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About Basic Geodetic Bases RGP SGS Permanently Operating In The Republic Of Uzbekistan

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ABSTRACT: This article describes the specifics of GRS reference geodetic points (RGP), satellite geodetic network (SGS) established in the Republic for the implementation of the investment project "Establishment of the National Geographic Information System" in accordance with the decree of the President of the Republic of Uzbekistan. A network of 50 GPS base stations for continuous geodetic production, manufactured by Leica Geosystems, is installed SGS-1. The author describes the ideas on how to check the accuracy of the plan and elevation coordinate system in the network and how to check and evaluate the accuracy of the next report on the mathematical processing of measurement results performed using the static method.

KEYWORDS: GRS, RGP, SGS-1, IGS, GNSS, DORIS, STATICS AND RTK, SPIDER BUSINESS CENTER

I. INTRODUCTION

In accordance with the Resolution of the President of the Republic of Uzbekistan dated September 25, 2013 No PP-2045 "On measures to implement the investment project for the establishment of the National Geographic Information System", the task of creating the "National Geographic Information System of the Republic of Uzbekistan" . Within the framework of this project, in 2013-2017, 50 GPS stations were built and installed in the territory of the Republic of Uzbekistan, and rooms for 14 regional centers and one central information analysis center in Tashkent were prepared and telephone and Internet communication devices were installed [5]. The LEICA GR50 receiver (receiver) and base stations of LEICA GR50 produced by Leica Geosystems by the EDCF Fund of Korea and the State Committee for Land Resources, Geodesy, Cartography and State Cadastre of the Republic of Uzbekistan (Davergeodezkadastr) were installed at the reference geodetic points.

II. RELATED WORK

In the practice of geodetic works in the territory of the Republic of Uzbekistan, real-time geodetic measurements of the satellite (RTK) are becoming more widespread. This technology involves the use of at least two satellite receivers. One of them is a permanent base (referent) GNSS station, the other is a station satellite receiver placed in series where it is necessary to determine the spatial coordinates. A continuously operating base station consists of a satellite receiver, an antenna, and a data transmission medium. The antenna is mounted on a building or reinforced concrete pole where it has specific spatial coordinates and is convenient for receiving signals from GNSS satellites (Figure 1). The receiver continuously determines the spatial coordinates of the antenna phase center and transmits the differential corrections received by the satellite via RTK communication channels.

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Figure 1. SGS-1 (UCH1) installed in the school building in Uchkuduk.

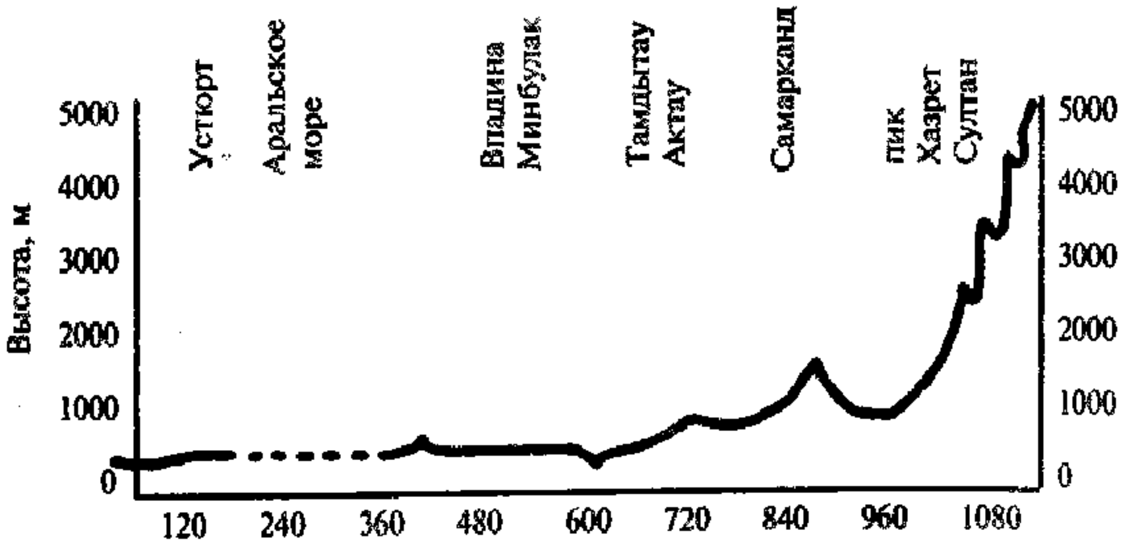
Nowadays, in many countries, networks consisting of three or more permanent base stations using not one but several base stations are widely used to determine the coordinates of a station, in addition to a single fixed base station (Network RTK). The RTK network ensures high accuracy and reliability of measurements when increasing the distance between the base station and the rover.
In addition, a network of permanent base stations is more efficient than traditional triangulation and polygonometry networks. Unlike triangulation, a line of sight between SGS points is not required. GNSS allows the installation of base stations anywhere that provide reliable reception of signals from these satellites [2–4].

III. LITERATURE SURVEY

The configuration of the network of reference geodetic points varies depending on the number of users of the means of communication, as well as the collection and processing of data from GNSS satellites. Network operation requires a server with appropriate software that connects individual GNSS bases to the network, creates network RTK fixes, and allows the operator to monitor station performance, number of GNSS satellites, and remotely control the network. When a network of reference geodetic points is available, the accuracy and security of spatial coordinate detection in real time, as a rule, does not depend on the distance between the base station and the means of communication, unlike a continuously operating base station. In addition, the availability of the network allows an unlimited number of users to perform measurements at the same time.
The area of the Republic of Uzbekistan is 447.4 thousand km2, which is almost 2 times larger than the rest of the world, 11 times larger than Switzerland and 14 times larger than Belgium. It also has large reserves of minerals ranging from precious minerals to precious and semi-precious stones and metals. Therefore, in the selection of reference geodetic points there were problems with the geophysical features of Uzbekistan [7].

IV. METHODOLOGY

According to the features of the relief, the territory of Uzbekistan is divided into two parts. The majority (78.7%) consists of lowlands, the rest (21.3%) consists of mountains and intermountain lowlands. From the west and northwest to the east and south-east the territory of the republic is gradually growing.



2 - picture. The relief of Uzbekistan along the peak of Minbulak along the peak of Hazrati Sultan.

The lowest part of Uzbekistan is located at an altitude of 60-100 m above sea level, in the lower reaches of the Amu Darya and along the Aral Sea (Figure 2) [4].

Signs of rising of the relief of Uzbekistan above sea level to neighboring areas are of great importance. All this has affected the deployment of permanent GNSS base stations in the territory of the Republic of Uzbekistan. According to the technical requirements, the distance between the stations should not exceed 70 km and should be located in the area [2]. At the same time, the following factors are taken into account to cover the entire territory of the Republic of Uzbekistan with a network of permanent base stations and ensure their uninterrupted operation in real time, which guarantees:

- constant study of the sky;
- Reliable reception of signals from GNSS satellites (this factor requires installing the antenna as far away from trees, buildings and other objects as possible from places where it can be a source of wave reflection);
- stable (unchanging) spatial position of the antenna;
- physical security;
- taking into account the weather conditions of the installation site;
- protection of equipment from external influences;
- availability of power supply and backbone networks (internet);
- Availability of permanent GNSS bases at a distance of 50-70 km;
- availability of large settlements;
- availability of meteorological stations.

V. EXPERIMENTAL RESULTS

50 GNSS reference stations covering the entire territory of the Republic of Uzbekistan have been installed. For the measurement cycles, the KIT-3 (Book) point was selected to calculate the vectors and pre-align the RGP and SGS-0 points (IGS points in continuous use). At the same time, in Tashkent city DAS MAGK (MAGK), Tashkent region - Boka district (BUKD), Yangiyul district (YAN 1), Chirchik district (CHIR); Fergana region - Fergana city (FARD), Besharik district (KOKA), Zafarabad district (GALA), Yazyovan district (YAZV); Andijan region - the city of Asaka (ASAK), Haqqulobod (HAKK), Kurgantepa district (KURG); Namangan region - the city of Namangan (NAMD), Yangikurgan district (YANN), Chust district (CHUS); Syrdarya region - Gulistan city (GULD), Syrdarya district (SIRD), Shirin district (BAUD); Jizzakh region - Jizzakh city Uchtepa (UCHT), Zaamin district (ZAAM), Dustlik district (DUST), Gallaorol district (GALL), Yangiqishloq (NEW); Samarkand region - Samarkand city (SAMD), Ishtikhon district (ISTD), Aktash district (AKTD); Bukhara region - Bukhara city (BUX1), Gijduvan district (GJDD), Alat district (ALT1), Karavulbozor district (KRBD); Navoi region - the city of Navoi (NAVD), the city of Zarafshan (ZAR1), the city of Uchkuduk (UCH1); Kashkadarya region - Karshi city (KRSD), Mubarek district (MBRD),

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Chirakchi district Kokdala (SRBD), Yakkabog district (YKBD), Guzar district (GUZD); Surkhandarya region - Termez city (TER1), Boysun district (BAY1), Denau district (DEN1), Kumkurgan district (KUM1), Yangiyul (SAR1), Shurchi district Dustlik (DUS1); Khorezm region - Urgench city (URGD), Turtkul district (TURT); In the Republic of Karakalpakstan - Nukus city (NUKS), Mangit district (MANG), Kanlikul (KANL), Chimbay (CHIM), Kungrad districts (ALTK) SGS points were installed (Figure 3).

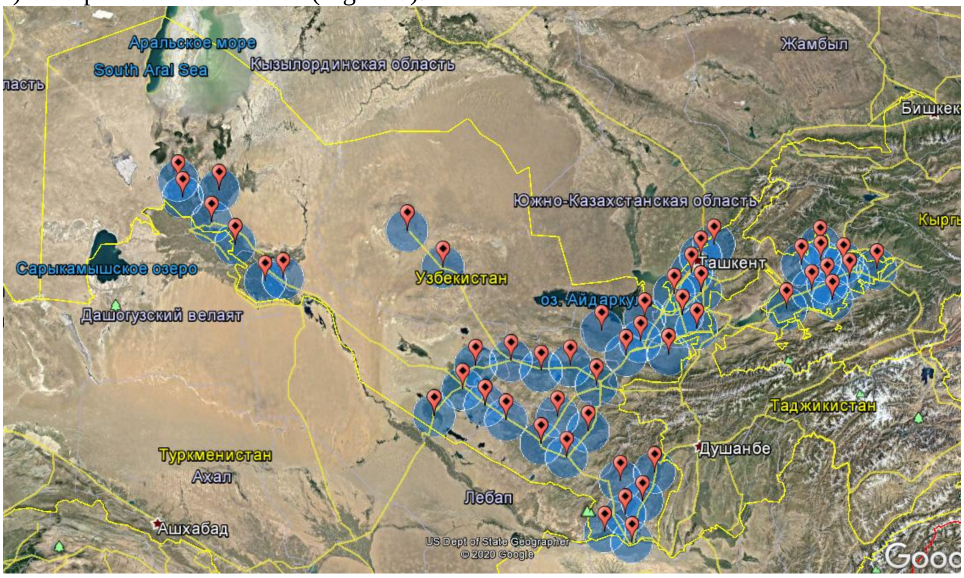

Figure 3. Geodetic points of satellite geodetic points (SGS) located in the territory of the Republic of Uzbekistan.

In addition, the international geodetic network is connected to IGS points POL2 (located in the Kyrgyz Republic), Tashkent (TASH), Kitab district IGS (KIT3) and others. The data for these items were uploaded from the Internet (http://sopac.ucsd.edu/cgi-bin/dbDataBySite.cgi). In addition, in Tashkent (TASH), Fergana region - Fergana city (FARD), Kashkadarya region - Kitab district IGS (KIT3) and DORIS (KIT1), Surkhandarya region - Termez city, Jarqurghon (TER1), Khorezm region - Urgench (URGD) RGP points were set (Figure 4).

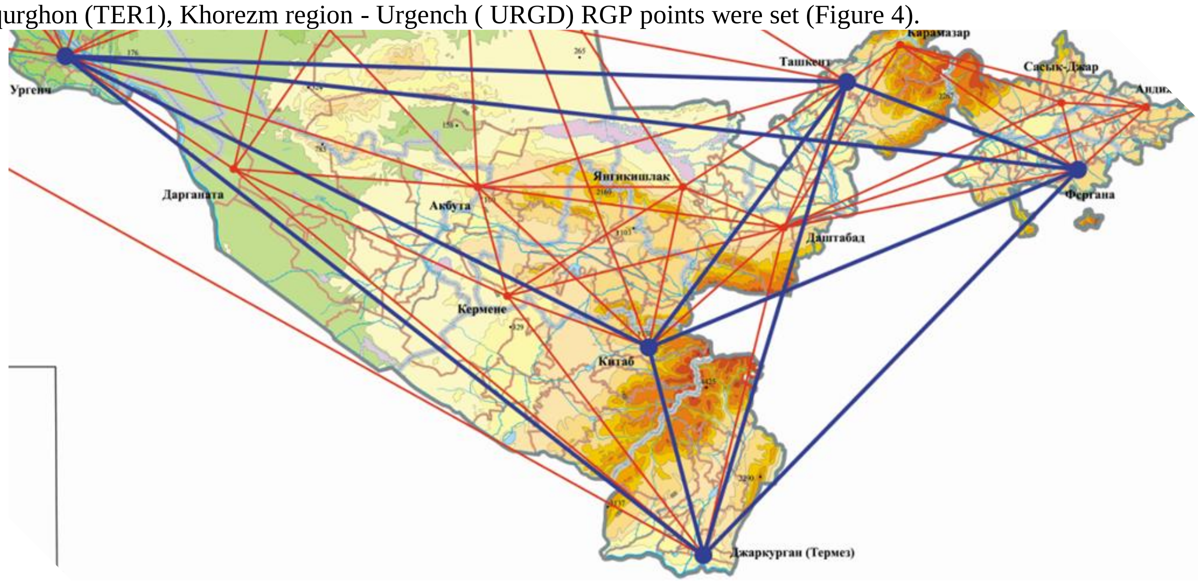

Figure 4. Scheme of reference geodetic points (RGP) located in the territory of the Republic of Uzbekistan.

The AR20 LEIM antennas of the LEICA GR50 receiver and base stations are mounted on concrete poles or metal pipes with a diameter of at least 10 cm, which in turn are attached to the load-bearing wall or roof of the building

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(Figures 1 and 5). From above, each antenna is covered with a cover made of radio transparent material (plastic). This protects it from rain and pollution.

The permanent base stations are equipped with Leica GR50 dual frequency GNSS satellite receivers and AR20 LEIM antennas. The choice of two-frequency receivers as reference stations is also explained by the fact that single-frequency GNSS receivers used in Uzbekistan do not always meet modern requirements.

Figure 5. Permanent GNSS base station antenna (Zarafshan ZAR1)

The network of permanent base stations is managed by the built-in GPS Spider Business Center software with a web interface. Each reference station can continuously and quickly transfer “sketch” data files to the server, and has an important internal memory to store this data in the event of any communication problems. Once the connection is restored, the “sketch” data in the receiver’s internal memory is automatically transmitted to the control center.

Since the base station antenna is located mainly at a great distance from the receiver (outside the building, on the roof), cables with a length of 10, 20, 50 and more meters are required to connect it to the receiver. The length of cables of permanent GNSS base stations of the Republic of Uzbekistan meets international standards and does not exceed 30-50 m.

Feedback . To protect the reference stations from the effects of external weather and climatic factors (lightning discharge and lightning), lightning rods are installed (Figures 1 and 5). They are located close to the antenna at low altitude so as not to interfere with the transmission of signals from GNSS satellites. During a thunderstorm, electromagnetic fields can create an electric current in the antenna cable and damage the equipment of the reference station. A lightning rod is used for protection, which is located in the cable between the antenna and the receiver and is connected to the lightning rod (Figures 1 and 5).

The network of permanent GNSS base stations of the Republic of Uzbekistan was commissioned in 2017.

The created network can be used in the following directions:

- cartography;
- topographic photography;
- Defining the boundaries of land management and property;
- provision of photopography;
- Data collection for GIS projects;
- engineering surveys, including aerial geophysical surveys;
- management of construction machines and mechanisms;
- land and air navigation;
- monitoring of the earth's crust, natural resources and the environment;
- emergencies, defense, etc.

A special spatial rectangular coordinate system based on the international ellipsoid WGS-84 has been developed for the network. Nevertheless, the user of the network of permanent GNSS base stations of the Republic of Uzbekistan, depending on the requirements, can receive data in WGS-84, SK-42, UTM and other coordinate systems.

The transition from one coordinate system to another is done in several ways: automatically, by entering the parameters and parameters of the corresponding coordinate system into the measuring devices or in real time on the website.

The operation of the network of permanent GNSS base stations of the Republic of Uzbekistan began in January 2018. The author of the article, together with the staff of the Department of Topography and Geodesy of the Samarkand Aerogeodesic Enterprise in June-August 2019, directly participated in geodetic measurements in the Zarmitan and Muruntau gold deposits of NMMC (Figure 6).

Figure 6. Geodetic survey process (Static method) with Leica GS10 GNSS receiver in the territory of Muruntau gold deposit belonging to NMMC.

VI. CONCLUSION AND FUTURE WORK

According to the terms of reference, in the plan, the standard error of location in the network of permanent GNSS base stations of the Republic of Uzbekistan is calculated according to the following formula (1):

$$M_{x,y} = (10 + D)\ мм, \quad (1)$$

where D is the distance from the receiver to the base station in km.

Based on the results of network testing, the author identified the following:

- in real time and in ideal atmospheric conditions, the standard error of the location does not depend on the distance to the base station;

- the mean square error of placement in the post-processing mode depends on the distance to the base station and is determined by the above formula.

Conclusions. Another source of error in determining the coordinates of the objects being inspected when using this network is trees, roof canopies, etc., in the signal path from the navigation satellites to the mobile receiver antenna. This error was reduced by special methods of signal processing.

Services of the network of permanent GNSS base stations of the Republic of Uzbekistan are provided to the public by the Committee for Geodesy and Cadastre. Currently, users of this network are provided with open data on the basis of paid services and relevant permits using a special program Spider Business Center of the State Geodesy and Cadastre Committee.

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