Adjusting the Nautical Cartography from ED50 to ETRS89 in a Database Production Environment

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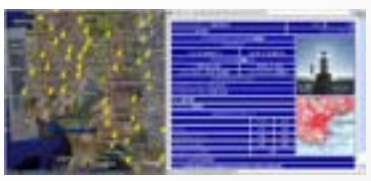
The Portuguese Cartographic Authority has recently established a new geo-referencing system to be used in Portugal based on the European Terrestrial Reference System 1989 (ETRS89). In order to establish an association with the national nautical cartographic folio series, migrating from the present ED50 datum to ETRS89, several adjustment techniques were considered at the Portuguese Hydrographic Institute (IHPT). Although there are several techniques to perform this adjustment process, the present option allows computing the correction value for all vertices (such as points, lines and polygons) as well as estimates its associated uncertainty. The proposed adjustment is divided in two steps. The first one is the establishment of a geo-statistical model that represents the true differences between the transformed coordinates (from ED50 to ETRS89) and the surveyed coordinates ("pure" ETRS89). This model is refined with some more locally selected differences until the affected areas have an insignificant uncertainty value. The second step is the extraction of the coordinates that assemble a cartographic geometry on the database underling CARIS HPD (Oracle Spatial Object), the analysis of those values against the geo-statistical model and the application of the local adjustment to all coordinates that belong to a unique geometry (each coordinate has its own adjustment). This poster presents the geo-statistical technique to adjust the existent cartographic products (not only the nautical charts), from the traditional ED50 to ETRS89. It also presents the technological approach, advantages and constraints to implement this solution in the IHPT's cartographic production database.

Adjustment model development

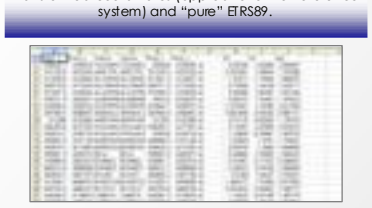
All legacy data within the Portuguese Hydrographic Institute (IHPT) is somehow related to an adopted national datum, the Lisbon Datum. In the 80's, the IHPT started to produce nautical charts related to the European Datum 1950 (ED-50). Pushed by the emerging maritime navigation technologies, such as GPS and ECDIS, the IHPT evolved towards the production of such products related to WGS84.

The spatial transformation between these referencing systems lacks of the required accuracy for its final usage. This is mainly due the fact of the transformation parameters are applied to a regional scale. When comparing the transformed values with the same position values (related to ETRS89) it is verified that some residual differences subsist. Therefore, it is necessary to perform a local adjustment to minimize those differences. A local adjustment model is achieved by a stepwise methodology as described below.

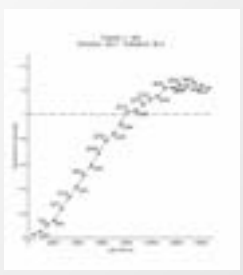
First Step: Collect all available positions coordinated in the former reference system and in ETRS89.



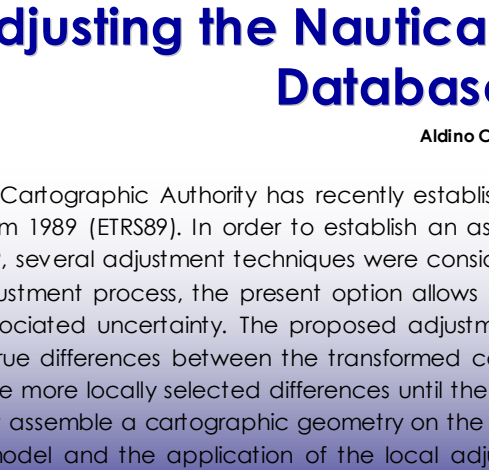
Second Step: Compute local differences between transformed coordinates (applied to former reference system) and "pure" ETRS89.

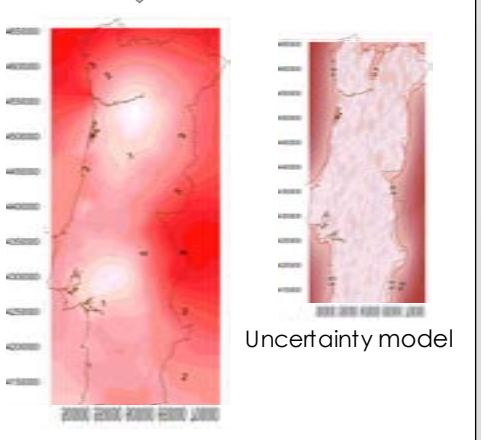


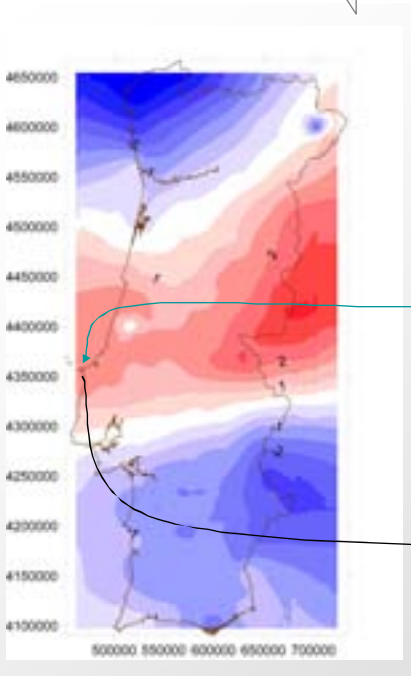
Third Step: Compute the adjustment model and its related uncertainty.

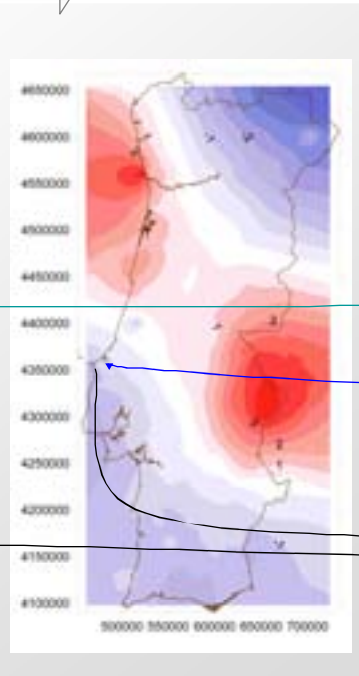


Fourth Step: Check uncertainty values in areas of potential interest. If that value is above the maximum allowed then recollect more local data (both reference systems) and rebuild the model (Go to step two).





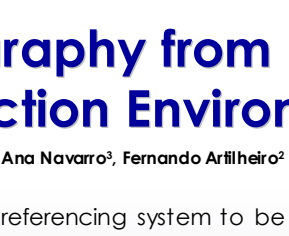




Ordinate correction models (dy + dx)

Adjustment methodology

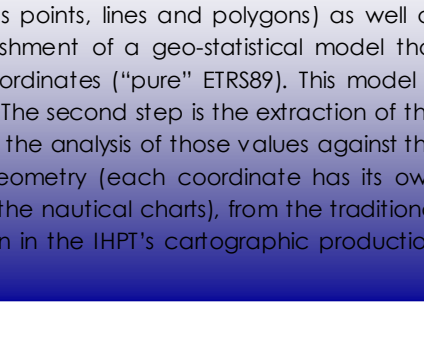
The adopted adjustment methodology follows the rubber sheeting principle. To achieve the success when implementing this methodology one must understand how the core infrastructure is organized. There is also the need to figure out how spatial features are structured within Oracle DBMS and how to get the basic components of those spatial features (the ordinate element). The great advantaged in using this methodology lies in the fact that all data attributes are not affected, but only their related geometries.

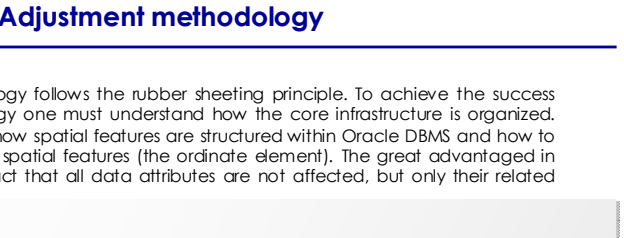


1. The first step in the implementation of the adjustment is the identification of all spatial layers that exist in the schema that underlie a specific cartographic production. This type of information can be found in the Oracle's native spatial schema (MDSYS) and is independent of any application that might be build on top of this particular database management system, such as HPD.

2. The second step is to spot all geometries that exist within each spatial layer (table), i.e., every existing tuples (lines) in a spatial table. Oracle Spatial data are organized following an Object-Relational model. This means that all tuples within the spatial layer contain not only the feature attributes but also their related geometry.

3. Moving into a higher level of detail, the third step allows to extract all corresponding coordinates that are the basis of the geometry feature. These data are stored within the spatial object as an array of numbers (SDO_ORDINATE_ARRAY). To preserve the original information, related to all cartographic elements, these values are the only ones that should be "updated". This means that neither the attributes nor the semantics of the spatial object are modified.

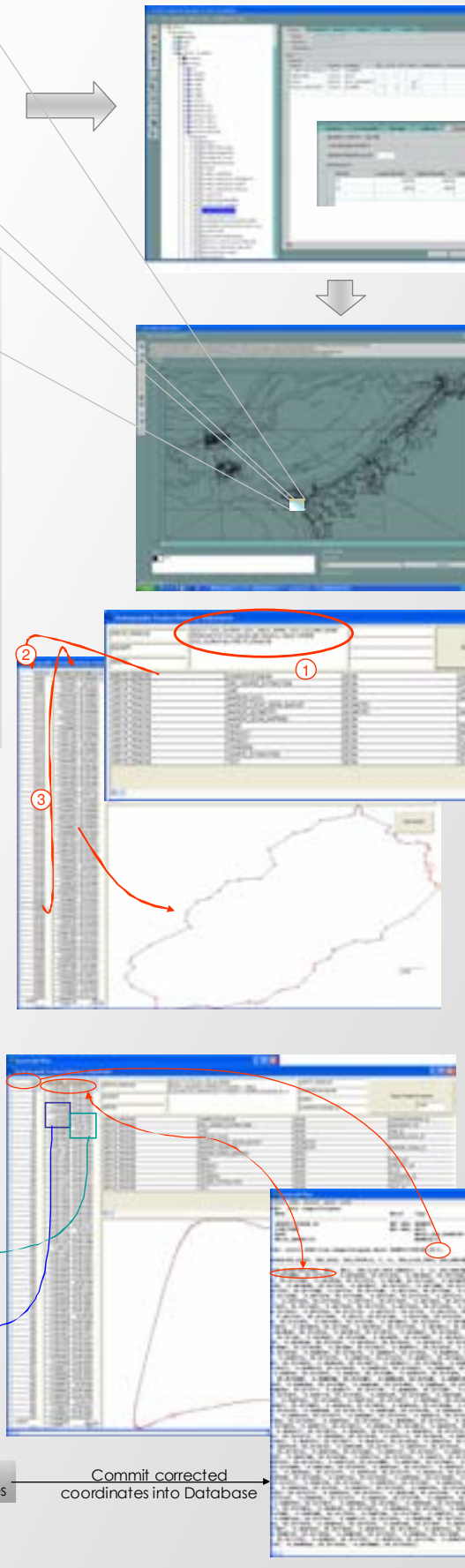




Once located the foundation data to adjust, one is now able to proceed to the final stage. That would be the integration of the created adjustment model with the ordinates that describe the whole geometry. To do so, for each pair of coordinates in the array, two adjustment values are retrieved from the decomposed local adjustment model (dx and dy). These values are then converted into the database geometry units (from metres to decimal degrees related to WGS84) and then added to the original values.
When all values from a specific geometry are adjusted, an SQL statement is generated and committed to the database.

A major pitfall when implementing this process is related to the restrictive number of ordinates to adjust. Oracle SQL statements only allow to "upload" 500 ordinates. When dealing with geometries that represent a large scale isobath that value may rise to 5000 ordinates (corresponding to 2500 points). This limitation was overcame using the native Oracle Data Provider (OO4O).

Get ordinate correction for each pair of coordinates



Apply ordinate correction (dx and dy) to all coordinates

Commit corrected coordinates into Database

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