"Environmental Engineering" 10th International Conference
Vilnius Gediminas Technical University
Lithuania, 27–28 April 2017
http://enviro.vgtu.lt

eISSN 2029-7092 / eISBN 978-609-476-044-0

Article ID: enviro.2017.248
DOI: https://doi.org/10.3846/enviro.2017.248

Struve Geodetic Arc – the Decade in the World Heritage List

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Abstract. Unique scientific project unifying scientitsts of present modern countries: Norway, Sweden, Finland, Estonia, Latvia, Lithuania, Belarus, Ukraine, Moldova, Russia was carried out in the first half of the 19th century. Results obtained for the mentioned period were very accurate especialy considering the size of the project and instruments used for the measurements.

Network of triangulation of 2820 km lenght running from Danube mouth till Arctic Ocean also called Struve Geodetic Arc was built and measured in 1816–1852. That was the longest and most accurate measured meridian arc in 19th century which measurements data were used during the century for computing and improving parameters of the Earth elipsoid.

Geodetic points of Struve Geodetic Arc were listed to the World Heritage List in 2005. Three points located in Meškonys, Paliepiukai and Gireišiai were commemorated in Lithuania. The Coordinating Committee of Struve Geodetic Arc was created for colaboration, spreading information for wider public, exchange of the best practice for preservation of Struve Geodetic Arc points. Practice, experience and problems related to the World Heritage List objects preservation are presented and analyzed in this publication.

Keywords: Struve Geodetic Arc, triangulation network, world heritage, size of earth.

Conference topic: Technologies of geodesy and cadastre.

Introduction. What is the Struve Geodetic Arc?

The Struve Geodetic Arc is a triangulation measurement chain, formed in 1816–1852, stretching from the 26° east longitude along the meridian from Hammerfest (Norway) on the shores of the Arctic Ocean to Ismail (Ukraine), by the Black Sea, i.e. from 4 °20′ to 70°40′ North latitude. The activities in establishing and carrying forward the measurements along the Arc have been executed in two countries: Russian Empire and Swedish Kingdom. Nowadays the Arc covers ten states: Norway, Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Belarus, Ukraine and Moldova. During the measurements, Arc length and position is calculated by the measured triangulation network fragments in the aforementioned countries. Connecting them together results in a 2,822 km-long chain, comprised of 12 sections, interspersed between astronomy points, having 10 measured bases, 258 triangles and connecting 259 triangulation points. The average length of the sides of the triangles – 27 km, but there are sides longer than even 50 km. The difference of the geographical latitudes of this chain's end points amounts to 25°20′. Until the mid-20th c. when the satellite geodetic methods were first applied, this was the most accurately measured and longest meridian arc, for a whole century the results of its measurement were used in calculating and adjusting the parameters of the Earth's ellipsoid (Fig. 1).

Friedrich Georg Wilhelm von Struve (1793–1864), professor of the Tartu University and the long-time head of the University's astronomy observatory, systematised the results of the selected measurements of the fragments of the triangulation networks for calculating the meridian's Arcand described them in a final report, *Arc du Méridien de 25°20′.* Based on this work by F. G. W. von Struve, in 1888 the length of the Earth's meridian was calculated by the geodesist I. Bonsdorff (Nomination of the Struve… 2005).

The Struve Geodetic Arc is one of the most remarkable attempts in human history to explore and determine the Earth's shape and size. The history on such attempts reaches the era of the famous Greek philosopher Aristotle (4th c. BCE). The radius of the earth was first determined by the Greek scientist Eratosthenes in the 2nd c. BCE. He assessed the 1 degree meridian, passing through Alexandria and Siena (currently Aswan, southern Egypt), length S and according to the formula $S = 2\pi R\ 360°S$ calculated the value of the radius R. He calculated the meridian arc length by the

Fig. 1. Map of the chain of Struve Geodetic Arc (Nomination of the Struve… 2005)

speed and length of time it took caravans to cross the desert. The arc, corresponding to the difference between latitudes, was calculated based on the measured height of the Sun on the meridian. Although the accuracy of the measurements was low, the offered method for calculating the Earth's radius was promising. It was eventually called the degree measurement method of degree observation. In order to more accurately determine the radius of the Earth, more accurate geodetic measurements had to be performed. The real turning point in strengthening the methodology of the precise measurement of the Earth's surface took place much later, in the 17th c., when the Dutch geodesist Willebrord Snellius proposed to apply the so-called triangulation method, while Isaac Newton in 1687 proved that the shape of the Earth rotating on its axis was similar to an ellipsoid. This meant that the Earth's meridian's curvature radius, moving from the equator to the poles, should increase. Using the triangulation method to determine the distance between the points on the Earth's surface, they are linked into a system of triangles, the angles of triangles are measured and at least one side – the base.

Outstanding Universal Value of Struve Geodetic Arc and its inscription to the World Heritage list

The results of F. G. W. von Struve's work were included in all later calculations of the parameter of the Earth's ellipsoid, on the basis of the triangulation. This Arc of measurements of the Earth's meridian has great scientific and cultural value. Therefore, in 1993, the National Land Survey of Finland and the Finnish Geodetic Institute proposed to inscribe the Struve Geodetic Arc into the World Heritage List and immortalise the key geodetic points of the meridian Arc as a UNESCO protected world heritage sites. The nomination was submitted to the World Heritage Committee in January 2004 and the object was inscribed into the World Heritage List in July 2005 (Nomination of the Struve… 2005). Its importance was recognised according to the three outstanding universal value criteria for UNESCO protected Wworld heritage sites:

– the first accurate measuring of a long segment of a meridian, helping in the establishment of the exact size and shape of the world exhibits an important step in the development of earth sciences. It is also an extraordinary example for interchange of human values in the form of scientific collaboration among scientists from different countries. It is at the same time an example for collaboration between monarchs of different powers, for scientific cause.

– the Struve Geodetic Arc is undoubtedly an outstanding example of technological ensemble - presenting the triangulation points of the measuring of the meridian, being the non movable and non tangible part of the measuring technology.
– the measuring of the arc and its results are directly associated with men wondering about his world, its shape and size. It is linked with Sir Isaac Newton's theory that the world is not exact sphere (UNESCO 2005).

Although the measurements were performed in complicated conditions, the geodetic work was performed surprisingly accurately. The average angle measurement error did not reach 0.7", while the Arc length's accuracy was 1/232390 (4 mm per km). Although in the 19th c. the political situation was not stable, in preparing and measuring the Struve Geodetic Arc there was close scientific and cultural cooperation between the heads of the expeditions and the most skilled local scientists. The advanced geodetic and astronomical measurement theories and methods of the time were created, for these measurements instruments were invented and made, observatories were established.

The Struve Geodetic Arc is commemorated and presented to public by 34 selected points. In each country, depending to the length of the arc, from one to six of the most important points are preserved: In Norway – 4, in Sweden – 4, in Finland – 6, in Russia – 2, in Estonia – 3, in Latvia – 2, in Lithuania – 3, in Belarus – 5, in Moldavia – 1, in Ukraine – 4 (Nomination of the Struve… 2005). The points preserved in Lithuania are Meškonys, Paliepukai (both in the region of Vilnius) and Gireišiai (Rokiškis district). The other preserved sites of the Arc are cared for at the national level.

All of the Struve Geodetic Arc points, included in the World Heritage List, are commemorated by building monuments with the UNESCO logo nearby and the site's information, introductory descriptions a prepared. Coordination of the protection, upholding and dissemination of information about it in society is performed at the international scale by the UNESCO National Commissions and the Coordination Committee of Struve Geodetic Arc, which is comprised of representatives from responsible governmental institutions.

Coordinating activities

There were a number of both public and private initiatives collaborating amongst responsible authorities, geodesy and astronomy experts, heritage specialists and other involved parties in exploration and utilisation of results from the investigations realated to the Struve Geodetic Arc internationally and in individual countries. Also many publications, presentations and events were organised under the umbrella of UNESCO national commissions. However, the State Parties – mainly National Mapping Authorities, the official representatives for the professional domain of Struve Geodetic Arc in all ten countries decided to form the permanent Coordinating Commitee of Struve Geodetic Arc in 2005 (EuroGeographics 2017).

Fig. 2. Participants of the 7th Coordinating Committee of Struve Geodetic Arc, Tallinn, 2016

The main objectives of the Coordinating Committee – to create and develop the common rules and good practice in order to protect, preserve, present and promote the World Heritage property "Struve Geodetic Arc" as an entire trans-boundary object. This requires active collaboration with the national instruments of management over the separate stations – parts of the monument, as well as effective coordination in making the monument more substantial and more known to the public. Particular tasks that result from the main objectives are realized through common management practice agreed by the State Parties. Through the established Coordinating Committee necessary coordination of the ten Arc State Parties is ensured, as well as joint responsibility over the trans-boundary World Heritage property "Struve Geodetic Arc".

Representatives of the ten "Struve Geodetic Arc" State Parties form the Coordinating Committee. Each State party nominates its primary representative to the Committee. EuroGeographics supports the Coordinating Committee by the resource of Secretary General, which handles a communication amongst Coordinating Committee members, other involved institutions and individuals. The list of the national representatives in the Committee is available in the EuroGeographics website. Commitee members elect the Chair perfoming for two years period. The operational terms

of the Coordinating Committee are land down in the document "International Management Mechanism for the Transboundary Property "Struve Geodetic Arc" (EuroGeographics 2012).

The main activities of the Coordinating Committee are carried out according to the following main topics:

- to maintain preservation of the "Struve Geodetic Arc" (SGA) as an entire World Heritage property, providing professional assistance and support implementing decisions and recommendations of the World Heritage Committee,
- to follow up the state of conservation of the SGA stations and achievements in protection, conservation, presentation and promotion of the SGA in various countries, organise Committee meetings, in which each representatives of the State Parties provide national reports, suggestions for common activities, make decisions and actions, and produce the meeting resolutions,
- to give recommendations and instructions to the management bodies of the ten SGA State Parties in order to improve the practice and apply coordinated achievements in protection, conservation, presentation and promotion of the SGA objects,
- to uniform particular designation of the SGA sites and to promote international use of the SGA sites for educational and tourist purpose,
- to promote improvements in national information about the SGA, to promote the national exploration and preservation of other than originally selected 34 SGA sites,
- to promote research work and make available for wider public both historical and new records of the SGA as well as related historical geodetic activities,
- to promote geodetic use of the SGA stations, plan and guide trans-boundary measurements with satellite and astronomical techniques.

Participation in the SGA Coordinating Committee meetings are open to national and international experts, representatives of governmental and non-governmental organisations and individuals, whom deal with activities related to SGA or protection of antiquities in field of geodesy in the territories of the State Parties.

Ordinary Coordinating Committee meetings were organised in frequency of two years, but in case of any need or under special circumstances Committee Chair could call an extraordinary meeting or organise consultation and decisions taken processes by electronic means of communication (email, webinar, etc).

During the decade of the activities of the Coordinating Committee 7 meetings (in the setup of open conferences) are organised:

- First Coordinating Committee Meeting, Helsinki, Finland, August 23–25, 2005;
- Second Coordinating Committee Meeting, Haparanda, Sweden, August 14–16, 2006;
- Third Coordinating Committee Meeting, Jekabpils, Latvia, August 22–23, 2008;
- Fourth Coordinating Committee Meeting, Vilnius, Lithuania, September 15–17, 2010;
- Fifth Coordinating Committee Meeting, Minsk-Oshmyany, Belarus, July 3–5, 2012;
- Sixth Coordinating Committee Meeting, Vilnius, Lithuania, 6–8 September 2014;
- Seventh Coordinating Committee Meeting, Tallinn, Estonia, 7–8 September 2016.

Participants agreed on common resolutions at each Coordinating Committee meeting. All decisions usually have been achieved by ovell concensus, but each member also has an individual voting right. Resolutions, presentations and proceedings are published in Struve Geodetic Arc webpages in EuroGeographics website http://www.eurogeographics.org/content/struve-geodetic-arc and in the voluntary maintained wikidot website http://struvearc.wikidot.com/.

The next (eight) meeting of the Coordinating Committee of the Struve Geodetic Arc will be organised in Saint-Petersburg (Russia) in 2018.

Monitoring of Struve Geodetic Arc and best practice cases

The permanent monitoring of the sites and activities of Sruve Geodetic Arc is performed by national and local authorities. UNESCO under support of ICOMOS organises the general supervision of restoration, maintenance and exploitation of all World Heritage objects including Struve Geodetic Arc. The latest periodic reporting on the quality measure criteria for Struve Geodetic Arc was completed in 2014. The report was compiled as the joined contribution of all State Parties of the Stuve Geodetic Arc countries, and submitted to UNESCO by the Ministry of Agriculture of Lithuania (EuroGeographics 2014). The periodic report was filled in electronical form and responded to the exaustive questionnaire, provided by WH experts. In general, the report on Struve Geodetic Arc was very positivelly appreciated. The overall coordination activities by UNESCO have been marked as "Excellent", State Parties as "Satisfactory", Site Managers as "Excellent" and Advisory Bodies as "Satisfactory" (EuroGeographics 2014). Certain issues have been raised in response to the content of the Periodic Reporting. The involved parties highlited that the questionnaire is very much focused to physical preservation/conservation of the property, while the value of the Struve Geodetic Arc contains both physical and non-physical elements to be maintained. Therefore, in addition to the current survey the infor-

mation about the status of publications, level of awareness and preservation of movable properties could be also evaluated. The coordinates of the sites could be maintained in geographical coordinates instead of decimals (EuroGeographics 2014).

In addition, the description of Outstanding Universal Value for Struve Geodetic Arc was revised as a part of the Periodic report documentation. The updated Statement of the OUV of the SGA was adopted at the 38th Session of the World Heritage Committee in Doha, Quatar, 15–25 June 2014 (Struve Geodetic Arc… 2014).

Since 2005, while Struve Geodetic Arc was inscribed to the Workd Heritage list the responsible state and local authorities made a big progress in research of sites and related elements to Struve Geodetic Arc (for example – baselines, instruments, applied techniques, etc) commemorating all the major sites representing Struve Geodetic Arc, producing publications, educational and promotional materials, minting coins, issuing post cards and others. However because of the nature of Struve Geodetic Arc this object is not so indicative as historical architectural monuments or the exceptional natural feature. Unfortunately, it is still not well understood and known in wide public. Only domain experts and individuals within scientific backgound properly appreciate the real value of Struve geodetic Arc.

There is a number of interesting initiatives applied in several countries that lead to a closer collaboration between the State Parties and local communicaties, involving local habitants, schools, students and tourists touching with Struve Geodetic Arc and its purpose in the calculation of shape and size of the Earth in virtual games (Latvia) or presenting the chain of towers in reduced size (Russia, Belarus) (EuroGeographics 2016).

Fig. 3. Model of the Belin site of Struve Geodetic Arc in the school, Belarus

Following the approved guidance from the 40th session of the World Heritage Committee in Istanbul (UNESCO 2016) the members of UNESCO are encouraged in developing the following two documents for each World Heritage object:

– Heritage Impacts Assessment, HIA.
– Environmental Impact Assessment, EIA.

Also the convention 5a of the same session in the World Heritage Committee (Decisions adopted by the World… 2016) stated the need of establish State policy for better integration of sites to public life and planning programmes. Worth mentioning the initiatives for an implementation of the guidance above in Norway. The Management Plan was produced and agreed between the Directorate for Cultural Heritage, municipalities, the county of Finnmark and the Norwegian Mapping Authority. The full-time project manager was appointed to perform and coordinate the actions in the Management Plan for inspection and improving:

– condition of monuments,
– accessibility of the sites,
– signposts,
– foothpaths.

The similar initiatives are on the way in Sweden and Finland (Presentations of the 7th… 2016). The important monitoring activities about the site visits of Struve Geodetic Arc points are recorded in Sweden and Norway. Based on the records the northest and the most popular Struve Geodetic Arc monument in Hammerfest (Norway) attracks over 15 000 visitors annually (in 2015) (EuroGeographics 2016; Lietuvos nacionalinė UNESCO komisija 2017; UNESCO 2014).

Fig. 4. The Northest monument of the Struve Geodetic Arc in Hammerfest (Norway) (EuroGeographics 2016)

Struve Geodetic Arc in Lithuania: status of restoration and investigations

The oldest part of Struve Geodetic Arc is located in Lithuania. It is the triangulation network of Vilnius province measured in 1816–1821. Province was composed of districts: Ašmena, Breslauja, Kaunas, Raseiniai, Šiauliai, Telšiai, Trakai, Upytė, Vilkmergė, Užneris, Vilnius, Zarasai. The South-eastern border of the province was at Braslau, Ašmiany, Lida and Grodno, South-western border was at Nemunas river, and Western border reached Palanga. Northern border of Vilnius province was similar to present border of Lithuania – Latvia. Within these borders the triangulation network was designed and measured by the Estonian officer of Russian Empire army Carl Tenner. Establishment of triangulation network was initiated by a private initiative of Carl Tenner. C.Tenner was in charge of the triangulation activities starting from Latvian Jekabpils till the Danube mouth at the Black Sea. Part of Struve Geodetic Arc from Latvian point Bristen till Belarus Belin is called the Lithuanian Arc (Mkrtychan 2013; F.G.W. Struve meridiano lanko… 2001).

The triangulation chain in Lithuania, as a part of Struve Geodetic Arc, is composed of 18 geodetic points (the coordinates are listed in Table 1), is conected by 18 triangles the continued networks of neighbouring countries (Fig. 5).

Table 1. Points of Struve Geodetic Arc in Lithuania and their coordinates (UNESCO 2016)

No.	Point	Coordinates of present points				Re-computed coordinates of Struve Geodetic Arc			
		B		*L*		*B*		*L*	
		° ′ ″		° ′ ″		° ′ ″		° ′ ″	
1	Pandėlis	56 01	42.6471	25 13	27.1602	56 01	43.05	25 13	26.17
2	Gireišiai	55 54	08.6797	25 26	12.4188	55 54	08.59	25 26	12.54
3	Kinderiai	55 46	27.2077	25 06	29.5037	55 46	27.15	25 06	29.30
4	Martinčiūnai	55 43	28.3189	25 37	25.3982	55 43	28.28	25 37	25.74
5	Kuzmiškis	55 32	22.2722	25 23	46.3895	55 32	22.20	25 23	46.45
6	Storiai	55 29	19.1919	25 08	59.8967	55 29	19.16	25 08	59.72
7	Čivyliai	55 19	06.4897	25 28	12.6309	55 19	06.43	25 28	12.75
8	Petrikiškiai	55 16	57.6861	25 09	13.3430	55 16	57.63	25 09	13.18
9	Kongedai	55 06	30.6982	24 46	54.1020	55 06	30.76	24 46	53.58
10	Meškonys	54 55	51.3882	25 19	00.3162	54 55	51.43	25 19	00.35
11	Šventininkai	54 51	42.8721	25 37	44.3849	54 51	42.95	25 37	44.70
12	Nuobariškės	54 42	14.8101	24 47	59.8920	54 42	14.86	24 47	59.56
13	Paliepiukai	54 38	03.9306	25 25	44.6623	54 38	05.24	25 25	40.70
14	Medininkai	54 31	51.8477	25 37	40.0358	54 31	51.95	25 37	40.38
15	Jokšiai	55 55	54.9900	25 08	47.4500	55 55	54.96	25 08	47.20
16	Ambraziškiai	55 08	24.5400	25 18	23.5900	55 08	24.42	25 18	23.69
17	Ganusiškės	–		–		56 08	46	25 31	48
18	Nemėžis	–		–		54 39	03.23	25 19	00

Fig. 5. Part of Struve Geodetic Network in Baltic countries

Baseline ends and some triangulation points were monumented from field stones with concrete in a dug pit. On a top stone the hole was drilled where melted lead was poured. The cross on a lead was cut for the centre, which later covered by bricks. Centre on the surface was marked by pole with a nail. Most of the triangulation points centres were marked on the brick, 0.5 m under the soil surface.

Wooden pillars of 5–11 m height were built for the observations in a hilly area and the signals up to 30 m were built in forest areas for direct visibility between points.

The angles of the triangulation were measured by vernier type theodolites with a reading accuracy of 10", by method of repetition. Every angle between adjacent directions was measured separately, in 20–50 repetitions. The closing error of the triangles positions was up to 3" (Eitmanavičienė 1964).

Mean lenght of the triangle side was 25 km. 10 baselines of Struve Geodetic Arc were measured in the whole arc with the best possible accuracy. Baselines of the triangulation network were measured by four iron rods, length of each was 14 feet. The rods for measurements were laid on the wooden holders with minimal gaps between them. The gaps were measured by the ruler with scale by using the magnifying glass for reading. The accuracy of the readings – 0.001 of inch. Temperature was measured by bimetallic instrument in the beginning of the observations and later by thermometer. Angles of inclination were measured by an ecklimeter with level (accuracy 0.1'). Relative errors of the measured baselines were 1:300 000 (UNESCO 2016).

13 temporary astronomic stations were established during the measurements of Struve Geodetic Arc. One of them was the astronomic station established at Nemėžis point in 1826, in 6 km from the Vilnius observatory, where astronomic coordinates were determined from observations. Only the determined latitude of the Nemėžis station was used in the computations of the triangulation network. The latitude was computed based on the difference of longitudes –1°24'13.50" (Zapiski voenno-topograficheskogo depo 1843) between the Nemėžis and Tartu observatories, using the triangulation records of 1828.

Azimuth of the triangle side Nemėžis – Meškonys was determined in 1839, by observing stars close to Pole by a passage instrument. Coordinates of the triangulation points were computed: Nemėžis point coordinates – North longitude φ = 54°39'03.23"; East latitude λ = 25°19'30.48". Azimuth of direction Nemėžis – Meškonys α = 359°59'57.93". Based on these initial data the coordinates of theVilnius province triangulation points were included into the Geodetic Arc's chain (Zapiski voenno-topograficheskogo depo 1843; Mkrtychan 2013).

Points of the triangulation, established and measured by C. Tenner, were demolished very quickly because of very week and not long lasting construction. However many of the triangulation points' sites were discovered after WWI from the topographic maps of 19th century and used for an establishment of new geodetic points in modern geodetic networks. Most of the points of the triangulation in XIX centurywere replaced by new ones and used even today, in modern geodetic GPS networks (F.G.W. Struve meridiano lanko… 2001).

New instruments and measuring methods were discovered in XX century. Struve Geodetic Arc has lost it's importance and was nearly forgoten. The idea to commemorate this unique geodetic project of XIXth century gradually was developed by a group of enthusiasts in several countries. The important influence to the idea of commemorating the Struve Geodetic Arc was elaborated by Jim Smith, Jean de Graeve Pekka Tatilla. The reports in the conferences and workshops of International Federation of Surveyors, International Union of Astronomers with a support of International Association of Geodesy turned this idea to practical steps for an inscription the Struve Geodetic Arc into the UNESCO World Herritage List.

Lithuanian National Land Service under the Ministry of Agriculture and Institute of Geodesy (VGTU) have selected 3 Struve Geodetic Arc points of 18 to commemorate the Arc: Meškonys (Meschkanzi) Paliepiukai (Beresnaki) and Gireišiai (Karischki).

Selected points were fenced with decorative fences, and information boards were established next to the points.

Tourists interested in visiting the famous UNESCO objects in Lithuania should search the web for information and check blogs of travelers. Rokiškis municipality has created a Facebook account "Struve/LT/Gireisiai". In 2012 the environmental management project supported by the EU Structural Funds and district budget was implemented at Gireišiai Struve Geodetic Arc point. The project enabled managing the environment and improving the infrastructure.

The remaining points of Struve Geodetic Arc in Lithuaniaare not monimented and accessible to visitors. There is no sufficiently developed infrastructure, a lack of access directions, routes and parking places, no access for people with disabilities. Some points are not even cleaned from grass and brushes. No information and promotion about those sites are available to tourists and wide public. However, there are initiatives to change the existing situation. The municipality of Vilnius district together with Lithuanian National Commission for UNESCO initiated the development of the infrastructure and establishment of tourism routes as well as information resources, which should make the Struve Geodetic Arc points more attractive to public and better adapted to the needs of tourism.

Conclusions

1. Struve Geodetic Arc is the only geodetic World Heritage object. It is undoubtfully one of the most remarkable attempts in human history to explore and determine the Earth's shape and size. The inscription to the World Heritage list raised the awareness about the expraordinary work of a number of geodetic and astronomic scientifists involved to the Struve Geodetic Arc measurements at XIX century.
2. International collaboration about Struve Geodetic Arc amongst State Parties in the ten countries provided significant benefits for achieving Struve Geodetic Arc the successful nomination to the World Heritage list and also in further maintenance of the elements of Struve Geodetic Arc in consistent, collaborative and mutually positive apporache.
3. Following the guidance from UNESCO the sites and other components of Struve Geodetic Arc shall be properly monitored, changes to be managed and infrastructural projects implemented for better commemoration and exploitation of Struve Geodetic Arc.
4. Closer collaboration between State, local authorities, universities and private actors will lead to a better awareness about Struve Geodetic Arc in society. The innovative methods in promoting this unique object lead to better understanding the outstanding universal value of Struve Geodetic Arc, and streamline the tourism industry.
5. There is high demand to commemorate and mark all sites of Struve Geodetic Arc in Lithuania. For the time being only 3 out of 18 points are monumented.

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