4th ICA International Workshop
Digital Approaches to
Cartographic Heritage
The challenges of Cartographic Heritage in the digital world

Evangelos Leveratos

“Cartographic Heritage”, as a regular working terminology, entered officially the vocabulary (glossary) of the international cartographic community in 2003 at the ICA General Assembly. Prof. Ferjan Ormeling – established three years ago in Gal-cia at the Atlantic coasts of Spain – in the promoted status of an ICA Commission (published in 2007) under the same name was established in Moscow on August 2007 by the ICA General Assembly.

As you can imagine a new complication is entering into the picture: What we mean by saying “as close as possible” in order to approach real digitization instead of just scanning and/or photo-capturing maps. The answer is obvious related to quality. The quality of know how, of expertise, of brain-ware and certainly of hard-ware.

If digitization looks as an important assisting tool for approaching the material of “maps” for the needs of conservation, preservation, restoration and protection, it is condition sine qua non for the study of the content of “maps” as carriers of “geometric” and “thematic” knowledge and information. Here, both “geometry” and “thematics” are referenced to coordinates and the digital route is oneeway. A number of possible items for new research on “maps” can then be listed, from rectification and stitching to geo-framing and geo-referencing, from deformation and scale analysis to comparative studies using best-fitting techniques, from the analysis of coastlines and map projections to the analytic mapping and representation of globes plus an almost endless list of implementation of whatever thematic content of “maps”.

Heritage in the digital world

The two volumes of the journal count more than 600 pages with numerous links in very many university libraries in all continents around the World. The two volumes of the journal count more than 600 pages with numerous links in very many university libraries in all continents around the World. The digital access to these pages has grown constantly since the issue is already clear and to the broad general major interest because it is addressed in the digital world.

Questions on access, diffusion and dissemination of the properly archived “maps” are of major concern to the great community of colleagues working in public and private archives and map libraries managing important map collections. The World Wide Web and the digital culture which is constantly propagated in the society and has reached the younger generation open new horizons to the up to now underestima ted culture of cartography and maps thereby creating new aspects as potential object of human perceptiveness, art, skill, history, ideology, geography, geometry, science, technology and power.

New concepts, like the distinction between knowledge and information which is crucial in the digital thinking, especially as far as communication is concerned, introduce weight criteria in the networking of the access and define levels of availability in communica ting cartographic and map heritage. In situ and web providers of cartographic heritage are now looking for a better communication management, taking advantage of the digital medium. The Third Workshop, in Barcelona in 2008, was a turning point in our vi sion, organization and work.

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The globe: from art object to cartographic representation
Andrea Adami, Francesco Guerra

Studying the globes, the significance of the disciplines that study the shape and representation of the Earth becomes apparent from the methodical point of view as well as for the application of new digital technologies. Indeed, in some sections of this work it will become clear that, as a consequence of the necessary approximation and scale differences, the representation and study systems recall those used for the Earth. Some aspects and problems typical of Geodesy will also be highlighted, such as those related to coordinate systems and reference surfaces, even if applied to cartographic globes. Furthermore, the globes represent the exemplification of the problem known since ancient times of unrolling a double curvature surface on a plane. Other than studying their shape, it will also be important to recognize their cartographic content.

The research starts from the observation that today cartographic globes, present in almost every museum and art collection, are deprived of part of their value. They are actually considered as art objects, meant to decorate the halls of historical buildings and now relegated in museums, without recognizing the cartographic value that they deserve.

From this consideration the work starts investigating the different aspects of these cartographic spheres. We intend to improve the knowledge of their cartographic value under the double aspect of the material support and the depicted (or applied) cartography. As for geometry, we intend to verify if the wooden support was built according to an ideal spherical shape or if some adjustments were planned to resemble the actual shape, even if it is clearly impossible to consider them as physical models of the geoid. As for their cartographic content, we intend to investigate the projective aspects in order to understand if the authors used some known representation. Moreover, we intend to compare the semantic content of the represented map with other historic or modern maps in order to detect similarities or differences.

The central focus of the thesis becomes therefore the transition from the sphere as an art object to the globe, intended as cartography to all intents and purposes. For the survey of the geometrical shape of the wooden sphere, different methods and technologies have been evaluated. Starting from photogrammetry, we moved forward to 3D scanners as effective instruments to acquire the geometry of these spheres.

To enable the cartography analysis, we needed to "peel" the cartography off from its wooden support. In this case, through photogrammetry and the theory of cartographic representations, it has been possible to extract a flat map.

The cartography analysis obtained was mainly related to the projective genesis. It has been observed that we cannot talk of cartographic projection in the same way that we do today, but it has been attempted to detect the projective genesis that best approaches the one used in the description of the gores.

The semantic content has been studied in depth in various ways. First of all, we had to select a method that allowed an easy fruition of the globe or, better, of its digital copy. Then, by using computer software to navigate around the globe, we identified some map peculiarities that have been elaborated and represented with other instruments, offered by the digital techniques of analysis.

Tests and analyses have been conducted on the printed globes of Coronelli (top image) and the sphere of Sanudo (bottom image) which have been offered by the Correr Museum in Venice.
The first part of the work consists in the survey of the physical support for the cartographic surface, typically a wooden structure covered with fabric, stucco and other materials. First of all, the knowledge of the shape is necessary to understand if there was a project held under the generic term of sphere. In fact, it will be interesting to understand if the globe has a precisely round shape or not, and possibly to study the differences from the ideal shape, trying to attribute it to the project or to the effects of usage and time.

Among current analyses, many aim at evaluating, processing and developing dimensional survey techniques and 3D rebuilding of objects and surfaces, with special attention to the metrological aspects of the problem, by using current improvements in computer science, optoelectronics and optical techniques to study Cultural Heritage. However, these researches have to face some difficulties that affect the collection and the analysis of data, due in part to globe location as well as to the general shape and the finishing of the globes themselves.

After many different tests, performed on both instruments and acquisition procedures, we can affirm that range cameras represent suitable instruments to survey complex objects. First of all they do not require the application of positioning targets on the surveyed object, nor the materialization of a reference system. Moreover they allow simultaneous acquisition of geometric and radiometric information in a few time. As concerning the metric aspect, they guarantee high resolution on the object and high precision achievable. Globe acquisition phases are not significantly different from other applications, for which an extended literature is available. The crucial moment, as usual, is the planning stage, when fundamental parameters of the operation are defined. While planning the survey, it is necessary to focus on some aspects such as the resolution on the object, the precision that we want to achieve and cloud overlapping, needed to record data in a single system. By observing the triangulated mesh at the end of the acquisition step, we will notice that the surface is not smooth, but has features, i.e. discontinuities caused by various factors. In particular, scanners detected some discontinuities in overlapping areas of two gores, and there is actually a variation compared to the general curvature. However, all scans highlight other discontinuities that are not actually visible on the object. After accurate observation, it appears clear that these discontinuities correspond to cartographic zones where the transition from bright to dark elements is abrupt. In this example, it results clear that the coast line is a three-dimensional element, because of the transition from bright land to dark water. In the middle of the ocean, we can also notice islands in relief and the corrugation effect is clearly due to the presence of bright writings on a dark background. These observations, common to all scans performed with different instruments, are caused by the ability of dark colors to absorb light. Since the triangulation algorithm works on the acquired images, this luminosity transition causes the appearance of features in relief compared to the general sphere curvature. This finding allows on one hand an approximate reading of the cartographic surface starting from the scan, even before we start using the textures acquired. However, discontinuities, both physical and real, are significant, because they characterize univocally part of the globe, i.e. the scanned spherical cap, that would otherwise have been difficult to record.

For this reasons we used the ICP (Iterative Closest Point) for the registration of the range maps also thanks to the possibility to consider color from a texture as an additional coordinate for each point in an ICP optimization where a color triplet is associated with each 3D point. The closest point search now becomes a search in 6D space, and a 6D k-d tree is used to accelerate the search. The 3D model obtained through the registration of all range maps gives the possibility of studying the shape of the globe and its possible deformations. This analysis can be conducted starting from the deformations of the model generated by the laser scanner compared to the best interpolating sphere. For this analysis we realized an ad hoc software that calculates the interpolating sphere, where the Z value is enhanced compared to the best interpolating sphere. To allow a better understanding of the deformations, we wrote another software application, which generates a three-dimensional representation of the deformed sphere, following the example of the classical representations of the geoid. Each point has been transformed into spherical coordinates A and A and the radius Rxyz where radius is the distance between the centre of the best fit sphere and the point P of coordinates x y z. Then we calculate the difference between Rxyz and the radius Rsp of the best fit sphere to find D. After this the value D is amplified for a scale factor S, so Dnew = D × S. Then we calculate the difference between Rxyz and the radius Rsp of the best fit sphere to find D. After this the value D is amplified for a scale factor S, so Dnew = D × S. In the final model the radius is calculated Rmin = Rxyz + Dnew so each point P is represented by A sp Dnew and the it is transformed in P xyz final.

In this way, we obtain the equivalent of the classical cartographic representations, where the Z value is enhanced by a known factor. In cartography these are the so called two-and-a-half-dimensional representations, while the deformed model obtained is definitely three-dimensional. It can be viewed in the 3D space and we can use all spatial navigation operations typical of three-dimensional models. Moreover it’s possible to attribute a color to each point function of the real RGB value of the point (from the cartographic surface) or of the dimension of Δnew. There is also the possibility to obtain some slices to represent the punctual value of deformation. This operation cannot be done on the real sphere because deformations have a little value and it is not possible to apply the exaggeration only to the value of deformation. Instead it is possible to apply the scale factor to spherical coordinates because we can amplify only the radius value.
Once we determined the shape of the spherical object, the next step is to survey the cartographic surface. The goal is to obtain an exhaustive knowledge of the cartographic globe, by assigning a cartographic content to the wooden support. This process can be divided into three different steps:

a) photographic acquisition;
b) image orientation by DLT;
c) reprojection of images in a known matrix.

Photographic acquisition is the first step planned to survey the surface. This operation, apparently free of issues, encountered many difficulties due to the specific characteristics of the object. First, obstacles are due to the shape of the spherical object and to the operating mechanism. Moreover, the poor conservation status may prevent the globe’s rotation, while keeping the camera steady on the tripod. We have to resort to inconvenient shooting positions, made more awkward by the long acquisition time required in low light conditions.

Another problem encountered during photographic acquisition was related to the reflective surface of the globe itself. The surface is often in bad condition and the covering varnish acts as a mirror, causing annoying reflections in the photographs, which make them useless for the map extraction process. Moreover, the reflective surface makes the use of photographic lighting equipment more complex due to glare in the picture so it is necessary to use more sophisticated acquiring system (polarized light, lamps and filters).

For the photographic acquisition we used a NikonD7200 with 35 mm lens and a Rollei 6008 with a digital back of 39 Megapixel and with 80 mm lens. To reduce the glare, the images have been acquired with polarized filters on the lens and on the lamps.

Proceeding with the proposed process, the next step is the orientation of film frames. The goal of this phase is to position film frames where they were when the picture was taken. DLT is the algorithm used in this step, expressing the direct relationship between image coordinates and the corresponding object coordinates. The Direct Linear Transformation is an alternative method for facing the problem of analytical orientation that finds an optimal application in photogrammetry with non-metrical images. In the last phase of this process, we move from the spherical surface to a known projection. Like for the Earth’s surface, the link between a point on the surface and one on the map is not immediate, but it is solved by means of a reference surface of known and simplified geometry. When we consider the Earth, the surface used is the rotational ellipsoid, while when we consider cartographic globes the geometrical shape used is the sphere. This approximation is introduced to bypass the deformation of the wooden sphere during the re-projection of the cartographic sphere. The suggested method aims to obtain a digital picture positioned in a given cartographic projection.

By writing the software, we obtained a custom product that can be used on the cartographic globes. At the same time, we implemented and tested an algorithm specific for the sphere. Combined with the application described above, we created a software package useful to the examination of the globes under study.

For this application we wrote a custom software to associate the spherical coordinates, describing the sphere’s points, with the pixels of the oriented digital image. The algorithm creates an empty image (matrix), where its coordinates $\varphi, \lambda$ are the spherical coordinates of the model. By using the classic sphere formula and determining the angular step in latitude and longitude, it is possible to reconstruct a sphere of known center and radius, according to the formulas that allow to transform spherical coordinates into Cartesian coordinates.

Then we calculate the correspondence between each point of the reference system and the pixels of the oriented image. The equations are those used by the DLT algorithm, which, once given the parameters calculated in the previous phase and object coordinates of the point, allow the identification of the corresponding pixel.

Once we identified the pixel, it is possible to extract its RGB value. However each pixel of the image can correspond to two distinct spatial points, because the sphere is a round shaped object. To avoid this effect, we searched for an empirical method to place the color extracted from the pixel onto the precise corresponding point. The solution consists in introducing a point P between C and O, defining the distance CP. The constraint imposed is the distance CP, which has to be always less or equal to the distance OC, where OC is the segment that links the camera center to the sphere center. By applying this constraint, the surface implied in the picture corresponds to a spherical cap at the most. First, the software calculates the CP value and, subsequently, it allows to modify it. In fact, to avoid the stretching effect of pixels corresponding to the sphere’s outermost areas (where CP is closer to CO), we can decrease the CP value with this software.

Finally we build the final matrix. On a grid characterized by the angular step set in the first part of the procedure, we insert the RGB color values extracted from the pixels corresponding to the surface points. If during the computation there is no correspondence between an image point and a globe point, the corresponding cell in the matrix is filled with a constant value (black). This situation happens regularly in the areas of the image where we do not see the globe, but the surrounding environment.

The resulting matrix can be imported in MatLab and therefore reprojected, choosing each time the cartographic projection most suitable for our representation requirements.

At the same time, the software creates an image in a known projection, the equirectangular one, where the longitudinal degree is equal to the latitudinal degree for each point. Of course, if we choose a angular step equal to 0.1°, the matrix and the final image will have the following sizes: 3600 pixel (360°/0.1°) in width-longitude and 1800 (180°/0.1°) in height-latitude.

To obtain the final cartographic, the last phase is image composition. If the images are realized with the same angular step, there is no necessity of mosaicking because they have the same dimension, and so the same reference system. Simply it’s necessary cut images and to realize a radiometric correction.
The analysis of the cartographic surface of the globes can be split in two parts, one each for the projective and semantic content levels.

The projective content of the printed globes is meaningful, being expressed in many phases and representing a direct as well as an inverse problem. First, the author unfolded the double curvature surface of the Earth on a plane to build the gores, then he recreated a cartographic sphere starting from the gores themselves.

If it is not possible to identify a known projection in the author’s writings, at least it is possible to understand the projective genesis of the map. According to Tobler’s approach, the problem is the investigation of a projective system that was probably in place, but is not one of the systems we know. A possible solution is the comparison between the map under study and other known reference models.

For globes in particular, the comparison takes place between the transforms of the gore drawn by Coronelli and those of the cartographic projection chosen. In the specific case of Coronelli’s gores, the procedure is simplified by the possibility to use the geographic grid of the map, instead of its content, to perform the comparisons.

The search for similarity consists in applying a global geometric transformation to the gore sector and the projection to be tested in sequence the grid’s “adaptation” (best fitting) to the map under projective study.

The best fitting is assessed based on the residual values calculated after the deformations induced by the applied model. Depending on the results, we can define the projective system that better matches the historical map. The analysis of the cartographic grid is carried out by generating a chart, which allows a clear view of the residual values, and therefore verify if errors are due to imprecise sources or to inaccurate course tracking.

Other advantages and uses emerge when these instruments refer not to the actual geography of the Earth, but to a historic cartographic product. A new concept of accessibility becomes possible for the historic cartographic heritage thanks to the creation of digital copies of printed cartographic globes such as those of Coronelli. The choice of writing specific software for the Coronelli’s globe was due to the need for software that, in addition to virtual navigation, would allow the visualization of certain characteristics emerged during the analysis.

The software surveys the sphere by using the classic functions of rotating and zooming. It allows to view the map in different ways. Usually, we have the classic view of the digital globe, where the map image is wrapped on a sphere. However, there is the possibility to change view and select a plane representation among those codified in cartography. The software also allows the overlapping of several images, both raster and vectorial. On the sphere we can overlap the original cartography, taken from the globe, a current satellite image, and Coronelli’s cartography, modified with respect to the Greenwich Meridian (this topic will be discussed in the following chapters).

As for vector elements, it is currently possible to upload the geographic grid with the same latitudinal and longitudinal graduation of the globe and current geographic borders. Another interesting application to the study of the globe is, for example, uploading the course of explorations as shown on the map, to verify the course tracking and therefore verify if errors are due to imprecise sources or to inaccurate course tracking.

It Both with raster images and vectorial features, the overlapping is immediate if we have georeferencing files available. The images uploaded so far into the software are in equirectangular projection and are automatically mapped on the spherical cartographic globe along with the present status of that geography using both vectorial and raster images. Highlighted some characteristics otherwise difficult to visualize. Thanks to the digital comparison, we notice how the coast profile differs from a positional point of view as well as in the drawing of the coastal line itself, even where the grid lines overlap with those of the original map. We can easily find an explanation for the differences in coastal drawings. In fact, we should consider the diverse sources represented by the exploration reports and the old maps used and the varying levels of each document. The cause of the differing coastal positions still needs to be explained. Indeed, we notice a translation between the globe map content and current coastal profiles.

The first answer to this question comes from the author himself. Coronelli tells us that in his globes the Prime Meridian corresponds to Ferro’s Meridian, as determined by cardinal Richelieu. The differences in the coastal lines have also been examined by means of a geographic comparison by representing the actual Earth in the same projective system. This comparison allows us to leave out the effect of the different reference systems, because it needs only one georeferenced map, the current one. As for the gores analysis, the comparison was carried out with digital instruments. In this case, too, we performed a Helmert transformation. We located some points on the coastal lines of the two maps, so as to create homologue point pairs between the two maps. In this case, too, vectors allow us to measure the shift between the correct position of the point and its position on Coronelli’s map.
Historical photoplans of Venice 1911
Francesco Guerra, Luca Pilot

Photoplans allow for new and more precise analysis and interpretations of that complex phenomenon that is today Venice. Venetian photoplans realized in 1911 and 1982, while substantial the same type of photographic map, show some important differences. The 1911 photoplan experimented on a completely new technique, while the one from 1982 represents the fundamental element in a complex cartographic system, designed and constructed using the instruments offered by a proven discipline. Their comparison is concrete evidence of the progress made in the survey discipline as well as urban representation. We can see how they both represent the desire to use modern techniques to establish and describe the shape of Venice and record its immense variations. It would seem that the formation processes of the 1911 photoplan and the 1982 photoplan were very different; uncertainties exist.

The perspective view of Venice of Jacopo de’ Barbari
Caterina Balletti, Paolo Vernier

The understanding of the contents of the old maps is undoubtedly difficult just because, on one hand, it assumes that there is an understanding of general cartography, on the other, a knowledge of the interpretative codes from the time period and the atmosphere of their production. The result makes be difficult in their reading on the part of the general public both of the geometric content and the semantic content. The fundamental idea is that of allowing anybody to extract information from the historical cartography, rendering more transparent the complex yet necessary operations of geo-referencing. The preliminary remark is to recover the meteorical content in historical maps using analyses which lead to a definition of a methodology for the quantitative analysis of historical cartography. This analysis implies to use procedures that treat of global and local transformations. The plane transformations allow for the deformation of a map in a way which makes them appear on a map, the metric and geometric content of a map is lost; the map has been mapped on the reference map. The term “mapping” is exactly in the meaning given to it in computer graphics: the adaptation of a texture to a form. Warping techniques can be used, not to transform maps but in order to create correspondence, realizing specific software which manage and visualize these correspondences between the maps. The procedure of referencing-transformation remains valid but is combined with in some cases replaced by the procedure of referencing-correspondence. What has just been described must be realized with special software that allows for the loading of digital maps and the identification of homologous points. The name 2WIN software is inspired by the fact that the screen is divided into two windows which contain two maps, the program calculates the differences the most useful method is to compare maps with small advantages in different application fields.

2WIN Software
Francesco Guerra, Silvia Mondin

The procedure of referencing-transformation is based on the application of two types of sequential transformation: first, a global transformation and then local transformations. These two types of transformations are each carried out on the basis of two sets of corresponding points, the first control points, which could originate from a survey, a map or an image, the second set identified on the image to modify. But considering the procedure of referencing-restoration-transformation, the metric nature of the initial reference map is lost: the map has been mapped on the reference map. The term “mapping” is exactly in the meaning given to it in computer graphics: the adaptation of a texture to a form. Warping techniques can be used, not to transform maps but in order to create correspondence, realizing specific software which manage and visualize these correspondences between the maps. The procedure of referencing-transformation remains valid but is combined with in some cases replaced by the procedure of referencing-correspondence. What has just been described must be realized with special software that allows for the loading of digital maps and the identification of homologous points. The name 2WIN software is inspired by the fact that the screen is divided into two windows which contain two maps, the program calculates the differences the most useful method is to compare maps with small advantages in different application fields.

Fra Mauro’s digital worldmap
Caterina Balletti, Giovanni Fanello

Recently it was published a new important work on Fra Mauro’s mapamundi, a masterpiece of historical cartography, composed around 1450 in Venice (Fra Mauro’s world map, a book and a CD published by Brepols, 2000), that aims at an analysis and an in-depth study of this important document, offering the reader an understanding within its contemporary cultural framework. The particular characteristics of Fra Mauro’s world map – which contains not only geographical and topological information but also a large number of descriptive features (topyonyms, inscriptions, comments) – implied an approach which was focused on the design and the development of an innovative fully interactive software that combined a facsimile level of reproduction of the original with the ability to navigate within the map and extract information from it. The main concern of this design was to give the general public an easy way to operate virtually into a now digital Fra Mauro’s mapamundi environment. This interactive software makes possible to examine each visual detail of the work; it provides a veritable research instrument covering all the visual and textual contents of the map. All the inscriptions within the digital images that make up the world map were linked together with a database containing not only the transcriptions of those inscriptions but also notes and comments upon each. The instrument for this link between image and text involves a window that makes it possible to consult the transcription of Fra Mauro’s inscription, an image of the geographical area to which the inscription refers and the associated notes and comments.

Image matching for historical maps comparison
Francesco Guerra, Caterina Balletti

The aim of the research is to test an algorithm of area based image matching to compare copies of maps with small differences, such as maps of the same cartographer but published in different years, presenting updating in contents. The comparison can be supported by ACM (Automatic Correlation Map) software, written by the photogrammetry laboratory of Sistema dei Laboratori – Circe, which find areas that are candidate to contain differences.

The result is two different photogrammetric charts per scale 1:2500 for the 1911 photoplan and 1:500 for the 1982 photoplan by cut and by orientation. In order to reach the aim of placing two photoplans side by side and deriving from their compared readings, a picture of the transformations of the urban texture, it’s necessary to homogenize it in order to merge them following the same geometric arrangement by using geometrical transformation which are the base of today cartography.
Aerial photos on line
Sistema dei laboratori CIRCE
Regione del Veneto

CIRCE and the Territorial Information System Department of the Regione del Veneto, started years ago to gather and to classify territorial data and documents into files that are nowadays spread known and consulted by a large and various number of users, professionals, students, public employees, researchers and amateurs that are willing to analyze territory and town development and transformation through aerial photos.

The plentiful legacy of iconographic documents is a detailed portrait of Veneto’s territory history, of the current state of Italy and of other European and extra-European countries, and represents the cartographic evolution up to satellite images. Both Institutes developed wide and articulated agreements of cooperation that produced significant results as the publication of their data archives. They both are willing to work on projects of mutual interest, using common communication standards and programs that could be a useful tool to study and to elaborate territorial data on scientific bases. According to this aim a digital file and the publishing on the Web GIS of the Veneto’s aerial photographic database have been realized. These are new instruments that offer a qualified service in accordance with the latest Italian institutional reform of the Public Administration and they allow a rational and simpler management of the photographic sortie, a geometry information necessary for the geographic automatic query and search on line, were realized in two phases the first consisted in collecting the few vector photographic sortie available, concerning flights made during the ‘90s, the second phase, the longest and the hardest, has been that of digitizing paper data with a digitizer, calibrated for each photographic sortie.

Afterwards all paper photographic sortie of aerial shots have been georeferenced in Gauss-Boaga coordinates (the Italian reference System) West Zone and the coordinate of each paper vertex has been extrapolated by the official IGM cartography. That at 1:50.000 scale has been used for photographs at small scale and from the website of Venice’s University IUAV CIRCE at page: (http://circe.iuav.it/website/afnet/Viewer.htm) or through the link Catalogo aeree-Catalogo geografico Area+SIT/web+gis.htm or through the website of Regione del Veneto at page: (http://www.regione.veneto.it/Territorio+ed+Ambiente/Territorio/Cartografia+Regionale/Area+SIT/web+gis.htm) or through the website of the Italian reference System West Zone and the coordinate of each paper vertex has been extrapolated by the official IGM cartography. That at 1:50.000 scale has been used for photographs at small scale and from the website of Venice’s University IUAV CIRCE at page: (http://circe.iuav.it) through the link Catalogo aeree-Catalogo geografico from the website of Regione del Veneto at page: (http://www.regione.veneto.it/Territorio+ed+Ambiente/Territorio/Cartografia+Regionale/Area+SIT/web+gis.htm) or through the website (http://mapserver.iuav.it/website/afnet/Viewer.htm)