1. Introduction

Napoleonic map 1801 C. identifies pre-modern Alexandria on village scale, neither that great ancient Ptolemaic capital nor a medieval harbor on world trade line that generated the main tax income of Islamic Egypt. The global land cover is rapidly changing due to anthropogenic activities and natural processes (Phiri et al. 2020). Since 1801, the premodern Alexandria LULC had been entirely changed, responding to modernization tendency that trespassed the city during Mohamed Ali's dynasty (1805-1952). Consequently, the Napoleonic map is considered one of the most accurate historic maps assigned premodern natural and human landmarks emphasize the LULC.

However, geospatial approach, mainly remote sensing and GIS, is outlining this contribution based on the appropriated LULC categorization, adhering to the French attributes of the Napoleonic map, hence, to reach up reasonable diagnosis for overlapped historic evolution.

2. Historical Urban Context of the Study Area

Boundary covers 42.375 km² of contemporary Alexandria adheres the historical borders and human activities over 2300 years. A narrow strip of land between the Mediterranean Sea to the north and Lake Mareotis to the south was an excellent strategic city. Alexandria access to the Mediterranean through two harbors as well as access to the rest of Egypt via the inland harbor on Lake Mareotis. Alexander the Great appointed Deinocrates of Rhode in 332 BC to plan his new city, according to Hippodamic urban pattern (Carole 2012). Ptolemaic erected splendid buildings, e.g. magnificent lighthouse of Pharos. Heptastadium, a thick wall, linked Pharos with the
landmass encompassed the Great Harbor to east and Eunostos Harbor to west. Water system of a canal, subterranean channels and cisterns conduct fresh water of the River Nile to the waterless city (Carole 2012).

Alexandria declined after the Arab conquest in 641 CE (Abouseif 1989). The city was growing, steadily during the successive Islamic eras, since Tulunid, Fatimid, Ayyubid and Mamluk (9th-16th C.) reconstructed the city. “Alexandria should only be seen as a warehouse of goods”, Gratien Le Père expressed the Ottoman city 1798 (Le Père 1991). Population mobilized to the Heptastadium that became the modern city 1789 (Salem 1982).

War, economy and natural hazard changed the urbanism of Alexandria and create 2-10m of multi-archaeological layers, furthermore the submerged antiquates (Table 1). Alexandria has archaeological survived landmarks such as “Pompey’s Pillar”, “Alexandria’s catacombs” and the “Roman theatre” (Abdelhady 2014).

Table 1 Samples of the most destructive earthquakes on Alexandria (Source: Riad et al. (2005)

<table>
<thead>
<tr>
<th>Date</th>
<th>Year</th>
<th>3D</th>
<th>Energy</th>
<th>1</th>
<th>2</th>
<th>Locality</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1922</td>
<td>1922</td>
<td>1922</td>
<td>1922</td>
<td>1922</td>
<td>1922</td>
<td>1922</td>
<td>1922</td>
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<tr>
<td>1900</td>
<td>1900</td>
<td>1900</td>
<td>1900</td>
<td>1900</td>
<td>1900</td>
<td>1900</td>
<td>1900</td>
</tr>
</tbody>
</table>

3. Land Cover Characteristics and Identifications

Context of the Study Area

3.1. Urban Area

The bulk of the compact urban fabric, known as *Ville Moderne* (modern city), concentrated in the northern part of the city (Le Père 1991). Six neighbourhoods scattered inside *Enceinte Des Arabes* (the ancient Arab city), four existed next to the main gate for accessibility and local trading consideration; two west to *Porte de Rosette*, two north to *Porte de la Calonne* (Table 2). Other two scattered buildings, one extends S/N in the middle of *Enceinte Des Arabes* destinated to the Sea Gate, while the other extends S/N parallel with the western wall, next to *Porte des Catacombes* (Figure 1).

3.2. Hilly land

Sand accumulated on ruins everywhere, resembling sand dunes, due to the urban decline. Kom al-Nadoura and Kom al-Dikka, formed by late Roman and medieval human activities, used as sailing landmarks (Léon 1983, Le Père 1826). However, sand accumulation represented most of the hilly land of the premodern city 19th C. could lead archaeologists as a landmark for promising discoveries (Figure 1). limestone heaps extended (SW/NE) north to *Canal d’Alexandrie* outside south wall of *Enceinte Des Arabes*. Likewise, *cap des figuiers*, west Pharos Island (SW/NE), which Mohamed Ali began removing for preparation of constructing Ras al-Tin Palace in 1830. Gradually, was still fading away until early 20th C. (Mubarak 1888, Al-Serouji 1963).

Table 2 LC analysis of pre-modern and contemporary Alexandria based on the Napoleonic map 1801

<table>
<thead>
<tr>
<th>Classification System</th>
<th>Pre-modern Land Cover (Napoleonic map 1801)</th>
<th>Contemporary Land Cover 2003</th>
<th>Pre-modern Area (1801)</th>
<th>Contemporary Area (2003)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Area</td>
<td>Ville Moderne</td>
<td>Urban area 1</td>
<td>3.267 km²</td>
<td>3.367 km²</td>
</tr>
<tr>
<td>Natural</td>
<td>Enceinte Des Arabes</td>
<td>Urban area 2</td>
<td>3.198 km²</td>
<td>3.319 km²</td>
</tr>
<tr>
<td>Hilly Land</td>
<td>Kom al-Nadoura</td>
<td>Kom al-Dikka</td>
<td>Urban area 3</td>
<td>3.058 km²</td>
</tr>
</tbody>
</table>

3.3. Shoreline

Elven small islands were scattered along the SW/NE Pharos Island. *le Diamant* Island was the most important among located north to Pharos island, the only survived remain of demolished Pharos at early 19th C. (Le Père 1826). This assert the island had been formed due to earthquake and tsunami, which submerged the other
isolated islands later (Le Pére 1826, Riad 2005). The long jetties which in ancient times closed the Eastern Harbour from the north did also disappear under sea level, leaving the *Megas Limin* wide open and totally unprotected (Figure 2). Ancient Cape Lochias submerged except a promontory remained visible (Tzalas 2020).

 Fortunately, the premodern shoreline is not fully buried under the construction of the corniche road of the eastern harbor in 19th and 20th C., where SE part can still be seen for divers. This discovery made possible to determine the dimensions and structure of these jetties in the harbor (Abdelaziz 2008). Three sections extended between the two ends of the eastern harbour arch, L 3,478.28 m, and connect two capes (Table 2 and Figure 2). Western harbor *Port Veiux* not was away of modern development of 19th and 20th C., as well.

3.4. waterbodies

Napoleonic map present Cape *Molis* in the northern shore of *Mareotis Lacus* containing urban feature and shelter old port *Portus Flurii* (Le Pére 1826), which is now entirely changed (Figure 2). *Lac Salin* (Saline pond) located in *Cap des figuiers*, entirely buried and replaced by playground within developing Ras al-Tin palace (Table 2).

4. Land Use Analysis Within Authentic Framework

4.1. Low Density Housing (LDH)

The Mediterranean residential style prevailed in premodern Alexandria, some still survived, with a height of 1-4 stories (Table 3 and Figure 1), built of burned bricks and logs discriminate the urban fabric of *Enceinte Des Arabes* and *Ville Moderne* (Badr 2004).

4.2. Institutional (INST)

*Douane* (municipality) overlooking *Port Neuf* in *Ville Moderne* was assigned. Fortification was limited, three forts were guarding *Port Neuf* and one for *Port Veiux* (Figure 1).

Medieval fortification discriminates *Enceinte Des Arabes* were valid to defend. Rectangular Walls with five gates were surrounding and fortified with five forts. Islamic, Christiane and Jews worship house diversity reflects cosmopolitanism of *Enceinte Des Arabes* represented in the two main mosques, two monasteries and synagogue. Cemetery was excluded around *Ville Moderne*, two at the south edge and one at north between the two ports for Muslims. Kom Wala (al-Nadoura) was deserted cemetery for Muslims inside *Enceinte Des Arabes*, while Jews cemetery east out, add to another one for Muslim next to *Porte de la Colonne* (Le Pére 1826) (Table 3).

4.3. Commercial/Industrial (COMIND)

French attributes of the Napoleonic map assign four COMIND buildings (Table 3). *Or du Consulat on Port Neuf*, fortunately was renovated as the modern building of Gold Market, despite demolishing the premodern structure. Buildings for marine logistics concentrated and overlocking on *Port Veiux*, the main harbour that developed, frequently (Figure 2).
Table 3. Land Use analysis for the city of pre-modern and contemporary based on the Napoleonic map 1801

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Pre-modern</th>
<th>Contemporary</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture (AGR)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premodern Alexandrian community of less than 8,000 concentrated in Ville Moderne, reclaimed flatlands inside Enceinte Des Arabes (Table 3) (Le Pére 1826).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subterranean channels and cisterns provide limited irrigation to cultivate scattered orchards of palm trees and oranges, moreover vegetables; eggplants, cabbage, artichokes (Figure 1).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anfoushi north to Ville Moderne and Cap des figuiers/Ras al-Tin (Cape of fig trees) was suitable to cultivate fig and palm trees regarding low water consumption and suitable calcareous soil.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SE the study area, 1.810 km of 6,000-7,000 km among the main four subterranean channels of Canal d’Alexandrie were cultivated with resilience crops count on wells and cisterns.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fields of alfalfa, barley and wheat were cultivated, add to some legumes denser in the orchards of Enceinte Des Arabes; such as beans, eggplant, onions, etc. (Le Pére 1826).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.5. Vacant land (VL)

Ali Mubarak concludes Le Pére observations on Alexandria (Mubarak 1888). Urban dysfunction outbreaks Enceinte Des Arabes generates vacant land (VL), including hilly lands, and seize Enceinte Des Arabes + Ville Moderne (Table 3 and Figure 3).

4.6. Transportation (TRANS)

High density of narrow and irregular secondary roads discriminated the survived compact urban fabric of Ville Moderne, essentially that a main road penetrated it vertically (SE/NW) and branched into other two, east to Le phare and west to Cap des figuiers (Figure 3).
had the same secondary road pattern, while fractioned long roads extended among the hilly lands. Network of random long roads connect the city to its external context, Rosetta road in the east that leads to Cairo, was the most important and authentic of which, furthermore *Esplanade de Port Neuf* outside the Sea Gate (Table 3).

4.7 Water infrastructure (WI)

Schedia / *Canal d’Alexandrie* was closely linked to Rosetta, the closest Nile western branch. *Canal* penetrated south wall of the city, diverged into four main subterranean channels “*Aqueduc Souterrain*” that flowed northward into the sea (Table 3), from which a network of subterranean secondary channels branched out, reaching to the houses and orchards (Soliman 2014).

*Citerne* gathered in *Enceinte Des Arabes* (Table 3), Le Père estimated 380-400 *Citerne* of the city by 1801 preserve water supplied from *Canal d’Alexandrie*, annually (Le Père 1826).

*Aqueduc*, high-water archways were carrying water from *Enceinte Des Arabes* to the huge tower at the east gate overlooking *Port Neuf* square, is either a modern or a medieval (Table 3). Unfortunately, it had been demolished for new French fortifications (Le Père 1826).

4.8 Archaeo. Ruins (CULTH)

Napoleonic map explored ten archaeological features at least within the study area. Most of which allocated around *Enceinte Des Arabes*. Internal heaps blocked detailed survey (Figure 1).

**Conclusion**

Inter-disciplinarily is an established and vital characteristic of the theory and practice of geography in its various fields, but while there is increasing acknowledgement in heritage studies and management that inter-disciplinarily should be fostered (Ripp & Rodwell 2015).

Geospatial analysis outlined historical facts of the contemporary urbanism intersects the pre-modern city, generating the LULC change. Geospatial approach became required to interpret and manage the cultural heritage, along with melting and visualizing the scattered compatible historical material. In the same context, LULC methodology is not exclusive for building futuristic change model of an existing status, but interpretation of historical features that support decision makers, as well. Accordingly, changing mindset of the classic approach of the cultural heritage became required to guarantee realistic perception and providing accurate data support ambitious site management plan.

Subsequently, digitizing the Napoleonic map identifies the LULC attributes, essentially the urban fabric and topographic features, add to classification and calculation interpret pre-modern Alexandria status over three centuries of downfall. However, Alexandria still owns a lot of mysteries, such this contribution help for building historical informatics database for the premodern city, as well as leading to promising exploration of the hidden treasures of Alexandria.
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References


