ANALYSIS OF COORDINATES CHANGE OF SHAZ GPS PERMANENT STATION

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1. INTRODUCTION

A nature of the change of stations coordinates determined in an accepted reference system is an important characteristics. This concerns especially the territory of Ukraine inasmuch as Ukrainian permanent stations operate relatively for a short period (only GLSV station works for 7 years). Therefore the determination of velocities of the coordinates change of these stations is an actual question. We have carried out a number of investigations with this aim.

At present Ukrainian GPS permanent network includes 11 permanent stations [1]: GLSV (Kyiv), UZHL (Uzhgorod), POLV (Poltava), SULP (Lviv), MIKL (Mykolaiv), KHAR (Kharkiv), EVPA (Evpatoria), CRAO (Simeiz), ALCH (Alchevsk), SHAZ (Shatsk), CHER (Chernihiv).

This paper considers principles of the determination of coordinates change of these stations and calculation results for SHAZ station for the annual period of permanent GPS observations.

SHAZ GPS permanent station was established according to CERGOP-2 Project and is located on the territory of geodetic training field of National University "Lviv Polytechnic" in the town of Shatsk, Volyn region. The approximate coordinates of the station are: $\varphi=51^0 34.2'$, $\lambda=23^0 54.1'$. It is equipped with Trimble 5700 GPS receiver and TRM41249.00 (Zephyr Geodetic) antenna. The station began to operate from the 158th day of 2004 (the 1274th GPS week).

SHAZ station works up till now in a closed regime due to a number of administrative reasons. The measurements data are accumulated at the station and transmitted to the local analysis centre of MAO (Main Astronomical Observatory, Kyiv).

For our analysis we included the (SINEX-files) processing results obtained by the MAO analysis centre for the period from 1274th till 1306th GPS weeks. As a rule, for the determination of the velocity of a change of a station coordinates we make up weekly solutions of the station and evaluate the velocity by comparison of corresponding coordinates changes.

There are several numerical methods. The most simple method is the determination of the regression line which takes on steady speeds. However, "sudden changes" of the time series of coordinates change may shift this evaluation terrifically. Therefore, it is necessary, at first, to correct the "sudden changes" in coordinates changes. The second way of velocities evaluation, the better one, is to transform the weekly or even monthly solutions to the common reference system. For this purpose one may use Helmert's transformation parameters and carry out the evaluation of them by means of Kalman filtering. In this regard we carried out two analysis of measurement results at SHAZ station.

2. DESCRIPTION OF THE EXPERIMENT

<u>Analysis 1.</u> Method of coordinates change determination of SHAZ station was the following:

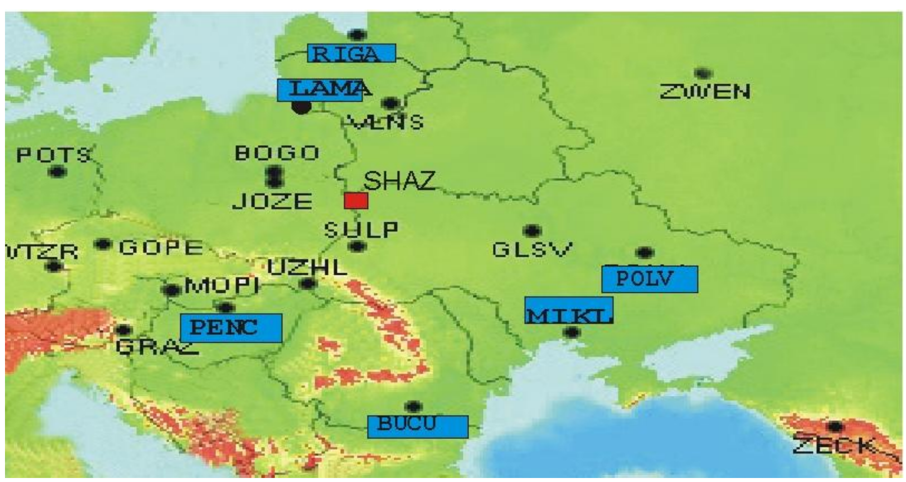
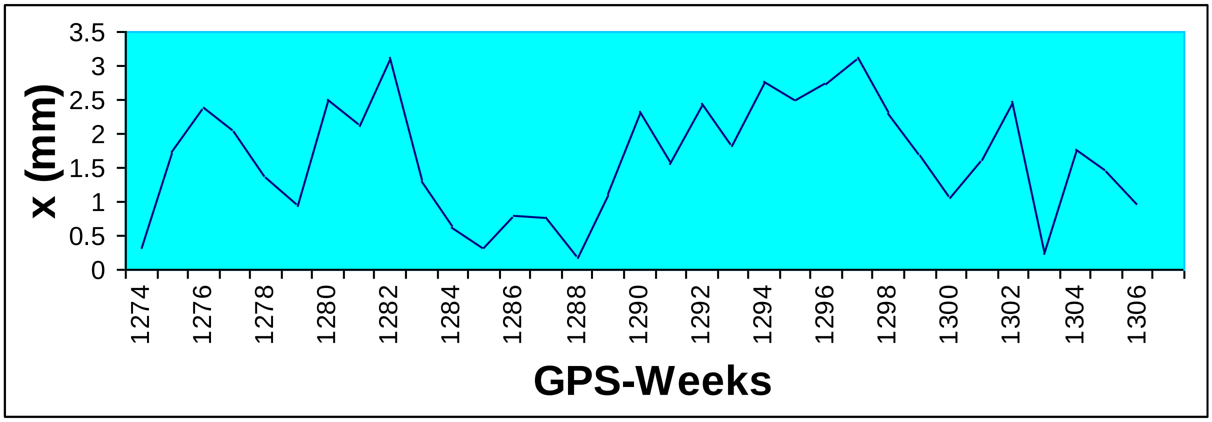


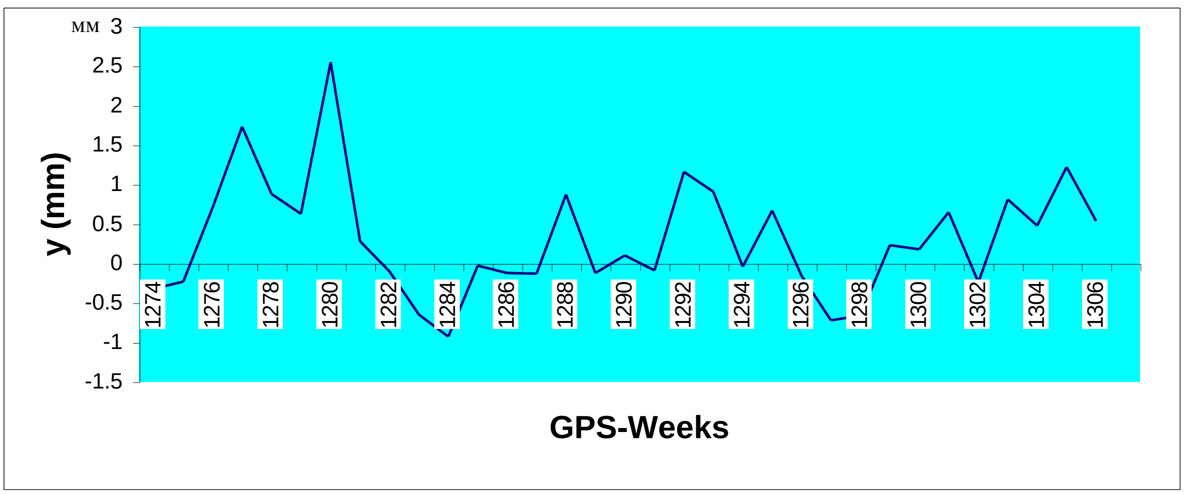
Fig. 1. Scheme of the station allocation by the data of which the Helmert's transformation parameters were determined

- **the weekly solutions of MAO were selected for 5 permanent stations from 1274th to 1306th GPS weeks: BOR1 (Poland), VLNS (Lithuania), SHAZ, SULP, GLSV (Ukraine) (fig.1);**
- **an estimation of the time series was carried out between the coordinates** X_i, Y_i, Z_i, **given on the running point of time** t **and coordinates** X_0, Y_0, Z_0, **known for some initial time (1274th GPS week);**
- **in order to take down the residual systematical influences the Helmert's coordinates transformation parameters were determined between** t **and** t_0 **moments by the data of the permanent stations located around of SHAZ station, namely: LAMA (Poland), RIGA (Lithuania), BUCU (Romania), POLV, MIKL (Ukraine), PENC (Hungary) (fig.1);**
- **the running coordinates of SHAZ station were calculated for the initial moment by means of the obtained transformation parameters;**
- **the weekly differences of the spatial grid coordinates were transformed into the topocentric ones (** $N, E, U = x, y, h$ **) relatively to its initial coordinates;**
- **the resulting coordinates of a time series show the coordinates change of the station.**
- **differences** $\Delta X_i = X_{0i} - X_0$, $\Delta Y_i = Y_{0i} - Y_0$, $\Delta Z_i = Z_{0i} - Z_0$ **served as a basis**

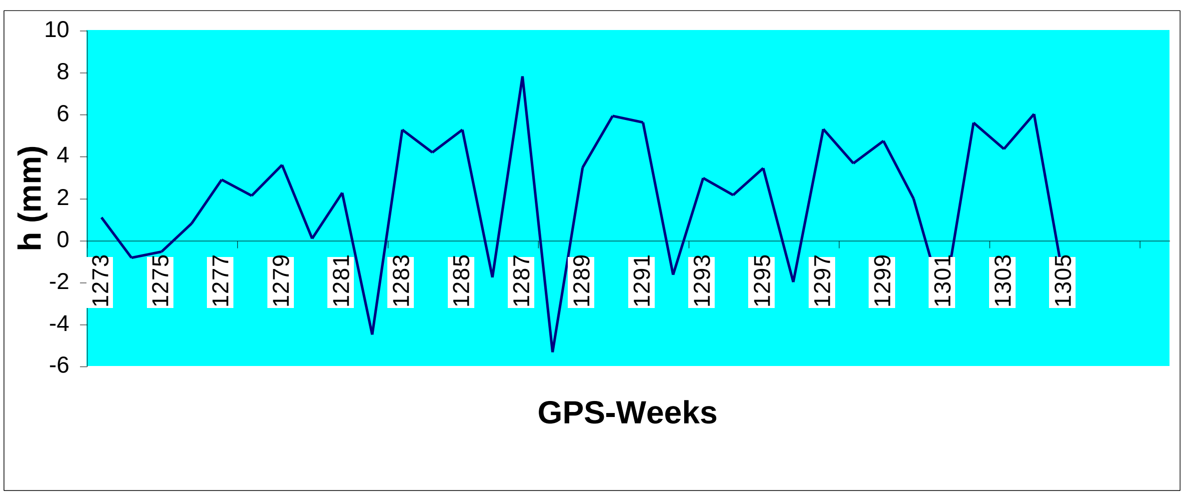
for receiving the estimations of the station coordinates changes. Averaged changes of the spatial topocentric coordinates of SHAZ station are shown in the fig. 2 a), 2 b) and 2 c).



a)



b)



c)

Fig. 2 a), b), c). Averaged changes of the spatial topocentric coordinates of SHAZ station

As it is obvious the averaged changes of the spatial topocentric coordinates of SHAZ station for the annual period do not usually exceed 2 mm in the horizontal plane and 3-4 mm in height This indicates on a high stability of the comparative position of the permanent station.

<u>Analysis 2.</u> Determination of coordinates change velocity of a local permanent station without the data of other stations.

For numerical procedures there were used weekly combined solutions of SHAZ station coordinates in ITRF2000 system obtained for the period from 1274th till 1306th GPS weeks. For the determination of the velocity of coordinates change there were calculated differences $\delta_X, \delta_Y, \delta_Z$ between coordinates of the given GPS week and simple mean ones for the whole measurements time. Then, the mentioned changes were transformed into topocentric coordinates of SHAZ station.

The dependence of the change of topocentric coordinates is shown in the fig. 3 a), b), c). The values x, y, h of topocentric coordinates are depicted on the abscissa axis and interval in years is on the axis of ordinates.

In view of a few coordinates changes and relatively short period of observations the approximation of the obtained diagrams was realised by means of the linear function $a + b \times t$. Then after the obtained coefficients we find the velocity coordinates change V_x, V_y, V_h.

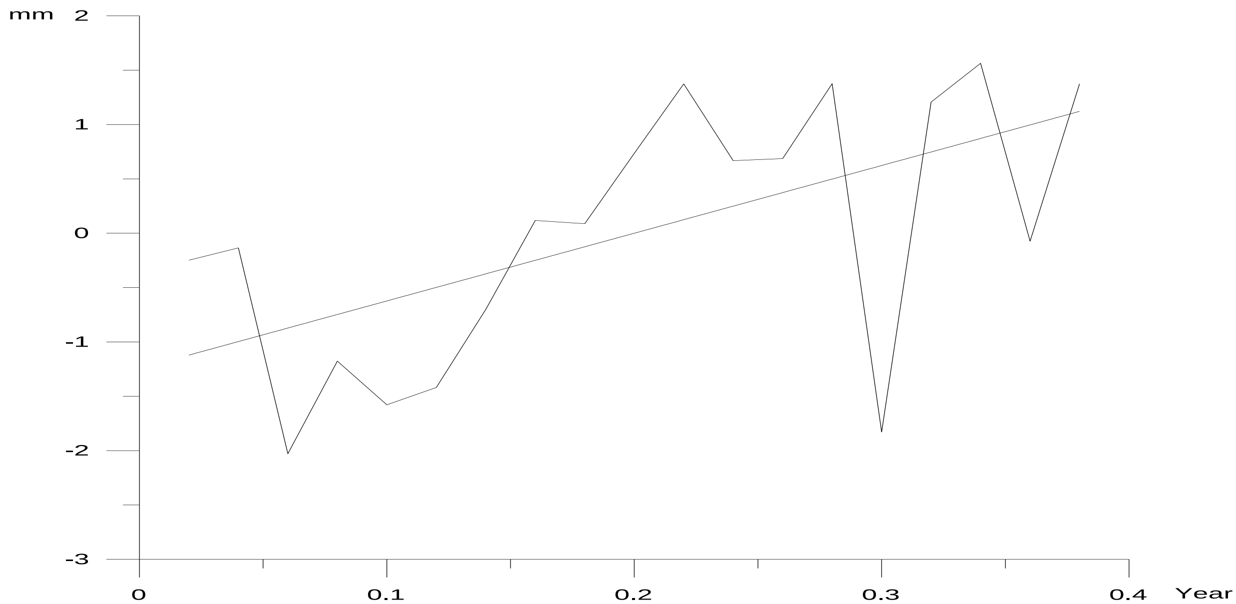


Fig. 3a. Coordinate change x from 1274th till 1306th GPS weeks

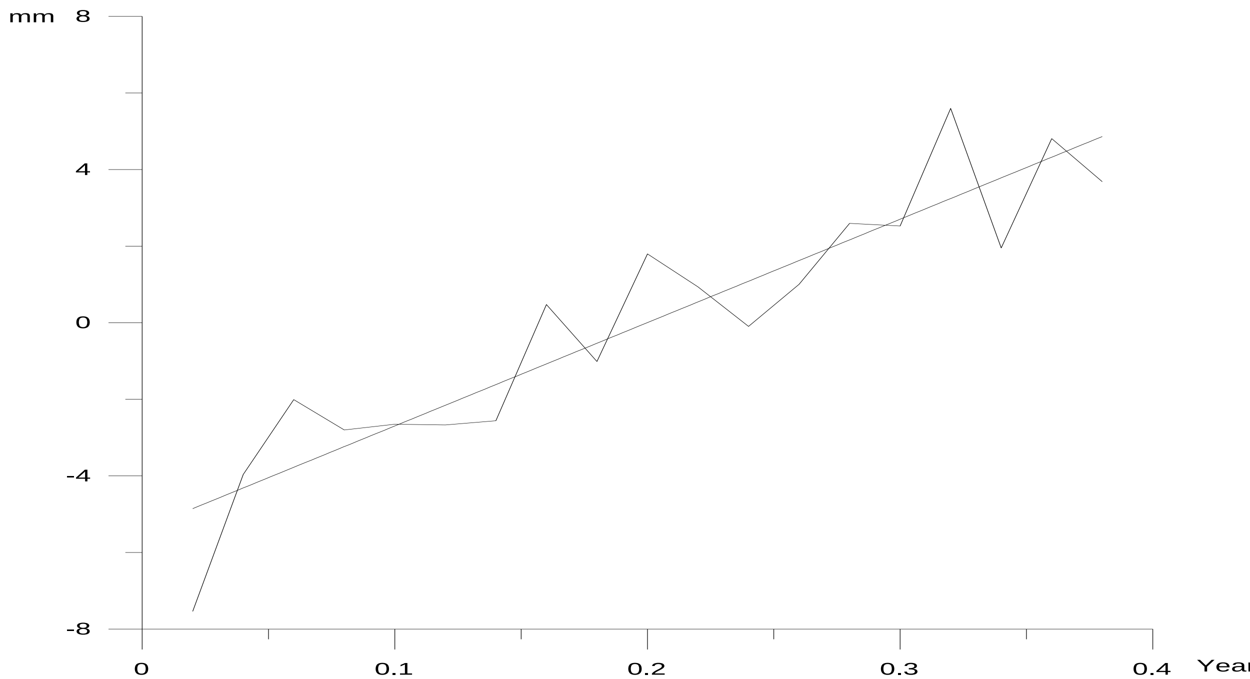


Fig. 3b. Coordinate change y from 1274th till 1306th GPS weeks

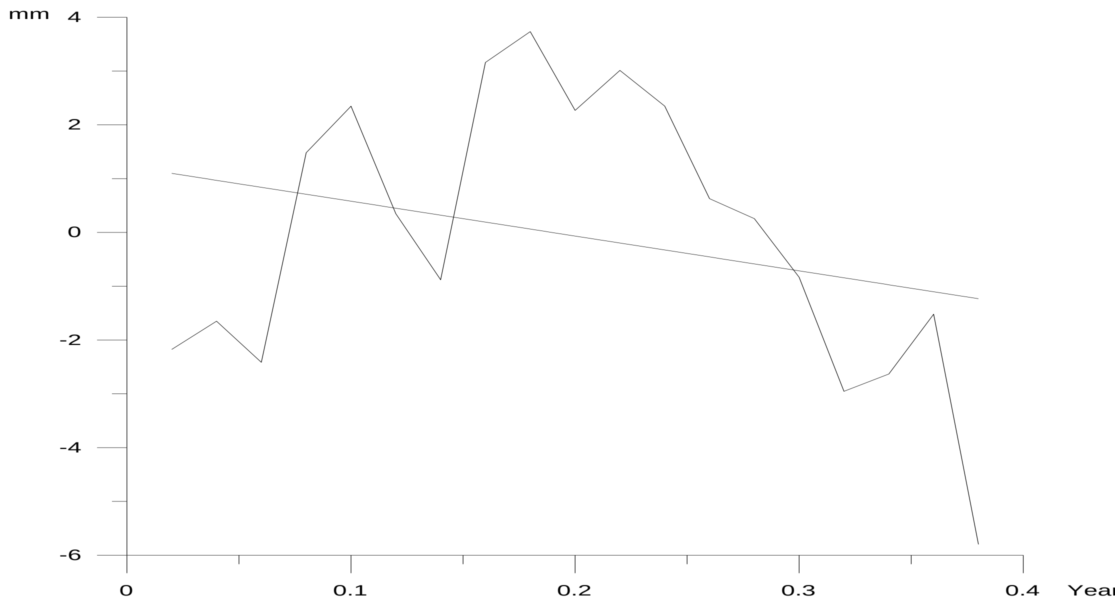


Fig. 3c. Coordinate change h **from 1274th till 1306th GPS weeks**

The below given table illustrates the final values of change velocity of the spatial grid coordinates of the SHAZ station.

Table 1. The values of velocities of coordinates changes of the GPS permanent SHAZ station

Station	MAO local solution for the 1274th-1306th GPS weeks		
	V_x, mm/year	V_y, mm/year	V_z, mm/year
SHAZ	-15.8	18.5	7.5

3. CONCLUSION

In the given paper an analysis of velocity of coordinates changes of the permanent SHAZ station was carried out as well as the values of velocity components were determined after one year of the station functioning.

REFERENCE

1 Ukrgeospacenetwork Ukrainian Space Geodesy and Geodynamics Network of Stations. - Kyiv. VAITE Company. 2005. – 60 p.