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## **Case Study 14.1: The Struve Geodetic Arc**

Belarus, Estonia, Finland, Latvia, Lithuania, Republic of  
Moldova, Norway, Russian Federation, Sweden, and Ukraine

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### **Presentation and analysis of the site**

*Geographical position:* Thirty-four different locations in the nominating states.

*Location:* Latitude 45° 19' 54" N to 70° 40' 12" N, longitude 22° 44' 45" E to 28° 55' 41" E. Elevation up to c. 250m above mean sea level. A full list of the 34 locations is available in the nomination file (see bibliography).

*General description:* The Struve Geodetic Arc World Heritage Site, a serial inscription made in 2005 under criteria (ii), (iii) and (vi), comprises a string of 34 surviving nodes of a 265-point triangulation network set up between 1816 and 1851 by the astronomer Friedrich Georg Wilhelm Struve (1793–1864) and his colleagues in order to determine the precise size and shape of the Earth. It runs through ten modern countries from the north coast of Norway down to the Black Sea.

*Inventory of the remains:* Of the 34 listed nodes, 4 lie in Norway, 4 in Sweden, 6 in Finland, 1 in Russia, 3 in Estonia, 2 in Latvia, 3 in Lithuania, 5 in Belarus, 1 in Moldova and 4 in Ukraine. A full description of each can be found in the nomination file. The various nodes are marked in different ways, which can be broadly classified as follows:

- a small hole drilled in the rock surface, sometimes filled with lead;
- a cross-shaped engraved mark on the rock surface;
- a solid stone or brick with a marker set in it;
- a mound of stones (cairn), with a central stone or brick, marked by a drilled hole;
- a single brick; and
- a specially constructed 'monument' to commemorate the point and the arc.

*History of the site:* A decision was reached in 1815 to establish agreed international boundaries in Europe and this required accurate mapping. Following the defeat of Napoleon, accurate mapping was also a priority for the new European rulers who did not trust the peace to be long lasting. It was in this context that the Russian Tsar Alexander I provided Struve with the resources to establish a new long geodetic arc. Struve was working at Dorpat (Tartu) University in what is now Estonia, and decided to establish a triangulation arc following a line of longitude (meridian) passing through the university's observatory. Several decades later, a 2800km-long arc was finally established by connecting and extending earlier, shorter arcs. It stretched from Fuglenaes near Hammerfest in the far north to Staro-Nekrasowka, near Ismail, on the shore of the Black Sea.

*Cultural and symbolic dimension:* Determining the size and shape of the Earth had been a key problem for natural philosophers since ancient Greek times. Eratosthenes' method, developed in the 3rd century BC, used length measurements and angles determined by observations of stars, but was very inaccurate. Only in the 17th century did accurate measurements become feasible, using the newly developed technique of triangulation. By this method, only much shorter lines had to be measured accurately, while the long distances were determined using a chain of connected triangles (a 'triangulation arc').



**Fig. 14.1.1.** The northernmost node of the Struve arc, marked by a memorial obelisk, at Fuglenaes, Norway. Photograph by F. Bandarin. © UNESCO World Heritage Centre.

During the 18th century, early arcs were constructed in France, Peru, Lapland, Italy, South Africa and Austria, but all of them had shortcomings. Struve's arc was the longest such arc when it was created, and remained so for over a century (its length was only eventually exceeded by an arc completed in 1954). It was also the most accurate, producing measurements correct to 4 mm in 1 km. It brought about the development of new and more accurate measuring equipment, and assisted indirectly in promoting the standard metric system. It was the first meridian measurement device crossing the borders of several countries and formed the basis for mapping not only of those countries that it traversed but also of central Eastern Europe in general.

Struve's arc is not only a key example of the broader application of astronomy in modern times; it also represents an important step in the development of the earth sciences and in the use of state-of-the-art technologies.

*Authenticity and integrity:* All 34 nodes are in their original location; some are in remote areas that are unchanged since the arc was created.

### **Present site management**

*Protection:* All 34 nodes are legally protected, in most cases by two laws—one protecting geodetic points and the other for the protection of cultural heritage.

*State of conservation:* The cultural-historical importance of some of the nodes was recognized long ago and many of them came under the protection of the cultural heritage legislation of

the relevant countries. As recognized monuments, the relevant laws have been applied, including those relating to conservation.

The present state of conservation of the 34 nodes on the World Heritage List seems good. Many of them still form part of their national geodetic grid, and are permanently maintained. Most of them still have their original plaques. Some have been reinstalled, but in the exact original position.

*Main threats or potential threats to the sites:* The only potential risk is from increased numbers of visitors, which is possible following the World Heritage inscription. Managing such risk is one of the considerations of a coordinating body that has been created by the ten countries.

*Management, interpretation and outreach:* Each of the nominating countries has their own regime to manage the heritage. At the same time, the ten countries have set up a joint ‘management mechanism’, in the form of a coordinating committee, to coordinate the management of the nominated sites.

Many of the nominated ‘sites’ are points or other shapes in the rock, with very small area around them. Most of them still form part of the relevant national geodetic system and therefore could potentially be used—in other words, they retain a practical importance. Therefore they are managed by national geodetic services and controlled by national cultural heritage institutions.

The existing management and legal protection were two of the criteria used by the State Parties to choose the 34 nodes for nomination from the many more that were originally in the Struve Arc and may survive.

### **Additional bibliography**

ICOMOS (2005). *Struve Geodetic Arc* [Evaluation document].

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