Abstract:

In many occasions researchers must establish linear, superficial and volumetric values from historical cartography, so it is important to characterize a specific framework (territory), at time of the available map.

The existing maps are drawn at small scales and analogical outputs (paper). It is very important to firstly assess the accuracy expected, and to validate the planimetric and altimetric values in the map, taking care of the scale, technical meanings at each time, the procedure, the author, the aim and the state in which the map is found.

This paper establishes a methodology intervention guide and its application in an important place, the Bay of Santander, along the period 1725-1975). In those years the port of Santander was a place with a booming economic activity, and its installations were surveyed in a lot of cartography and different years.

For this reason, this cartography represents a good example to apply this methodology, and to value its contribution.

Key Words: Historical Cartography, Surface estimation, GIS

1. SANTANDER, ITS PORT AND ITS BAY.

Towards 1750, the city of Santander and its port start experimenting an extraordinary growing. The small mariner village changed to become a city (this year is the 250 anniversary of this fact), when several circumstances were fulfil and then a revitalizing process started:

- The appreciation of the port of Santader; it is located in a big bay which offers a spacious and safe natural protection

- The persistence of Cenón de Somadevilla, Marquis of La Ensenada, minister with a lot of power who tried to strengthen the port and
upgrade the exportations as an alternative way to Bilbao’s which did not pay tariffs to the crown.

- The opening of Camino Real de Reinosa, an authentic ancient carriageway which linked the port to the Plateau (1748-1753). It was considered as the first road built in Spain with high capabilities.

- The eagerness of Francisco de Rábago (reverend Rábago), confessor of Fernando VI, king of Spain and personal counsellor, which was born in Tresabuela (Cantabria). He obtained the desired diocese of Santander and propitiated the rise and growing of the city.

The port of Santander is located within the Bay. It is a wide natural space that groups currently 250,000 inhabitants, that means half of the Cantabrian Community. This huge reservoir of marine water has been systematically losing its primitive space. The bay has a tide height next to 4 m, with a big hydraulic potential, due to the big volume of water that continuously was moved, the balance was kept and the sediment transport followed its natural evolution.

But the balance was broken due to human activity. This process would have needed several thousands of years to be realized in a natural way, but it was developed in less than 150 years. In these years more than 50% of the effective surface of the Bay has been lost, decreasing in an alarming way the tide prism endangering the accessibility to the new site of the port, located on west-bottom of the Bay in converted to land surface.

This extraordinary accelerations of the events has been possible due to the following reason:

- The emergence of the railway Alar-Santander (1860) which needed to cross the marsh and acquire a large space (the area for the city entries) to being able to build the railway-station in the center of the city, gaining space to the sea.

- Iron minery (1875-1950) in the group of mountains Peña Cabarga converted the Bay into a deposit for the wastes produced by the 12 mineral laudries placed in the southern area of the Bay.

- The construction of the railway Santander- Bilbao-Oviedo (1900) and the new Bilbao road, which fence still more the spaces of the primitive Bay.

- The urban pressure which demands soil, this means new spaces in the northern area along the coastal front of the Bay (1850-1950)

- The creation of the siderurgy industry in the Oleo Island (Nueva Montaña Society, 1898), which obliged to gain more surface to the Bay.
- The infrastructures construction which needed big occupational surfaces such as the airport or the new commercial port of Raos.

Notwithstanding, nowadays the Bay is the great free space of the city. It is scenery that characterizes the Capital of Cantabria and gives it a great attractive. It is not possible to separate it since it constitutes a part of the urban frame.

2. HISTORICAL CARTOGRAPHY OF THE BAY.

The senior and best represented image of the Bay is the draw included in “Civitates Orbis Terrarum”, Colonia (1575) by George Braun and Frans Hogenberg. It is a perspective of how was the environment then. In spite of having lack of metric conditions, the view of a so old Santander deserves to contemplate it. Nearest in time the Map of Villa de Santander (1726) can be found; this map enhanced the outlines (main estuary, port and shipyards). It was updated in 1730, setting the new domains to estuaries of Tejero and Solía in South, Quintres Cape in East and San Juan de la Canal in West. This map can be found in historical cartography library of the Geographical service of Army. It has graphic scales and it appears bounded the mainland previous to the following fillers. (MAP 1 in appendices)

Another cartographic reference that must be appointed is the Geometrical Plane of the Port of Santander, surveyed in 1840 by the frigate captain D. Antonio Arévalo. It has graphic scale also, and shows units of length in miles and rod of Burgos. It shows bathymetrical heights in the entrance of the navigational channel and has the primitive outline of the ancient Bay before being filled. (MAP 2 in appendices)

In Plane of the Port of Santander at Scale 1/40.000, surveyed towards 1860; the whole of the Bay is represented and shows the general panorama of its environment. The railway Alar-Santander outline is included, maybe in the first sight of the new structure. In this cartography initial mainland and projected docks within the filling of the Port of Maliaño which consolidates the taken-to-the-sea terrains from the center of city to Maliaño, passing through Island of Oleo. (MAP 3 in appendices).

The plane surveyed by civil engineering D. José Peñarredonda in 1870 shows the later modifications which added details of interest of our analysed space. Areas faraway from the Bay were included from the map of D. Francisco Coello (zones of Heras and Setien). The urban area of Santander has been completed with the plane of the municipal
architect D. Ramón Lavín. The most famed version is the one edited by Junta de Obras del Puerto de Santander (MAP 4 in appendices).

To be able to assess the occupied surfaces, a contrast between National Topographic Map at scale 1/25,000 and the plane at scale 1/5,000 edited by the Government of Cantabria from a photogrammetric flight made in 2001, generalized at different scales.

The appendix shows 5 different cartographies that endorse the evolutionary development of the Bay of Santander in the last 250 years that have been taken as a basis for the current analysis.

3. EVOLUTION OF THE SURFACE

To be able to overlay the current state of the Bay with the different analysed stages it is necessary to digitize the previous cartography and to make the appropriate transformations. It is possible to set the superficial states, considering the initial situation of the Bay the represented as mainland in the senior map (1730), whose approximated surface is 4,000 Ha.

- Situation in 1730: MAP 1. 4,000 Ha approx
- Situation in 1840: MAP 2. 90% of the original surface
- Situation in 1860: MAP 3. 80% of the original surface
- Situation in 1920: MAP 4. 65% of the original surface
- Situation in 2001: MAP 5. 40% of the original surface

The percentages express, approximately, the reduction in surface that the Bay has experimented for the different analysed stages.

Figure 1 is an aerial photography from the Army Nº28980, dated the 9th October 1956, at an approximate scale of 1/32,000. The photograph represents the western part of the Bay which has been traditionally the most dynamic where the most characteristic stages of the filling process since 250 years have been highlighted.
FIGURE 1: Aerial Photography showing the evolution of the western part of the Bay until 1956.
FIGURE 2: Aerial Photography showing the current limit of the western coast of the Bay of Santander.
Appendixes: Historical Cartography
MAP 1: The update of 1730 is deposited in the Historical Cartography library of the Army Geographical Service. Dimensions 600 x 970 mm. Graphic scale in Castilian rods (1 Castilian rod is equal to 98359 m)

MAP 2: Geometric plane of the port of Santander made by Antonio Arévalo, frigate captain (1840). It can be found in the Maritime Museum of the Cantabrian Sea. Dimensions 980 x 730 mm. Graphic scale (marine miles, Burgos rods)
MAP 3: Plane of the Port of Santander. Numeric scale 1/40,000 and graphic (1 cm is equal to 400 m). It is included in the public works magazine. College of Civil Engineers.
MAP 4: General plane of the Bay edited by Junta de Obras del Puerto de Santander(1920). A very close version is deposited in Camara oficial de Comercio, Industria y Navegación in Santander. Dimensions: 540 x 600 mm, it has graphical and numerical scale 1/20.000.
**MAP 5:** For the spatial validation, a contrast between National Topographic Map at scale 1/25,000 and the plane at scale 1/5,000 edited by the Government of Cantabria (2001), appropriately generalized.