0 19' 42'\,09 \]
\[ A_0 = \alpha_0 - \eta_0 \tan B_0 = 121^0 40' 36'\,13 + 2'\,66 = 121^0 40' 38'\,79 \] (Bugry)

\[ \xi_0 = -dB_o = 0.16'' \]
\[ \eta_0 \sec B = -dL_o = -3.54'' \]
\[ \eta_0 = 1.78'' \]
**THE GAUSS-KRUGER PROJECTION**

**Gauss K F**

(1777 – 1855)

\[ x = S + \frac{l^2}{2} r \sin B + \frac{l^4}{24} r \cos^2 B \sin B (5 - t^2 + 9\eta^2 + 4\eta^4); \]

\[ y = lr + \frac{l^3}{6} r \cos^2 B (1 - t^2 + \eta^2) + \frac{l^5}{120} r \cos^4 B (5 - 18t^2 + t^4 - 14\eta^2 - 58\eta^2 t^2); \]

\[ m = n = 1 + 0.000152l^2 \cos^2 B; \quad p = m^2; \quad w = 0; \quad t = \tan B; \quad \eta^2 = e^2 \cos^2 B, \]

**UZBEKISTAN**

J. Krüger

1853-1923

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**SK42 (Pulkovo)**

\[ B_0 = \varphi_0 - \xi_0 \]

\[ L_0 = \lambda_0 - \eta_0 \sec B_0 \]

\[ A_0 = \alpha_0 - \eta_0 \tan B_0 \]

\[ y_{wgs84} - y_{sk42} = 64 \text{ m} , \quad L_{wgs84} - L_{sk42} = 2.90 \text{ arcsec} \]

\[ x_{wgs84} - x_{sk42} = 9 \text{ m} , \quad B_{wgs84} - B_{sk42} = 0.23 \text{ arcsec} \]

\[ h_{wgs84} - h_{sk42} = 109 \text{ m} \]

<table>
<thead>
<tr>
<th>Scale</th>
<th>( \Delta X_{wgs84-sk42} )</th>
<th>( \Delta Y_{wgs84-sk42} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:100 000</td>
<td>0.09 mm</td>
<td>0.64 mm</td>
</tr>
<tr>
<td>1:50 000</td>
<td>0.18 mm</td>
<td>1.28 mm</td>
</tr>
<tr>
<td>1:25 000</td>
<td>0.30 mm</td>
<td>2.56 mm</td>
</tr>
<tr>
<td>1:10 000</td>
<td>0.9 mm</td>
<td>6.40 mm</td>
</tr>
<tr>
<td>1:5 000</td>
<td>1.8 mm</td>
<td>12.8 mm</td>
</tr>
</tbody>
</table>
The first geoid

Prof. Pomeranzev 1847-1921

The geoid of Ferghana valley (1897). B-\(\varphi\)=12.73", L-\(\lambda\)=16.31", Rms= \(\pm\)0.30"
33 points.

International Latitude station (1899)

\[ \phi^* - \phi = x \cos \lambda - y \sin \lambda; \]
\[ \lambda^* - \lambda = (x \sin \lambda - y \cos \lambda) \tan \phi; \]
\[ \eta^* - \eta = (\lambda^* - \lambda) \cos B; \]
\[ A^* - A = (x \sin \lambda - y \cos \lambda) \cos \phi. \]

Change of the north pole coordinate


IGS Network

DORIS Network

Kitab, Uzbekistan

Kit3

CHAMP

Tashkent

MAID

Maidanak
Transformation of coordinate system

\[ x = (N+H) \cos B \cos L \]
\[ y = (N+H) \cos B \sin L \]
\[ z = (N(1-e^2)+H) \sin B \]

\[
\begin{bmatrix}
X \\
Y \\
Z
\end{bmatrix}
= \begin{bmatrix}
X \\
Y \\
Z
\end{bmatrix}_{84}
+ \begin{bmatrix}
T_X \\
T_Y \\
T_Z
\end{bmatrix}
+ \begin{bmatrix}
\mu & \omega_Z & \omega_Y \\
-\omega_Z & \mu & \omega_X \\
\omega_Y & -\omega_X & \mu
\end{bmatrix}
\begin{bmatrix}
X \\
Y \\
Z
\end{bmatrix}_{42}
\]

\[ L = \arctan \frac{Y}{X} \]
\[ B^{(i)} = \arctan \frac{Z + Ne_i^2 \sin B^{(i-1)}}{r_p} \]

\[ x = S + \frac{t^2}{2} - r \sin B + \frac{t^4}{24} r \cos^2 B \sin B (5 - t^2 + 9 \eta^2 + 4 \eta^4) \]
\[ y = lr + \frac{t^3}{6} - r \cos^2 B (1 - t^2 + \eta^2) + \frac{t^5}{120} r \cos^4 B (5 - 18t^2 + t^4 - 14 \eta^2 - 58 \eta^4 t^2) \]
\[ m = n = 1 + 0.000152l^2 \cos^2 B; \quad p = m^2; \quad w = 0; \quad t = \tan B; \quad \eta^2 = e^2 \cos^2 B, \]

\[ y_{wgs84} = y_{sk42} + \Delta y \]
\[ x_{wgs84} = x_{sk42} + \Delta x \]
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References

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Thank you for your attention!

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