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GEODETIC BASE PREPARATION FOR STATE BORDER DEMARCATION

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Introduction

Providing state border demarcation (pinning and output) processes the geodesy plays an important role in them. It provides both coordinate acquisitions, measurements on the state boundary fitted to border posts, the border line fixations with some land spatial pattern and the boundaries pinning legal technical papers creation – as the national border map (demarcation map) and bounds description. In all cases remains the need for spatially understood and mathematically registered area information applied to a specific fragment of the earth's surface – which is located within a particular state border. By linking the mathematical reference system with the surface of objects and shapes displaying options in mathematical environment we are definitely returning to the classic geodetic technologies understanding and needs for national delimitation and demarcation processes. To ensure one particular state border marking works in united geodetic reference system according to the world's long-term practice and experience it is required for a united used geodetic reference system for the all demarcated border and it can be ensured only by choosing to use a unified geodetic base. If unified of the base does not exist then the works of organizers need take care about geodetic base development and realization of territory of a particular national boundary. If the geodetic base is already available then it is necessary to make sure whether the quality criteria have been laid down in accordance with the border demarcation work performance needs. In adequacies it is necessary to plan their construction or development work. Frequently in the base of united geodetic basement creation is involved neighbouring countries different geodetic substrates - which highlights the need to combine them, or synchronize each other. Also possible are cases that neighbouring specialists agree on the establishment of a completely new substrate which is different from them what was used in both countries, and which is meant for this particular state border demarcation work security.

In State border cases this united substrate must be able to ensure:

1) the state border fastening elements in the area (such as a national border landmark, landmarks and other border fastening elements) for accurate spatial position coordinate extraction;

2) the definite and demarcate state border line recording (fixation) in the specific ground coordinate system;

3) the border demarcation map development, together with an appropriate description of the borders – as one of the leading state border demarcation and its international registration papers.

At the same time – creating a geodesic base should remember that it will remain for many years after its initial installation. Always as the result of different natural or human activities impact process there will be need for border section or these stiffening element renewal or clarification.

All of the needs for geodetic base are pointing to its compliance to the classical national geodetic base after the use of parameters and the covered territory amount and the functioning deadlines. In simplified point of view – in each country has usually already for use defined, adopted and implemented their national geodetic reference system which covers a much larger area than a single national border fragment. It could just as well be used without paying additional resources and time for creating a new specific geodetic reference system to each border. Such an approach is rational on condition that the particular neighbour country which is formed common state border the national geodetic base is having the same characteristics as the other side, as well as that the substrate is also interconnected and aligned regularly maintained. Such ideal cases almost do not exist in World practice therefore the first problem for state border establishment is what geodetic reference system can available used in common works. As next problem follows the need to achieve both parts selected system administration specialists professionally correctly performing geodetic surveying works always obtain comparable results which include in professionally acceptable deviation (error) terms.

Next the evaluation of all Latvian land border demarcation process realized geodetic works, their starting positions and orientations of geodetic bases in the field before the start of the demarcation work and changes in work processes during the course we get an idea about the different approaches to dealing the realization of geodetic base issues and their solutions accordance with the final result extraction.

Materials and Methods

As a first example of problem solving can see Latvian – Russian border demarcation process realization example who was the last realized in practice. It can be defined as classical geodetic base preparation process realization of the common border demarcation case. Immediately characterize with the fact that in both countries are in use different geodetic base. The differences are not only the expansion system of the plane but also the much more fundamental position – it is also used a variety of reference ellipsoids. Additional problem – in the Russian side currently used new base is defined as a secret – foreign cooperation unexpected.

In the territory of Russian Federation to the demarcation start time in 2010 in the final phase was a new generation of national geodetic reference system implementation. System name is "1995th the coordinate system" (СК-95). It is based on the former USSR astronomical-geodetic network (АГС) common alignment of the Cosmic/space geodetic network (КГС) and Doppler Geodetic Network (ДГС). The system is closely aligned with the united state geocentric coordinate system (ПЗ-90). The resulting accuracy can be described with the following mean squared error between points in perspective coordinates: 2–4 cm between nearest (АГС) network points; 0,3 to 0.8 m error on the distance between the points from 1 to 9 thousand kilometers.

Already in December 2012 the Russian Federation adopted a new – state coordinate system – ГСК-2011. It is built in right orthogonal geocentric system which is identical and consistent with the world-known ITRF system to Epoch 2011.0 in first centimeter range. At the same time in the country still in use are hundreds of local coordinate systems. For example Pskov region in state border areas cadastral maps are created in local coordinate system.

On the final stage of creation is the current СК-95 coordinate system throughout the country including networks consisting of 50 fundamentally astronomical-geodetic network points (ФАГС), 300 high-precision geodetic network points (ВГС-1) and 4500 Class 1 satellite geodetic network points (СГС-1). Unfortunately not all Soviet-era state geodetic network points in Latvian-Russian border case was included in the system. Many of the border zone geodetic point coordinates were available only Soviet time coordinate system 1942 (СК-42).

In Republic of Latvia since 1992 as a national geodetic reference system was introduced the national coordinate system "1992 Latvian Coordinate System" (LKS-92). It is based on World Geodetic System used 1984 model (WGS-84) with the following earth ellipsoid (GRS-80) parameters: a = 6378137 m; e = 1/298.257222101. It is integrated with common European reference system ETRS89 (ETRS 89). In the area involved in the system with 4 zero class geodetic reference network points: Riga, Kangari Indra and Arajs who are evenly distributed in the territory. As National height system Latvia continues to use the former USSR height system – Baltic Normal Height System 1977. LKS-92 expansion to plane coordinate system formed based on Mercator cylindrical projection law for the area central meridian choosing 24-degree meridian and applying a scale factor of 0,9996.

The starting point coordinates are defined as follows: X = 6 000 000 m; $У$ = 500 000 m.

Approximation factor is calculated by the following formula:

$$m = 0,9996 + \frac{0,9996 \cdot y_0}{2R^2}, \quad (1)$$

where: y_o – ordinate adapted to the LKS-92 ($y_o = y_o$ km – – 500 km); R – Radius of the arc start meridian in Latvia used reference ellipsoid.

To the beginning of the demarcation as the part of LKS-92 practical realization in the composition was included the newly established Latvian global positioning system (GPS) network "LatPos" (Fig. 1). It consisted of 24 permanent operating base stations evenly spaced in territory of Latvia with an average distance between them 70 km. Data storage and processing center is located in Riga. For GPS signals receiving system is processing to the frequencies L1 and L2, it is planned to perceive L5 frequency signals. It is also possible, GLONASS and GALILEO system signal reception and processing.

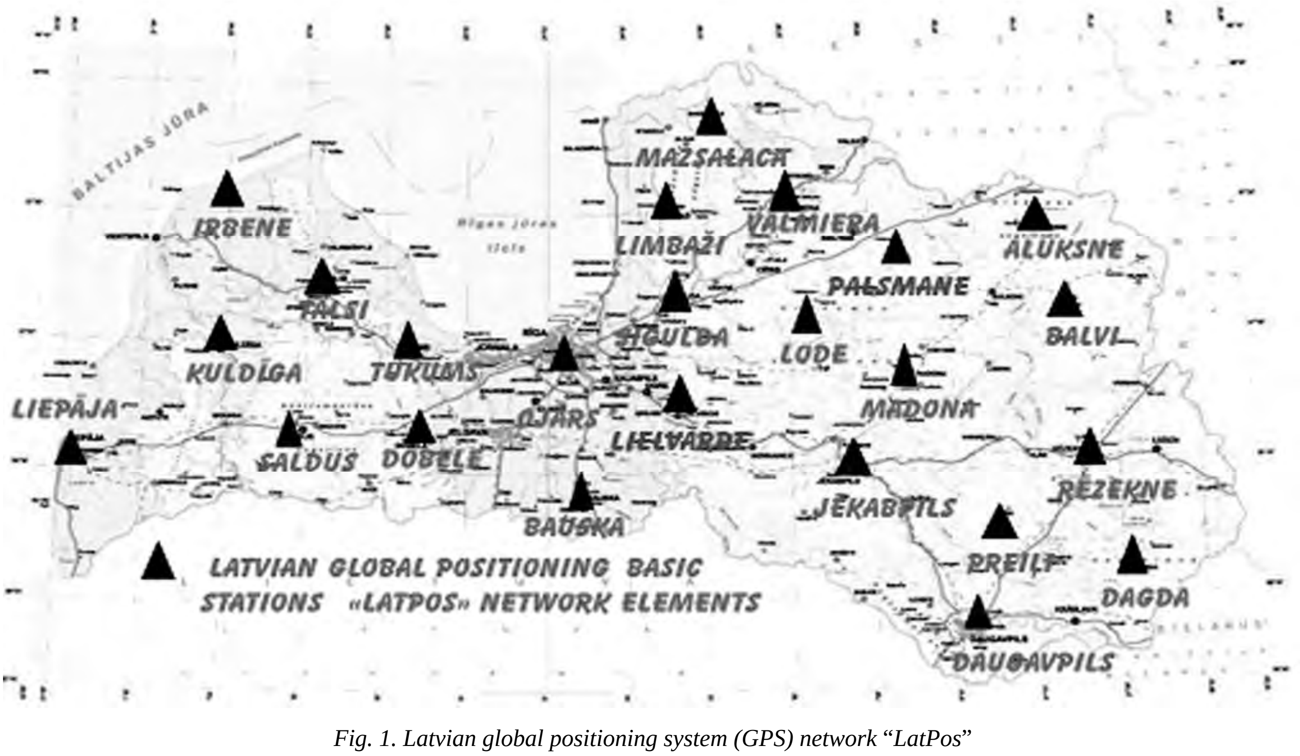

Fig. 1. Latvian global positioning system (GPS) network "LatPos"

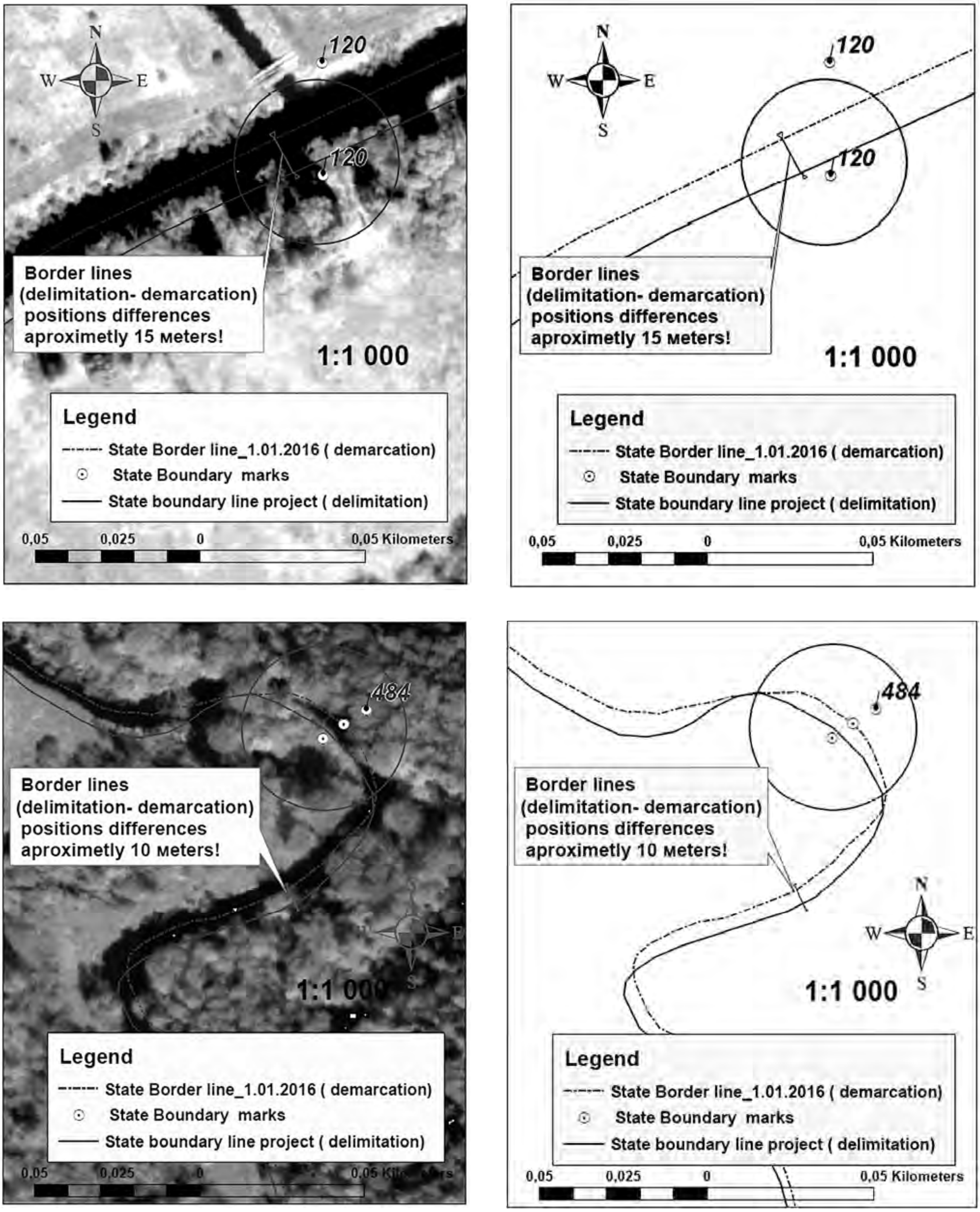

Fig. 2. Practice constituted a substantial excess of a meter off-limits which may be assessed visually

For assessing the situation in both countries and comparing used geodetic bases technical parameters it became clear that they are different and their ability is significantly different. In order to create a basis for joint operations on the border as the next common geodetic base it was necessary to choose either one of these national systems and to develop it in border area or build a third base for both countries which is well known and acceptable geodetic system from which both parts experts could have all possible measurement data to transformation to their national systems with no significant losses. The existing systems disparities threatened the use of national systems in parallel for each country – especially in those cases when the measurement data or manufactured cards should be designed to ensure unambiguous comparisons excluding of permissible errors being exceeded, regardless of what system was used in geodetic surveying.

In this case the two sides professionals agreed to project and create for this special border demarcation needs to a united geodetic support system which includes a network of geodetic points from the two countries in the border areas (thus creating a secure base for future measurement data transformations on the national systems). For the common geodetic base of the mathematical base was chosen WGS-84 using the GRS-80 parameters and ETRF89 (ETRS89). To plane expansion – on demarcation map development was chosen UTM system with zones (axis) meridian of 35 degrees. For both parts experts these systems were known and understood for use. On Latvia part WGS84, using GRS-80 parameters in ITRF 89-ETRS89 – on they are based national system. On Russian side they are often used in GPS measurement works for civilian purposes. The plane expansion on the UTM system and its parameters were piloted work in both countries. In Latvia in this system are preparing maps for the European Union institutions and international cooperation projects. The Russian side of such expansions is also used in international projects. So it must be recognized that use of LKS -92 plane expansion in the state border area did not guaranteed the high precision measurement parameter extraction, in particular in cases of the further transformation.

In the creation process of the common base of its establishment beginning was important new technological possibilities influence on the realization, but it did not rule out the need for a specific geodetic base development. Even if the internationally known geocentric coordinate system WGS84 realization would be accepted as the common system base on which is based the Latvian National Geodetic System, practically for the new base of the realization the Latvia national system could not be approved for use after different influences. Also agreeing on geodetic measurement plane expansion in internationally known system – UTM within the zone 35 N had to meet a number of common geodetic base of the building activities which until now has not been realized neither Latvian nor Russian geodesic system for building and maintaining framework. Without the necessary measures - to creating a common geodetic base, geodetic surveying results of transformation to neighboring geodesic reporting system – in practice constituted a substantial excess of a meter off-limits which may be assessed visually using Geoinformation system capabilities (Fig. 2).

Common system implemented consists of two interrelated stages of development. In the first phase it was developed and implemented a total of geodetic base (frame) network (Fig. 3) which includes 6 points from the Russian Federation national geodetic network and 5 points from the Latvian national geodetic network among which four points are the Latvian permanent base station network “LatPos” system points.

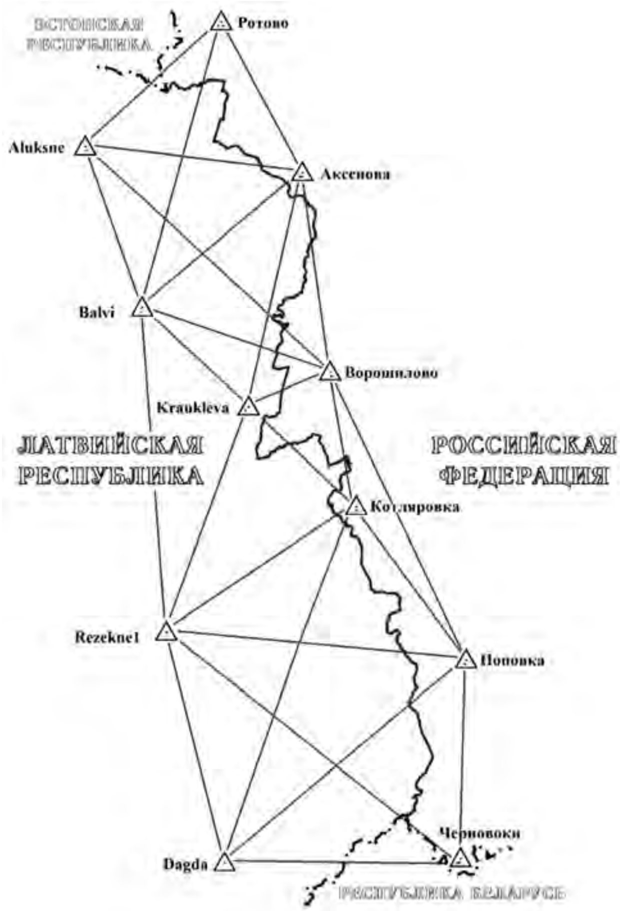

Fig. 3. Common geodetic base of the frame network scheme

From an overall measurement performance and the resulting data smoothing it was defined the overall frame established geodetic network with the accuracy of the points that the root mean square error of less than 0,7 cm (Table 1).

Table 1

Overall frame established geodetic network with the accuracy of the points

Name of the location point	Mean square error latitude, m	Mean square error longitude, m	Combined mean square error, m	Height mean square error, m	Overall mean square error, m
тр. Котляровка	0.0009	0.0006	0.0011	0.0054	0.0055
тр. Ворошилово	0.0009	0.0006	0.0011	0.0054	0.0055
тр. Аксеново	0.0009	0.0006	0.0011	0.0057	0.0058
тр. Ротово	0.0010	0.0007	0.0012	0.0060	0.0061
тр. Черновоки	0.0011	0.0007	0.0013	0.0064	0.0065
тр. Поповка	0.0011	0.0007	0.0013	0.0068	0.0070
Kraukleva	0.0015	0.0010	0.0018	0.0089	0.0091
Central	**0.0011**	**0.0007**	**0.0013**	**0.0065**	**0.0066**

The second geodetic base of the preparatory phase in the border zone on both sides of the border at a depth of 1 km along the border there were found, arranged or installed geodetic reference point pairs. Total of 28 pairs each side of the border with distances up to 10 km between pairs. These points measured by and carry out the treatment of the results, along 217 geometric figures. After equalization liabilities (851 triangles network) surveyed points maximum mean square error (point ORP 0066) did not exceed 0.0425 m.

As a further solution – the Latvian-Belarusian border cases. Starting demarcation works on the Belarusian side of a national geodetic base still remained from the Soviet Union era legacy Geodetic System (coordinate system 1942) СК-42, with all of its previous parameters. Latvian side had already implemented their national system LKS-92, but it had not yet been included Latvian Global Positioning System (GPS) network "LatPos", which was under construction and demarcation work in the final stage of working in test mode.

Evaluating in both sides used systems experts initially believed that in work over both sides of geodetic measurements without restriction will be used their own national systems and for test cases to transform the results in other national system – using the transformation program mad in Latvia. An impression formed that the establishment of a common geodetic substrate may be limited to the border zone of the national geodetic points streamline and to exchange of coordinate catalogs. Opinion is based on the fact that in the territory of Latvia most of the existing national geodetic reference network points are of the former Soviet system nodes of the network and have access to the coordinates of the СК-42 system – i.e. it used by the Belarusian part. From this point of view the plane expansions - to map projection was justification to choose this system, because the LKS-92 system that in border case was inconvenient for Belarusian part and at the same time consisted of the same negative quality risks – referred to the Russian border case. Adopted geodetic reference model are used in the process of demarcation work almost till work completion. In the final stage it had to modify and make the initial selected network (Fig. 4) measurement and alignment measurement operations – so marking its as full-fledged common geodetic network design process. To obtain high-quality conversion of options from the WGS-84 coordinate system into the coordinate system 1942 there were chosen close to the border existing 1st and 2nd class national geodetic network points: Behova (Бехова), Ozolkalni (Озолкални), Šatilova gora (Шатилова Гора), Tepljuki (Теплюки), Urbanovo (Урбаново), Lipovka (Липовка), Berezki (Березки), Mikuti (Микуты), Kirjaniški (Кирянишки), Stankoviči (Станковичи), Ušanišķi (Ушанишки). It was created a full-fledged common geodetic reference network. The reason for additional activities resulting from the measurement of inter-comparison results - where the data surveyed in LKS – 92 after transformation of СК-42, placing them in testing began to show the unacceptable, imminent or systematic unacceptable differences.

Following the established network of common measurement and equalization – was carried out in Latvia used coordinate transformation program improvement and then coordinate transformation results got significantly better scores.

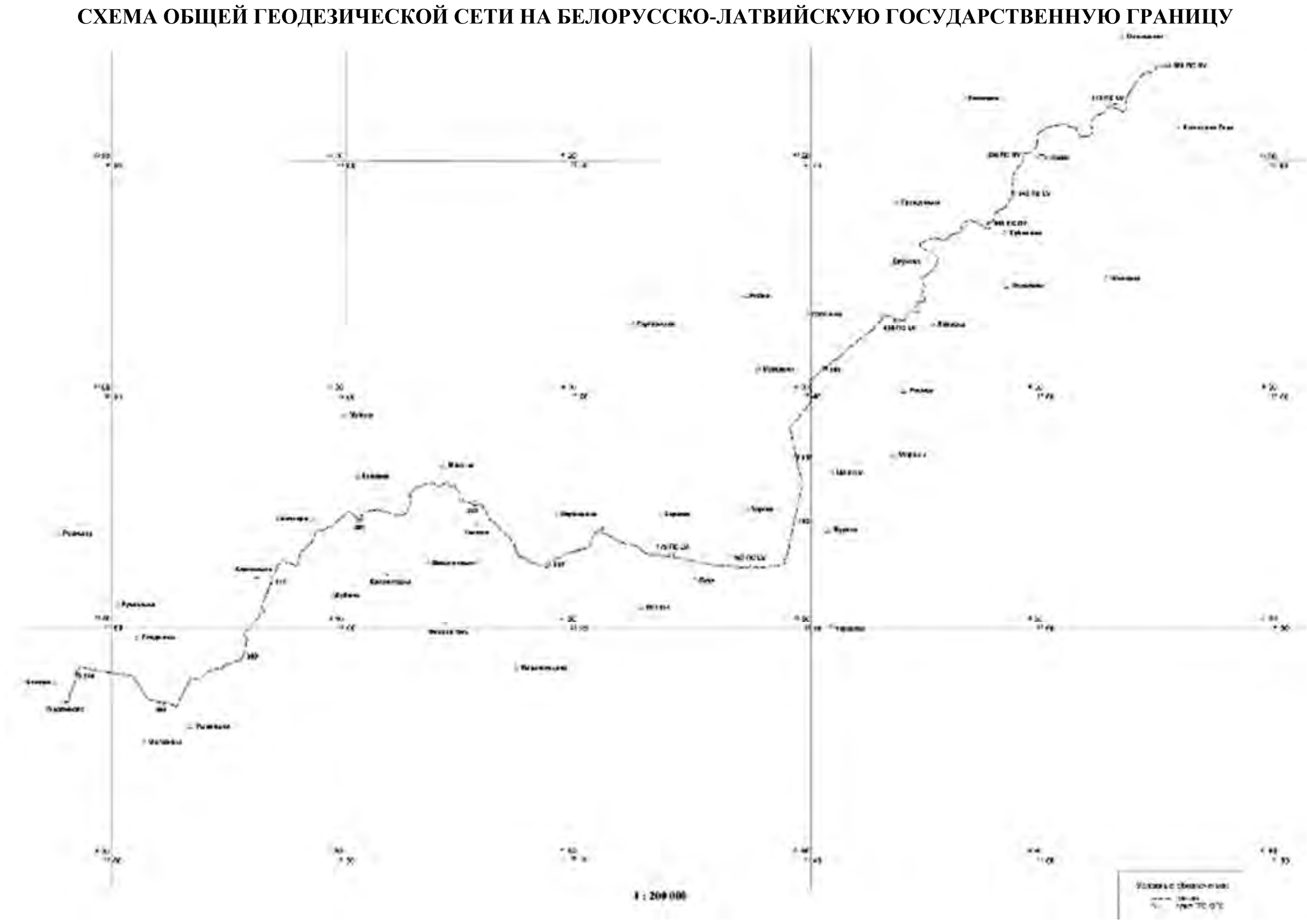

Fig. 4. Common geodetic network scheme

The next example, the Latvian-Lithuanian border case. Starting demarcation works of the Lithuanian side as a national geodetic base was used the LKS-94 (1994 Lithuanian coordinate system) which was set up almost simultaneously with the Latvian coordinate system LKS-92. It almost completely was a complete analog to Latvian coordinate system LKS-92 except one item – a scale factor which in the case of Lithuania is 0,9998 (Latvia – 0,9996). Latvian side had already implemented their national system LKS-92 but in this system had not yet included the Latvian Global Positioning System (GPS) network «LatPos» who were just in the planning stage. Everything pointed to the possibility that the both sides for common measurements can use geographical coordinates and then using the same formulas to transform them to their national plane systems. It was able to use a united card frames. Taking into account that the most of geodetic points of two countries geodetic systems were inherited from the united СК-42 system and in catalogs were available uniformly adjusted coordinates in this system as well as the fact that for the transformation needs from the national systems derived parameters in both countries were developed united performance, based on the same, internationally organized campaign of GPS results (the goal was to obtain accurate coordinate transformation parameters for conversion from СК-42 to WGS-84 in the Baltic territories) so in the demarcation works could count on the correct results are obtained regardless of the state geodetic network used measurement execution. In practice these assumptions were confirmed but however the conditional border demarcation geodetic base of the creation was realized – the establishment of a common geodetic reference point coordinate catalog (Table 2) including the points of the two territories as well as the setting condition of that each measurement session wear as support the two countries in the territory of existing geodetic points which are included in the common catalog so match that further control measurements will be valid for cross-checking. During the works as the basis of the list contained both countries geodetic network points there were also conducted a thickening networking and survey work – setting up across the border length the baselines (two geodetic points with mutual visibility) with the approximate distance between them 5 km to the border line. The baseline points were then used to coordinate both the boundary using GPS receiver as well as support points for Taxiometer works.

The next example is the Latvian-Estonian border case. Taking into account that these border demarcation works was launched as the first – Latvia and Estonia sides' specialists still had no experience in this job organization – including the Geodesic support organization. Starting demarcation works on the Estonian side as national geodetic base was used for the Lambert Conformal Conic Estonian Base map projection which geodetic coordinates are based on the same parameters as the WGS-84 using the GRS-80 and ETRF89-ETRS89 of which Latvian LKS-92 system is also used. Estonian system – as the same as in the case of Lithuania was also built almost simultaneously with the Latvian coordinate system LKS-92 and is fully in line geographic coordinate segment but an expansion is applied to the Lambert Conformal Conic projection with the axis meridian of 24 degrees (as well as Latvia and Lithuania). Latvian side had already implemented their national system LKS-92, GPS technologies in both countries was only the identification and exploration phase. Assessment of the situation pointed to the fact that both parts for common measurements can use geographic coordinates which they do not have to be different, then each with their own transformation formula to convert their national plane systems. Taking into account the radically different projections – the establishment of demarcation map was developed individually – a new border map projection and apply individually styled, maps page frames. The projection based on the some adoption of the Lambert Conformal Conic projection – which are differed from Estonia adopted projection. Similar to the case of Lithuania, is taken into account that the two countries geodetic systems most geodetic points was inherited from the single СК-42 systems, and catalogs were available uniformly adjusted coordinates in this system, as well as the fact that the transformation needs from the national systems derived parameters in both was launched by a single performance on the basis of one and the same international organized GPS campaign results. Demarcation works could count that the correct results are obtained regardless where of the state geodetic networks used for execution measurement, provided that the exchange of data and control both sides used the geographical coordinates. In general, in practice these assumptions were confirmed but the conditional border demarcation geodetic base establishment had to work where at the end of performance end of the acceptance of works and cross-reference test course identified a number of cases with an unacceptably large boundary coordinate detection errors (Table 3). In the final stage had to urgently carry out a single survey-based network model (to the parts' responsibility areas) and to establish a baselines for densifying network points or pairs along the border line with the average intervals between 3–5 kilometers, in order to correct the erroneous survey results. Reason for errors detection assessment indicates the need for an in-depth study of the causes and consequences of this work is not intended. Some impact on the error detection and correction impact possibilities of the new technological of use – when the border demarcation between the two countries work final round specialists began professionally and massively used the GPS precise tools. Prior to that, during work, the following tools were used only from foreign specialists – in some cases creating additional geodetic survey points of the border needs. Other boundary landmarks were measured using traditional theodolite-march technology. In view of the earlier traditional technology of the advanced requirements on a united geodetic survey support network quality (density, accuracy and configuration) – just such a common state border survey work performance network established at an early stage could prevent the control process identified errors from occurring.

Table 2

A fragment of common geodetic reference point coordinate catalogue of Latvia-Lithuania border

Network geodetic points coordinates LKS-92 and LKS-94 in plane orthogonal coordinates and ellipsoidal heights in the Baltic system								
Nr.	Point name	Point placement of Territory LT-Lithuania LV-Latvia	Class	Ellipsoid GRS - 80 B/ L,	LKS - 92 coordinates X/Y, m	LKS - 94 coordinates X/Y, m	Ellipsoidal height H_t, m	Height in Baltic system H, m
Lithuanian responsible territory (zone)								
1	Aleksandrija	LT	2	56 17 00.89201	240032.932	6241281.437	68.564	43.996*
				21 41 36.98334	357225.126	357196.560		
2	Auksūdys	LT	2	56 21 31.02185	246999.634	6248249.533	107.589	83.463*
				22 30 11.57573	407519.146	407500.642		
3	Baznīckrogs	LV	2	56 23 08.01002	248993.046	6250243.345	51.522	–
				23 57 58.26798	497912.110	497911.693		
4	Benaičiai	LT	2	56 05 51.62601	220373.029	6221617.600	69.801	45.300*
				21 14 39.19262	328586.707	328552.411		
5	Bīrmaņi	LV	2	56 15 59.00350	238628.101	6239876.326	57.971	–
				21 27 37.62953	342724.886	342693.418		
6	Buknaičiai	LT	2	56 22 09.06369	248397.610	6249647.789	91.109	66.917*
				22 20 46.55202	397850.971	397830.533		
and so continue								

Table 3

Extract from the Latvia-Estonia border piers measuring control results protocols

Nr. Border pier	Coordinates X			Coordinates Y		
	Results of control, m	Original data, m	Differences, cm	Results of control, m	Original data, m	Differences, cm
300	438520,08	438521,05	–97	575886,03	575887,54	–151
412	424636,01	424635,04	97	534620,04	534620,75	–71
413	423769,53	423768,60	93	533917,43	533917,94	–51
411	423437,30	423436,43	87	536099,97	536100,93	–96
299	438510,64	438511,67	–103	576407,82	576409,35	–153
298	438049,22	438050,35	–113	576961,40	576963,02	–162

Results and Discussion

By combining and comparing the experience gained in various border cases formed confirmation that in all cases remains practical need for a united – common geodetic base of the development of each individual state border case. Even if the initial process of the organizers, it seems that a particular case, there are all necessary conditions for the following job performance could save, it seems there is a safe probability of full two countries geodesic system compatibility, at work the final phase however it turns out that have to allocate resources to carry out a common geodetic base of the steps for its creating. Such a need has become urgent in finding errors in previous measurements – already in works making process and errors elimination process. Identify that their primary source associated with a common geodetic base of the design flaw.

Common geodetic base of the creation technological scheme:

1. Identification of the situation on both sides of the border to use adopted geodetic systems (their mutual comparison of the advantages and disadvantages of evaluation – in connection with border demarcation requirements).

2. The most suitable geodetic base of the choice (of the two countries involved in specialist reviews, opportunities and readiness to work in the selected system).

3. The total base of network development project (usually the maximum involvement of the countries involved in the border area available geodetic network points and data):

a) Common base their nominations formulate technical and technological requirements.

b) Existing geodetic network and point the general regime and the results obtained in comparison with a set of technical requirements for demarcation support compliance.

c) The necessary complement to the development / design – to build unambiguous compliance with the requirements.

d) Development of project documentation, presentation, submission for approval.

4. Implementation of the project:

a) Total included in the base of the geodetic points and network elements inspection in the nature.

b) Project adjustment by the field survey results.

c) The draft points adjustments (repair, renovation, preparing etc.) as well as a new point creating in plan locations.

d) Common measuring the total work planning.

f) Common measuring the total work organization and execution.

g) Measurement results processing, catalogue, and report development.

5. Installed in the common geodetic of base development outcomes and adoption.

The scheme does not differ much from the classical geodesy adopted geodetic support system for making policy. The differences relate to the need for equal partners conditions to attract these works two national professionals group, where each of them can even be a very different experience this amount of geodetic bases for development and implementation, and even at times significantly different views and options for specific technical solutions. Sometimes countries have even different views on different technological systems application admissibility sector tasks, they face even complete prohibition cases. The second difference-often used in the neighbouring national geodetic support system may be based on a radically different to those of the criteria which is complicated by the common system of selection, development and implementation of measures. The third difference is related to the neighbouring countries used geodetic system readiness levels of the fragments of the adaptation of the common border demarcation geodetic base of the building (usually a maximum avoids available geodetic networks refusing to join in). Here you can find very different situations from total similarity – when a new networking more considered as a formal event. As an example can be Latvia-Lithuania border cases. And very different geodetic system cases – when the new network should be as really a new third system with parameters which are not used in any of the neighbouring national geodetic systems – as a rough example considered the Latvia-Russia state border.

Conclusions

1. Common geodetic base of the establishment of the state border demarcation process support must be regarded as a mandatory component of the work of any state border demarcation works no matter what degree of mutual integration in certain neighbouring geodesic substrate.

2. Quality common geodetic base and within its framework established geodetic point networks provide a good basis for unambiguous and highly precise boundary survey in the installed state and reciprocal measurements for the control of both parts national experts.

3. Comparing the newly established geodetic base of the impact on the measurement results with measurement results obtained using the National Geodetic System before the establishment of the common substrate can detect differences in the results obtained.

4. Despite the new global satellite navigation systems use a significant positive impact on the geodetic measurement technology – it does not preclude the application of the common geodetic base of the establishment of the need for each member state border establishment – demarcation case.

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Підготовка геодезичної основи для демаркації державного кордону

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Розглянуто досвід практичного використання геодезичної основи для демаркації державного кордону Латвії з сусідніми країнами.

Подготовка геодезической основы для демаркации государственной границы

Раткевичс А., Целмс А., Кукуле И.

Рассмотрен опыт практического использования геодезической основы для демаркации государственной границы Латвии с соседними странами.

Geodetic Base Preparation for State Border Demarcation

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In any organizing activities for the national boundaries the established works includes as the first – the political agreement processes, which is known as the “delimitation”, and as second subsequent – state border real technical eviction in the current land area, which is called as the «demarcation» and be understand that a cross-discipline such as Geodesy there are always play an important role. If in the first delimitation phase of measurement accuracy requirements for geodetic data not so important, then in the next demarcation stage the geodetic accuracy of the data already play an important role.

This primarily related to the fact that the general politico-legal status in border demarcation phase becomes also as a real physical and technical objects. As in each technical construction or structure it also generates a serious attention to mathematical precision criteria directly in the field of geodesy. Similarly as in the designing and constructions for any engineering object or in forming land properties. In turn, increase the accuracy of the criteria in the field of geodesy, it is always associated with a theoretical and practical position of the geodetic base and its quality. Quality criteria of geodetic base are always linked with the future activities with geodetic data and services provided for the use of project. They are usually set or needs can be satisfied with the already available the base of the structure and the parameters or it is necessary to improve or build from scratch.

Engaging in the border demarcation process, the question of the geodetic base is always topical and it is not always a simple solution. The article examines the in Latvian Republic practices gained experience and knowledge on the geodetic substrate preparation, analyzing the current process of demarcation of the Latvia-Russia border cases and previously realized border demarcation works on the other Latvian national borders (Latvia – Estonia, Latvia – Lithuania and Latvia – Belarus).

The end result corroboration of the assumption that in all cases the geodetic base of creation is excludable and indispensable measure, which of course can be realized in various technical, technological or conceptual model versions. Also the latest GNSS technology options do not exclude the need for the establishment of such a substrate.