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Standard Parallels Choice for the Lambert Conformal Conic Projection of Bulgaria – BGS2005

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Abstract:

This research examines the optimal selection of standard parallels and projection origin in the Lambert Conformal Conic (LCC) (Lambert, 1772) projection used for Bulgaria, focusing on the Bulgarian Geodetic Systems BGS2000 and BGS2005. By comparing different parameter sets, the study evaluates deformation distribution across Bulgaria's territory to determine the configuration with minimal and most uniform scale distortions. The findings indicate that parameters determined according to the cartographic "one-sixth rule" yield the most evenly distributed distortions, while the current BGS2005 configuration produces the highest distortions.

Accurate cartographic representation requires minimizing scale, angular, and areal distortions within projection limits. The Lambert Conformal Conic projection, widely applied to mid-latitude countries with east–west extensions, is suitable for Bulgaria's geographic form (41°14′–44°13′N, 22°21′–28°37′E). Bulgaria has historically employed LCC projections in several coordinate systems, evolving from the 1970 system to BGS2000 and the current BGS2005. Despite extensive research on geodetic and projection systems in Bulgaria, the linear and areal distortions of BGS2005's cadastral LCC projection have not been systematically analyzed. This study fills that gap, providing a comparative assessment and proposing improved parameters for future cadastral and mapping applications.

The research analyzes scale distortions (m) in five different LCC configurations:

1. BGS2000,
2. BGS2005 (Cadastral),
3. Airy's criterion,
4. One-fifth rule, and
5. One-sixth rule (Hinks, 1912).

Each projection is assessed through numerical modeling of the scale factor and its variation across Bulgaria's latitude range. Calculations are based on standard LCC formulas for cone constant, auxiliary functions, and polar radii (Pearson, 1990). Deformations are evaluated at 10′ latitude increments between Bulgaria's southernmost (41°14′N) and northernmost (44°12′N) points, and graphically visualized through deformation curves and thematic maps. Comparative parameters for all projections are summarized in comprehensive tables.

The results demonstrate that:

- BGS2005 achieves good accuracy between its standard parallels but shows increased distortions toward northern and southern extremes;
- BGS2000 provides better balance overall but still introduces higher errors at the extremes;
- The one-sixth rule delivers the most uniform distortions distribution across Bulgaria, minimizing differences between northern, central, and southern latitudes;

- Airy's criterion and the one-fifth rule yield intermediate results, with slightly higher distortions than the one-sixth rule.

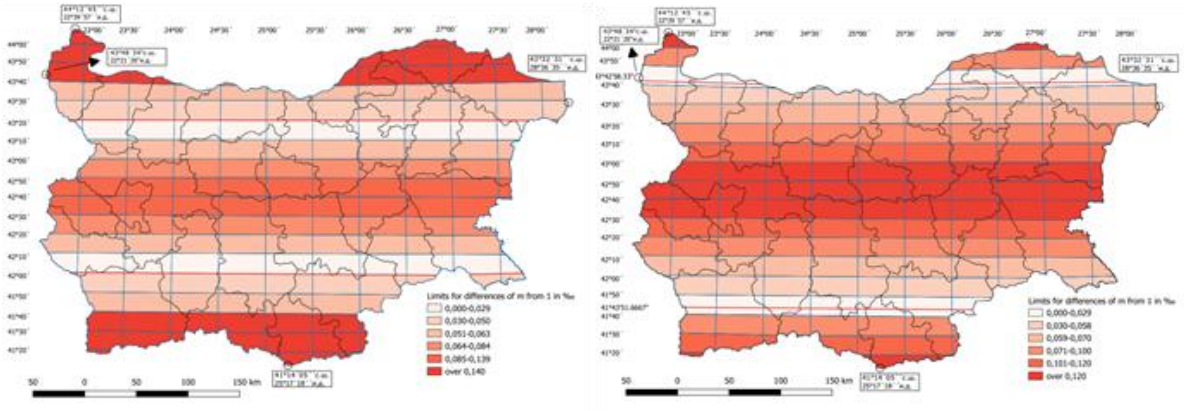
Quantitatively, the one-sixth rule achieves a total distortion variation of only 0.521‰, compared to 0.605‰ in BGS2005. Areal distortions patterns confirm the same trend (see Figure 1).

The study verifies that Bulgaria's geometric form and latitude span are best served by a two-standard-parallel LCC projection. However, the existing parameters in BGS2005 do not provide optimal distortion distribution for cadastral mapping. The proposed parameters based on the one-sixth rule (see Table 1) reduce overall scale variation, ensuring minimal distortion across the entire country, including border regions. This approach enhances positional accuracy and consistency for geospatial and cadastral data integration.

Table 1 Parameters according to the rule of one sixth for the Bulgarian territory

Projection	**Lambert conformal conical with two standard parallels**	
Standard parallels of the projection	ϕ_1	41° 49′ 48.9999″
	ϕ_2	43° 37′ 00.9999″
Central meridian	λ_0	25° 30' 00"
Origin of latitude	ϕ_0	42° 32′ 03.59″

The Lambert Conformal Conic projection remains the most suitable projection for Bulgaria due to its conformality and balanced distortion characteristics. Among the analyzed configurations, the one-sixth rule provides the most uniform deformation distribution and should be considered as a refinement for the Bulgarian Cadastral Coordinate System. The results contribute to improving the accuracy of geospatial datasets and the reliability of cadastral and engineering applications in Bulgaria.



(a) (b)

Figure.1 Distribution of the linear deformations, for the territory of Bulgaria according to BGS2005 (a) and according to the rule of 1/6 (b) The legend shows the limits of the differences of the linear scale along the parallel of 1 in per mil.

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