



Quadratic functions used in the estimation of projections of antique maps

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“Substituting projection” is a projection defined by a set of projection parameters in GIS systems, for a map, whose “true” projection parameters are not known.

Defining „substituting projection” is easy for maps with overprinted meridians and parallels. In this case any projection is acceptable as a „substituting projection” that has a same shape for geographic coordinates, as it is printed on the map. This makes it possible to find out the projection type at least (conic, cylindrical or azimuthal) using basic cartometry rules. After defining the “substituting projection”, a linear or a Helmert transformation can be used to transform the image into this projection.

If we do not have geographic coordinates overprinted on the map, we still can estimate them, using map features as ground control points (GCPs), and using the geographic coordinates of these GCPs. Some GIS software applied for georeferencing raster maps are capable to show the transformed grid defined by the GCPs’ coordinates on the raster image. If we use second or third order polynomial (quadratic or cubic) transformation, the transformed geographical coordinate grid can be regarded as an overprinted geographical grid. In this case this “overprint” can be used for finding out the projection type and parameters.

In this case, the root-mean-square (RMS) of the residual error of the GCPs measured and transformed coordinates is not negligible. We get similar RMS errors if we use modern coordinate system coordinates as GCP coordinates. In this case the magnitude of the RMS errors is almost independent of the system chosen. This RMS error is due to by the inaccurate measurement of location coordinates during the mapping process, and can not be reduced choosing another projection.

If we found out a good parameter set for “substituting projection” this RMS error is the same magnitude, even if we use a linear or Helmert-type transformation. This can be used as a criteria for selecting between projection types and parameter-sets.

This criteria was used for finding out the Ptolemaian projection and the parameters of this projection for the first printed map of Lazarus (1528) of Hungary (Timár et al., 2010).

References:

TIMÁR, Gábor, MOLNÁR, Gábor, SZÉKELY, Balázs, PLIHÁL, Katalin (2010): Orientation of the map of Lazarus (1528) of Hungary – result of the Ptolemaian projection? In: GARTNER, Georg, ORTAG, Felix (eds.): Cartography in Central and Eastern Europe. Lecture Notes in Geoinformatics and Cartography, Springer, Berlin-Heidelberg, 487-496.