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Late 18th century Russian Navy maps and the first 3D visualization of the walled city of Beirut

Keywords: Beirut; Russian maps; GIS; 3D visualization; cityscape.

Summary

In 1772 and 1773 Beirut was twice besieged by Russian forces in the context of a war between the Russian and Ottoman empires. Two manuscript maps of Beirut held at the Russian State Navy Archives in St. Petersburg, a sea-front view from the logbook of *shebeca* "Grecia" (1772) and a coastal map (1773), contain many details on the area inside the city's walls and the surrounding countryside. Using available information and its comparison with maps produced several decades later allowed a significant part of depicted objects to be identified and georeferenced. These findings were used to estimate the accuracy of the map sources. Applying GIS techniques made it possible to produce a tentative reconstructed cityscape of Beirut for the late 18th century. The 3D map produced by the described method aimed to show how 18th-century Russian navy maps, combined with modern altimetric and topographical data, could help visualize the urban morphology and organization of the walled city of Beirut. The document used as the base-map is the oldest detailed cartographic document discovered as yet of the city and provide invaluable — though occasionally inaccurate — data of the position and shape of the military fortifications, the walls and other main buildings such as mosques, church, baths, *khans*, etc. Numerous problems were encountered and dealt with during the carrying out of this case study. Found solutions and developed techniques may greatly contribute to the production of similar documents for other cities of the Levant, as well as other 3D maps based on early 19th-century maps.

Brief historical background

The rise of capitalism, the changing trade routes, new military technologies, the relative decline of the Ottoman Empire and the rise of regional identities, all contributed to edge Russia towards new markets and to extend her sphere of influence. In this expansionist movement South (characteristic of other European powers as well), the Russians confronted the Ottomans, both on land and on sea. During the Russo-Ottoman War in 1768-74 the Russian Navy entered the Mediterranean for the first time in its history. At the decisive battle of Çesme Bay (1770) the Ottoman fleet was destroyed. After this victory the contacts were made with Ali Bey, the rebel Mamluk leader of Egypt.

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The first Russian occupation of Beirut

In this process of consolidating their presence in the Eastern Mediterranean, a complicated series of alliances were made with local Arab leaders, involved in their own power struggles both against the Ottomans and the local princes and rulers. These tactical alliances did not always last, and the Russians had often to find other support for their plans. Thus, in 1771, Abou-Dahab, the son-in-law of Ali Bey of Egypt, together with Daher el-Omar, governor of Acre, reached Damascus, in the hands of the Ottomans. However, an agreement was reached with the Ottomans and Abou-Dahab returned to Egypt, leaving Daher el-Omar to face the Pasha of Damascus, and Ali Bey to face Abou-Dahab.
The Russians identified the possibility of using these local conflicts for their own interests only after Abou-Dahab had defeated his father-in-law. Ali Bey managed to escape and reach his ally, Daher el-Omar. Orlov, the Russian commander, with the blessing of Catherine II, agreed to help Ali Bey and Daher el-Omar. In 1772, the Russian squadron turned the tide of the battle of Sidon; it proceeded to bomb and occupy Beirut, which was in the hands of the Druze Emir Youssef, who had backed the Ottomans. The fleet left the area only after having been paid a ransom.

The second Russian occupation of Beirut

In 1773, Ali Bey was killed just before the Russian fleet could intervene in his plan to retake Egypt. In the mean time, the Emir Youssef had recruited Ahmad al-Jazzar to strengthen Beirut, following pressure from the Pasha of Damascus, the strongest representative of the Ottoman hierarchy in the area and the old enemy of Daher el-Omar. However, Ahmad al-Jazzar quickly began to act independently, so the Emir contacted Daher el-Omar and suggested that with Russian help, he could be defeated. Captain Kozhukhov, the squadron leader, agreed to help him, demanding payment for not plundering the city when it would be taken. After a heavy bombardment and blockade, the city was evacuated by Jazzar's troops in accordance with the compromise negotiated by Daher el-Omar. However, Ahmad al-Jazzar agreed to enter in Daher el-Omar's service with all his troops; a few months later, he deserted him. Russian troops and their allies occupied Beirut; they refused to leave the city until the Emir Youssef had paid them, as specified in their agreement, a point of contention that was settled only after four months. As a point of interest, it must be noted that the tide changed once again a few year later, at the end of the war: Daher el-Omar was executed by the Ottomans for his act of treason, and Ahmad al-Jazzar was appointed a governor of Acre. He led the defence of the city against Bonaparte's troops in 1799.

Sources

During the Russian troops stay in 1773, two maps were produced: a naval map and a land map. The first, produced on board of one of the vessels of the Russian Navy squadron, was later used for the preparation of the *Atlas of Archipelago*, published in 1788. The fate of the original manuscript map is unknown. The printed map mainly contains information crucial for navigational purposes, such as depth measurement series, the shape and disposition of the coastline, dangerous rocks, etc. It is relatively poor for details located on land. The second map is different in the sense that it extremely rich in details of the inner structure of the walled city of Beirut. It was drawn by von Palen, one of the commanding officers of the Russian garrison. Different stages of the siege are also shown on the map (Fig. 1).

Figure 1. Von Palen's map of Beirut, 1773. Russian State Navy Archive, fund 1331, list 1, file 25. The frame shows the area used for geo-referencing and modelling.

Base map

During the last two centuries the city of Beirut has extended rapidly. Its population has grown from a few thousand at the end of the 18th century to more than 1.5 million inhabitants at the end of the 20th century. However, the most significant changes in the Beirut cityscape took place during the second part of the 20th century. In order to avoid as much as possible dealing with these recent cityscape changes, we used an accurate detailed modern map of Beirut, produced before WW2.

The 1:10.000 map published in November 1936 by the Bureau Topographique des Troupes Françaises du Levant (T.F.L.) was used for our project, both for geo-referencing and for the creation of a DTM (Fig. 2).

In order to relate the high-resolution image of the T.F.L. map to the spatial coordinates four reference points were used – one for each corner. For reference points, intersections of the coordinate system's grid were used.

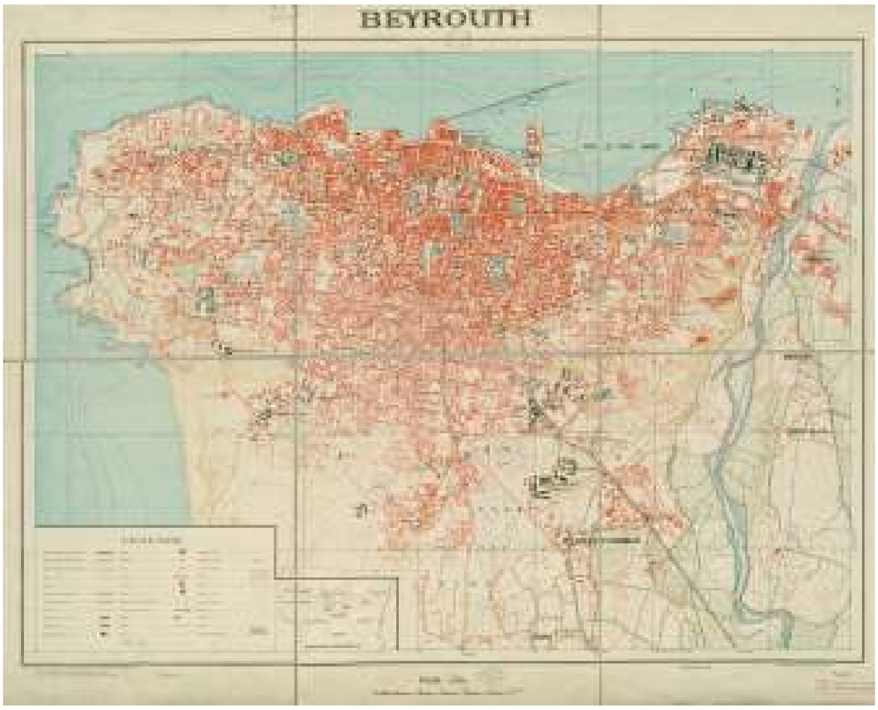

Figure 2. Bureau Topographique des Troupes Françaises du Levant, 1936, scale 1:10000,
Courtesy of Historic Cities Research Project (http://historic-cities.huji.ac.il),
The Hebrew University of Jerusalem & The Jewish National and University Library.

Digital Terrain Model (DTM)

The Digital Terrain Model was prepared by digitizing the 5m-contour lines of the T.F.L. map from the geo-referenced map image as a set of extending concentric polygons (vector-type of data representation). The coastline changes were taken into account during the digitizing and the coastline (sea level, 0 meter contour line) was digitized according to the geo-referenced von Palen's map of 1773. The set of polygons was converted to raster grid with size of cell equal to 5x5 meters. Every cell was given an elevation value derived from the corresponding polygon. The resulted surface was used as a DTM for further 3D modelling (Fig. 3).

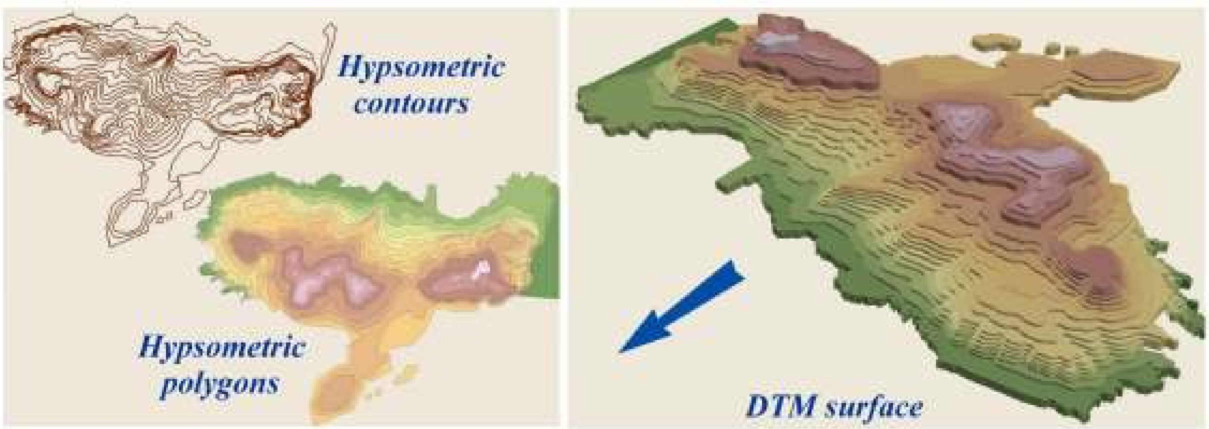

Figure 3. Creation of the Digital Terrain Model.

Geo-referencing

Von Palen's map did not take into account the coastline change of direction near Beirut. The most likely explanation we can offer is that the map was compiled from two separate sheets: one for the area to the East of the walled city and the other to the West of the city. These parts were crudely assembled during the compilation process of the final map. Thus, even attempts to directly overlay the contemporary naval map from the *Atlas of Archipelago* with von Palen's map as a whole were unproductive, despite the general similarity of the coastline shown on both the Russian maps. Better results were achieved by separately overlaying the naval map according to two different angles (Fig. 4)..

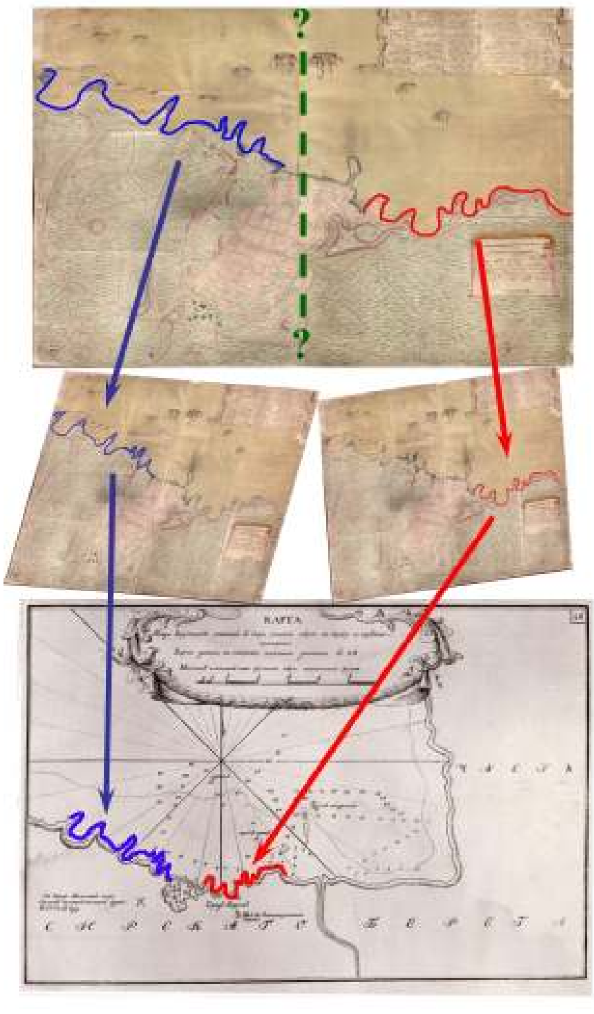

Figure 4. Overlaying the naval map from the *Atlas of Archipelago* (1788) with two coastline patterns taken from von Palen's map: blue line represents the coastline to the West and red line represents the coastline to the East of the walled city of Beirut. The overlaying was done separately, according to two different angles.

The geo-reference of von Palen's map as a whole is a much more complicated, if not impossible task, than a simple overlay of the two contemporary maps. The coastline near Beirut underwent significant changes during the last two centuries, partially because of natural reasons, but mostly due to large extent of building activities, caused by rapid growth of the city and especially of its port's infrastructure. The main difficulty was to identify and to very precisely place them on the T.F.L. maps. This required a series of careful examination of 19th-century photographs, maps, paintings and sketches, as well as personal knowledge of today's city.

However, the lack of precision in the spatial relation of different parts of the coastline shown on von Palen's map does not necessarily mean the incorrectness in the depiction of the walled city of Beirut itself. A certain number of buildings shown on von Palen's map can be easily identified today, such as the Assaf, Omari and Monzer mosques, together with the Greek-Orthodox St-George's cathedral. This situation led us to geo-reference only a small part of von Palen's map: the walled city of Beirut and its direct surroundings (Shown on the Fig. 1 as a frame). Although this part covers less than 20% of the total map area, it is no doubt the most significant and interesting part of von Palen's map from the point of view of historical geography.

The choice of reference points is very important for the geo-referencing results in general and especially in the case of old maps with known problems of spatial non-uniformity. An attempt was made to use as many spatially-distributed points as possible for geo-referencing. The selected points were used to adjust both the length and width of the walled city. Eight points were used for the geo-referencing process: two points near the coast, four different points in the central part of the city, one point closer to the southern city wall, and finally one point to the outside of the city wall. The four points in the central part of the city form an east-west section, half way between the sea and the southern city wall (Fig. 5).

Figure 5. Geo-referenced part of von Palen's map. Distribution of the points, used for geo-reference is shown

The resulted Root Mean Square Error (RMS) is approximately 43 meters. If the two coastal points are dropped from the geo-referencing process, the RMS Error can be reduced to 20 meters. This fact leads us to note another kind of spatial incorrectness and non-uniformity in the map: some parts of the city are “stretched” more than other parts. The length of Beirut city in the north-south direction is most probably exaggerated on the map.

3D - modelling

In order to visualize the urban morphology and organization of the walled city of Beirut in the 18th century, a 3-dimensional model, based on von Palen's map, was produced. Several model elements were reconstructed with different levels of detail. Three main types were identified: the general built-up area, the walls and the historic buildings.
2D-outlines for all three types of objects were digitized as polygons from the geo-referenced von Palen's map. Two shape files were created, respectively for general built-up area objects (Fig. 6) and city walls (Fig. 7). Historic buildings required modelling with a much more sophisticated level of detail; they were managed as separate shape files. In the case of complicated roof structures of buildings, such as the domes of the mosques, additional shape files were added in order to better-differentiate height levels (Fig. 8).
The Base Heights parameter for all objects was obtained from the T.F.L.-based Digital Terrain Model. From this base height level, objects were extruded by adding to each object's minimum height an extrusion value or expression. General built-up area objects were given an extrusion value from the attribute table. The city wall objects extrusion was based on the combination of two parameters: the relative height of the object (obtained by the examination of 19th century photographs, sketches, paintings and drawings) and its extrusion value. Two types of the objects were used: walls and towers, which had different relative height parameters, the tower being higher than the walls. In both cases — the general built-up area and the city walls — the extrusion values were the result of estimation and informed approximations.

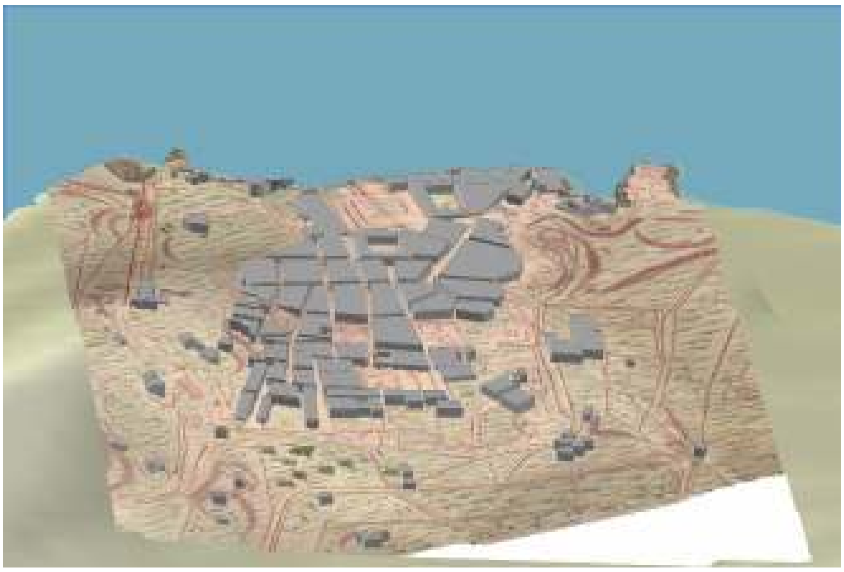

Figure 6. DTM, geo-referenced von Palen’s map and 3D reconstruction of general built-up area.

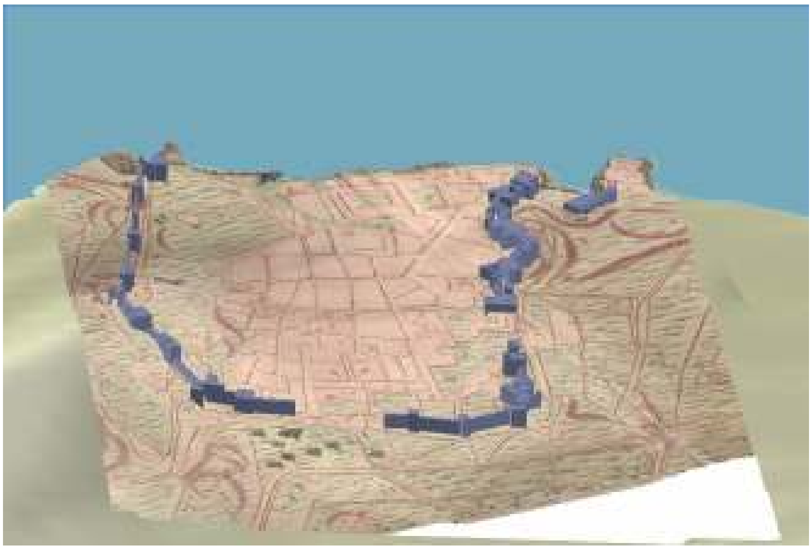

Figure 7. DTM, geo-referenced von Palen's map and 3D reconstruction of Beirut city walls.

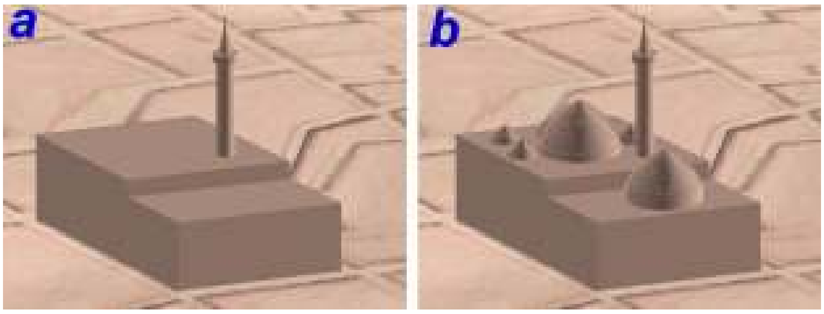

Figure 8. The Omari Mosque building has a complicated roof structure. Domes of the Omari Mosque were managed as a separate shape file. (**a**) - general 3D reconstruction of the Omari Mosque building. (**b**) – the same with an addition of domes.

A small number of buildings, some of which are still standing to the present day, were modelled with reference to available graphic sources of different kinds, from 19th century romantic paintings (Fig. 9) to modern satellite images (Fig. 10). This information helped to better understand the vertical structure of the buildings and to provide a more realistic estimation of height.

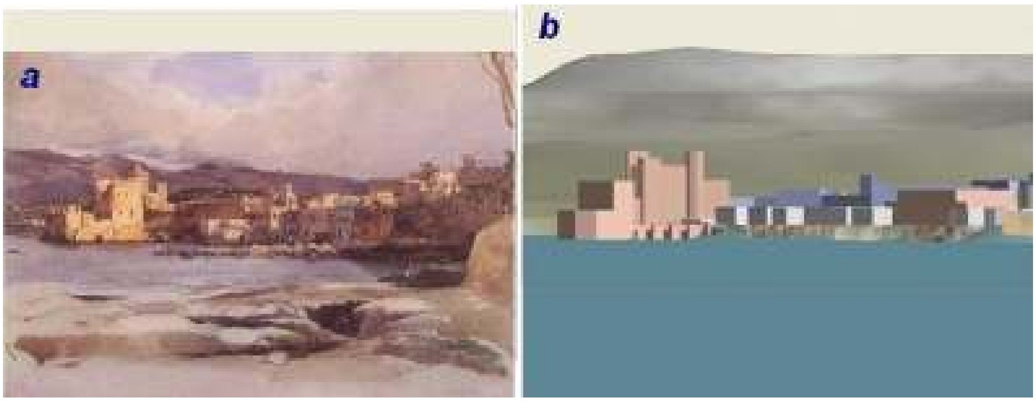

Figure 9. (**a**) Max Schmidt, *Beirut*, 1843-1844, pencil and watercolour (**b**) 3D reconstruction of the Sea and Land Castles. View from the North-West

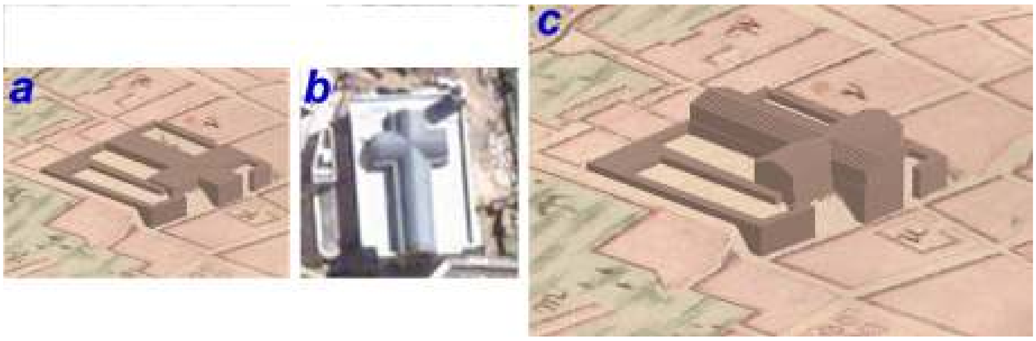

Figure 10. 2D outline of von Palen's map
(**a**) and part of natural colour, 60-centimeter high-resolution QuickBird satellite image (2005, February 15th) of Beirut, (courtesy of DigitalGlobe, http://www.digitalglobe.com/)
(**b**), used for 3D reconstruction of the Greek Orthodox St-George's cathedral (**c**)

A case in point was the Greek Orthodox St-George's cathedral, which survives to this day. From recent photographs and architectural surveys produced for its rehabilitation during the last years, is was possible to give a good estimate of the heights of the walls and of the roof. However, the detail of the inner walls and other adjacent buildings (which no longer survive) was impossible. As for the heights of the mosques' minarets they were deduced from contemporary photographs, postcards and other information. We believe that the combination of the 2D outlines of von Palen's map with these reliable descriptions achieved a high level of details.

Separation of the complicated building structures into two shape files (the building and the roofs) made the management of the extrusion expression much easier. No doubt a better answer to the problem would be the use of polygons with built-in 3D geometry (*polygonZ* in GIS terminology). However during this pilot project, we only used regular polygons.

3D Model Verification

During the production of the 3D model we had to compromise with accuracy due to lack of sufficient information regarding the exact geo-referenced position of objects on von Palen's map, the exact aspect of historic buildings and of the city walls, etc. The question is thus posed as to the reliability of the results obtained and of the success of modelling process. Happily, a tool for self-control exists. In 1772, one year before Kozhukhov's expedition, another Russian squadron passed near Beirut. In the only surviving logbook of this squadron's ships the *shebeca* "Grecia" (the Russian form of "xebeque", a type of a fast 3-masted Mediterranean vessel) there is a sea-front view of Beirut.

We rotated our model in order to observe the city from the bay, as the Russian sailors had once done, and compared our reconstruction with the sketch made in 1772 (Fig. 11). In our opinion, the results are satisfactory, taking into account the number of assumptions we made during the modelling processes. All major city landmarks, such as mosques, fortifications and towers are clearly seen on the sea-front view, obtained from the 3D model.

Figures 12-15 present views of the 18th century Beirut, obtained from the 3D model from different angles.

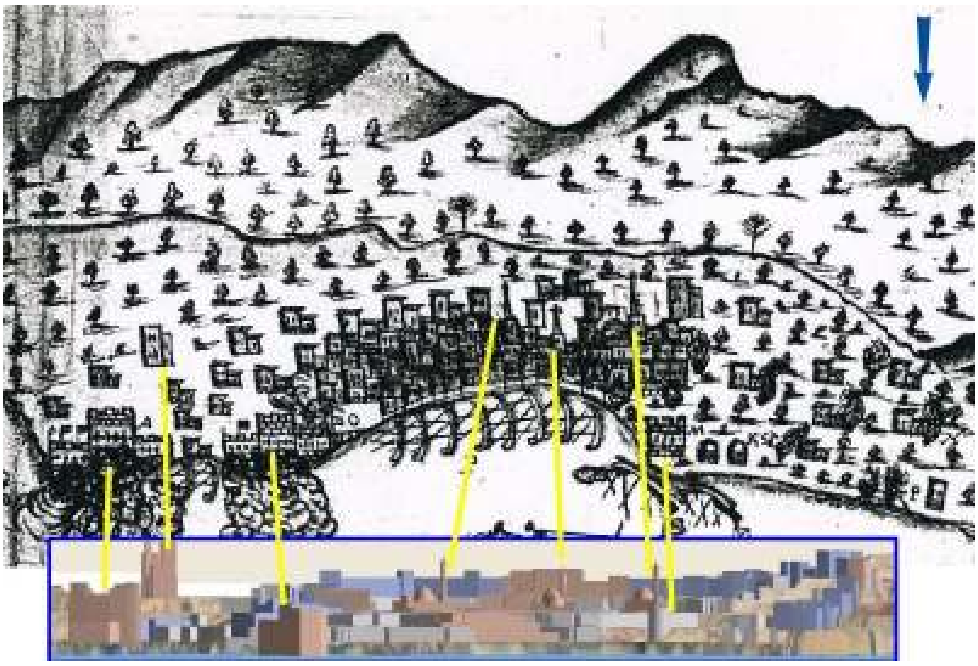

Figure 11. Comparison of the sea-front view of Beirut, made on board of shebeca "Grecia" in 1772 (Russian State Navy Archive, fund 870, list 1, file 1149, p. 74 back – p. 75) with the sea-front view obtained in 3D model. Yellow lines connect clearly recognized landmarks: the sea and land castles, mosques, towers etc.

Figure 12. 3D model. View from the North-East

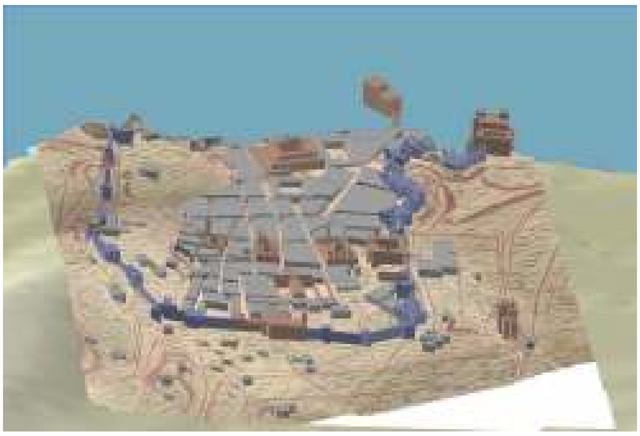

Figure 13. 3D model. View from the South

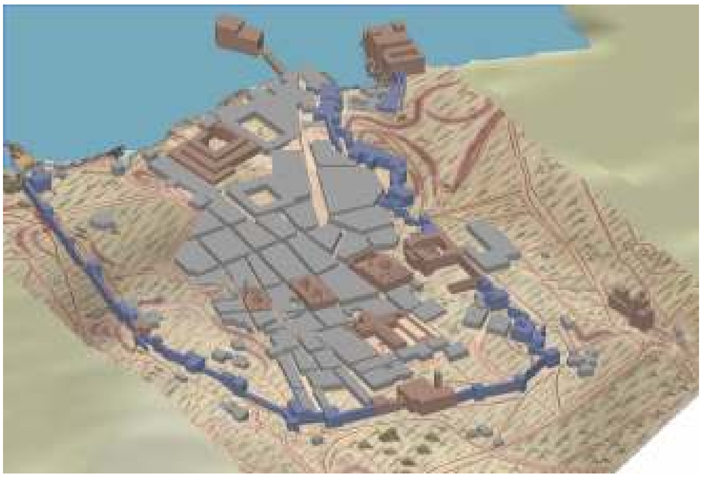

Figure 14. 3D model. View from the South-West.

Figure 15. 3D model. View from the West

Discussion

The use of 18th-century maps to reconstruct Beirut's cityscape is a daunting challenge. There is, of course, no possibility of field-checking the information, so as to correct the observed deformations that may have been introduced by the various surveyors, both on ship and on land, as we noted above. The fact that no documents seem to have survived concerning the actual calculations and field measurements also render the internal double-checking impossible. Some monuments observed on the sketch of the city produced in 1772 still exist: the three minarets of the three mosques (Assaf, Omari and Monzer), together with the Greek-Orthodox St-George's cathedral. A 2005 satellite image was also used to identify the relative positions of the surviving landmarks.
As noted above, the approximate positions (±5m or better) of other landmarks were placed thanks to an extended knowledge of the city, 19th-century photographs and French-Mandate cadastral and large-scale topographic plans and maps. The positions of the city's walls were also deduced from later surveys and from scholarly articles and research. All the walls and fortifications, as well as both sea castles were levelled in the 19th century and early 20th, leaving no possibility to further check the information, and

the results of archaeological digs undertaken in the late 1990s, in areas that interest us have not yet been completely published.

Whatever the case, the general layout of the internal streets, the shape and position of several buildings pose a series of problems for the historical geography of the city. It would seem that the inner parts of the city were not surveyed in the modern sense of the term, but only very quickly sketched. This contrasts with the extreme detail of the military positions (see, for example, the Sea and Land castles, the western walls, the trenches and obstacles which were noted to the West of the city, or the position and depiction of the ships in the port). The external roads are also relatively well drawn, as they were of vital military importance, either for defensive or offensive purposes.

The indifference to the internal disposition of the city no doubt derives from the fact that the Russians had no real intention of permanently occupying the city. For the Russian troops, its capture required the taking of military positions (the two castles, the defensive forts along the badly-maintained city walls). The markets (the *souks*), smaller mosques and churches, the khans, when not important for the military, were not located, and neither was the exact size and shape of the inner roads and impasses. For the military, it was sufficient to know that there were major passageways that lead from the South of the city to the port, or from one gate to the other. The relatively short presence in the city (only four months) seems to confirm this interpretation.

As for the rendering of the cityscape, the real problem was that of estimating the real height of the buildings and fortifications. 19th-century photographs were used to obtain a relatively precise estimation of their height, so as to produce a convincing impression. The Greek Orthodox St-George's cathedral and the heights of the minarets are good examples. The heights of the Bourj tower, of the Sea and Land castles were estimated from drawings, paintings and photographs. The port rendering was established by comparing it with a series of paintings and drawings (now in private collections) produced more or less at the same moment as the Russian maps, but usually in the early and middle 19th century. The problem faced was that of placing these objects according to their real local topography and disposition. As noted above, the Russian map is inexact as to urban details, so the rendering was schematic, albeit very close to what the graphic sources point as being reality.

A detail over which no control was possible was of course the actual colours of the city. Most of the buildings were made of local reddish sandstone (*ramleh*) which has a tendency to become grey when not protected. However, the Mediterranean tradition is to protect stonework with a coat of plaster, which the *Beirutis* often coloured in light yellow. The minarets of the mosques were made with hard white limestone, except for the Omari mosque, made of *ramleh*. The contrasts of colours, the other objects with bright colours (flags, awnings, vegetation, etc.) do not appear on the reconstruction

Conclusion

The use of 18th-century maps, even though imprecise, is a very valuable tool for the understanding of the spatial dynamics of this Levant city. The next best detailed map would only come 60 years later, with the British occupation of the city in 1840, and the first *in situ* topographic survey with modern instruments.

Together with the description of the siege and capture of the city, the Russian maps illustrate, for the very first time, a relatively unknown period of the city's history. The Russian presence, although it left no major landmark, had a profound impact on the city: Ahmad Jazzar rebuilt the walls, which survived till the very end of the 19th century, thus effectively constraining the city and defining its later development, both during the late-Ottoman period and the French Mandate. The last remaining portions of the walls were pulled down in the 1920s, with only a 5m-section surviving in today's partially-rebuilt down-town Beirut.

Acknowledgments.

The whole project was conducted using different ESRI developed GIS software, namely ArcGIS 9 family products and applications: ArcView, ArcEditor, ArcGIS Spatial Analyst, ArcGIS 3D Analyst (ArcScene). The modelling was accomplished using facilities of the GIS Center of Israel Nature & National Parks Protection Authority. Consultations were provided by the inter-disciplinary GIS center of the Hebrew University of Jerusalem.

Short bibliography

Bulatov, V. E., Zaitsev, A. K., Markina, E. D. & Solovyeva, N. Yu., eds., 1997. *Atlas of Archipelago and Manuscript Charts of the First Archipelago Expedition of the Russian Navy, 1769-1774*, Exhibition Catalogue, Moscow, 1997 (Russian), *Atlas of the Archipelago*, St. Petersburg , 1788.

Davie, M., 1996. *Bayroût al Qadîmat* : une ville arabe et sa banlieue à la fin du XVIIIème siècle. *National Museum News*, 3, 25-33.

Davie, M., 1998. Le couvent Saint-Georges de Bayroût al Qadîmat. *Chronos*, 1, 7-31.

Davie, M., 2001. *Beyrouth 1825-1975, un siècle et demi d'urbanisme*. Beyrouth: Ordre des Ingénieurs et Architectes de Beyrouth, 136 p.

Davie, M. F., 1984. Trois cartes inédites de Beyrouth. Éléments cartographiques pour une histoire urbaine de la ville. *Annales de Géographie de l'Université Saint-Joseph*, 5, 37-82.

Debbas, F., 1986. *Beirut : our memory : a guided tour illustrated with postcards from the collection of Fouad Debbas*. Beirut: Naufal, 256 p.

Debbas, F., 1994. *Beyrouth, notre mémoire. Promenade guidée à travers la collection de cartes postales anciennes*, 3ème édition revue et corrigée. Paris: Éditions Henri Berger, 256 p.

Debbas, F., 2001. *Des photographes à Beyrouth. 1840-1918*. Paris : Marval, Collection-Passion, 180 p.

Du Mesnil Du Buisson, C., 1921. Les anciennes défenses de Beyrouth. *Syria*, 2, 235-257 & 317-327.

Fani, M., 1995. *Liban, 1880-1914. L'Atelier photographique de Ghazir*. Paris & Beyrouth: Éditions de l'Escalier.

Fani, M., 1996. *L'Atelier de Beyrouth. Liban 1848-1914*. Paris & Beyrouth: Éditions de l'Escalier.

Fani, M., 2005. *Une histoire de la photographie au Liban 1840-1944*. Beyrouth : Éditions de l'Escalier, 424 p.

Frumin, M., 2004. Russian Navy mapping activities in the Eastern and Southern Mediterranean (late 18th century). *The Portolan*, Journal of Washington Map Society, Vol. 60, Fall 2004, 13-26

Frumin, M., D. Gavish & Rubin, R., 2004. Mapping of Haifa–Acco Bay by the Russian Navy in the late 18th century. In Y. Bargal, N. Kliot, A. Peled (Eds.) *Eretz Israel Studies: Aviel Ron Book*, Haifa, 2004, 290 – 306 (in Hebrew)

Harvard Semitic Museum 1983. *Beirut & Lebanon, photographs from the last century. Legacy of light*, Beirut: Imprimerie Catholique.

Jidejian, N., 1993. *Beyrouth à travers les ages*. Beyrouth: Librairie orientale, 237 p.

L[usignan], S., 1783. *A History of the Revolt of Ali Bey against the Ottomane Porte*. London.

Persen, W., 1955. The Russian occupations of Beirut, 1772-74. *Journal of the Royal Central Asian Society*, XLII (3-4) 275-286.

Pleshcheev, S., 1773. Daily memoirs of a journey from the island of Paros, belonging o Russia, to Syria and to notable places located in the environs of Jerusalem. With a short history of Ali-Bey's conquests by Lieutenant Sergey Pleshcheev…", SPb (in Russian)

Postnikov, A. V., 2000. The Russian Navy as chartmaker in the eighteenth century. *Imago Mundi*, 52, 79-95.

Tarle, E. V., 1956. The Çesme Battle and the first Archipelago expedition of the Russian Navy. In *3 expeditions of the Russian Navy*, Moscow.

The British Lebanese Association 1986. *Romantic Lebanon. The European View 1700-1900.* Leighton House, 10 February-8 March 1986. London: The British Lebanese Association, 96 p.