Comparison of Past and Present Maps of Istanbul Historic Peninsula in GIS, Based on the Insurance Maps of Jacques Pervititch

Keywords: Cartography; history; GIS; insurance maps; planimetric accuracy

Summary: The Historic Peninsula is the urban and historic protected area because of having a rich monumental and architectural heritage in Istanbul, Turkey. This area was added to the UNESCO World Heritage List in 1985. The insurance maps made by topographer and engineer Jacques Pervititch between 1922 and 1945 for the Central Office of Turkish Insurance Agents carry different meanings today from when they were first issued. At the time, the aim of Pervititch’s maps was to illustrate the risk factors considered by insurance companies to mitigate the heavy burden of large fires occurring in Istanbul. Today, this work is an artistic corpus that contains unequalled documentation of an architectural heritage that has largely been lost. In this study, a comparison of past and preview views of four neighborhoods of Eminönü in the Historic Peninsula has been analyzed in GIS. The database about the past has been produced based on Pervititch insurance maps. According to the results of the study, monuments lost their surrounding context, and therefore their former meanings, which erased the most important places of daily life during the period. The results of similarity analysis have been presented via thematic maps.

Introduction

The insurance maps made by topographer and engineer Jacques Pervititch between 1922 and 1945 for the Central Office of Turkish Insurance Agents carry different meanings today from when they were first issued. At the time, the aim of Pervititch’s maps was to illustrate the risk factors considered by insurance companies to mitigate the heavy burden of large fires occurring in Istanbul. Because of its densely packed wooden structures, wide-ranging fires often affected Istanbul. In particular, the Hoca Pasa and Pera fires, occurring in 1865 and 1870, respectively, were major disasters. The former destroyed a significant section of the Historic Peninsula, and the latter, an extensive area from Taksim to Galatasaray.

Istanbul underwent several notable reconstructions over a century, beginning after the great fire in 1870. This event marked an important turning point in the development of fire insurance in the city. The conversion of traditional wooden houses to more fire-resistant stone and brick buildings became a decision of government. To achieve this end, it became necessary to obtain more detailed maps of the various regions of the city than the existing general maps. This became an especially important issue after the second half of the 19th century.

The series of maps by Pervititch is a unique work of architectural history; it comprises an urban architectural plan of Istanbul. Pervititch meticulously researched both public monuments and privately owned structures, and he expressed his findings on the maps as semantic information. Pervititch’s maps use both traditional graphical methods and detailed schemes for architectural representation. His symbols, colors and fonts represent cartographic properties. The colors of the buildings indicate their type of structure, and he also provides information about the numbers of floors and heights of topography.

* Assistant Prof. Dr., Department of Geomatic Engineering, Division of Cartography, Yıldız Technical University [alpersen@yildiz.edu.tr]
Today, this work is an artistic corpus that contains unequalled documentation of an architectural heritage that has largely been changed or lost. The rapid changes of the city after 1950, with successive expropriations and the construction of new squares and roads, have rendered the original maps obsolete. The names of some streets, avenues and buildings have been changed. However, Pervititch’s maps can still provide extremely rich reference material for researchers. These maps should be re-evaluated, as they contain much information that reveals the greatly changed fabric of the city (Cumhuriyet, 2001).

In this study, a comparison of past and preview views of four neighborhoods (Yavuz Sinan, Demirtaş, Sarıdemir and Rüstempaşa) of Eminönü in the Historic Peninsula was analyzed in GIS. The database about the past was produced based on Pervititch insurance maps. Also, planimetric accuracy of a Pervititch map was determined.

The study area was the Historic Peninsula has been the focal point of many civilizations, notably the Roman, Byzantine and Ottoman empires. It is bounded by the Istanbul’s Bosphorus to the east, the 2nd Theodosios walls to the west, the Golden Horn to the north, and the Sea of Marmara to the south in Istanbul. The Historic Peninsula is the urban and historic protected area because of having a rich monumental and architectural heritage. This area was added to the UNESCO World Heritage List in 1985 (Gunay et al. 2015).

**Data source**

Today we do not have a complete collection of the Pervititch maps. Most of them are kept at the Istanbul Metropolitan Municipality Taksim Atatürk Library and the archives of Axa Oyak Insurance Group (Sabancıoğlu, 2003). All maps have been scanned and they are stored in digital format in Atatürk Library, and can be shared. Pervititch maps used in this study in pdf format were downloaded from the website of Atatürk Library.¹ The archive of Pervititch maps in Atatürk Library is shown in Fig. 1. Current geographic database based on large-scale maps has been obtained from Istanbul Metropolitan Municipality.

Properties of Insurance Maps of Jacques Pervititch

The Pervititch maps, the first of which was dated 1922, were derived from the 1890 map of Galata and Pera region drawn by R. Huber, and the Goad maps. The last map of the series dates from 1945. Most of the maps covered the Kadıköy, Üsküdar, Moda, Erenköy, Eminönü, Fatih, Beyazıt, Beyoğlu, Beşiktas, and Şişli regions (Sabancıoğlu, 2003).

Who was Jacques Pervititch?

The great efforts of Müsemma Sabancıoğlu clarified who was Jacques Pervititch. Jacques Pervititch was born in Republic of Croatia in 1877. His father was a sailor and he moved to Istanbul with his wife, three sons and a daughter in 1880. Jacques went to Saint Pierre Elementary School, and he continued his education with a scholarship at the French Saint Joseph High School. He graduated with distinction from Saint Joseph in 1894. It is unknown where he had the cartography education. The date of his last map, 1945, is also the year of his sudden death (Sabancıoğlu, 2003).

The cartographic properties of Pervititch maps

The Pervititch maps include 243 sections. They have detailed legends and provide necessary information of features in very large scales. The systematic approach of the Pervititch maps also included a sectional guide for each region (Fig. 2).
The legends of the Pervititch maps are remarkably elaborate. Qualitative characteristics of buildings are marked with differentiated coloring: wood frame structures are indicated in yellow, brick, stone and armored concrete in pink, stone-and-brick ground and wood frame top floors in yellow and pink frame. Blue, for instance, indicates glass rooftops, pools, fountains, cisterns, wells and seas, while green stands for parks and gardens (Sabancıoğlu, 2003). In addition to this, reinforced concrete structures are indicated in purple, Turkish or Byzantine vault in olive, and brick, stone and wooden structure in orange. The legend also explains the use of “letters” which add more information to the colorings and define the fire risks of the property to be insured. The Pervititch maps are mostly in French. Therefore abbreviations usually stand for French names, as in Vieux Bois: Vx Bs (Sabancıoğlu, 2003). The details about the representation and abbreviations of building types and number and height of floors are given in Tabs. 1, 2. Furthermore, maps have remarkable notes. For example, there is a note about garbage area on the coast on section 78. Taking into consideration the fact that in Turkey street names and house numbers change often and until the 1930’s a large part of Istanbul lacked street signs, the effective and highly analytical address finding systems are available in the Pervititch maps as unparalleled guides for social or urban history research. Furthermore, they provide a search index with alphabetical ordered street names and block numbers (Pervititch, 2000).

The general legend of the Pervititch maps consists of following categories:

a. Building types;

b. Corbelling, roofing and super structures;

c. Walls and openings;

d. Number and height of floors;

e. Streets and numbering systems; and

f. Abbreviations and other symbols.
<table>
<thead>
<tr>
<th>Representation</th>
<th>Building Types</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete-Masonry (A-class)</td>
<td>Turkish (V.T.) or Byzantine (V.B.) vault</td>
<td>Massive walls and roof.</td>
</tr>
<tr>
<td>Fire security is high</td>
<td>French vault (V.Fr.) or concrete</td>
<td>Brick walls, massive roof</td>
</tr>
<tr>
<td>Concrete-Masonry (B-class)</td>
<td>Brick walls or concrete</td>
<td>Timber floors, massive roof</td>
</tr>
<tr>
<td>Concrete-Masonry (B-class)</td>
<td>Exterior sides of galvanize iron for massive roof</td>
<td>Iron or timber frame for massive roof</td>
</tr>
<tr>
<td>Wooden structure (Bs.) (C-class)</td>
<td>2, or more, exterior sides of timber, or agglomerate, where timber predominates. Any roof whatever.</td>
<td></td>
</tr>
<tr>
<td>Mixed structure</td>
<td>Ground floor (Rz.) French vaulted (V.Fr.), + 3 floors (ET.) of timber (Bs.) – Massive coverage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ground floor (Rz.) ordinary massive (M.O.), + 2 floors (E.) of timber (Bs.) – Massive coverage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Massive entresol, (up to 2 meters) above foot-pavement, + 2 floors timber</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Street front 2 floors M.O.+3rd timber and backside 3 timber floors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Warehouse French vaulted (V.Fr.), isolated independent entrance to the floor</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. The representations and abbreviations of the Pervititch maps for building types (http://Atatürkkitapligi.ibb.gov.tr)

<table>
<thead>
<tr>
<th>Representation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE.: Floors exceeding 4m in height</td>
<td>ET.: Floors 3 m to 4 m</td>
</tr>
<tr>
<td>pE.: Floors 2 m to 3 m</td>
<td>½ Et.: Floors less than 2 m</td>
</tr>
<tr>
<td>-4E: Floors at the back, occasioned by slope of ground</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. The representations and abbreviations of the Pervititch maps for number and height of floors (http://Atatürkkitapligi.ibb.gov.tr)
Study Area

The study area is in the Eminonu district in Historic Peninsula. It is bounded by the Eminönü Square to the east, the Arap Çeşmesi Street to the west, the Golden Horn to the north, and the streets of Küçük Pazar, Hayriye Hanım, Kantarcılar, and Hasırçılık to the south in Istanbul. Totally 9 sections were digitized which are 69, 75, 76, 76A, 76B, 76C, 77, 78, and 79. The section number 78 is given in Fig. 3.

![Figure 3. The Pervititch map section number: 78 (http://Atatürkkitapligi.ibb.gov.tr)
Urban conversion factors in the study area – Eminönü, Istanbul Historic Peninsula](image)

After the Tanzimat period (Ottoman Reform 1839–1876), different environmental intervention methods were explored with the aim to modernize in the Ottoman and Republic era and the understanding of urban conservation, which emphasized the monuments. As a result, while the monumental buildings were being preserved, civil and commercial structures around the monuments were destroyed, and wide roads were opened. Monuments lost their surrounding context, and therefore their former meanings, which erased the most important places of daily life during the period.

During the Ottoman period, the coastline between Eminonu and Unkapam was vital to the daily activities of the city due to its narrow streets and dense urban texture. There was a strict
connection between the shops and the warehouses on the back streets of piers and the crowded boats and trade conducted on the piers.

The Balıkpazarı (fish market) was a very old, lively, and bustling bazaar that included the streets of Balıkpazarı, Lüleci, Balıkçilar Lonicası, and Balıkhane. The streets of Peynirci Akif and Helvacı Bekir appeared in 1936 before the expansion of Eminönü Square. Balıkpazarı Pier, which was just in front of the Balıkpazarı Gate and included fishermen’s shops, was also the same place in the Byzantine period.

There were shops selling lemons and salt on the Hasır Pier and boats that drove to the Bosphorus. A tobacco custom next to this pier relied on vessels to bring tobacco. There was also a fruit custom on Yemiş Pier, and greengrocers were on the back streets. Olive oil shops were on Yağ Pier. Zindankapı Pier housed coffee, rice, and honey warehouses. The Pervititch map of 1941, section 76 shows that there was a covered bazaar near the Çardak and Yemiş Piers, which were next to each other, just outside of Zindankapı (Fig. 4).

![Figure 4. Left: Pervititch map of 1941 section 76. Right: Covered bazaar at the Balıkpazarı Değirmeni Street in the 1970s (Tulek, 2015).](image)

Plans that were created after the great fire (1870), the laws and executions, such as the expansion and fixing of existing streets, the abolition of strict controls over trade, the demolition of old fortification walls, and the incorporation of land holding fortification walls into commercial structures, affected many places and caused serious changes in the field of study (Tulek, 2015). Obtaining effective road networks by opening new, wider roads, opening new squares around the monumental buildings, and encouraging the building of brick and stone structures were the basic targets in 1839. There were also provisions for fire prevention, such as building masonry walls between wooden structures. These provisions were considered an opportunity to update the city fabric and apply regulations.

The Kule-i Zemin, an important regulation, was implemented in 1864; it rapidly changed the region of Balıkpazarı ve Yemiş’s piers, especially in areas around the walls due to the government’s selling of lands that contained ruins of the walls. This practice was halted by the declaration of Meşrutiyet (constitutional monarchy) in 1908.
From the early years of the republic until the 1930s, the Eminönü coast, where the Balıkpazarı and Yemiş Piers are located, was a ruined and neglected region. Pervititch's insurance maps from the beginning of the 1940s indicate that the buildings on this coast were lying toward the Golden Horn, indicating that some places were full of mud and garbage (Section 76). With its ruined and neglected status, the area had an important role in the planning work post-1936, when the process that resulted in the collapse of the zone began.

During the early Republican period (1928–1938), another development that affected the region in both the spatial and economic senses was the construction of a new state building on the Keresteciler Pier.

Henri Prost was invited to re-plan the city. After various negotiations, the contract was signed on June 21, 1936, and Prost started to work, which began the process of change for Eminönü and the coast. Prost stated that the city’s current map was missing and had to be updated, and he requested aerial photographs, which became the first step in planning.

Prost adopted a conservation concept that emphasized monuments. At the end of the 1930s, the buildings around the New Mosque (Yeni Cami) and the Egyptian Bazaar (Mısır Çarşısı), the block that contains the Valide Han, the block between Helvaci and Peynirci streets, the Balıkpazarı Mosque at the beginning of Peynirci street, and the buildings to the east of the square were demolished for the square’s expansion (Fig. 6) (Tulek, 2015).

The Golden Horn coastal road, which was proposed in many plans from 1839 to 1950, was opened after reconstruction activities ended in 1960. The old fortification wall and its texture, Balıkpazarı, the state building built in 1935, the traditional buildings, and streets in the area were demolished, and Ragıp Gümüşpala Street between Eminönü and Unkapamı was opened. Ruins of the old fortification wall and the urban texture that was lost can be seen on the Pervititch map, section 76A (Fig. 7) (Tulek, 2015).
Figure 6. Old Eminönü Square and Valide Han (on the left). The Balıkpazarı coast and Balıkpazarı Mosque (on the right) (Tulek, 2015).

Figure 7. Ruins of old fortification wall on the Pervititch map.
Finally, Yemiş Pier and the buildings around the Ahi Çelebi Mosque were demolished during the coastal regulation operations of the 1980s. During these destructions, Eminönü and Balıkpazarı, which were in one of the most important places of daily life throughout history, lost their characteristic structures.
The Analysis in GIS Based on Pervititch Maps

*Planimetric Accuracy of Pervititch map*

The purpose of a cartometric analysis of an historical map is to investigate its planimetric accuracy. Using the freely available MapAnalyst software, the map historian identifies complementary sets of control points on the historical map and a modern reference map. When interpreting accuracy visualization, one must keep in mind that the visualization reflects geometric imprecision induced by two sources:

- Errors at the different stages of map production (e.g. surveying and data compilation, map drawing, and reproduction)
- Paper maps are not inert materials, i.e. shrinking and stretching distort the map’s geometry.

Engineers and researches in surveying, geographical information science or computer graphics usually accomplish a geometrical transformation by using affine transformations.

Pervititch produced maps according to the city's official triangulation network, as stated in each section. Although the grid reference system does not exist on the maps, elevation values of the points are represented on some of the streets. The north arrow is shown, whereas projection information is not available on the maps.

The map section 75 in 1940 was used to calculate the planimetric accuracy in MapAnalyst. In order to determine the planimetric accuracy of the map, 24 control (link) points were used for the transformation (Figure 10). The control points were chosen from the details of buildings on both the Pervititch map and present map.

The well-known affine transformation, with six parameters \( x_0, y_0, m_x, m_y, alpha, beta \) to define (see below), was used in this study. The scale factor was chosen as unity (1) in the transformation.

The system of equations for the affine transformation, with six unknowns, is:

\[
\begin{align*}
X &= x_0 + m_x \cos(alpha) x - m_y \sin(beta) y \\
Y &= y_0 + m_x \sin(alpha) x + m_y \cos(beta) y
\end{align*}
\]

where: \( x, y \) known coordinates and the unknown parameters to define on the map plane are: \( x_0 \) and \( y_0 \) the translations (shifts) to the coordinate directions \( x \) and \( y \), directions; \( m_x \) and \( m_y \) the corresponding scale factors to \( x \), \( y \) directions; \( alpha \) and \( beta \) the counter-clockwise rotations, to \( x, y \) directions respectively. Having defined the six parameters of the affine transformation, new transformed coordinates \( X, Y \) can be computed satisfying the properties of the affine transformation.
The downloaded map scale is 1:500, as stated in the map, whereas the evaluated global scale is 1:360. The rotation of x-y axes is 61 degrees. Root mean square position error for the map is 0.9 meters.

The distortion grid is a comprehensible method to visualize the accuracy of an old map. The distortion grid size was chosen as 50 meters. The graphical result of distortion grids is shown in Fig. 10, using the MapAnalyst application (Jenny, 2006).

**Georeferencing the Pervititch Maps**

In this study, a comparison of past and preview views of the study area was analyzed in ArcGIS 10.1. The database about the past was produced based on Pervititch maps. Sections do not contain spatial reference information. Thus, to use them in conjunction with the spatial data, they were exported to raster format, and georeferenced to the coordinate system of the existing spatial data. The process involves identifying a series of ground control points (known x, y coordinates) that link locations on the raster with locations in the spatially referenced data (target data). Control points are locations that can be accurately identified on the raster and in real-world coordinates; in our case as control points were chosen the evident details of buildings on both the Pervititch map and present map.

The control points were used to build an affine polynomial transformation that will shift the raster from its existing location to the spatially correct location. The connection between one control point on the raster and the corresponding control point on the aligned target data is a link. The links were tried to spread over the entire raster rather than concentrating them in one area (having at least one link near each corner of the raster and a few throughout the interior). Geometric transformation is the process of changing the geometry of a raster from one coordinate space to another. For this purpose, nearest neighbour resampling technique was used for resampling the raster (ArcGIS 10.1, Help).

**Results**

After the transformation process, images were digitized as the feature classes such as building, street centrelines, height points, tramway line, wall, fountain, plot, backyard, and garden. The attributes such as height values, building names, types and materials (reinforced concrete, vault,
wooden, wooden-masonry, concrete-masonry, mixed, and unclassified), and street names and types were constituted. Totally 2118 buildings were evaluated on Pervititch map, while 618 buildings on present database. The results of the change in the city fabric are given in Tabs. 3, 4. Totally 60 streets were erased in the study area.

Ethem Pasa Konak was destructed in 1967 as a result of land speculations and profit greed, and in the direction of the desire of property owners careless about the cultural preservation. It was one of the earlier stonework houses constructed in the period that the Ottoman State turned its face to West (Fig. 12).

<table>
<thead>
<tr>
<th>Building Material</th>
<th>Past</th>
<th>Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforced Concrete</td>
<td>370</td>
<td>381</td>
</tr>
<tr>
<td>Vault</td>
<td>282</td>
<td></td>
</tr>
<tr>
<td>Wooden</td>
<td>371</td>
<td>12</td>
</tr>
<tr>
<td>Wooden-Masonry</td>
<td>620</td>
<td>17</td>
</tr>
<tr>
<td>Concrete-Masonry</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Mixed</td>
<td>407</td>
<td></td>
</tr>
<tr>
<td>Unclassified</td>
<td>29</td>
<td>208</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2118</td>
<td>618</td>
</tr>
</tbody>
</table>

Table 3. Number of building materials on past and present maps.

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Past</th>
<th>Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Han</td>
<td>57</td>
<td>44</td>
</tr>
<tr>
<td>Konak</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Fountain</td>
<td>7</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 4. Number of some types of building on past and present maps.

Figure 11. Graphics of past and present building materials.
Conclusions

The series of maps by Pervititch is an artistic corpus that contains unequalled documentation of an architectural heritage that has largely been changed or lost in Istanbul. After the Tanzimat period (Ottoman Reform 1839–1876), different environmental intervention methods were explored with the aim to modernize in the Ottoman and Republic era and the understanding of urban conservation, which emphasized the monuments. As a result, while the monumental buildings were being preserved, civil and commercial structures around the monuments were destroyed, and wide roads were opened. Monuments lost their surrounding context, and therefore their former meanings, which erased the most important places of daily life during the period. The Golden Horn coastal road, which was proposed in many plans from 1839 to 1950, was opened after reconstruction activities ended in 1960. Finally, Yemiş Pier and the buildings around the Ahi Çelebi Mosque were demolished during the coastal regulation operations of the 1980s. During these destructions, Eminönü and Balıkpazarı, which were in one of the most important places of daily life throughout history, lost their characteristic structures. Ethem Pasa Konak was also destructed in 1967 enigmatically.

In this study the cartographic properties of Pervititch maps were discussed. Planimetric Accuracy of a Pervititch map was evaluated. A comparison of past and preview views of the study area was analyzed in ArcGIS 10.1. The database about the past was produced based on Pervititch maps. After the transformation process, images were digitized with feature classes and attributes. Totally 2118 buildings were evaluated on Pervititch map, while 618 buildings on present database. Furthermore, changes in the street names were researched.
Figure 13. Pervititch Maps (Study Area)

Figure 14: Present Maps (Study Area)
References


