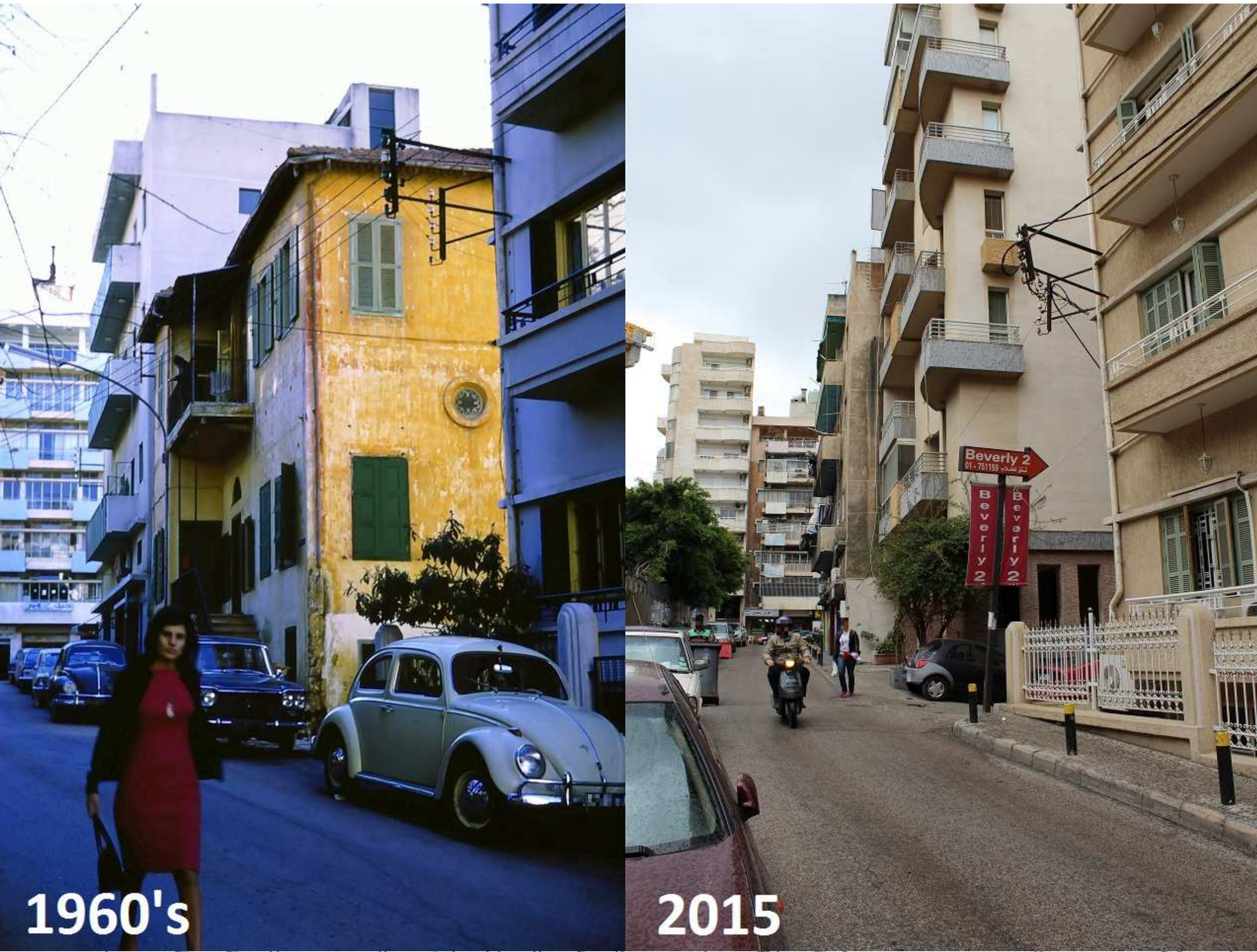
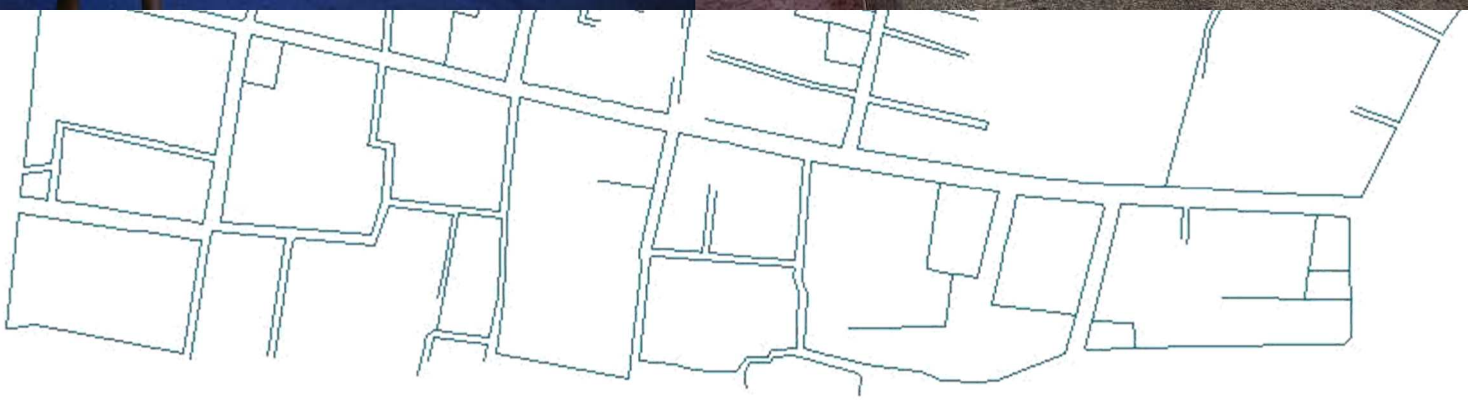
Integrating Historical Maps and Photographs into Geographic Information Systems (GIS): Hamra of Beirut Revisited





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In 1973 geographer Per Kongstad and sociologist Samir Khalaf published the book *Hamra of Beirut – A Case of Rapid Urbanization*. The book contains a series of cartographic elements and analysis from the Hamra area in Beirut, Lebanon. The material is mainly from the 1960's.

We gained access to these original maps, as well as unpublished photographs of the time, and proposed to digitise and integrate them into a Geographical Information System (GIS) environment.

We discuss the validity of integrating these materials, into urban studies, and describe the technical aspects related to processing the data.

Issues such as database design, scanning, georeferencing, vectorising, attribute filling, and sharing online are discussed in the thesis.

At last we reflect on the results and suggest future research.

PREFACE

This is the final thesis of the Msc in Geoinformatics at Aalborg University Copenhagen in Denmark. The project was prepared in cooperation with the *Neighborhood Initiative* at the American University of Beirut, and the thesis is written by Bruno Cardoso and Elise Thing.

References are made in the APA format (American Psychological Association) 6^{th} edition.

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ACRONYMS

AAU: Aalborg University

AUB: American University of Beirut

BCE: Before Common Era

CE: Common Era

CSDGM: Content Standards for Digital Geospatial Metadata

DBMS: Database Managements System

e.g.: exempli gratia ("for example")

Esri: Environmental Systems Research Institue

DPI: Dots per Inch

GDB: Geodatabase

GIS: Geographic Information System

GPS: Global Positioning System

i.e.: id est ("that is")

NI: Neighborhood Initiative

POI: Point Of Interest

R.B.: Ras-Beirut (Per Kongstad's abbreviation on the photographs)

RGB: Red, Green, Blue

UC: University of Copenhagen

WFS: Web Feature Service

WMS: Web Map Service

ACKNOWLEDGEMENTS

We would like to thank a number of people who have helped in the success of this master thesis project. First of all we would like to thank Per Kongstad's wife **Mette Mønsted** who, after his death in 1982, lent the materials for storage at RUC to make it available for further research. **Rasmus Ole Rasmussen** from whom we received the material from *Hamra of Beirut*, and who has been storing the materials at Roskilde University Center (RUC) (Denmark) while searching for someone to show interest in it. We are very grateful to **Cynthia Myntti** and **Dalia Chabarek** of the *Neighborhood Initiative* for their collaboration and for hosting our project and making an office space available for us in their building at the AUB, as well as to everyone else from the Neighborhood Initiative who aided us with data and practicalities, amongst those **Hani Al-Naghi** and **Hayat Gebara**. **Samir Khalaf** who is still teaching at the American University of Beirut (AUB), met with us when we were in the city and enriched us with stories about the fieldwork with Per Kongstad back in the 1960's. We were happy to see that he is pleased with the new interest in the historic material. A special thanks goes to **Maria Abunnasr** and **Yaser Abunnasr**, for sharing with us their in-depth knowledge of Hamra and Beirut, to be overwhelmingly excited about and engaged in our project, adding stories and anecdotes to the material, inviting us into their home on weekdays and weekends, feeding us cake and providing us with raincoats. Without their endless engagement we would not have located the number of photographs with such precision and certainty and the product would have been lacking greatly. The fieldwork was conducted in cooperation with **Marie Brøndgaard Jensen** who is using some of the historic material at her Master in Tourism at Aalborg University CPH in for the thesis "Embodied Urban Spaces of Ras Beirut and the Inherence of Tourism – *A case study of mental mapping and photographic narratives*", we want to thank Marie for the cooperation before, during and after the fieldwork.

The fieldwork in Beirut was partly funded by **Den Obelske Familiefond** through **Aalborg University**, for which we are extremely grateful. For free access to scanners for the image slides and the maps, we want to thank **Ulrik Danneskiold-Samsøe** and **Posterland**, respectively.

Last but not least, thank you to our supervisor **Thomas Balstrøm** for his collaboration and dedication to our topic, which is not typical for the Msc in Geoinformatics

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1 INTRODUCTION

*“Cities are famously seen through the opposing lenses of redemption and corruption”, s*o starts the essay “Visible Cities” by David Lowenthal (2001).

Throughout history and in modern times cities, on the one hand, are seen as the crown jewel of civilisation, a place of freedom and justice and a refuge against the wilderness, the mundane and the trivial. But cities are also battlegrounds where physical and periodically social decay is an inevitable premise, where the hopes and visions of planners and citizens are sometimes overlooked or overruled by greed and autocracy (Lowenthal, 2001). This is the tale of Hamra of Beirut.

Beirut, the capital of Lebanon, has witnessed repeated flourishing and ruining throughout ancient and modern history. Located on the eastern coast of the Mediterranean Sea (Figure 1), it has always been a cosmopolitan centre of trade and cultural exchange between Europe and the Middle East. In the 1960’s it was known as *‘Paris of the Middle East’* and attracted tourists from all corners of the world. In more recent times, the city has had the status of the financial capital of the Middle Eastern oil-countries, but has suffered severely, both financially and culturally, from several years of repeated war within the country and with its neighbour to the South, Israel (AUB (a), 2015; Krijnen & Beukelaer, 2015).

In the 1960’s the researchers Per Kongstad and Samir Khalaf from the University of Copenhagen (UC) in Denmark and the American University of Beirut (AUB) respectively, joined forces to investigate the urban development of several neighbourhoods in Beirut. The project focussed on the demographics of the city and their influence on the diverse development in the different districts. An extensive survey was carried out in the Hamra District of Ras Beirut (north-western part of Beirut) in 1964 and 1967 (Figure 2), after which the research came to an end due to unrest and the outbreak of the Lebanese Civil War in 1975. The research of the Hamra district resulted in the book *Hamra of Beirut – A case of Rapid Urbanisation* in 1973.

Figure 1: Location of Lebanon and Beirut (Owl & Mouse, 2015)

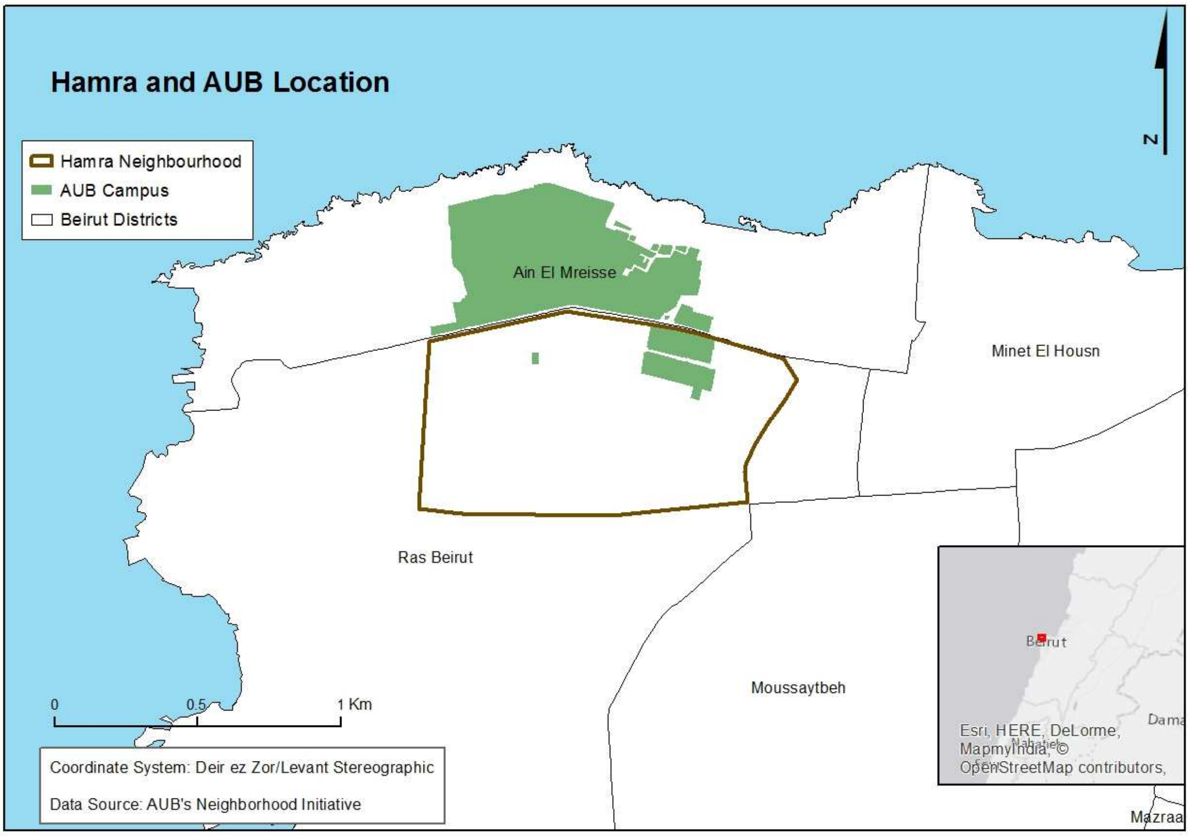


Figure 2 - Map with Hamra and AUB's Location

By a number of coincidences, we have gained access to the remaining part of the material, which was given to geographer Rasmus Ole Rasmussen, a friend of Per Kongstad, after his decease in the 1982. The material consists of a collection of maps and slides with photographs of the Hamra district, collected, created and captured by Per Kongstad and his team. Since then, this material has been stored at Roskilde University Center (RUC) in Denmark but has not been worked on, digitised, or in any other way copied for back-up. Rather it seems it has been waiting to be significant again for research of the urban development of Beirut.

The significance came when we contacted the *Neighborhood Initiative* (NI) of the American University of Beirut (AUB) and informed them about the historic material of Beirut. The *Neighborhood Initiative* is located in the Hamra area and was established in 2007 in order to engage the university's staff and students with their Ras Beirut neighbours. The initiative is doing cross disciplinary work, addressing issues of urban and social development in the area in collaboration with residents, business owners and the public sector. They monitor the construction and development of Ras Beirut in order to communicate and protect the heritage of the Hamra area. In the 1960's Hamra was known as a fashionable and cosmopolitan place, occupied mainly by the middle class of varied ethnic and religious groups (AUB (a), 2015; Krijnen & Beukelaer, 2015). Figure 3 shows the Hamra neighbourhood in detail, with names of the streets that will be mentioned in the report.

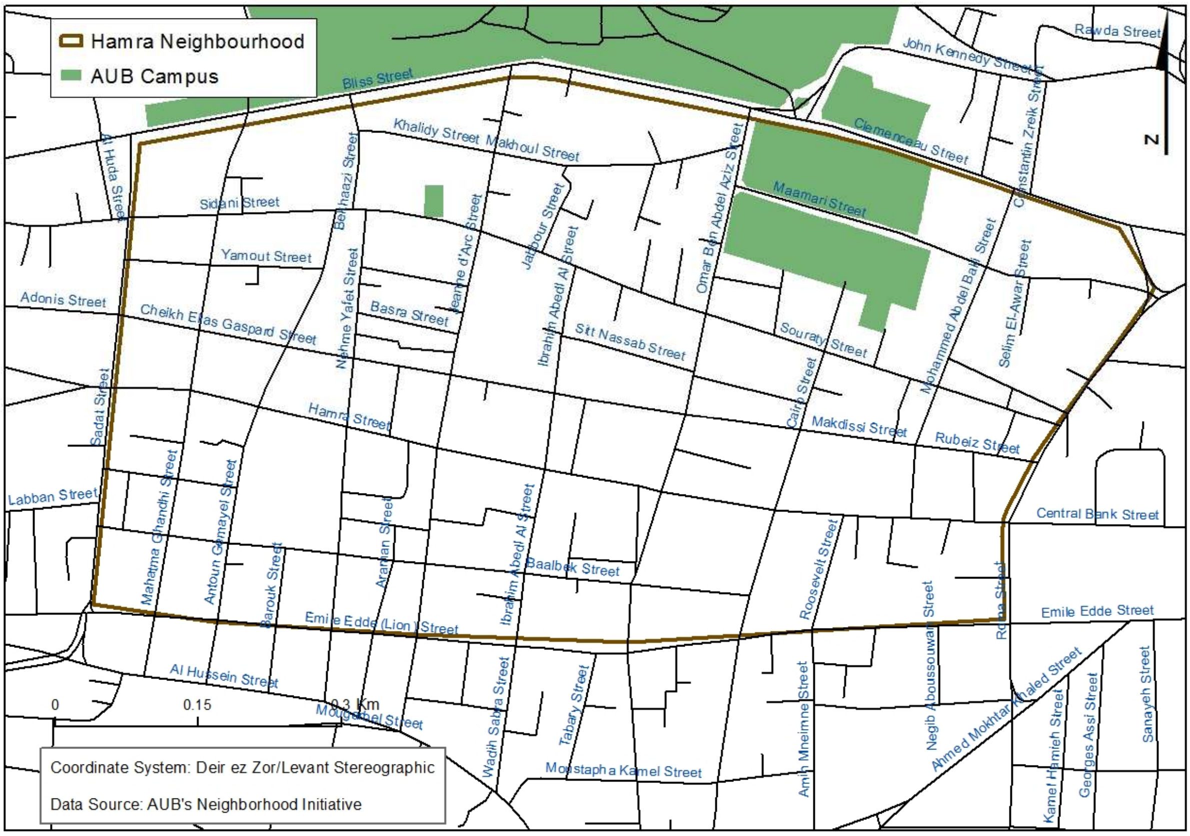


Figure 3 - Detail of Hamra with Street Names

Today Ras Beirut is a building site where large multi-storey buildings with luxury apartments are being constructed for an international elite, while long-term residents are being displaced and businesses are closing down. Thus, gentrification is currently a keyword in the motivation of the *Neighborhood Initiative* (AUB (a), 2015; Krijnen & Beukelaer, 2015). For the *Neighborhood Initiative* the dataset we have at hand offers a unique historical perspective concerning analysis and understanding of this development and a look into the local urban landscape before the civil war.

1.1 MASTER THESIS RESEARCH

The focus of this thesis is the digitising of the material from Per Kongstad and Samir Khalaf's research as well as its integration into a geographical database, in order to allow analysis and display of this historical dataset in a modern context. We wish to continue the line that the *Neighborhood Initiative* has taken, in which the work is made accessible to all agents of the *NI* as well as to the public. We wish to do so by preparing and reworking our data so it fits with the database schemas and standards already used by the initiative and publishing it through an online map service (ArcGIS Online) and in the form of a *Story Map*. For this purpose, we also want to enrich the historic data with new photographs from some of the same locations as the original ones, in order to create a link between the past and the present. This way the public can get an insight into this historical period and the cultural heritage of their city.

Aspects regarding data preparation and accessibility to various users are investigated in order to make the right decisions during the digitising and visualisation processes, with the goal of facilitating an understanding of our procedure. Due to the nature of the material, we will address issues of working with geographic data from different time periods. Although this is a thesis of the Master of Geoinformatics and not specifically about urban geography, we believe that the material can aid in building a bridge between the pre and post-Civil War Beirut and benefit urbanisation studies in the region.

The project was carried out in cooperation with the *Neigborhood Initiative* at the *American University of Beirut (AUB)* in Lebanon and included 4 weeks of fieldwork in Beirut.

Research question: How can historical maps and photographs be integrated into a modern context with GIS in order to facilitate studies of urban development as well as to present the urban development and historical data to the public?

The thesis explores problems of:

- Digitisation of historical data
- Database integration of multi-period datasets
- Fieldwork to collect comparative data to the historical sources
- Visualisation and communication of the data to the public: News ways of visualising old material.
- Urban memory
- Online sharing and presentation of information

1.2 GEOGRAPHY OF LEBANON AND BEIRUT

Beirut has officially been the capital of the Republic of Lebanon since 1946. The country is located on the eastern coast of the Mediterranean Sea and borders Syria to the North and East and Israel to the South (Figure 1). The country measures approximately 60 km East-West and 210 km North-South and is characterised by large nature-geographic diversity. Two mountain ranges divide the country parallel with the coast; these are the Lebanon and the Anti-Lebanon. Demography of Lebanon is characterised by great religious and cultural diversity (see Table 1) (Gyldendal b, 2014).

Beirut, the capital of Lebanon has a population of 2 million inhabitants (2012) and is located on the Mediterranean coast, partly on a peninsula (Gyldendal a, 2014). Outside and on the outskirts of the city, large refugee camps are located, housing refugees from the Arab-Israeli wars and now from the ongoing wars in Syria (Gyldendal a, 2014).

	**Lebanon**	**Beirut**
Local name	Al-Jumhouriyya al-Lubnaniyya	
Independence	1946	1946
Area	10,450 km^2	20 km^2
Inhabitants	5,880,000 (2014)	2,000,000 (2012)
Languages	Arabic (official), English, French, Armenian	Arabic (official), English, French, Armenian
Population	Lebanese (84%) Palestinian (9%) Armenian (6%) Other (1%)	
Religion	Shia Muslims (35%) Sunni Muslims (21%) Maronites (19%) Druze (8%) Greek-Orthodox (6%) Eastern Catholic Christians (5%) Protestants (1%)	
Currency	Lebanese pound (LBP)	Lebanese pound (LBP)
BNP/Inhabitant	15,800 $ (2013)	
Life expectancy	Male: 76 years Female: 78 years (2013)	

Table 1 - Fact box of Lebanon and Beirut ((Gyldendal b, 2014); (National Geographic, 2015)

1.2.1 Divisions of Beirut:

The city of Beirut is divided into electoral districts and quarters (or sub-districts), locally called *mahallat* and *manatiq* respectively. Officially the city is composed of 12 *mahallat* and 60 *manatiq*, each with a name and number. The quarters are also called sectors or “secteur” because they were created during the French mandate (1920-1946). However, the definitions and divisions are somewhat arbitrary and ambiguous and names are used interchangeably across divisions. As demonstrated in the cartogram in Figure 4, names can occur several times with different meanings (Abunnasr M. B., (In print)).

This is how “**Ras Beirut”** can refer to the *mahallat* Ras Beirut or the *manatiq* Ras Beirut. To confuse things further, the *manatiq* Ras Beirut is not within *mahallat* Ras Beirut, but in *mahallat* Dar Mreisseh. It is rarely clear which of the two definitions of Ras Beirut people are referring to, which may be because Ras Beirut (and Hamra) is historically recognised by its social, cultural and economic diversity and therefore has fostered different perceptions and definitions of the areas size and limits; because borders of culture are arbitrary (AUB (a), 2015; Abunnasr M. B., (In print)).

Based on a combination of topographical, popular and official associations, when the Neighborhood Initiative speak of the Ras Beirut that belongs to their “neighborhood” (i.e. included in their area of study and outreach), they usually mean all of the western most extension of the city. According to the Beirut Municipality Map (Figure 4) that includes the quarters of Ras Beirut (35), Jamaʻa (the university) (31), Manara (the lighthouse) (36), Hamra (34), and part of Ayn Mreisseh (30) (Abunnasr M. B., (In print)). When we speak about it in this thesis that is what we refer to unless anything else is mentioned..

Hamra only exists as a manatiq/quarter but may be referred to as the Hamra area or Hamra neighbourhood, as this seems to be practise in some contexts (Abunnasr M. B., (In print)). Per Kongstad and Samir Khalaf generally referred to the Hamra quarter as the Hamra district, which can cause some confusion. When Hamra is mentioned in this thesis we always refer to the Hamra quarter despite the fact that we might call it otherwise; Hamra area or the Hamra neighbourhood.

Another potential element of confusion is the street naming system, which are also numbered starting from 1 within each quarter. A typical street sign can be seen in Figure 5, on street 30 of the Snoubra quarter/*manatiq*. The actual name of this street is not on the sign. This too is normal practise in Beirut, although all streets do have names. If you buy a map (for navigation in the city), it will usually have the street names but not the numbers, which makes it difficult to find your way around as a visitor. Many streets have changed names since the 1960’s, such as *Rue de Lyon*, which is now called *Emile Eddé street*.

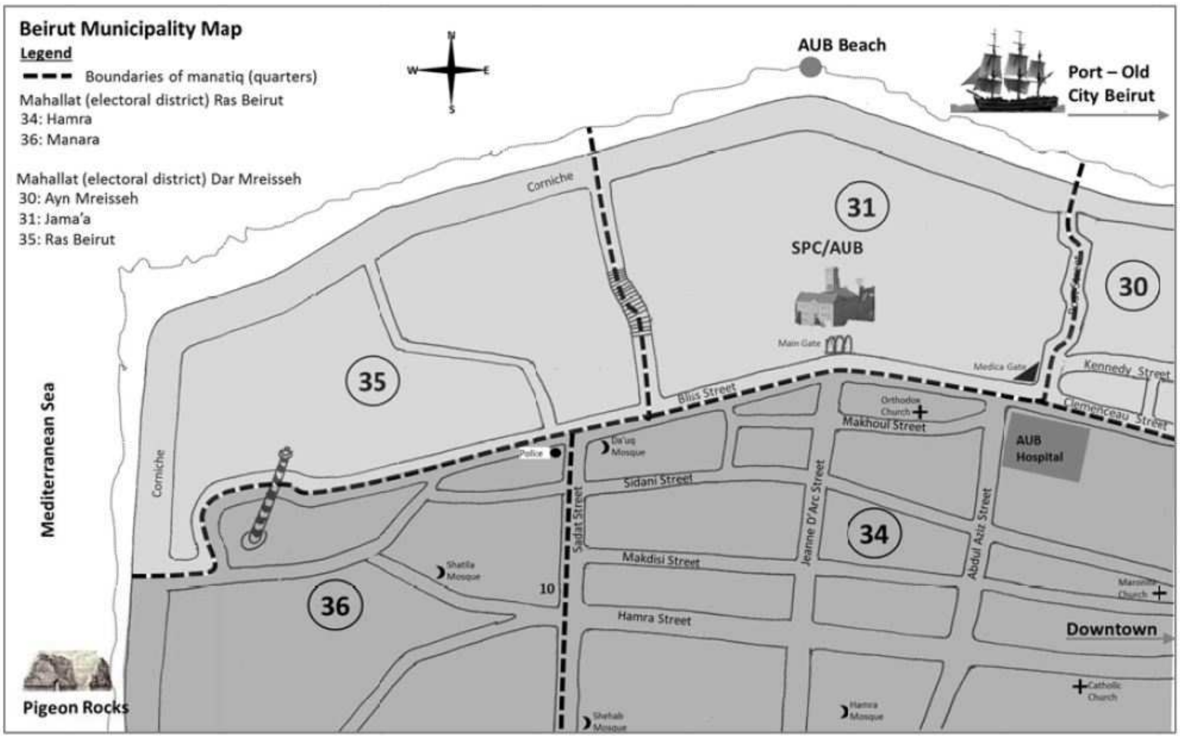


Figure 4 - Ras Beirut with manatiq (quarters) and mahallat (electoral districts). A municipality map from 2012 acquired from: (Abunnasr M. B., (In print))

Figure 5 - A typical street sign in Beirut from the quarter Snoubra

1.3 HISTORICAL BACKGROUND:

Beirut has always had a cosmopolitan character with close connections across the Mediterranean Sea. The following is a short chronological overview of the early history of the city before the 20th century to give an insight into the significance of the place through time. Many past events in the city played a role in the emergence and composition of the Hamra area.

The first settlers in the Beirut area were the Canaanites around 4000 BCE (later known as the Phoenicians by the Greeks) and the place is mentioned as a Phoenician capital in the Egyptian al-Amarna texts in **15th century BCE.** In 15 **BCE** it was founded as a roman colony under the name *Colonia Julia Felix Berytos*. Berytos became the centre of silk fabrication and –trade during the Roman Empire and seat of the recognised roman school of law from **200 - 600 CE**. It was destroyed in an earthquake in the **500's CE**. In **635 CE** the city was occupied by the Arabs and in **1110 CE** conquered by the Crusaders who were then driven out by the Mamluks in **1291 CE**. From **1512 – 1920 CE** Beirut was a province and important place of trade in the Ottoman Empire. In spite of the long term occupation of the area, in 1860, Beirut was still only a small, fortified medieval town of about a quarter of a square mile in size. The centre of the city, shown in Figure 6 was around the port (east of Hamra, now known as "Downtown") (Gyldendal a, 2014; Khalaf & Kongstad, 1973).

Figure 6 - The busy port in Beirut in the 1800's (Gyldendal a, 2014)

1.3.1 Beirut in the 20th Century:

The importance of the silk export to Europe brought social advancement for the Christian Maronites who moved to Beirut and became competitors to the Sunni Muslim merchant families (Gyldendal a, 2014).

Beirut became the capital of the new state of Lebanon in **1946** and flourished in the following decades as the financial capital of the oil countries. The influx to the city was immense, in particular by Shia Muslims from South Lebanon and exiled Palestinians (Gyldendal a, 2014). The city developed quickly between c. 1950 and 1970, with a concentration of development in the three districts *Achrefiyeh, Basta* and *Ras Beirut* (Khalaf & Kongstad, 1973).

Achrefiyeh was mainly inhabited by a Christian (Greek Orthodox and Maronite) middle and upper class with a predominantly French cultural orientation and style. *Basta* was mostly inhabited by Sunni Muslim population of lower socio-economic status with a pro-Arab orientation. *Ras Beirut* was centred around the Hamra area, and according to Khalaf and Kongstad, had no distinct unifying character. It was a fashionable and cosmopolitan area, predominantly occupied by the middleclass with an Anglo-Saxon life style and a heterogeneous religious and ethnic composition (Khalaf & Kongstad, 1973).

Until the outbreak of the Lebanese Civil war in **1975**, Beirut was known as the political, commercial and cultural centre of the Middle East, evident in former nicknames such as "Switzerland of the Middle East" and "Paris of the Middle East". The capital attracted Arab as well as European tourists with its many nightclubs, casinos and hotels. This status ended with the outbreak of the civil war (Gyldendal a, 2014). Before the war, the population was 1.4 million. Since then, many have emigrated temporarily or permanently and many others have moved in from other areas of the country as well as the neighbouring countries, due to wars and political instability (Gyldendal a, 2014).

1.3.2 The Lebanese Civil War (1975-1991)

The population of Beirut, as well as the rest of Lebanon, consists of several ethnic and religious groups. With the outbreak of the Lebanese Civil War in **1975**, the city was split by the so-called 'Green Line' into an eastern, Christian part and a Muslim, western part. The *'Green Line'* or *'Demarcation Line'* (Figure 7), which functioned as a completely closed border during long periods, passed through the old city centre, *Place de Martyrs*, which was left completely in ruins after the war (Gyldendal a, 2014).

In **1982**, Israel bombarded Beirut and occupied the city, while Christian Phalangists committed massacres in the Palestinian refugee camps Sabra and Shatila. At this point, the poor suburbs in South Beirut became a power factor as the home of the Islamic resistance group Hezbollah (Gyldendal a, 2014).

The *Al-Taif* agreement of **1989** brought peace to Beirut under the supervision of Syria and officially the civil war was over in **1991** (Gyldendal a, 2014). In reality Syria occupied large parts of the country from **1976-2005** (Gyldendal b, 2014)**.**

By the end of the Lebanese Civil War in **1991**, the capital was left in ruins and the Lebanese government initiated an extensive and ambitious plan for the reconstruction of Beirut. This included the creation of a new district on an artificial peninsula in the Mediterranean Sea. This was the first construction boom after the civil war and it wilted by the end of the 1990's (Gyldendal a, 2014).

With the withdrawal of Syrian occupation in the spring of **2005**, Beirut experienced temporary optimism after the country's *'Cedar Revolution'* against Syria. Already in **2006**, numerous political assassinations (including the assassination of Prime Minister Rafiq Hariri) and bombings by Israel has slowed down the development (Gyldendal a, 2014).

Since 2012, the country has accepted more than 1 million refugees from the civil war in Syria (unofficial sources speak of more 500.000 unregistered refugees) (Gyldendal b, 2014).

Religion and constitution: The Lebanese population is divided between 18 different religious groups, of which the three largest are Shia Muslims, Maronites and Sunni Muslims. The religious diversity of the country is reflected in the legislative power of the country, within the 128 members of the National Assembly. The 128 seats are divided equally between Christians and Muslims; they are elected for four years by a party list system and regular proportional representation (Gyldendal c, 2009).

Figure 7 - Beirut's Civil War Religious and Ethnic Areas and the "Green Line". Image from (Palgrave Journals, 2009)

1.4 The Work of Per Kongstad and Samir Khalaf

The following is an overview of the work by Kongstad and Khalaf in the 1960's. It outlines their aims, methodology and some of the results, in order to understand the material we are working with in the remaining part of this thesis. We presume, that those who are interested in working with the material for analysis of their own, will consult the book ("Hamra of Beirut – *A Case of Rapid Urbanization"*) for details.

In the 1960's Per Kongstad (Institute of Development Research of Copenhagen University) and Samir Khalaf (American University of Beirut - AUB) conducted a survey of the Hamra area in Beirut, in order to understand the dimensions of urban development from 1876 and until the 1960's (Khalaf & Kongstad, 1973). Per Kongstad was a geographer from the University of Copenhagen in Denmark, with links to the *Department of Foreign Trade* at the Copenhagen Business School in Denmark (for a detailed description of Kongstad's life and work, see Appendix A). Samir Khalaf is professor of Sociology and Director of the *Center for Behavioral Research* at the American University of Beirut. At the time of the fieldwork, he had just finished his PHD at Princeton University (1964) and had returned to the AUB (AUB (b), 2015).

1.4.1 The Aims:

In the 1960's Hamra was an area in the Ras Beirut district particularly well known as a fashionable and cosmopolitan place, occupied mainly by the middle class of varied ethnic and religious groups. The area was characterised by an unusual rapid growth, completing a full cycle of urbanisation in 20 years from a garden farming community to a dense and fashionable commercial and cultural centre. Kongstad and Khalaf tried to find the reasons behind the rapid growth that occurred in this particular area. Originally the research was meant to focus on three urban communities in Beirut, the other two being *Basta* and *Achrefiyeh*, but in the end only Hamra/Ras Beirut was investigated (Khalaf & Kongstad, 1973). Previous studies in the region had focused on rural areas and on socio-economic and ecological surveys. But according to Khalaf and Kongstad, Middle Eastern urbanisation studies focusing on distinct urban social areas within a city had not been prioritised, not to mention comprehensive household and land use surveys. They were particularly interested in the social and historical forces that are in play when urban social structures form and how they are articulated. In short, the three dimension of the study were the *historical, physical* and *social* aspects (Khalaf & Kongstad, 1973).

1.4.2 The Methodology:

Different efforts were taken towards the three dimensions mentioned above:

Historical: Historical documents were consulted to understand the growth of Hamra within the context of Beirut's urban history. This included cadastral maps and registers, travellers' accounts and oral history from a number of archives (Khalaf & Kongstad, 1973).

Physical: A door-to-door land use survey was carried out in 1967 in which all parcels, buildings and floors were mapped. The space, the physical characteristics and the use of space was recorded. It amounted to a total of 658 parcels, 833 buildings and 3263 floors. All collected data was classified and coded and punched for analysis (with traditional punch cards). The data was analysed by a program which applies a grid net to the quantitative urban data[1]. The resulting grids are so-called chorograms. The size of the grid net was decided by limitations of the program, and the final grid used was 80 x 80 m cells in a total number of 75 cells. At a scale of 1:2000, each cell represents 6400 m^2 while the entire grid covers 48.0 hectare. Average content per cell is 9 buildings, 7 parcels and 10640 m^2 of floor space. A total of 4040 households were identified in the area (Khalaf & Kongstad, 1973).

Social: The social structure and the changing patterns of the social relationships in Hamra were expected to be involved in the swift and massive urbanisation of the area and were investigated through a household survey. A sample of 15% of the 4040 households identified by the land use survey was selected for the social survey. The survey area was divided into 40 subareas for sampling, roughly by street block. 17 households were interviewed on average per area. An area stratified sample was drawn with a fraction of 15% in each area amounting to a total number of 607 households. The interviews began in May 1967 but were interrupted several times, amongst other things by the June War of 1967. It was completed in October 1968. 74 (or 12.5%) of the households refused to participate in the interviews. In all 533 households with 1943 people were interviewed. Pre-coded questionnaires were used for the interviews and were transferred to punch cards. The questions focused on everything from occupation to leisure activities (Khalaf & Kongstad, 1973).

1.4.3 The Results:

The final outcome of the fieldwork and research was the book *Hamra of Beirut – A Case of Rapid Urbanization,* which is part of the series *Social, Economic and Political Studies of the Middle East*. It presents, by means of maps, descriptions, photographs and tables, the demographics, the land use and spatial growth patterns of this particular area. As we have seen, the book focuses not only on hard facts associated to the development of Hamra, but also on the history of the city and the role of that in the development. The research was concluded when the civil war broke out in 1975 and destroyed a great part of Lebanon and Beirut. Reconstruction work began after the war and consequently the work by Kongstad and Khalaf now represents a historical view of the Hamra area in Beirut.

Their conclusions to the work are that Hamra is indeed a special case considering urbanisation, and that much is still not understood as to the processes leading the development. What is understood is that:

1. The process of the urbanisation of Hamra is very much linked to surrounding circumstances in the greater metropolitan region and in the neighbouring countries,

[1] We will not go further into the details of the program, but it was developed by Ole Hebin and can be studied in: Ole Hebin (1968),"An Elementary Program on Urban Description", *Geografisk Tidsskrift* Volume 67. Copenhagen.

such as the 1948 war in Palestine, which lead to dense migration to Lebanon, particularly to the available lands in Ras Beirut.

2. The AUB's presence in the area since 1866 marked the first dramatic change in the garden farming area, regarding street layout, location of houses, building style and land use.
3. AUB's presence had an impact on the social composition in the area and although it attracted various groups, it could have been instrumental in forming a germane lifestyle in the area.
4. No clear spatial segregation patterns were revealed by the analysis of the residential quality of housing. However, there were some difference between socio-economic attributes in some areas.
5. The population of Hamra was fully urbanised. Many of the residents came from other, already urbanised areas of Beirut and most residents considered Hamra as a permanent residence (only 16% did not).
6. Hamra is an example of how urbanisation can be defined in different ways: as a physical and demographic phenomena and as a way of life. The population was growing dense, buildings were growing upwards, the average number of floors per building was 5 and a certain degree of areal specialisation had developed during the past 10 years. At the same time, Hamra had in some regards preserved un-urbanised practices, such as the continued role of agriculture. Hamra continued to be a self-sufficient urban era in this period and kinship ties remained intact to a larger degree than in other urbanised areas. Finally, Kongstad and Khalaf characterise the Hamra residents as a type of "urban villagers" who are never truly detribalised (Khalaf & Kongstad, 1973).

1.5 GENTRIFICATION

Since the work by Kongstad and Khalaf, many events have taken place in Beirut and have transformed Hamra and the entire city. One of these is an ongoing process of gentrification, one of the main concerns of our local collaborator the *Neighborhood Initiative* of the American University of Beirut (AUB). The subject of gentrification is manifold, and this is not an in-depth introduction but merely an overview of the main aspects of the issue in order to understand the topic that our collaborators are concerned with.

The term gentrification was coined by Ruth Glass in 1964 in her book "*London: Aspects of Change"*, in which she described gentrification as a process of uneven urban development and more specifically, a shift in demography within an urban community. The term is based on her observation of how working class quarters were being taken over by the middle classes (the "gentry") and transformed into elegant, expensive residencies (UCL, 2015; Krijnen & Beukelaer, 2015).

Gentrification is a process in which houses and shops in dilapidated urban areas are being bought and either renovated of torn down to make room for new buildings, by and for a wealthier social group. In effect, property values increase and typically the results are the displacement of low-income residents and small businesses to less central areas. It is an issue globally in urban planning, however the exact processes and forms may differ from place to place (Atkinson, 2012; Krijnen & Beukelaer, 2015). Gentrification is often the result of increased interest of external citizens to live in a certain environment. In western societies, early "gentrifiers" may belong to a low income group of artist communities, which increase the attractiveness and “flair” of a certain neighbourhood. Thereafter follow increased investments in the community by the local government and community activists and then more economic development and lower crime rates, which increases the attraction for businesses (Atkinson, 2012).

1.5.1 Gentrification in Beirut

Urban change in Beirut is not only caused by gentrification but also rooted in the many other events, such as wars and general instability and migrations in the country and region. Different processes of gentrification are happening in different centres of Beirut but here we will focus on Ras Beirut, in which Hamra is the urban centre. However, what applies to gentrifications in Beirut in general, is that they are driven by transnational capital and facilitated by state interventions including tax breaks for investors and the liberalisation of rental contracts (Krijnen & Beukelaer, 2015). Real estate is one of the most important sectors of the Lebanese economy and has kept growing since the after the civil war, even during the financial crisis. From 2011 the war in Syria has caused a steady stream of migrants to the country and provided cheap labour force to the building industry. This has made Beirut particularly sensitive to gentrification (Krijnen & Beukelaer, 2015; LSE: Middle Easts Centre, 2014).

Ras Beirut and Hamra was the most cosmopolitan district in Beirut prior to the Lebanese Civil War. During the war, the neighbourhood suffered severe damage and when many residents fled the area, squatters moved into the vacant buildings. Ras Beirut was left in a state of deterioration for years after the war ended, and not until recently has the real estate business shown interest in the area again. Now, the devalued building stock combined with views of the Mediterranean Sea has made the area a desirable place in which to invest and live (Krijnen & Beukelaer, 2015; LSE: Middle Easts Centre, 2014). Recently the area has experienced large changes in land prices, causing consequences to the local population. Long-time residents are being displaced off their buildings in order to give space to high-end luxury towers, aimed at the global financial elite. This is transforming the physical as well as the social landscape of Ras Beirut (AUB (a), 2015; Krijnen & Beukelaer, 2015).

1.5.2 Confronting Gentrification

When a battle against gentrification succeeds, it is often because of local social movements who mobilise to push back. This can typically be challenged by the displacement of the community activists themselves. Community activism in Lebanon is further challenged by sectarian politics and the fact that few people can afford to have a day away from work.

Protest have to go through or be arranged by political parties, as do negotiations of compensations and general sharing of relevant information. These are some of the condition which make resistance limited in Lebanon (Krijnen & Beukelaer, 2015).

1.6 The Collaborator: Neighborhood Initiative:

The American University of Beirut is located in the Hamra area of the Ras Beirut district and therefore, in 2007 the university established the *Neighborhood Initiative* (NI) to engage the AUB's staff and students with their Ras Beirut neighbours (AUB (a), 2015). One of the main concerns of the initiative is the recent urban developments, more specifically the gentrification of Ras Beirut. The engagement consists of a combination of research, outreach and advocacy activities. The initiative's teams works across disciplines at the university, as well as with residents and business owners in the neighbourhood and the public sector in a combination of studies and outreach programmes (AUB (a), 2015). From 2013-2015 the initiative has cooperated with the *Middle Eastern Centre* of the *London School of Economics* on a project to put focus on the problem (AUB (a), 2015; LSE: Middle Easts Centre, 2014).

The aims of the project are (LSE: Middle Easts Centre, 2014):

- To investigate patterns of social, economic and physical change in Ras Beirut through theoretically-informed empirical fieldwork
- To develop a research-based strategy responding to processes of neighbourhood change through interdisciplinary analysis, scholarly and public debate
- To build collaborative links between AUB and LSE in urban research
- To build research capacity at AUB across academic disciplines and enhance the university's practical contribution in its urban context
- To create a base for the engagement of public, private and community sector partners in Lebanon, and with academic partners in the region and internationally.

Of the five aims, our thesis project will mainly (but hopefully not only) contribute to the second and the latter, offering new material and a method for communicating the changes that happening in Ras Beirut to a wide audience of a large variety.

The activities of the Neighborhood Initiative are funded by international foundations, most notably the *Ford Foundation Office for the Middle East and North Africa*[2]. Project Leader of the Neighborhood Initiative is Cynthia Myntti, Professor of Public Health. Dalia Chabarek is the coordinator and holds an MSc in Urban Development Planning. The Neighborhood Initiative consists of three overall groups: *Protecting the Diversity of Ras Beirut*, *Community and Well-being* and *Urban Environment* (AUB (a), 2015).

Protecting the diversity of Ras Beirut focusses on protecting the cultural, economic and social diversity of Ras Beirut, which are the historic characteristics of the area. Today the diversity

[2] Ford Foundation website: www.fordfoundation.org/regions/middle-east-and-north-africa

is threatened by the rapid urban transformations, in which the worn down residential buildings are being demolished and long-time residents displaced off their properties, to give way for high-end luxury towers aiming at catering a global financial elite, a process known as gentrification. One consequence of this is that students, staff and professors can no longer afford to live close by the university, and the AUB is thus interested in promoting the neighborhood as a place for all people to live under the theme "Neighborhood Diversity" (AUB (a), 2015).

Community and Well-being focuses on the wellbeing of the residents and the community of Ras Beirut. Under this theme, the NI has conducted participatory demographic and health surveys of Ras Beirut, campaigns on indoor smoking and senior activity programmes. A major project has been the "Ras Beirut Oral History Project" which was about capturing memories and voices of the oldest residents of Ras Beirut, with a focus on life before and after the Lebanese Civil War (AUB (a), 2015).

Urban Environment is working towards solving environmental problems affecting Ras Beirut, based on interviews with the residents from different social and economic backgrounds. This has focused on: traffic congestion, poor walkability, decrease in green areas, traffic noise and lack of space for parking (AUB (a), 2015).

1.7 THE DATA

The following is a description of the central part of the material we have had access to, and which we used as the core of the project.

1.7.1 The Maps

The cartographic material from Per Kongstad, that we have had access to amounts to a total of 47 maps (See Appendix B and Figure 8), varying from work maps to final versions for printing (there are usually several copies of the same map). Some of them still have handwritten notes related to the survey locations. Most of the maps are printed in tracing paper, maybe so they could be inserted in the book. The original scale of the maps is of 1:2000, although they have been reduced to book printing size in the published version. They are based on a cadastral map from 1964 of the Hamra area.

The material also contains a grid used for the classification of data, in the original scale, and several already classified grids (chorograms), in book printing size. These are the same as those in the printed book. Figure 9 shows us an example of a scanned map on tracing paper. This one has a lot of information, for example it shows the layout of the city in 1967 as well as the grid with numbers.

Figure 8 - All the maps as we received them

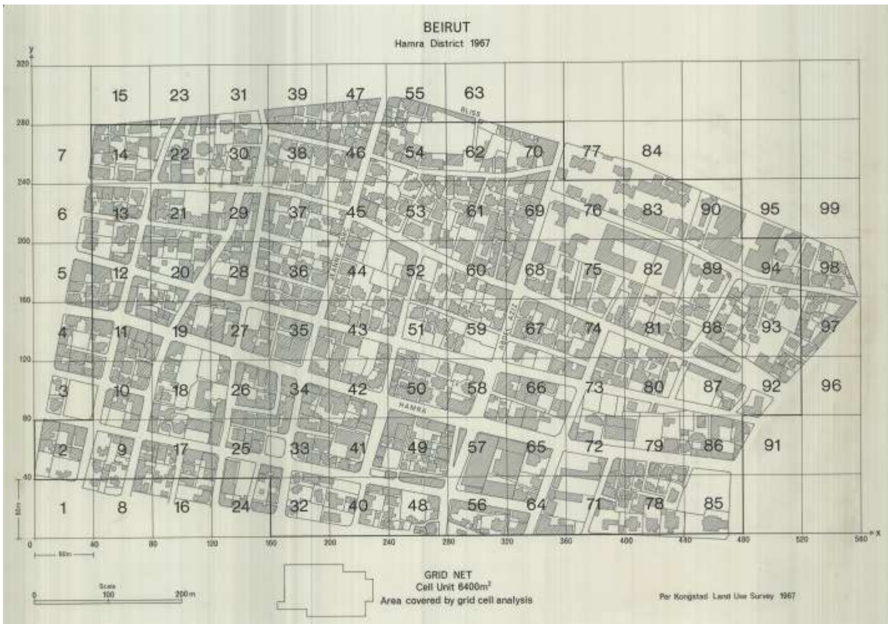


Figure 9 - Example of Scanned Map

1.7.2 The Photographs

The photographic dataset was a suitcase full of slides, more or less ordered in boxes. In total a number of approximately 421 colour slides of which 221 was from Beirut (Figure 10). We must assume that all photographs were taken by Per Kongstad, unless anything else is indicated on the slide, such as a few with the initial J.M., supposedly standing for Jan Magnussen who participated in the survey as a student.

The slides are of glass or film with a plastic or cardboard frame on which notes have been written by Per Kongstad. Typically the notes describe a specific feature or building on the photograph and/or the district, street name and direction, but not always.

As an example the text on the slide in Figure 11 reads (in Danish) *"Moske. Ras Beirut. Rue de Lyon. Den ældste I R.B. Juli 64"*.

Translation: "*Mosque. Ras Beirut. Rue du Lyon. The oldest in R.B. July 64"*.

This is an example of a slide with a lot of information. In the end it turned out that this specific mosque was not in fact on Rue du Lyon (now named Emile Eddé Street), but on Makdissi Street, which is the second parallel street North of Rue du Lyon.

The numbers on the slide refer to lists or descriptions that we do not have.

In Appendix C it is possible to see an example of the collected information from each slide, prior to fieldwork.

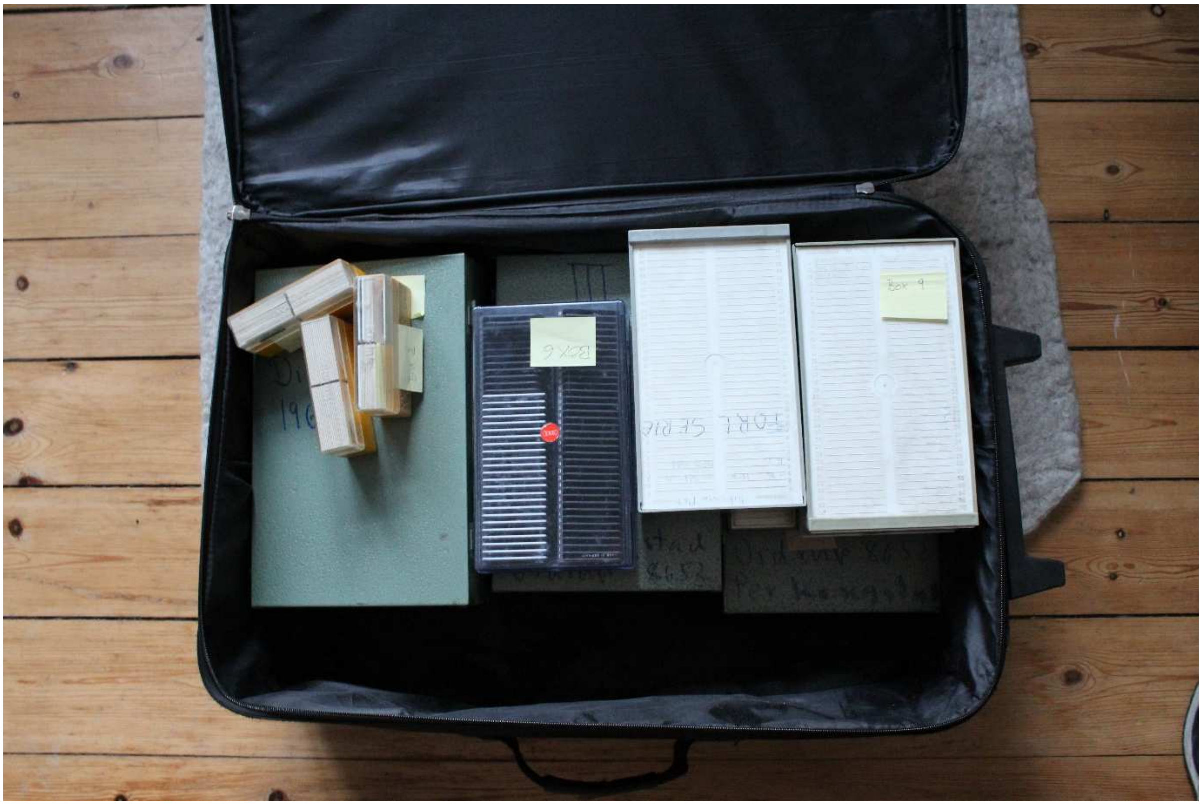


Figure 10 - The suitcase with Per Kongstad's photographic slides

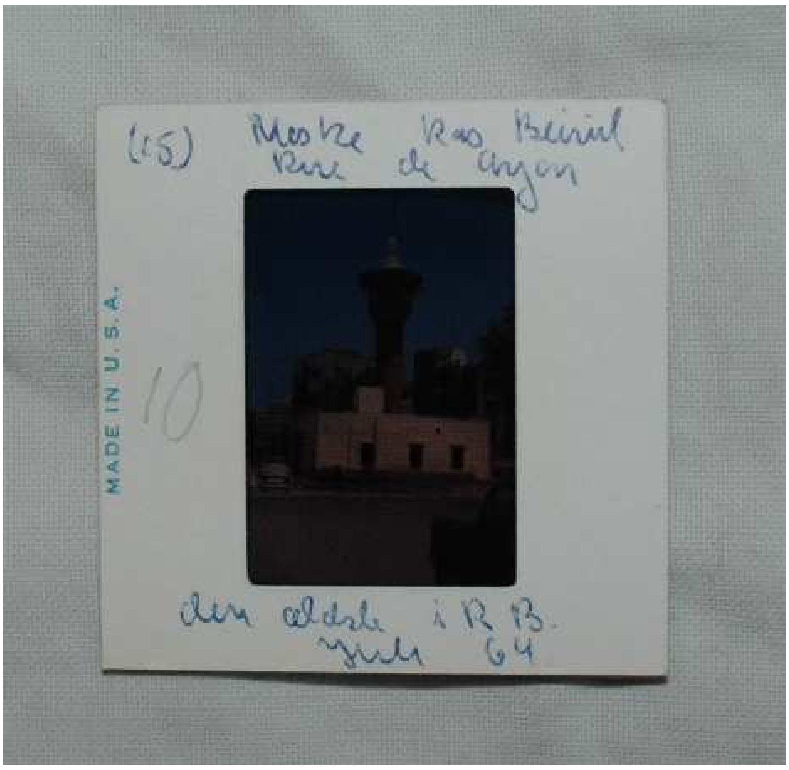


Figure 11 – Example of slide with handwritten text

2 Theory and Method

This chapter will start by clarifying why we believe this type of study is important in general and in this specific case as well as why photographs, maps and GIS are useful tools for investigating and solving issues in urban development. For this purpose we draw on works and theories by David Lowenthal, John Berger and Jean Mohr, and Ian N. Gregory about urban memory and the power of photographs and Historic GIS. Afterwards we lay out the methodological approach taken towards the issue and lastly introduce the theoretical aspects behind the technical steps taken in the project.

2.1 Why is this important: when cities change

"Impermanence along with formlessness characterizes the modern city. Urban fabric tends to be evanescent, easily erased from local memory. Civic worthies may exalt pride in ancient origins and enduring continuities, but on the ground heritage gives way to entrepreneurial demands for novelty" (Lowenthal, 2001).

Although his description is based on examples of American cities, David Lowenthal's description of the modern city very much resembles the fate of Beirut, as seen through the eyes of engaged individuals and initiatives such as the Neighborhood Initiative, who are worried about the changes that the new wave of high-rises are causing in the urban and social landscape (Nag, 2013; AUB (a), 2015).

But is it possible for past and present to cohabit? Attempts are often made to integrate the past into the modern urban scene, be it the creation of monuments, the conservation of mundane and monumental buildings or preservation of historic place names. According to Lowenthal, such initiatives represent idealised and imagined memories and do not always enrich an impoverished urban present. They fail to do so because they are imposed from the top down and put forward an outsider's vision over local perceptions. At the same time such urban initiatives are rarely cohesive social programs but one-dimensional and incoherent plans from architects, marketeers and planners (Lowenthal, 2001).

In reality, the daily choices of the citizen consist of a variety of needs and values that are not as simple and one-dimensional as past or present, aesthetics or function, memory or action (Lowenthal, 2001).

2.1.1 Urban Memory:

Lowenthal (2001) perceives cities as possessing or at least capable of possessing an "urban memory". The Neighborhood Initiative are already addressing this concept through projects such as the "Oral History Project", in which they have been collecting narratives and photographs of Hamra residents (AUB (a), 2015; Abunnasr M. , 2015). For one definition of memory, we can look to John Berger and Jean Mohr, who in their book "Another Way of

Telling" (1982) explore how photographs can be used for narrating, due to their close association with memory: "*Memory itself is not made up of flashbacks, each one forever moving inexorably forward. Memory is a field where different times coexist. The field is continuous in terms of the subjectivity which creates and extends it, but temporarily it is discontinuous*" (Berger & Mohr, 1982, s. 280).

Cities need a sense of mission and destiny to achieve substance. Often this is expressed competitively in some way or other. Where repeated upheaval is an issue, citizens either cling to surviving tokens of continuity or fabricate new ones. Artists, writers and architects are hired for reanimation of the urban past; cities attest to fabled origins, heroes, and epochal events through parades, preservation and commemoration. Or, in the midst of the competition, the city becomes a "blank page" dominated by the monotone, gigantic and vacant (Lowenthal, 2001).

In Lowenthal's opinion, the "pages" of the urban memory should neither be blank nor should they be filled with parades and fabled origins. *"The pages of urban memory deserve to be enriched with quotidian variety, telling city stories of every kind"* (Lowenthal, 2001). So if the mundane is what provides a city with a soul, by whom and how should these stories be told? The answer depends on a number of factors tied to time and place.

2.1.2 Photographs and Memory

In our private lives we use photographs, exhibited on walls, shelves and dressers, to recall earlier stages in live. If this is transferred to the city, collaborative projections of memory in public spaces can be used to enlarge a sense of self and community by commemorating urban social pasts. In Los Angeles and elsewhere, it has been fruitful to memorialise particular ethnic and community stories, by putting focus on seminal sites and routes with narratives, public art and photography (Lowenthal, 2001).

Bearing in mind that Beirut, in an endless number of ways, is different from American cities, this could be a way of approaching the changes in Beirut, and it has to some extent been the path taken by the Neighborhood Initiative. The aforementioned "Oral History Project" draws on *"…the theoretical framework of memory studies and the practice of oral history, this project examines the claims of Ras Beirut's uniqueness in stories that describe a distant, and in many cases, mourned, past. But far from being an older generation's futile longing for that past, their stories demonstrate how individuals and families created this special place"* (Abunnasr M. , 2015). The project was conducted through interviews with long-time residents of Ras Beirut. In connection with the project, the Neighborhood Initiative have been collecting old photographs from the residents in order to add the narratives of Ras Beirut.

Photographs can be used to demonstrate the change in urban tissue, but further, Berger and Mohr consider photographs to be a strong tool in commemoration. The photograph is retrospective in its form and an effective way of narrating the past due to its close associations with the memory. At the same time they perceive the memory as a place where past and present coexist and thus photography can be used for linking the past and the present (Berger & Mohr, 1982).

2.1.3 Historic Maps and GIS

Maps can set the scene for a story, but like photographs, maps can also tell stories of their own. Telling stories is an activity that has existed since the first days of human existence. Stories have been a way of transmitting information about daily activities, as well as cultural values across ages. Storytelling can take many forms, of which we have already encountered a few, for example, oral tradition, drawings and paintings in caves, written text, photographs and songs (Tyner, 2010).

Maps add to all the above by being another graphic way of transmitting information and, thus stories. Maps that have the purpose of presenting findings to an audience fall in the category of thematic maps (Tyner, 2010). Today it is possible to use dynamic and interactive graphics in order to further engage the audience (Dykes, 2008).

GIS has become an accepted tool in historical research during the last 10-15 years. The spatial aspect of GIS enhances visualisation for dimensions of historical change and reality, that are not revealed by other approaches, since GIS can reveal spatial patterns across time (DeBats & Gregory, 2011).

Urban history is the field in which the most progress has been made towards historical GIS becoming an established part of the discipline. This is due to the discipline of urban history having a long tradition of acknowledging geographic features, and therefore urban studies can often offer historians a rich variety of spatially referenced sources like maps, street names, electoral lists, etc. Urban areas also tend to be relatively small in area which makes the data easier to store and work with, than large datasets of entire countries or continents. Historical GIS in urban history is typically used for quantitative analysis, such as to explore tract level data over time and urban growth or decline (DeBats & Gregory, 2011, s. 457-459).

Other uses of GIS in historic urban research is to integrate a variety of datasets in order to explore medieval cities. This has been done in an archaeological project in England and Wales. GIS was used to integrate and explore archaeological records, GPS points from surveys and environmental data. The historical GIS was used for two purposes: to get new insight into the structure of towns in the medieval period and as a means to communicate information to a wide audience in a more interesting and attractive way, by the digital atlas website: Mapping the Medieval Townscape[3] (DeBats & Gregory, 2011; Lilley, Lloyd, & Trick, 2005).

[3] The digital atlas of Mapping the Medieval Townscape is available here: http://archaeologydataservice.ac.uk/archives/view/atlas_ahrb_2005/atlas.cfm

2.2 WORK METHOD

One of the first steps when developing any software related work is to define goals and be aware of the steps necessary to reach it. Resources need to be contemplated, either in terms of available time or data and software.

In order to minimise problems, derived from bad choices at the beginning of the work process, several project management methods have been used, including Agile (Szalvay, 2004). The Agile method is an incremental and iterative one, allowing one to revisit the different stages of work, checking if requirements are being fulfilled and if new ones arise.

The project is seen as comprised of modules, with priority given to core functions, and extensions evaluated according to remaining time. This allows for ongoing adaptation of the goals, decreasing the probability of delays.

The essence is to complete one task, certify its quality, and then move onto another task, and so forward (Szalvay, 2004).

We have chosen an Agile approach to our project since at the beginning we were unsure as to how much information related to the book and photographs we would be able to gather, therefore, not being able to estimate the available time to accomplish every task. This allowed us to try and finish identified objectives, see what added value they have brought, and move to other areas of the work. But it allows us to go back if new data or information appears (Szalvay, 2004).

The field work is a good example. We identified the photographs and proceeded to the field trying to locate the places where they were taken. We had a specific time to achieve this, so first we focused on the ones that seemed most interesting and more likely for us to find, and only afterwards looked for the remaining.

During the elaboration of the project we made attempts to find more information regarding the data at hand but, proceeded working on what we had at the time, thereby refraining from being set back whilst waiting for replies.

Figure 12 demonstrates, through a simple fluxogram, the workflow of the project. The first step was to gather the historic data and checking its quality. Next, we undertook the task of scanning all the mapping and photographical data, moving afterwards to go *in situ* and collect new photographs for comparison, as well as questioning local interested parties about any other available data and gather local knowledge.

With all the data in our possession it was time to perform all the necessary tasks to integrate it into digital format compatible with AUB's own data. Lastly, we proceeded to publish the results online.

Figure 12 - Project Workflow

2.3 GIS SOFTWARE: ARCGIS

Figure 13 - Esri Logo. From: www.esri.com

ArcGIS was the choice of Geographical Information System (GIS) for the project. ArcGIS is the GIS software used by the Neighborhood Initiative and the AUB in general. Since the product and project in the end will be handed over to the Neighborhood Initiative, it was the logical choice. At the same time, ArcGIS is the GIS that both writers of this thesis are most familiar working with. ArcGIS provides easy ways of sharing data and projects online, which is an important goal of the project.

ArcGIS is developed by the American company Esri (Environmental Systems Research Institute) which was founded in 1969. Esri develop GIS software for desktop, geodatabase management applications and web GIS (Esri (f), 2015). Version 10.3 of ArcGIS was used for this project, at the moment of implementation, it was the latest release on the market.

The following subchapters will go into more depth on the theoretical and methodological basics of ArcGIS, which include: ArcMap, geodatabases and different types of datasets. Focus will be on the elements relevant for this project.

2.3.1 ArcMap

ArcMap is the central application used in ArcGIS, it is where GIS datasets are created, edited and explored and where map layouts are created. Geographic information is represented as a collection of layers containing different types of information, depending on the area of study (Esri (c), 2015).

2.3.2 ArcGIS Geodatabase

The geodatabase (GDB) is the primary data format used for storing, editing and managing data in ArcGIS. In simple terms, an ArcGIS geodatabase is a spatial database holding a collection of geographic datasets contained in a common file system folder (File GDB), a Microsoft Access database (Personal GDB) or a multiuser relational (ArcSDE GDB) Database Management System (DBMS) (Esri (d), 2015). The architecture of a geodatabase is object relational and the geodatabase storage model is based on simple relational database concepts. This means that the schema, rules and spatial attribute data for each geographic dataset is stored in tables with well-defined attribute types (Shekhar & Chawla, 2003). This provides the formal way of storing and working with the data in ArcGIS databases and enables the use of structured query language (SQL) to modify, create and query tables and associated elements (Esri (d), 2015; Esri (e), 2014).

An ArcGIS geodatabase can be one of three types mentioned and is decided upon depending on what it will be used for and how:

- **Personal GDBs:**
  All datasets are stored within a Microsoft Access Data file, which is limited to 2 GB in size.
- **File GDBs:**
  Datasets are stored as folders in a file system and each dataset is held as a file that can scale up to 1 TB in size. The file geodatabase is recommended over personal geodatabases.
- **ArcSDE GDBs:**
  This type is a multiuser geodatabase. Datasets are stored in a relational database using Oracle, Microsoft SQL Server, IBM DB2, IBM Informix, or PostgreSQL. These geodatabases require the use of ArcSDE and can be unlimited in size and numbers of users and users can edit content simultaneously (Esri (e), 2014; Esri (d), 2015).

For our project we have been working in a File GDB. The choice of database was decided based on the amount and size of data we had to work with and expected to produce. It was also decisive that we are two people working with the same data and that we need to share it and make integrable with AUB's data.

Datasets are the key mechanism used to organise geographic information in ArcGIS, and a database can contain three dominant types of datasets:

- Feature classes
- Raster datasets
- Tables

These are also the three types of datasets used for our thesis project.

ArcGIS Datasets:

Feature classes are thematic collections of similar geographic features with the same spatial representation and a common set of attribute columns, e.g. a line feature class for representing road centerlines. The four most commonly used feature classes are points, lines, polygons and annotation (Esri (e), 2014).

Feature classes are vector features and are stored as tables in which each row in the table represents one feature. Required fields are the *ObjectID* column (the unique identifier of each feature) and the *Shape* column, which are automatically created, as well as length columns for lines and polygons and area columns for polygons. The shape column stores the geometry for the features. The contents of this table, including the shape can be accessed through SQL (Esri (d), 2015; Esri (e), 2014; Gregory, 2005, s. 22). Any additional attributes can be added as fields and, if further organisation is desired, feature classes can be organised into **feature datasets**. Feature datasets are created based on common geometrical or conceptual commonalities between feature classes. For example, all line features can be organised into the same feature dataset or all features relating to common phenomena such as roads centrelines, curb lines, manholes etc. The advantage of organising feature classes into feature datasets can be to further systematise the data, but can also limit geoprocessing steps. Some tools can work on entire feature datasets as opposed to performing the same process separately on each feature class (Esri (e), 2014). Previously, vector features in ArcGIS were stored in an Esri format called *shapefiles.* We only use this format for the purpose of uploading our features to ArcGIS online (Esri (a), 2015).

In **raster datasets**, geographic features are represented by dividing the world into square or rectangular cells organised in rows and columns in a grid. Each cell has a value that represents some characteristic of that location, such as temperature, elevation, or a spectral value. Rasters can be used to represent all types of geographic information, i.e. features, images, and surfaces. They are typically used for representing phenomena such as imagery and digital elevation models, but are as often used to represent point, line, and polygon features. As an example this is the case with scanned paper maps (Esri (e), 2014). Rasters can be stored inside or outside geodatabases. When working with rasters stored outside a geodatabase, they can be a number of different independent files in formats such as jpeg or tiff. To improve management of rasters and perform certain processing steps, storing them in a geodatabase can be useful, as well as simply for keeping all data together in one place (Esri (e), 2014; Gregory, 2005, s. 24-25).

Usually, four geographic properties are recorded for raster datasets:

- Its coordinate system
- A reference coordinate or x,y location (typically the upper left or the lower left corner of the raster)
- A cell size
- The count of rows and columns

These are useful for georeferencing and explain how raster data files are stored and managed in geodatabases. Each raster dataset usually has a so-called header record holding its geographic properties, and the body of the content simply consists of an ordered list of cell values. The raster data structure lists all the cell values from the upper left cell, by each row to the lower right cell (see Figure 14). Raster datasets define geographic locations by storing locational information for each cell. Once the cells or pixels in a raster have been accurately georeferenced, it is possible to find the exact location of any cell (Esri (e), 2014). (See more on georeferencing further below).

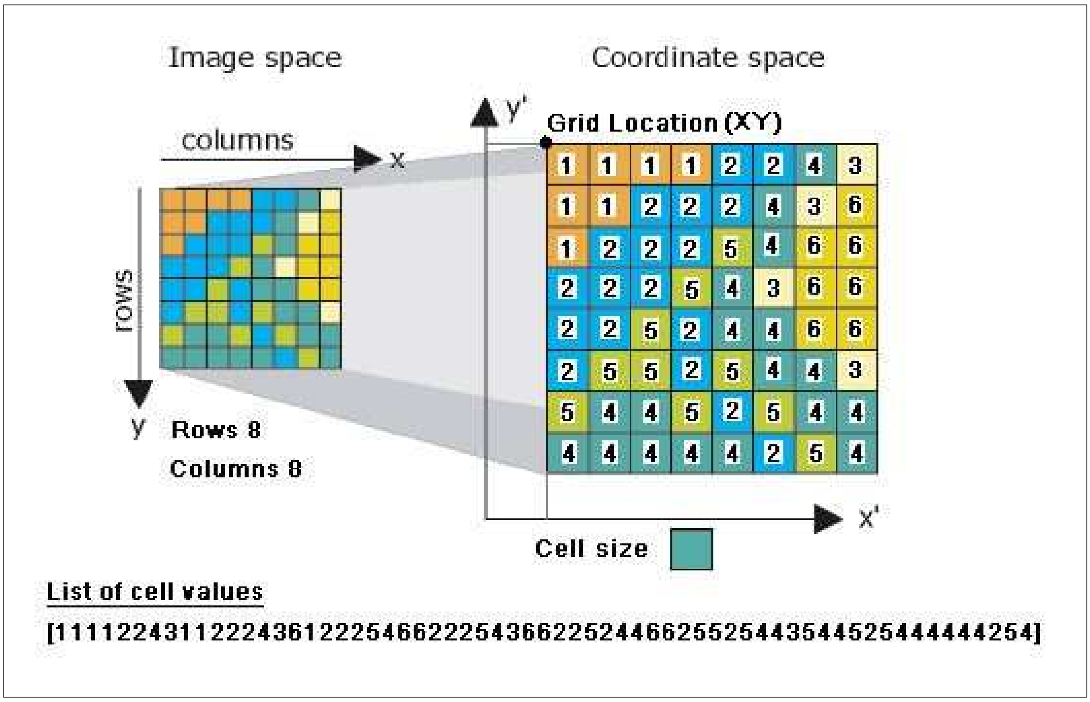


Figure 14: Raster (Esri (e), 2014)

Tables: Besides being the backbone of the way data is stored and managed in ArcGIS, tables can be useful for storing and adding additional (non-geographical) information to geographical layers. This is practical for enhancing geographical features with e.g. statistical data on stored in spreadsheets. As long as there is a unique identifier in common between the data, it is possible to import and add the extra information to one's geographical features (Esri (a), 2015; Gregory, 2005).

2.4 Other Software

Various non-GIS related software were used for the project. Two image-editing programs for editing photographs and Microsoft Excel spreadsheets for indexing photographs as well as for documenting fieldwork and additional information about the photographs and locations.

2.4.1 Microsoft Excel

Microsoft Excel is a spread sheet application that, using a grid format with rows and columns, allows organising numerical or text data. It has numerous built in formulas for analysing numerical data, from scientific, to statistical or economical ones. Data can be manipulated to extract information and create new one with standalone operations or with the help of user define macros that automate processes. Operations can also be performed on text fields, with replacement, addition and removal of characters. After the analysis, it is possible to create charts and graphics to better visualise the results. (Microsoft (a), 2015).

Excel can import many different binary formats of data including ones directly created from simple notepads. It can also export to text files, which is an important feature, since these last ones can be directly accessed by the geographical analysis software. (Microsoft (a), 2015)

We have used version the 2013 version of Microsoft Office Excel.

2.4.2 Image Editing

Picasa

Picasa is a free digital photo viewing, organising, sharing and editing program by Google Inc. The program was created in 2002 by the company *Lifescape*, at the time residing at *Idealab.* (Tomkins, 2002). Picasa was bought by Google in 2004 and released as a freeware (Google Inc., 2014). A major part of the Picasa features is the web albums, but the desktop application offers a broad range of editing tools. For this project, only editing features were used, and only for making collages from the original photos and fieldwork photos. The program is released for Windows, Mac and Linux (Google Inc., 2014). For this project version 3.9.137 for Windows was used.

Figure 15 - Picasa logo. From: (Wikia, 2015)

Microsoft Paint

Microsoft Paint is one of the oldest image editors. It is an integrating part of the Windows package since its beginning, and allows for drawing, colouring and editing of images. It is a simple software, without advanced editing capabilities but, on the other hand, it is simple to use by someone not used to image editing.

Figure 16 - Microsoft Paint logo. From: (Cheezburger, Inc, 2015)

It is possible to add text to images, as well as to draw several shapes. It is also possible to extract and blur selected parts of images, which was the main use of the software for this project. The software opens the majority of the raster formats, and can also save them with different ones, so they can be recognised by other programs (Microsoft (b), 2015).

We used the version 6.3 of Paint for windows 8.1

2.4.3 Considerations of historic Datasets:

Modern GIS can bring out new information from the historical sources, but one should be aware of certain limitations that may come with these types of datasets.

If we recognise two basic sources of spatial data*, primary* and *secondary*, the main source of data being used for the purpose of this project is secondary. From the perspective of GIS, primary data is defined as that which is captured directly from the real world into the GIS, e.g. by remote sensing from satellites or locations from a Global Positioning System (GPS). Secondary data is captured from abstracted sources such as paper maps that are converted into digital form and this type is most commonly used in in Historic GIS (Gregory, 2005, s. 33). The digitisation can consist of one or two steps:

1: Scanning maps to produce rasters.

2: Digitising the maps to vectors by tracing point, line and polygon features from the scanned map in a GIS.

For both data sources, it is central to realise that any limitations of the original source will inevitably limit any subsequently derived products. In that respect, particularly the scale of the source is important. Generally speaking, the larger the scale of data, the more flexible the data is. But usually also more expensive in price as well as time invested in capturing and filtering of redundant information.

When it comes to secondary data, another issue to consider is if the reasons for the producing the original maps are compatible with the objectives of a new digital representation (Gregory, 2005). Also, the conditions under which maps have been stored since their creation can affect physical state and quality. Particularly when it comes to paper, liquids and moisture can cause uneven shrinking in the map, which affects the scaling.

Some historic maps, such as ours, have already been traced from older sources. In that sense, our maps from Kongstad are already interpretations of other, older datasets. It is sometimes evident that his maps of Hamra were traced off manually from older maps, in that there are slight shifts in between the features of the map. We have tried to avoid using those specific maps that have obvious inaccuracies, but we have to accept that this is now a possible error in all of them in some degree. Other implications can be the loss of the exact original shape of feature (Gregory, 2005).

Buildings are conceptually orthogonal in layout (with exceptions of some architectural adventures, of course). When working with maps that have been traced manually this may not be the case and one has to decide whether to follow the concept or the actual data (Esri (a), 2015). From the beginning, it is crucial to decide how much to trust the source. If the data does not line up with data from other sources, which one do you rely on?

2.4.4 Scanning Maps

The scanning process is straightforward and consists of placing a physical map or image (of paper or similar material) on a scanner, by which a digital raster copy is produced. Imperial to the quality and accuracy of the product is the size, spatial resolution (dots per square inch (dpi)) and spectral resolution (number of colours it is able to distinguish) of the scanner (Gregory, 2005, s. 34). Depending on what the scan will be used for, it is worth considering if it is necessary to have the scan in colour (RGB) or if black and white is more suiting. Post-processing of the scan can be necessary before it is ready to use in GIS's and for certain automatic processes a large spectral resolution can in fact impede the work. An example of this issue is explained in depth in the implementation section (3.1.2).

2.4.5 Vectorising Maps

Whereas the scanning process produces a copy of the source map, vectorising extracts certain features from the source and creates layers of points, lines and/or polygons. This way it is possible to create layers only containing the features one is interested in, such as roads or waterbodies (Gregory, 2005). Vectorising can happen manually or semi-automatically. The best method depends on the given material and the amount, since the automatic way can require a large amount of post-processing, as will be exemplified later.

It is not possible to create a direct copy of the source map like with scanning. The manual vectorisation happens in so-called "editing sessions" where you "draw" on top of the features you are interested in (more on this below in the ArcGIS tool chapter 2.6, about the editing toolbar). Points are simply digitised by clicking on the features that are required. Lines are digitised by tracing along the lines and clicking at points where there is a change in direction. Polygons are created by tracing the outer lines of polygon features (Gregory, 2005).

2.5 GEOREFERENCING

Georeferencing is the act of uniquely identifying specific locations on the earth's surface (we can in fact georeference places outside our planet, but let us stick to earth). Georeferencing can be done using very different means, like place names, postal codes, cadastre parcels or, in our case, through the use of a coordinate system (Goodchild, Maguire, Rhind, & Longley, 2011). After maps or images have been scanned, the underlying coordinate scheme will typically be in centimetres or inches identified from the bottom left corner of the scanner or digitiser. Georeferencing is the process where those coordinates are converted into real-world coordinates and projected. This way it is possible to measure and calculate distances and areas and integrate various sources (Gregory, 2005, s. 35).

Usually a minimum of four reference points are required for georeferencing a raster, and preferably distributed at all corners of the map or imagery. By referring these points to the real-world location either by typing in the correct coordinates or by clicking the points to the right location, the map is referenced and scaled correctly throughout (Gregory, 2005, s. 36).

To georeference maps correctly, it is crucial to have the GIS set up in the right coordinate system.

2.5.1 Coordinate Systems and Projections

The earth is a globe or sphere and locations are described in latitude (the number of degrees north/south of the equator) and longitude (the number of degrees east/west of the Greenwich meridian). Since the earth is a globe and maps are flat sheets of paper, projections are necessary translations to convert from a curved earth to a flat surface. This process introduces distortion of shapes, areas, angles or distances. Depending on the projection the coordinates of the underlying geographical coordinate system will be converted from degrees of longitude and latitude to miles, kilometres or metres for a specific location. This way longitude becomes the x-coordinate and latitude the y-coordinate (Gregory, 2005, s. 35).

Since we will want to represent features on a flat surface, we want to use a coordinate system that uses Cartesian x,y axes, that is, that measure the distance to each point with two values that are parallel to an original zero value for the x and y axes.

A Cartesian coordinate systems uses a projection associated with a datum to uniquely identify locations. Projections always distort shapes in some way or the other, and can have conformity (preserve small shapes and angle bearings) or equal area properties (preserve areas) and can be planar, cylindrical, azimuthal or conical (Goodchild, Maguire, Rhind, & Longley, 2011; Tyner, 2010). A Datum is the defining position of a spheroid, which is the imaginary line that best represents the irregular “roundness” of the earth’s shape, relative to the earth’s centre. They can be geocentric, and be globally valid, or be better aligned with a specific area and be, therefore, local (Esri (a), 2015; Tyner, 2010).

Usually, thematic maps like ours do not pose challenges regarding irregularities of the earth’s shape as they often deal with small areas where geodetic issues are not a problem (Tyner, 2010, s. 91). This turned out not to be the case here, as will be clear in the implementation chapter.

The official coordinate system used in Lebanon is the local ***Deir ez Zor/ Levant Stereographic***, which uses a Levant Stereographic projection over a Deir ez Zor Datum (Clark 1880 Spheroid) (For details see Appendix D). The coordinate system is used on shore in Syria and Lebanon and has been in use since before World War II for cadastral and large scale topographic mapping (Butler, Schmidt, Springmeyer, & Livni, u.d.). It is a double stereographic projection, in most details identical to the regular stereographic projection as explained in the following.

Stereographic Projections:

A stereographic projection (Figure 17) is a planar projection created by assuming that a light source is at the exact opposite side of the globe from the tangent plane. This way it is possible to show more than one hemisphere but not the entire sphere. Parallels and meridians cross at right angles and the spacing of the parallels in pole-centred cases become greater closer to the equator (Tyner, 2010, s. 114; Esri (g), 2013). Stretching is introduced east and west when moving away from the centre. The spacing of parallels increases proportionally to the spreading of meridians and the stereographic projection is therefore a conformal azimuthal projection (Tyner, 2010, s. 114; Esri (g), 2013).

In **conformal** (or orthomorphic) projections local angles and shapes are preserved, however this only applies to features with small sides such as peninsulas, whereas larger shapes like continents will have distortions (Tyner, 2010, s. 102; Esri (g), 2013). Common to all conformal projections is that:

- Parallels and meridians cross at right angles.

- Scale is the same in all directions, meaning that if stretching occurs in the longitudinal dimension, an equal amount of stretching must occur in the latitudinal dimension.

This way angles are preserved but the areal scale can be strongly distorted. Squares of the same size will remain squares but will appear of different sizes at different locations on the globe (Tyner, 2010, s. 103; Esri (g), 2013).

Azimuthal (or zenithal) projections show azimuths correctly, however, only from the centre point on the map. It is possible to measure the azimuth (angle) from the centre point and any other point correctly, but not in between other points (Tyner, 2010, s. 103)

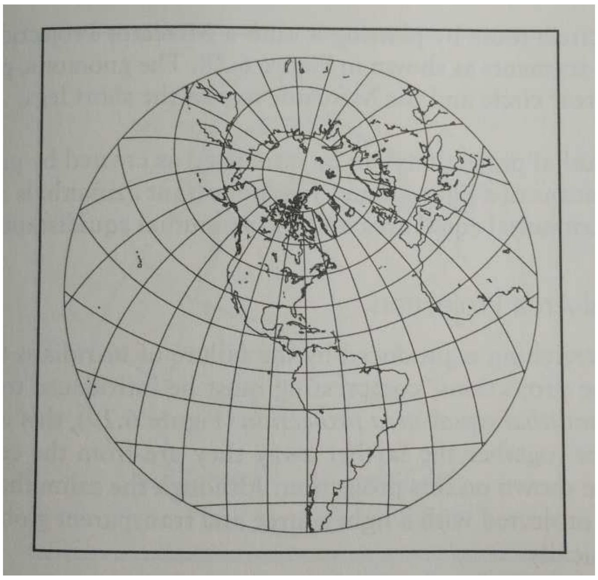


Figure 17 - Stereographic projection in oblique case. From (Tyner, 2010)

Double Stereographic Projections:
A double stereographic projection, like the one used in Lebanon, is similar to the regular stereographic projection as explained above. Both the stereographic and the double stereographic projections are planar perspective projections. The difference between the two is that the regular type projects points on a spheroid directly to the plane whereas with the double projection, points are transformed from the spheroid to a Gaussian sphere before being projected to the plane (Esri (g), 2013).

2.5.2 Geotagging

Geotagging is the process of adding geographical information directly into image, video messages or websites. The coordinates will be an integrating part of the file, appearing as any other attribute field. If it allows to automatically locate a file in space, on the other hand users should be aware that anyone could access that information and know where the file was crated (Esri (a), 2015).

Some modern digital cameras have internal GPS devices, or the possibility to connect with them, in order to georeference images automatically, and most of contemporary mobile phones perform geo-tagging automatically when a photograph or video is made.

In our case, we have opted to create a point feature class with the location where the pictures were taken, instead of geotagging them (3.3.6 Points of Interest (Feature Class)) because we did not have the appropriate equipment to do so and, even if we had, importing geotagged images into ArcGIS creates a point feature class where the images are automatically attached, being the end result identical (Esri (a), 2015).

2.6 ArcGIS Tools

During the implementation work we used diverse ArcGIS desktop tools. At this point we will make reference to its general uses and capabilities.

Create Feature Class – It allows creating an empty feature class inside geodatabases. If the output destination is a folder it will create a shapefile. Feature classes and shapefiles are the files that contain geographical information that can be of point, multipoint, line, or polygon type (Esri (a), 2015).

Edit Toolbar and Advanced Editing Toolbar – These toolbars contain the tools that allow editing inside ArcGIS. Editing is the process of modifying, compiling and updating geographical data. It is the editing mode that allows actually changing the stored data, since otherwise it can only be accessed, queried and symbolised in different ways, but maintaining the same geometry and attributes (Esri (a), 2015).

In edit mode one can manually create and alter the geometry of feature classes or its table attributes, changing them permanently, with the use of the many editing tools available. Apart from the options of creating and editing vertices, usually via manual vectorisation, the applied tools were (Esri (a), 2015):

- **Planarize** – Planarize allows splitting features where lines intersect. One has to manually select which lines he desires to planarize and only those will be split into new features at intersection points. The tool also removes duplicate features.
- **Construct Polygon** – Construct polygon creates polygons from the shapes of existing lines or polygons. The user selects which lines he wants to transform into polygon and, if they have an enclosed space, that space will be turned into a polygon. It is necessary to specify a destination feature class where the polygon will be stored.
- **Cut Polygon** – This tool allows splitting a polygon, into two or more, by simply drawing a line that crosses it from side to side. The cut updates the shape of the existing feature, passing its attributes into the new one(s).

Reclassify – The reclassify tool allows changing input cell values of a raster into alternative ones. The user specifies how many output values are desired, and the input range values that should go into each of the new ones. Ranges should not overlap except at the boundaries. If overlapping boundaries exist, the higher boundary of the lower range will be inclusive and vice-versa (Esri (a), 2015).

Slice – The slice tool belongs to the group of reclassifying tools, grouping input raster values into intervals or area groups. It does it by "*dividing the value range into an equal number of specified intervals or by distributing the number of cells into a defined number of groups until each group has the same number of cells*" (Esri (a), 2015).

If one wants to slice a raster into 10 intervals, the tool will go through the interval range, divide it by the number of intervals (10), and assign the value 1 to the first 10% of the range values, the value 2 to the range values between 10% and 20%, and so forward. Figure 18 shows us an example of slicing by interval.

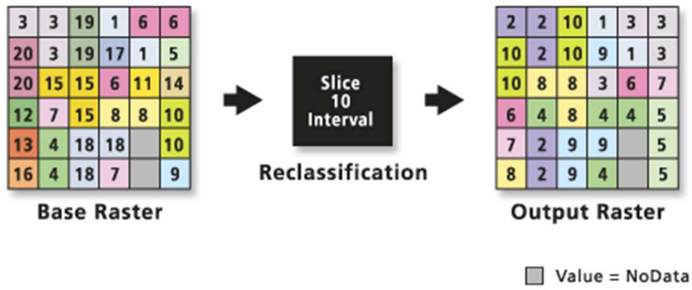


Figure 18 - Slice Tool: Reclassify by Interval (source: (Esri (a), 2015))

Slicing by area "*attempts to distribute an equal number of cells in each group based on the count of cells in each zone*". It is the number of values and cells in each of the input zones, crossed with the chosen output group areas that will define how close the output grouping values are, so they will have the same number of cells (Esri (a), 2015). Figure 19 shows us an example, for 5 equal zones.

Figure 19 - Slice Tool: Reclassify by Area ((Esri (a), 2015))

Slicing by interval should be used when there is a similarity in scale between the input and output values, and by area when representing similar types of features.

Model Builder – ModelBuilder is an application that allows creating, editing and managing workflows that link together sequences of geoprocessing tools, or Models. The output of a tool is fed into the one linked to it afterwards. It is a visual way of building workflows, running over python scripting (Esri (a), 2015).

All the ArcGIS tools can be accessed through ModelBuilder, having also some tools of its own, related to iterators and file naming. One model can only contain one iterator, but it is possible to have a model inside a model, and therefore several iterating sequences.

Models can be saved as tools and can also be used to integrate ArcGIS outputs with other applications (like sending automatic emails if certain results are obtained) (Esri (a), 2015).

- **Iterate Raster** – Is a ModelBuilder tool that iterates over all the rasters of a workspace or raster catalogue. In other words, it performs a repetitive action over all the rasters contained in a specific location (Esri (a), 2015). Specific raster types can be chosen for the iteration, limiting its extent.
- **Parse Path** – Also a tool contained by ModelBuilder, it parses the input into its file, path, name, or extension part. The resulting output can be fed into other tools as a variable name (Esri (a), 2015).

Make Raster Layer – This tool creates a temporary raster layer from an input one. This raster is temporary and will disappear when the current session ends, unless the map document is saved. It is used, for instance, if one desires to extract information from a specific subset of bands (Esri (a), 2015).

Save to Layer File – Creates a Layer File that references geographical data stored on disk. In other words, it saves data stored in memory, such as the outputs of the *Make Raster Layer* or x,y events. If a selection is applied to the input data, it will remain in the output (Esri (a), 2015).

ArcScan – ArcScan is an ArcGIS extension built for the purpose of transforming scanned images into vector-based feature classes, or vectorising them. This vectorisation can be performed semi-manually, by tracing cells over the image, or automatically, where the vectors are generated for the entire raster based on specified parameters. The parameters for automatic vectorising can be saved in order to be used in other vectorisations.

It is a tool that was developed when the transition of hard-copy paper maps into digital ones was crucial, and organisations needed to convert large amounts of information.

2.7 SHARING DATA:

A goal of the project is sharing the data we have acquired and produced. The two environments where we intend to make data available: ArcGIS Online and a Story Map, will be described briefly.

2.7.1 ArcGIS Online

ArcGIS Online is a recent, online platform from ESRI, which allows accessing a wide variety of maps through the internet, whether on a computer or mobile phone. It is ESRI's answer to the recent spree of social media and its purpose is to connect maps and data to a wider variety of audience.

Everyone that creates an account can visualise the maps and data that different creators have shared online. This allows someone who is not accustomed to geographical data, apart from the usual road and orientation cartography, to gain knowledge from various maps. This service is also free of charge for everyone that wants to consult it, making it a powerful tool for sharing data online.

If one wants to add their data to the web service he needs an editing license. With that, it is possible not only to add content but also to perform analysis on it, and create new thematic contents that can in turn also be added online. The raw data can be made available, as well as user created maps, with chosen scales, colours, etc., which better transmit the creator's intentions (Esri (b), 2015).

The tools available online follow the pattern of the desktop version, making it relatively easy for someone to get up to speed with the online tools, if already used to the desktop version.

For all of these reasons we have decided to use ArcGIS Online as our means of making the maps available to the GIS users who are interested in the data. (Esri (h), 2015)

2.7.2 Story Map

The growth in the use of computers and the internet is allowing more people to create their own maps, and sharing subjective information. *Story Maps* can be part of this new personalised information and can be used to communicate stories with geographic data to a wider audience than those with professional interest.

A *Story Map* should contain at least two things: A map, where geographical information of any kind is shown, and a narrative, which can be composed by text, images and multimedia content (Esri (i), 2015). This symbiosis should allow each of the components to stand out, raising the value of the whole. We are using Esri's Story Map app, because it offers a direct way of sharing already created web map layers from ArcGIS Online.

According to Esri (Esri (i), 2015), storytelling with maps should follow five basic principles:

- Connect with the Audience – Before creating the map, one must think of who the target is, and what its expectations are. Text, geographical content and multimedia should be created in a way the audience will naturally understand it.
- Lure People – The first moments of the story are very important since they should capture the viewers' attention and motivate them to proceed. Stories should start with strong visual impact and be exciting. The title, besides being descriptive, should bring the feeling of activeness. Core concepts are to be introduced early and, inversely, distracting hyperlinks should arrive later on.
- Support the story with user experience – Several templates are available for constructing story maps, and the user should, using its perception of the different visualisations aspects, choose the most adequate one.
- Easy-to-Read Maps – The maps should be easily understandable and transmit the desired information. Excess of information or detail will make it harder to focus on the essential, reason why the data should not contain superfluous features. Basemaps and interactive information are to be chosen and worked for simplicity.

- Striving for Simplicity – As is well known, the digital age is affecting attention spans due to high level of stimulating objects. A story is a resume of an event (real or fictional), and for that, removing non-essential elements should lead to a better telling. Create, review, simplify, review, simplify until the moment one can easily read through the story, understanding its concepts and mission.

Other online options for creating story maps are https://storymap.knightlab.com/ and http://mapstory.org/.

2.8 Cartography and Geovisualisation

How the results are visualised is significant, because we want to share the product, and should communicate the past to a variety of people with different interests.

According to the "Encyclopedia of Geographic Information Science" the short definition of geovisualisation, or geographic visualisation is, *"…an approach and a process through which maps and graphics are used to gain insight from geographic information".* (Dykes, 2008)

Today it often includes using dynamic and interactive graphics in order to engage the user and generate ideas from digital datasets (Dykes, 2008).

The purpose of geovisualisation is to advance understanding of spatial phenomena, either to communicate information to an audience or to enhance one's own understanding of the data being worked on. At the same time, it can serve the purpose of visual analysis or aesthetic representation (Dykes, 2008).

The maps on which geovisualisation applies can usually be divided into three groups (Tyner, 2010):

- **General-purpose maps**, or reference maps, do not emphasize any particular feature, showing a variety of phenomena of an area, being used for reference, planning and location.
- **Special-purpose maps** are created with a specific aim, usually being of large scale and for specific users. Cadastral, geologic and soils maps, as well as maps created for route finding are grouped into this category.
- **Thematic maps** usually show a single distribution or relationship, and other existing information serves the purpose of locating that distribution. They can be qualitative, showing characteristics, or quantitative, showing numerical data.

Per Kongstad's maps are of the two last kinds, that is, *special purpose maps* (the cadastral data with the buildings and parcels) and *thematic maps*, where he shows the analysis results of several components.

Per Kongstad's analysis layers were represented as chorograms, and these are today the most common quantitative maps produced with GIS (Tyner, 2010).

We will briefly discuss the fundamentals of chorogram visualisation, as shown by (Tyner, 2010), but a small previous note must be made. Tyner refers to choropleths, as opposed to Per Kongstad's chorograms. Both represent uniform values inside an areal unit, being that choropleths are bounded by administrative or other statistical subdivisions of the mapped territory (Wright, 1944), and chorograms have user defined boundaries.

Three types of chorograms exist: simple, dasymetric and unclassed.

- **Simple chorograms** have values for each area put into categories or classes, the number of classes limited by the limit of the human eye. Boundaries and values are the only requirements. It is not possible to show variation inside each area and the boundary lines have no attached values. Unless the areas are of the same size, no absolute values should be used (only normalised values).
- **Dasymetric chorograms** take into account variations within enumeration areas, having uniform values inside, like the simple ones, but areas of similarity and rapid change are first determined, allowing for better representation of reality. It requires local knowledge on determining the areas, and exact values cannot be determined inside the areas either.
- **Unclassed chorograms** or classless one, are the most exact representations of the data models, since no generalisation is done for the reader. It uses symbols, like cross-hatch patterns that vary in density to represent each enumeration area. Derived from the difficulty of creating the areal symbols, they became feasible to make with computer assisted cartography.

The most appropriate ways of representing chorograms are colour lightness and saturation and pattern combined with texture (this last one was the only option for the first computer drawn maps). Colour has the limit of human perception, and the limit of steps perceived is a combination of lightness and saturation.

Since GIS allows the free use of colour, it should be used freely. One just needs to take into consideration that sequential data should use sequential colour schemes and diverging data diverging schemes.

Apart from the previous, we have added data symbolised as points and over areas, related to the places where we took photographs.

Point symbols show events that actually happened at those locations or aggregate data at the point location, partially due to scale issues (think of cities representation at small scales) (Tyner, 2010).

Qualitative symbols may be pictorial, associative or geometric, using shape and/or hue as variables. They are placed at their actual location and should be of equal size, large enough to be distinguishable from each other and not to lose legibility. GIS software usually offers a considerable amount of symbols to represent different phenomena.

Quantitative symbols tend to use size as a way of differentiating values, and can be dots or proportional figures. In the first type each dot represents a specific quantity and has as purpose to show the phenomena distribution, not actually determine its quantity. In proportional symbols, its area represents a quantity and are used when the range of data is too big to be represented by dots, or to represent total values at a point or over an area (Tyner, 2010).

The representation of qualitative areal data is simple. Hue, pattern and direction are used as variables. The first shows different nominal categories, the second should be used when colour is not an option (shades of grey represent different amounts), and orientation is part of the pictorial or abstract patterns.

2.8.1 Metadata

Metadata, in its classical definition, is "*Data about Data*" (American Library Association, 2015), in other words, it is information contained in the data that describes to the user the content of the data itself. Object-level metadata, describes the content of a single dataset (Goodchild, Maguire, Rhind, & Longley, 2011).

Metadata is a form of cataloguing for digital data. It should allow to search and retrieve "*all the information needed to read and interpret a complex digital file*" (American Library Association, 2015). Correct and complete metadata should leave no doubts to a random user about the contents, creators, persons of contact and any details concerning the data. Taking advantage of the computer processing power, it allows sorting items by many other properties besides the ones described before.

After discovering a dataset, metadata should allow the user to be certain if the data will satisfy requirements regarding resolution and quality, sometimes via commentary fields made by the authors. Contact points may also be provided, in case of doubt (Goodchild, Maguire, Rhind, & Longley, 2011). It is a way of generalising and abstracting the contents of the data for querying.

Metadata is a very important aspect of geographical data, and usually also complex. Since there are many standards for metadata, depending on the data type, and some of them competing with each other, it is sometimes difficult to know exactly which metadata type is more suited for each file type.

The fact that several standards exist, mean that records should be consistent, in case a cross check between different standards is necessary and also because it cannot be said that one standard is better than another, only that it can be applied better to a specific kind of data.

Some of the most used standards are the *Content Standards for Digital Geospatial Metadata* (CSDGM) and the *Dublin Core Metadata Standard*. The first one became the basis for later standards, it focuses on the items that should be in a metadata file without prescribing how they should be formatted or structured (Goodchild, Maguire, Rhind, & Longley, 2011). The second tries to address the effort of finding the minimum set of properties needed to support querying in databases in general, and not only geographical datasets.

ArcGIS has the possibility of creating metadata files using different standards, convert between them and to import metadata files from other datasets.

3 DATA ACHIEVEMENT

This chapter explains how we went about documenting, digitising, integrating and sharing the materials and our results. It also includes a chapter on our fieldwork in Beirut.

3.1 SCANNING THE SOURCE MATERIAL

In this first chapter of the data achievement, we will describe the process of scanning the material from Kongstad and Khalaf. It consisted of scanning the old photographs, in analogue slide format, and maps on tracing paper and regular paper.

3.1.1 Scanning the Photographs

The slides were digitised using scanner of the brand Veho^{tm} Professional Imaging, version VFS-008 SMARTFIX V1.1. The scanner digitises 35mm and 100 mm film negatives and slides in a resolution up to 5 mega pixels (veho). This scanner was chosen because it was freely available to us through friends and we regarded the resolution sufficient for our purpose, considering the large number of images to digitise. At the point of digitising there had only been a rough sorting of the images and we were still unaware of which pictures were of greater or lesser value. We therefore scanned all images that had words relating to Beirut, Hamra or Lebanon on the box or on the slide itself.

All the images were indexed in an excel spreadsheet (a sample of this spreadsheet can be seen in appendix B. The entire document amounted to a number of 16 pages, and is therefore not included in its entirety here).

We numbered the boxes they were in, and numbered the scanned images sequentially as we scanned them. For each slide with notes or other information on the frame, we also took a picture of it. These were also numbered sequentially in the spreadsheet. Other information that was documented, when available, was: the year the photograph was taken, the location, notes on the image (in Danish and translated by us into English), and a remark about whether or not the slide had a sketch on the frame. Often we were unable to read the text entirely, and in these occurrences we would make a note hereof.

Example: (Figure 20 - Hamra Mosque Picture)

Size: 584 KB

Dimensions: 2544 x 1696 pixels

Dpi: 96

Bit depth: 24

Figure 20 - Hamra Mosque Picture

3.1.2 Scanning the Maps

Once we chose which original maps would be interesting to bring into the digital world, we had to convert them from analogue (paper) to digital (image). For this we needed a scanner capable of scanning large size sheets and with a good resolution. Luckily, we got access to a HP Designjet T1200 HD MFP scanner, which had very good quality for the task at hand.

This scanner allows 300 dpi (dots per inch) resolution, 24 bit colour depth and can scan large formats, up until A0. The scanning process, shown in Figure 21 is simple. The user only needs to feed the sheet through the front of the scanner, it grabs it and pulls it all the way up until the end, and returns the paper. At this point it has performed a preview of scanning, and one can accept it or change any desired settings. If the settings are ok, we just have to press *save* and the paper is fed again, this time performing the final scanning.

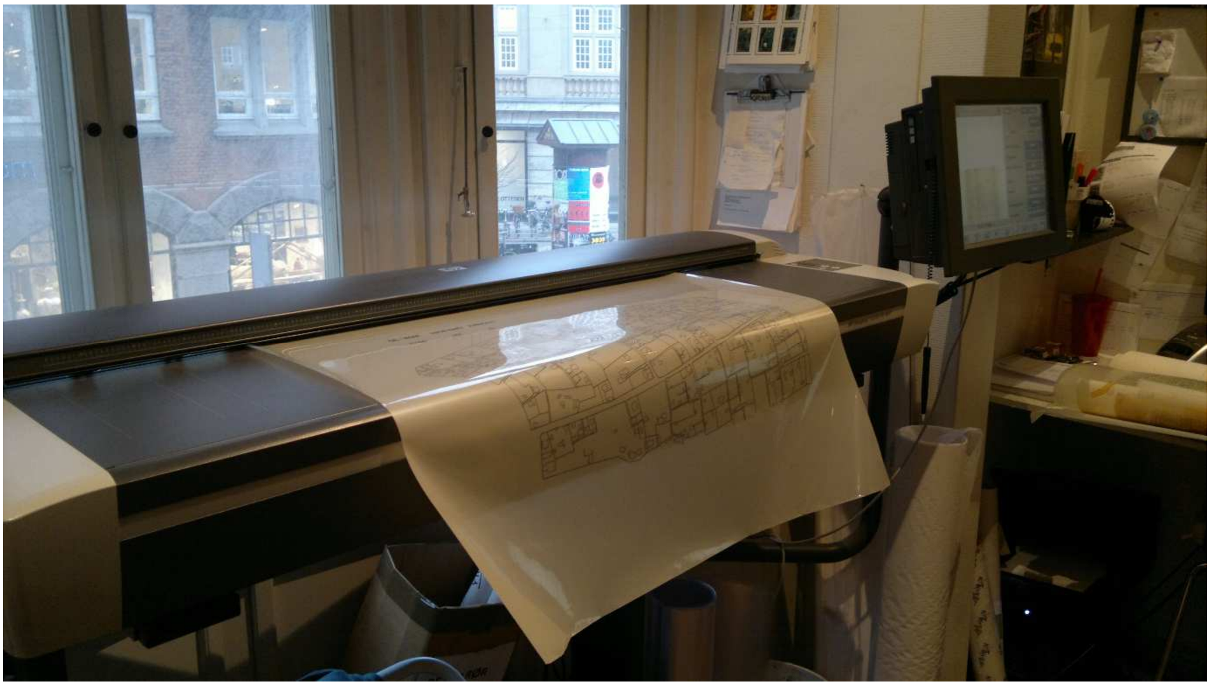


Figure 21 - Scanning Example

On Figure 22 we can see the console of the scanner. It has a touch screen interface, and it is quite intuitive to change any settings. The scanner was made available to us by Posterland[4].

The scanning of all the selected maps, some of them with the same data, took around two hours to accomplish. We digitised not only the maps to integrate, but also work maps, so that we would not need to pick up the original maps anymore. Besides preventing any damage to the originals, it also allowed more freedom to consult the information at hand.

[4] Posterland: http://www.posterland.dk/

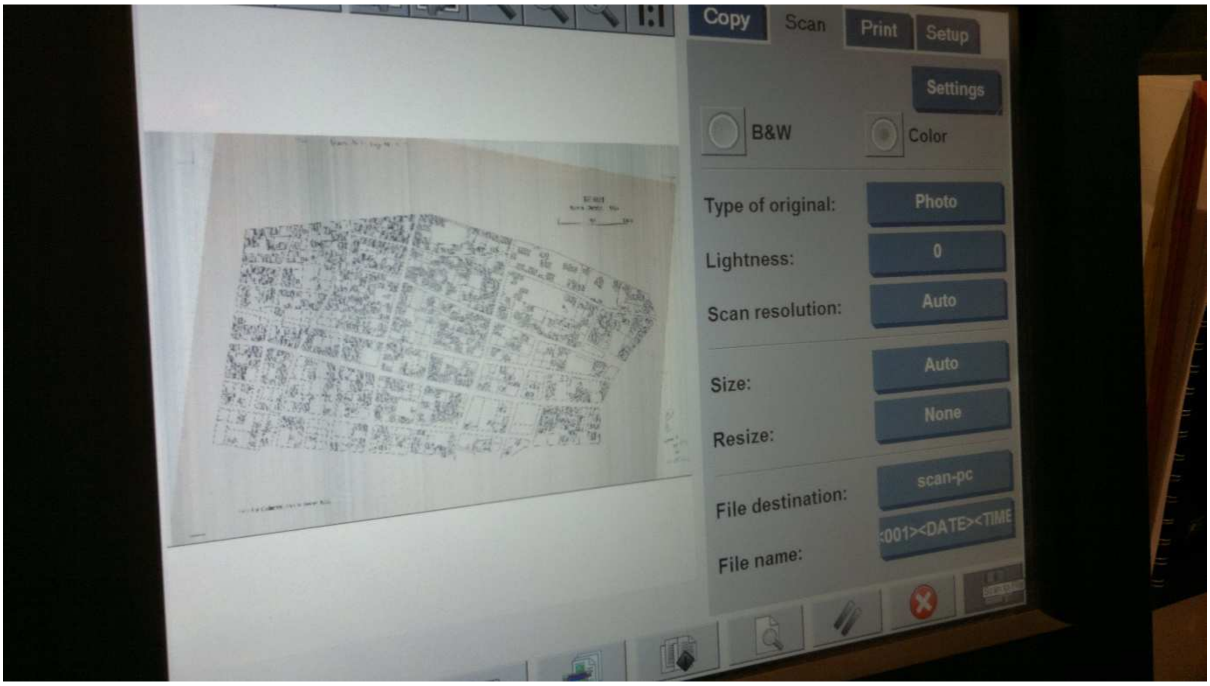


Figure 22 - Scanner Console

Next (Figure 23) we can see an example of a scanned map. The resolution has been reduced in this example, but it is possible to notice that, since they were printed in tracing paper, a lot of light differences, appearing as lines, arose.

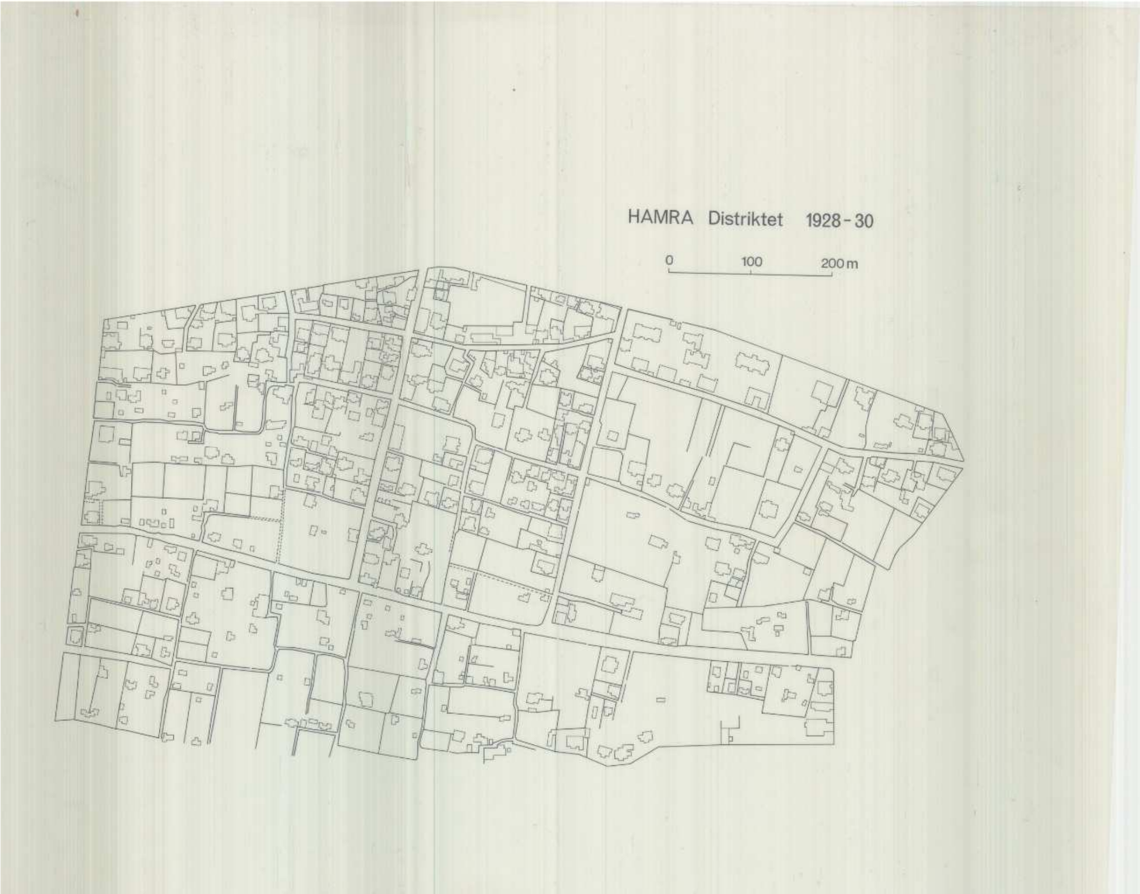


Figure 23 - Example of Scanned Map

3.2 FIELDWORK IN BEIRUT

Our dataset, maps as well as photographs, were lacking coordinates or other type of information useful for geotagging and georeferencing, and the many transformations of the city since the creation of the material made it impossible to settle for at remote study of the area. The purpose of the fieldwork was to locate, confirm and document the photographs of buildings and urban scenery taken by Per Kongstad in 1964 and 1967 in Hamra, Beirut. In order to add an extra aspect to the visualisation of the "then and now" – the past and present - point of our research, part of the purpose of fieldwork was to take new photographs at the same location of some of Kongstad's photographs.

The fieldwork was partly funded by "Den Obelske Familiefond" through Aalborg University.

Prior to the fieldwork, the material had been scanned, photographed, described and indexed in an Excel spreadsheet (1.7 The Data). The digitised material was brought with us to Beirut while the originals were left in Denmark.

The fieldwork took place during 4 weeks from March 3rd – 31st 2015 and was partly conducted in cooperation with Marie Brøndgaard Jensen from the Tourism Masters at Aalborg University Copenhagen. Marie is using part of the material for her final thesis "Embodied Urban Spaces of Ras Beirut and the Inherence of Tourism – *A case study of mental mapping and photographic narratives*".

Apart from the data collection and preparation as explained in more detail below ("methodology of fieldwork and data collection", section 3.2.1), the fieldwork included:

- Participation in the conference *City Debates: Other Gentrifications*, arranged by the Neighborhood Initiative at the AUB. The conference formed a solid foundation for our theoretical understanding of cities where gentrification is a central issue in urbanisation studies.
- Many guided and unguided city walks and -talks in Hamra and Ras Beirut general.
- Visits to local archives
- Meetings and discussions with staff and others involved with the Neighborhood Initiative, particularly regarding the online publishing of our product and database design and decisions, took place at their office. This is described thoroughly in the "Database Design" chapter (3.3).

3.2.1 Methodology of Fieldwork and Data Collection

In basic terms, the data collection was carried out with a camera, an e-reader and a paper map, but much time went into preparatory work with selecting and locating the images.

The processes of selecting and locating the images were carried out over several sessions in cooperation with Maria and Yaser Abunnasr (Figure 24). Maria Abunnasr is from the Neighborhood Initiative and Yaser Abunnasr is assistant professor at AUB. Both are born and raised in Hamra, and are still settled there. Furthermore they have dealt thoroughly with the urban development of the city in their studies and work. Without their intimate knowledge of the city, it would not have been possible to locate the same number of photographs.

Amongst other things, this is due to the enormous changes in the urban geography of Beirut, since the time of the creation of our dataset. Many street names that are mentioned on the original slides are no longer to be found in the Beiruti cityscape because many of the streets have changed names since the 1960's. Furthermore, streets names are often only to be found on maps and not in the streets, where they are only marked with numbers.

Figure 24 - Maria and Yaser Abunnasr assisting us with locating the Per Kongstad's photographs and looking at old cadastral maps of Beirut

Approximately one day per week, we would meet with Maria and Yaser Abunnasr in order to locate the old pictures and mark them on a map to take into the field. Additionally there was much help to gain from local people in the streets, as we can see in Figure 25 where locals promptly offered to help us find the location where the old Hamra Mosque (shown in Figure 20) stood.

Figure 25 - To lifetime residents of Hamra discussing the location of the "Hamra Mosque" in a photograph. It turned out that Per Kongstad had written the wrong street name on the slide and we managed to find the right location with their help.

Sometimes it was not possible to find locations just by enquiring in the streets, as people might recognise vaguely the old image, but not really relating it to nowadays landscape. This was the case of Figure 26, where we can see an old house with a well. Several people we confronted with the image had different opinions about its location, and none of them confirmable.

Figure 26 - Old House with Well in 1964 and Current Building

Maria and Yasser Abunnasr, again, where extremely helpful and managed to identify the well in front of the house in the aerial image from 1963 (Figure 27)

With this information we could be certain of where to go, and we confirmed that today's scenario is totally changed, as seen above.

Figure 27 - Aerial image from 1963 showing the well's location

In-Field Validation

Appendix E shows and example of one of our fieldwork maps created and used for field validation and data collection in Hamra, Beirut in March 2015. The map was printed in A3 size and brought to the field. Due to the purpose, the map is lacking legend, north arrow and scale (North is to the left). The basemap is Per Kongstad's working map from 1967/1968. The purple lines are the modern streets with street names, provided by the Neighborhood Initiative, AUB. The green dots are our "Points of Interest" (POIs), which was the expected location of Kongstad's photographs to be validated and thus the place to take a new photograph. The POI's are labelled with the photo number ("Old Photo Number") of the photograph to be validated.

Data Collection

If validation was successful, the same map or another paper map was used to mark the actual location from where the photo was taken with a pen, and that location was assigned a "Survey Location Number". The Survey location number is a running number, starting from one and assigned in the order we managed to validate photo-locations in the field. New photographs were taken from the location, aiming at getting the same view as in the original photographs. A Canon EOS 1200D was used for this purpose. The rough direction in which the photograph was taken was marked on the map with an arrow.

All information was recorded in-situ in a table created for the purpose (See appendix F), with the following specifications:

- ***Old Photo Number*** is the number assigned to Kongstad's photographs during the digitisation process.
- ***Location Number*** is the "Survey Location Number" described above.

- ***Field Photo Number*** is the number of new photographs taken at the location.
- ***Direction of Photo*** is the rough direction in which the photo was taken, e.g. "NE" for North-East.
- ***Notes*** is an optional field for anything relevant to the process, pictures or certainties/uncertainties about the location etc.
- ***Street Name*** is the name of the street or the streets crossing at the location.

3.2.2 Limitations of the Fieldwork

Doing this type of field work in a place with the historical and modern conditions of Beirut is bound to present certain limitations. The limitations of our fieldwork were mostly refined to the actual data collection.

Cameras: As is the case in most places in the world, it is not allowed to take any photographs of military personnel or areas in Lebanon, and the military is densely present in the Hamra area of Beirut. However, also other groups and individuals of different affiliations are not keen on cameras for a variety of reasons. On two occasions, we were asked not to take photographs by people in the street. On the one occasion we were kindly asked to delete the photos we had just taken and to not take new photographs until certain people and cars were no longer visible. In the second case we were asked to leave the area completely and were not permitted to do any work or take photographs in a street where we had 4-5 POI's.

GPS***:*** We had originally planned to use a GPS for collecting coordinates in the field, and had in fact brought one with us. However, we did not use it. The reason for this is the same issue as with the cameras: we feared that it would catch the unwanted attention of military personnel and some individuals in the street and thus impede the data collection instead of assisting it. We decided that marking the location with pen on a map and later digitising the locations in GIS would be as accurate or at least accurate enough for our purpose.

The exact locations and details of these incidents will not be further explained in this context, but are to be expected and are important limitations to consider when working in the region, keeping in mind the historic as well as present conditions.

This is also one more reason why we have chosen to blur the faces and license plates in the photographs that we have taken and that are made available online.

Urban Development and Traffic***:*** These are two central factors that are to be expected due to the theme of this project. Some buildings are gone and other new buildings have arisen. The architectural development of the city makes it completely impossible to recognise some places, while completely impossible to have a view at all at other places. This too was expected. The increase in traffic is also evident in the photographs of now and then, and often made it impossible to get photographs from the exact same location as Per Kongstad, simply because he was often standing in the middle of a half-empty street that is now heavily trafficked.

Peoples Associations of Places:

As mentioned, many of the locals that we talked to in the streets were excited about the photographs and often wanted to help locate them if they had an idea of where it was. However, we experienced that people's associations of places are at times tied to other things than actual location. As an example we were trying to locate an image seen in Figure 28. There was no mentioning of street names on the original slide and not much of the urban landscape is visible in the picture, but the many birdcages outside the house made us think that it could be distinct enough for some long-time residents to recognise the place. When showing the picture to people in the street, several pointed us to the location of a parking lot at the crossing of Cheikh Elias Gaspard Street and Mahatma Ghandhi Street (Figure 3). Nothing similar looking was visible at the spot, but when we showed the picture to the men working at the parking lot they were very excited and took us to their guardhouse where they had a large number of birds in cages inside and outside (Figure 29). Since there is nothing else than the birdcages evidently connecting the old picture to the place, we decided to leave it out of the final product.

Figure 28 – Per Kongstad photo of house with birdcages

Figure 29 – Location thought to be the same as in Per Kongstad's previous photograph

3.2.3 Results

We managed to locate a total number of 35 of Per Kongstad's photographs in Hamra. These are all photographs from Hamra, except for a few that are just outside the original study area, but include important place marks such as the Manara (the original lighthouse) and the Corniche (the promenade). All are within the Neighborhood Initiative's definition of Ras Beirut. Appendix G contains the spread sheet with all the located photographs and notes from the fieldwork.

3.3 Database Design

The database was designed to match the design of the Neighborhood Initiative's database as well as the data we had to digitise, and consists of a collection of feature classes stored in an ESRI File Geodatabase. The feature classes fall into three conceptual categories, based on purpose rather than geometry:

- City Layouts
- Analysis layers
- Points of interest (POI)

The tables in the Appendices H to J show the details of each feature class regarding names, contents and attributes and provides a preview example of each feature class. A model of the database design for the features can be seen in Figure 30. Since the data will be handed over to the Neighborhood Initiative, we named features according to the American conventions (e.g.”urbanization” instead of “urbanisation”), although the thesis is otherwise written according to the English (UK) spelling conventions.

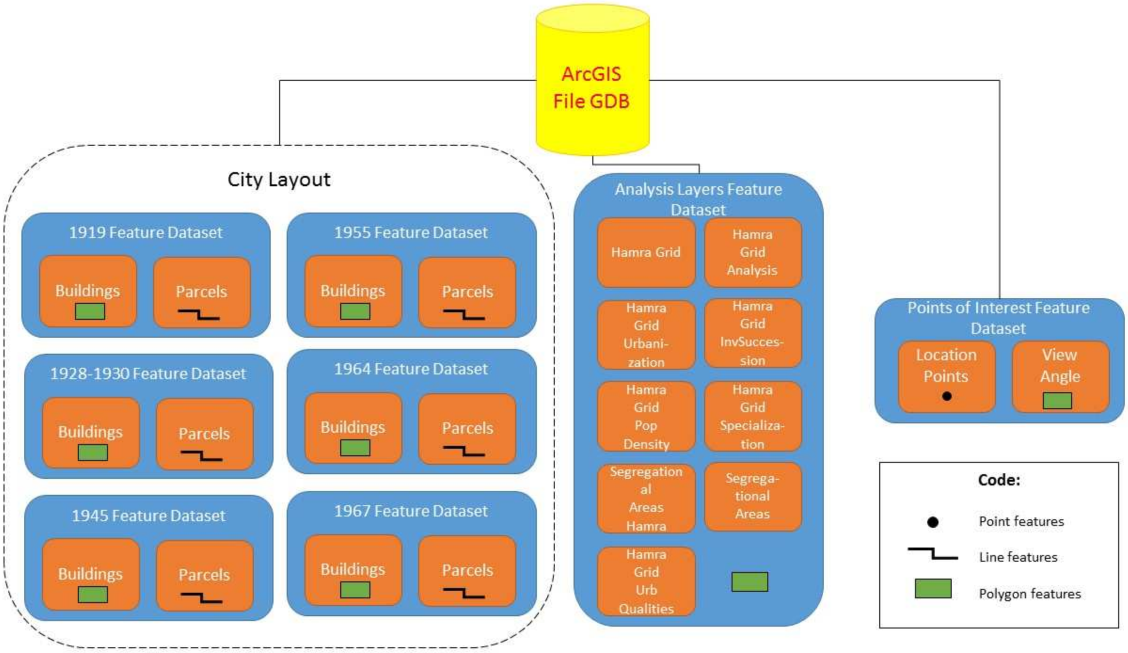


Figure 30 - The database design in ArcGIS on the desktop

City Layouts

The feature classes of the *City Layouts* (Appendix H, tables h1 to h6) are organised in feature datasets per year, and contain polygon- and line feature classes representing the buildings and parcels of the Hamra area that were digitised from Kongstad and Khalaf’s maps. Polygons were chosen for the buildings, because they are closed entities and lines for the parcels, because they are often represented as open areas in the source map.

Analysis layers

The *Analysis layers* represent the final chorograms from Kongstad and Khalaf’s analyses, as represented in their book. All the chorograms are compiled in one feature dataset, in which each feature class represents one chorogram-topic, e.g. “population Density” (Appendix I, tables i1 to i8).

Points of Interest

Points of Interest is a feature dataset containing two feature classes: The point feature class *Points of interest* and the polygon feature class *View Angles (Appendix J)*. The points of Interest feature class represents the locations from where the photographs were taken and contains a URL-field with a link to the online location of the photographs as well as other information that we wanted to appear in a pop-up on the online maps.

The *View Angle* feature class represents the approximate angle and direction in which the photographs were taken.

3.3.1 Georeferencing the Maps

The original format of our subject maps, as explained above, is analogue. Once scanned, the first step was to correctly place them in space. To do so, we needed to know what coordinate system they were referenced, and find places on the maps that we could recognise in other ones already georeferenced, otherwise we could not attribute coordinates to the first ones.

The GIS people of the Neighborhood Initiative provided us with the projection file they use for their GIS work. This file is called "stereolev", referring to the *Deir ez Zor/Levant Stereographic* coordinate system of Lebanon. This is the file we have been using to define the coordinate system of our maps and data. Specifics of the coordinate system are available in Appendix D, where they are compared to the specifics of the official *Deir ez Zor/Levant Stereographic* coordinate system of ArcMap.

A Reference Map:
Fortunately, one of the paper maps we had access to, was the same Per Kongstad himself used as source to draw the ones in his book. This was a cadastral map from 1964 in scale 1:2000. It was in the *Deir ez Zor/Levant Stereographic* coordinate system, which uses a Double Stereographic Projection, over a Deir ez Zor Datum (Clark 1880 Spheroid).

This map, produced by the French Army, had x and y coordinates on the sides which belong to points symbolised as crosses on the map itself. Figure 31 gives an example. With this data we were able to start the georeferencing process.

Opening and empty ArcMap project, we entered the coordinate system into the data frame onto which the rasters ought to be georeferenced, and from here on all the data to be georeferenced would receive coordinates based on it.

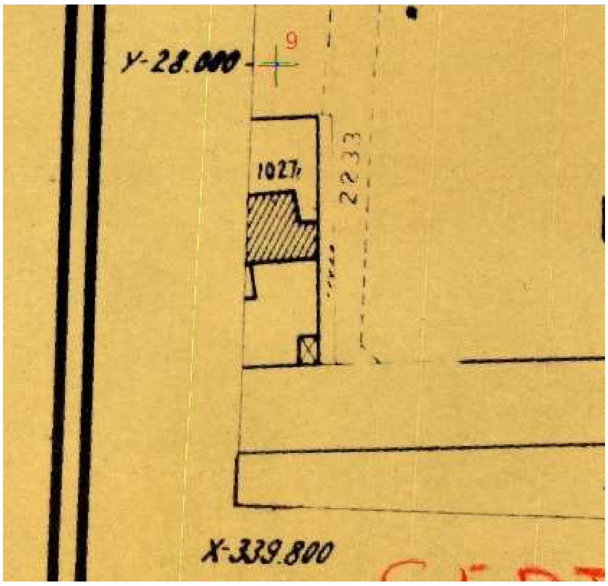


Figure 31 - Map Coordinate Bullets used for Georeferencing

The process of georeferencing itself can follow two paths. One is of selecting control points in the raster that we want to georeference, and manually assign its known coordinates to it (Figure 32) or, in another way, to select a control point on the raster to georeference (Figure 33) and then select the same point in another layer that is already georeferenced (Figure 34). Of course the selecting of control points is not always perfect, so it is possible to discard already chosen control points in favour of other ones with better positioning.

We georeferenced the first map assigning coordinates to the existing bullets, and the remaining ones using the first one as source. ArcGIS allows for several shifting transformation methods, and we have used the 1st order polynomial, or affine. This transformation "*scales, rotates, skews, and/or translates images or coordinates between any two Euclidean spaces,…**,** parallel lines remain parallel, the midpoint of a line segment remains a midpoint, and all points on a straight line remain on a straight line*" (Esri (a), 2015).

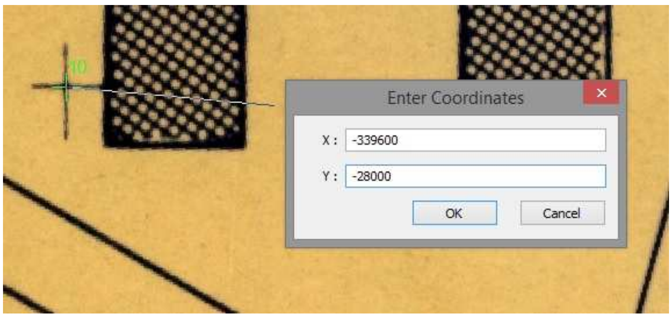


Figure 32 - Georeference: Enter Coordinates

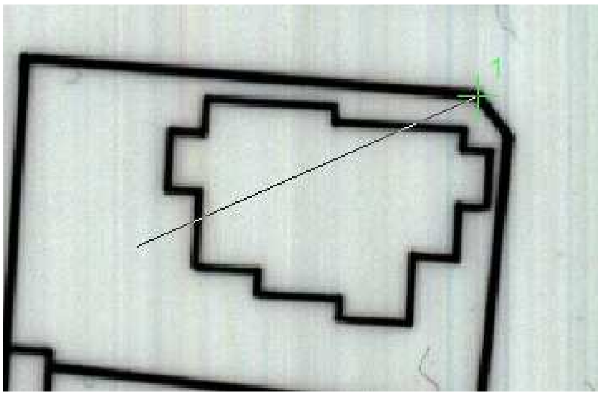


Figure 33 - Georeference: Select Point to Georeference

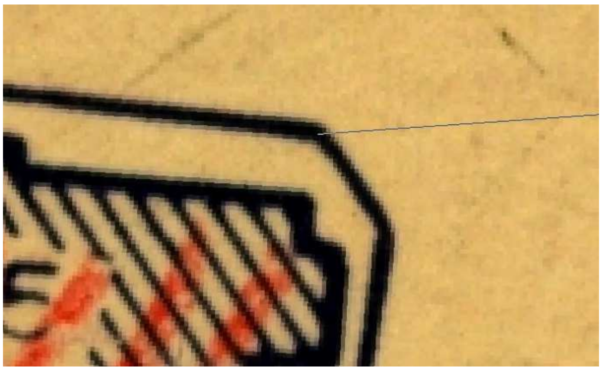


Figure 34 - Georeference: Select Point Already Georeferenced

This process of georeferencing cannot be achieved without some residual errors to the coordinates. Since we are assigning coordinates manually, there will always be some error, even if the chosen locations are perfectly identified in both datasets. The affine transformation emphasises the overall accuracy instead of the local one, which means that slightly higher residuals might in fact correspond to better overall accuracy, if the control points are evenly distributed along the area to georeference (Esri (a), 2015).

Table 2 shows us the residuals from all the georeferencing. The first map to be georeferenced got residuals of 0.17 metres, and the ones from 1964 and 1967 of 0.13 and 0.15 metres, respectively. Since the original scale of the maps is 1:2000, this error corresponds to less than a tenth of a millimetre in the map, which seems quite positive.

As we go back in time, the residuals grow, since the several objects in the map start differing from the map with known coordinates. In fact, the georeferencing was partly hybrid, since we utilised the 1964 cadastre map as reference, as well as the previously georeferenced map, to minimise the difference in map objects. Even so, the worst residuals (1.8 metres in the 1945 map) correspond to 0.9 millimetres in the map, which is also a good value. Taking into consideration the line widths of the objects, we do not think we could have obtained much better accuracy.

Map	Method	Transformation	Residuals (m)
1964 Cadastre Map	Assign Coordinates	1st Order Polynomial (Afine)	0.17
1967	Shift Raster	1st Order Polynomial (Afine)	0.13
1964	Shift Raster	1st Order Polynomial (Afine)	0.15
1955	Shift Raster	1st Order Polynomial (Afine)	0.95
1945	Shift Raster	1st Order Polynomial (Afine)	1.80
1928	Shift Raster	1st Order Polynomial (Afine)	1.36
1919	Shift Raster	1st Order Polynomial (Afine)	1.50

Table 2 - Georeferencing Residuals

When all the maps where georeferenced we could start the process of vectorising them.

3.3.2 ModelBuilder Preparation Workflow

ArcGIS has a graphic interface to create, edit and manage models of task workflows, called ModelBuilder (Esri (a), 2015). These models link together sequences of geoprocessing tools, allowing feed the output of a tool into the next one, and so forward. It can also iterate over fields, feature classes or rasters, which automates repetitive processes over large quantities of data. One can also write scripts that can be run and so execute custom made tasks.

In order to be able to use ArcScan to automatically generate vectors from raster images, it is necessary to "*symbolize raster layers with two unique colours*" (Esri (a), 2015). Since our raster images were scanned as RGB we needed to convert it properly from 3 channels into a single channel (using *Save to Layer File*), and then to a raster with only two values (using *Slice* and *Reclassify*).

This operation would involve several tasks and, at the same time, these tasks would have to be repeated the same number of times as the number of rasters to vectorise. This meant that any way to make this process less dependent on human interaction would be more than welcome.

We have therefore opted on using ModelBuilder to run all the tasks on the different rasters, after we had fine-tuned them. It is possible to see the created model in Figure 35.

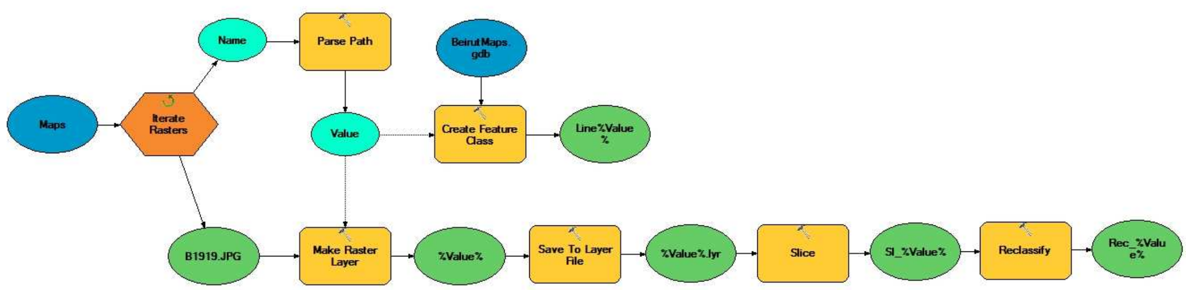


Figure 35 - Raster Preparation ModelBuilder Expression

Converting from RGB multichannel to a two values raster was done in several steps. At the same time, since we ran the process automatically, we took advantage of file names that were being used to create several empty *line feature classes* that we could afterwards use to populate with the ArcScan processes. We can see the feature class creation in the upper branch of the model, and the process of the raster preparation on the lower one. We will first focus on the latter.

The first step of the model iterates over all the rasters (stored in *Maps*), which is basically *looping* over the desired data (in this case all the raster files), allowing to perform all the tasks on each of them. On the interface (Figure 36), the user only has to choose the folder in which the data is stored. Optionally a wildcard can be chosen (a particular character or word), allowing for the iteration to run only on the files that contain it. It is also possible to define the type of raster to use, and if subfolders are to be taken into account.

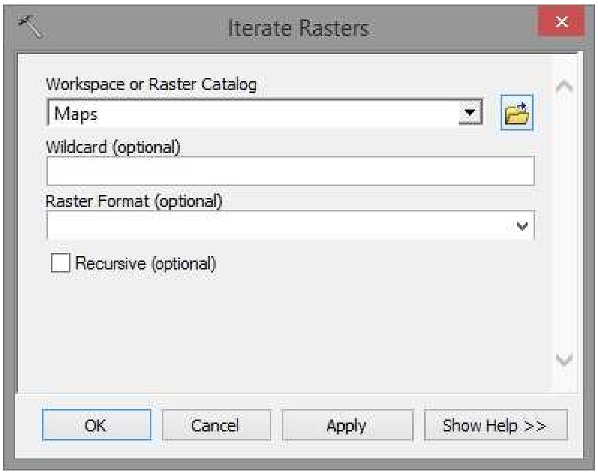


Figure 36 - ModelBuilder: Iterate Raster

The input rasters had to be stripped of the file extension to avoid a file format error when used in the model. This was done with the *Parse Path* tool, shown in Figure 37, where only the NAME (in Parse Type) of the rasters is kept for the next tool, which is the one that actually starts the reclassification process.

It is also important to notice that raster files cannot start with numbers, and have a maximum length of thirteen characters (Esri (a), 2015) otherwise an error will occur.

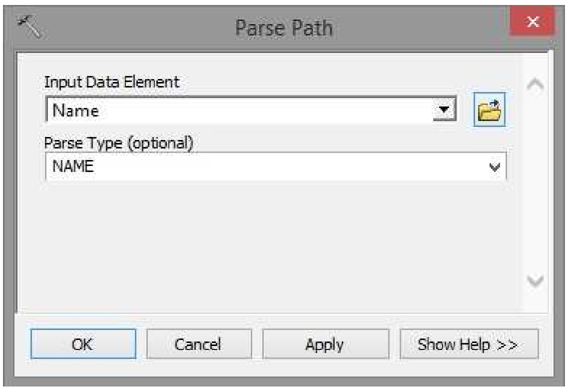


Figure 37 - ModelBuilder: Parse Path

The first step of the reclassification process was then to reduce the RGB raster into a single channel. For this we used the *Make Raster Layer* tool (Figure 38), which created a temporary raster. We specify in the *Bands* field how many bands we wanted to use, here we only used band 1.

In the *Output Raster Layer Name* field we can see the expression "*%Value%*". The "%" symbols show that the word between them is a variable which, in our case, is the Value – or the layer names that originate from the *Parse Path* tool. This will in turn create the single band rasters using the same name as the original ones.

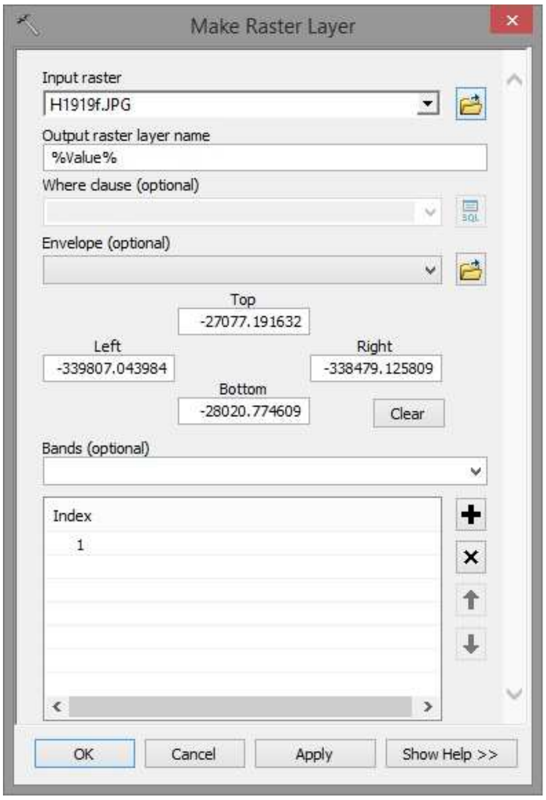


Figure 38 - ModelBuilder: Make Raster Layer

Using the "*%Value%*" as input layers, we used *Save to Layer File*, as shown in Figure 39. The layer file allowed to keep the visualisation settings of the Raster Layer (single channel), without actually creating new rasters. It is a way to define how the data from the original rasters is displayed. The warning sign alerts us that, at the time we wrote the report, there was already a file with the same name in the destination folder. The layer version parameter allows us to choose which version of ArcGIS format we want to save in.

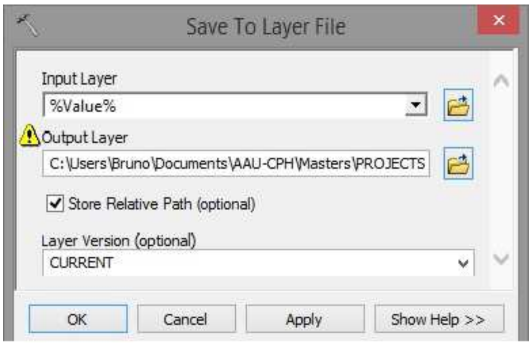


Figure 39 - ModelBuilder: Save to Layer File

The *Slice* tool (Figure 40) "*reclassifies the range of values of the input cells into zones of equal interval, equal area, or by natural breaks*" (Esri (a), 2015). With it, we were able to convert the stretched distribution of the raster values into different classes, so we could better visualise how to reclassify the rasters into two unique values.

Since each raster had very different cell values, the only way to automatically reclassify them was to have them normalised (otherwise, we would have to analyse each of the rasters, check their values manually and define which threshold to choose for the reclassification). That was done by splitting the values (independently of their range) into classes. The number ten was reached empirically. It still allowed a wide range of values, but narrowed them into a number that could be visualised in a way that the drawing lines would become identifiable. We used *Natural Breaks* as the *Slice Method*.

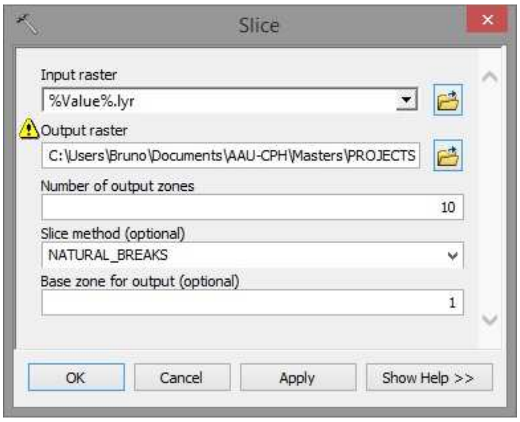


Figure 40 - ModelBuilder: Slice

In Figure 41 we can see an example of the *Slice Tool* results, in which only ten (random) colours exist.

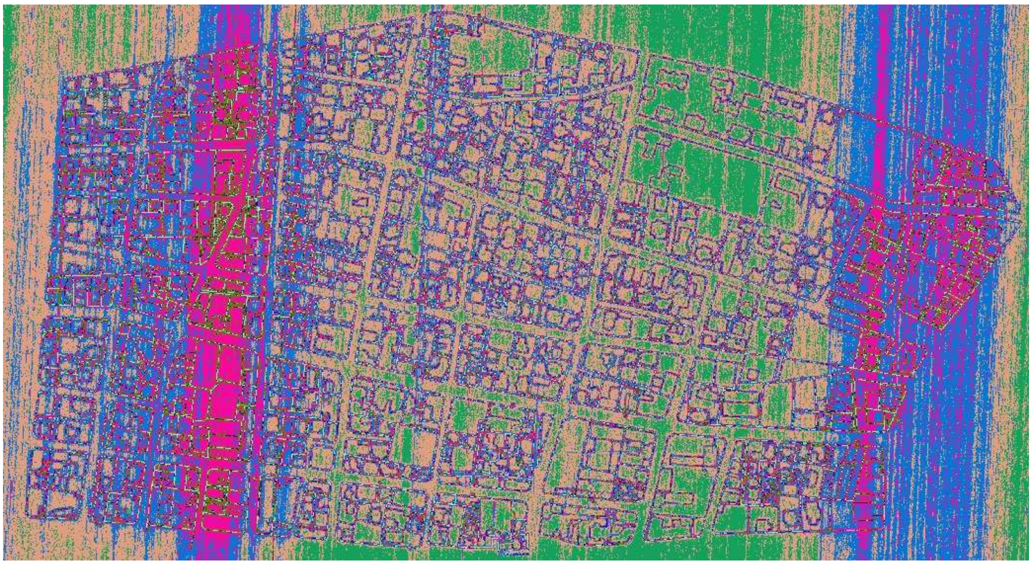


Figure 41 - Slice Tool Result Example

Finally, the last step was to reclassify the data into only two values, as shown in Figure 42. We chose to reclassify the first four sliced zones into "1" and the remaining six into "2". The value "1" is the one that corresponded to the features to vectorise.

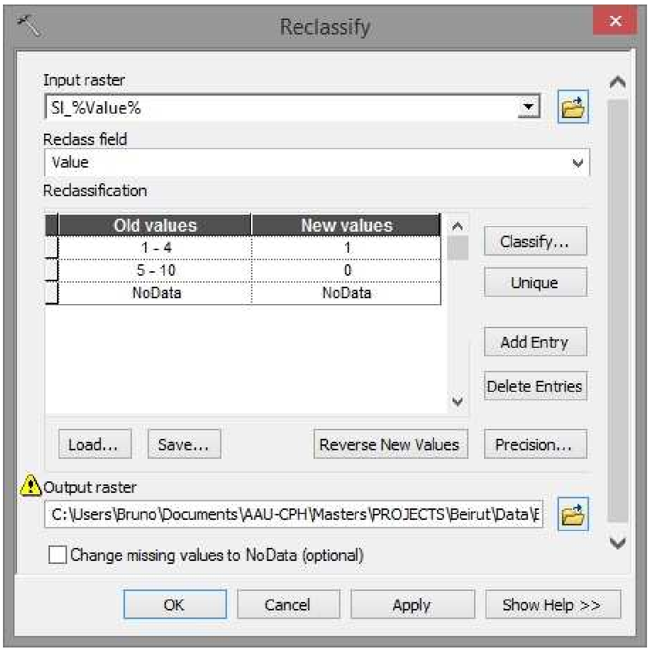


Figure 42 - ModelBuilder: Reclassify

It is possible to see an example of a result of the *Reclassify Tool*, in which the features we wanted to digitise appear in pink, and the rest in green (Figure 43).

Figure 43 - Reclassify Tool Result Example

As described before, this model allowed, at the same time, to create feature classes to be used as destinations for the ArcScan vectorising. Making use of the *Create Feature Class* tool, shown in Figure 44, we created line features that would be named *Line%Value%*, meaning they got the same name as the original grids preceded by the word *Line*. This way it was easier to know which feature classes would contain the lines from the different years.

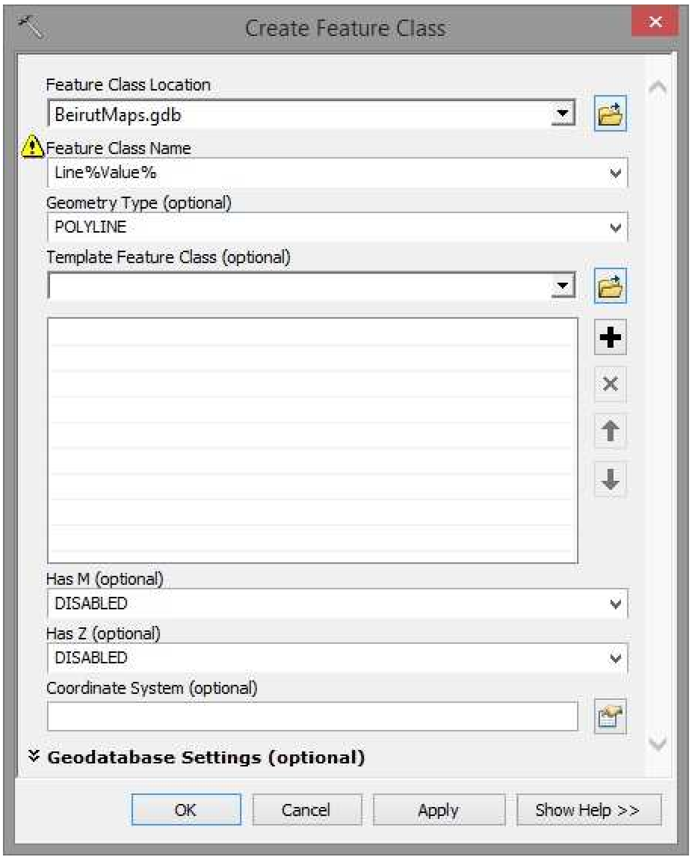


Figure 44 - ModelBuilder: Create Feature Class

3.3.3 ArcScan Post Processing

The ArcScan extension allows converting rasters into vector feature classes (Esri (a), 2015). Our aim was to use ArcScan to automatically generate the vector features, based on predefined settings, and therefore save time instead of manually vectorising the maps.

In order to use ArcScan, we needed a 2 value raster, and a line feature class to be the destination of the vectors, elements that have been prepared previously. The choices made with the *Vectorisation Settings*, shown in Figure 45, were essential to the results of the tool. To make these choices we had to try several times, until we found the most satisfying results.

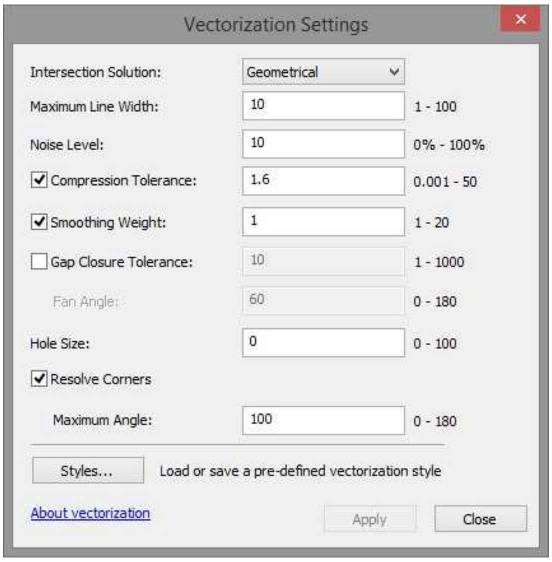


Figure 45 - ArcScan: Vectorisation Settings

After choosing the settings, one just has to press the *Generate Features* button (Figure 46), in order to run the process. The drop down menu visible at the top left of the image, shows the selected raster from which to generate the features.

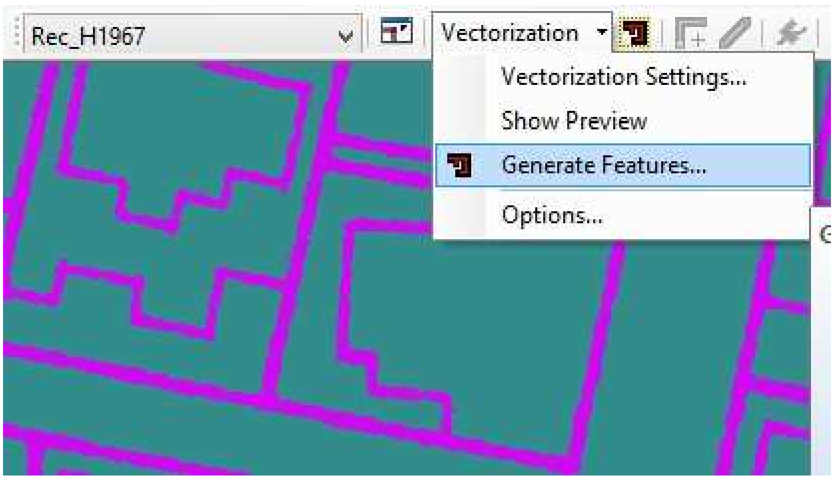


Figure 46 - ArcScan: Generate Features

The results we got, shown in Figure 47, were not satisfactory. Since the original maps were drawn by hand, and also derived of the transformation process from RGB to 2 values raster, the lines had small imperfections that affected the end result (perceptible only with a large zoom) and caused some undulation of the vectorised lines.

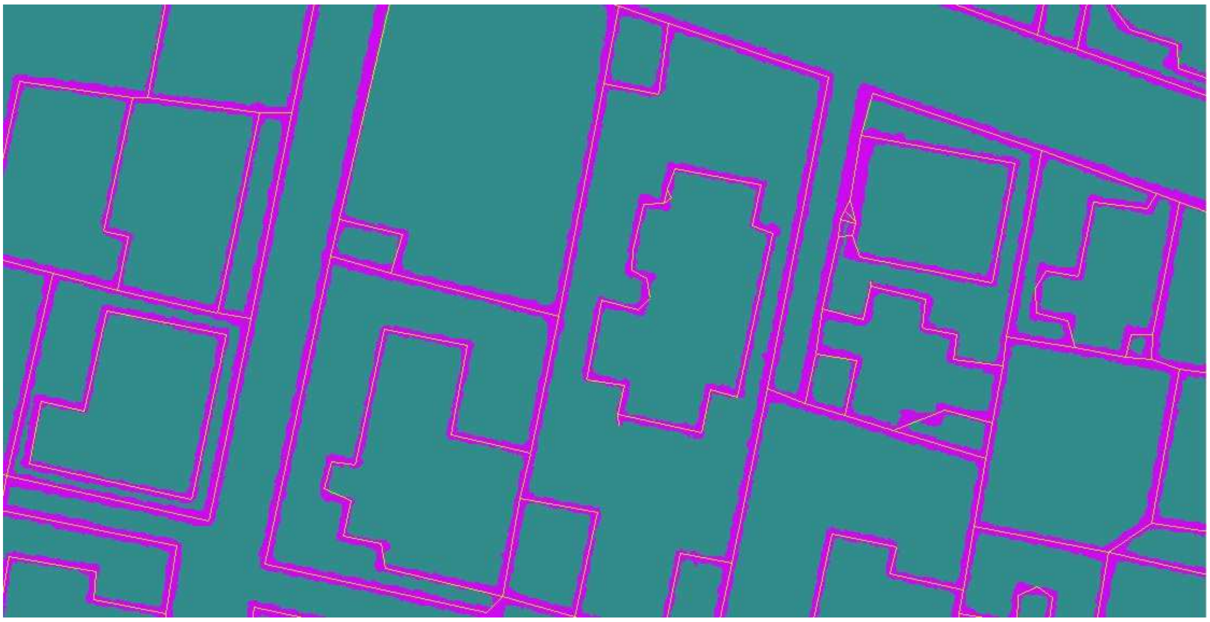


Figure 47 - ArcScan: Results

To avoid this zig-zag of the lines, we had to use a larger *Compression Tolerance*, which reduces the number of vertices per line feature (Esri (a), 2015; Esri (g), 2013) (see again Figure 45). This worked well with the parcel lines but, unfortunately, it still did not eliminate entirely wobbling in the buildings. Also, the corners of the buildings had many irregularities, a situation that might be related to the original by-hand drawing, which created some large corner patches (again, only perceptible with a large zoom) that the software had trouble to work around.

These results left us with two options: either we would accept these accuracies and afterwards "clean" the feature classes looking for vectorisation errors and poor quality intersections and correct those manually, or we would vectorise the entire original maps manually. Since the areas were not that big and we did not have a huge amount of maps to vectorise, we estimated that it was more feasible to do the processing by hand. At the same time, doing it manually would assure us that any imperfections would not escape our attention.

Even so, we decided to scan some of the maps again, in black and white and with higher brightness setting, to see if we could achieve better results. At first glance, this new scanning seemed to distinguish the black lines from the background better, as it can be seen in Figure 48. Since we raised the brightness of the scanner at the same time, the imperfections of the paper faded considerably, making the lines stand out from the background

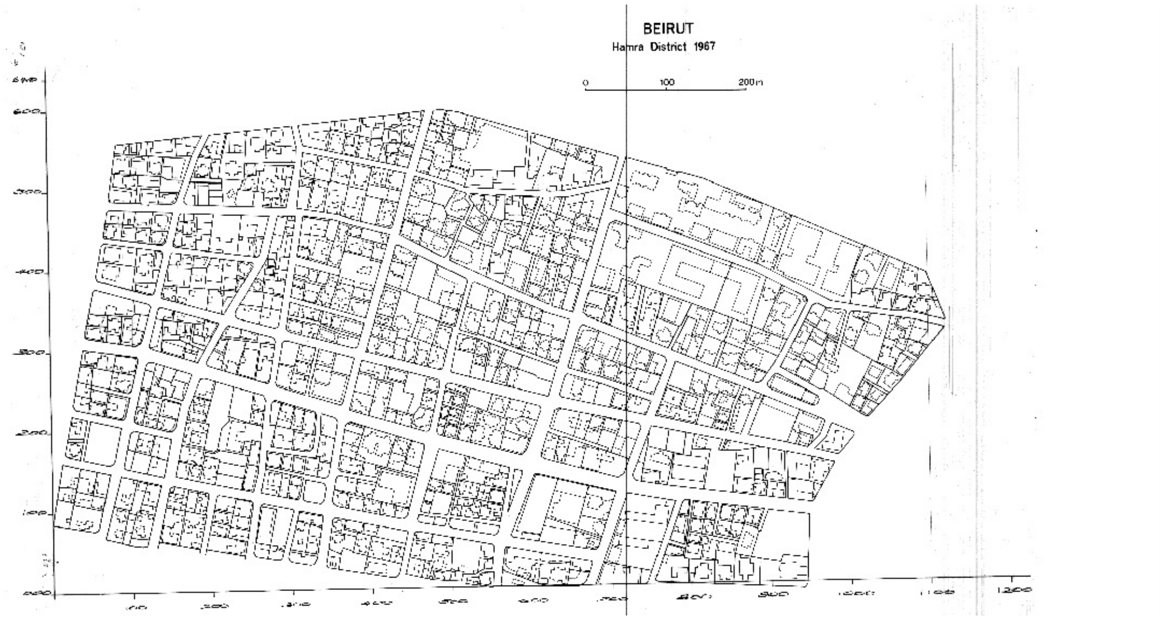


Figure 48 - Example of Scanned Map (Black & White)

The black and white scanning proved to have some advantages. Since it is composed by a grey scale, with values ranging from 0 to 255, the process of reclassifying it into two separate values was quite simple, one just had to enter the raster properties and reclassify it into two classes, as it is shown in Figure 49.

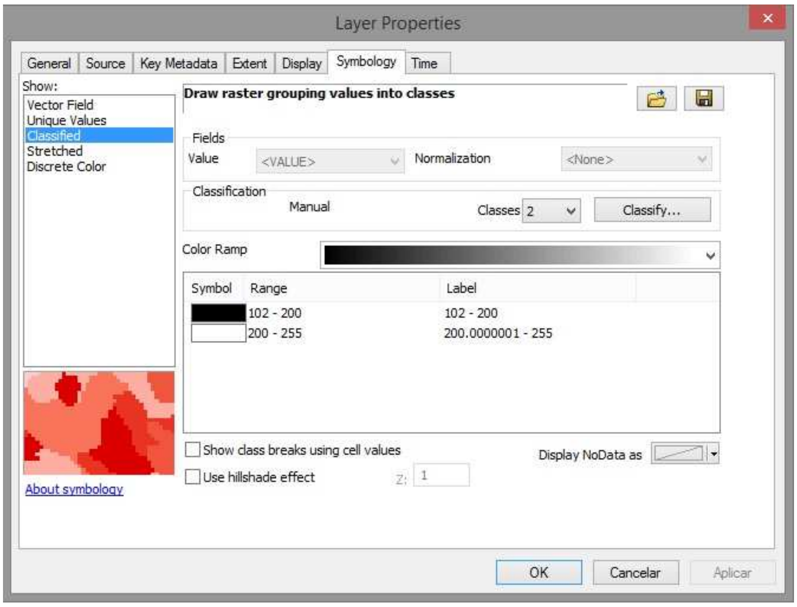


Figure 49 - Black & White Raster Layer Properties

Running ArcScan again, we noticed that the resulting lines presented higher smoothness when compared with the colour scanning. Even so, the problems related with the vectorisation of the building corners persisted, although to a lesser degree. Also, the compromise between smooth lines and higher number of vertices left the same deficiencies in the round corners of the parcels. These examples can be seen in Figure 50.

Figure 50 - ArcScan Results (Black & White)

Although this last ArcScan results showed to be more promising, it still seemed to us that the time spent checking and cleaning the vectorisation would not compensate either in terms of speed or accuracy. We therefore finally decided to do the vectorisation manually.

3.3.4 Manual Vectorisation

The manual vectorisation of features in the original maps was done using the editing tools of ArcGIS, and was relatively simple to accomplish. Starting with an editing session, selecting as target feature class the already created line features (created using ModelBuilder). Afterwards, using the *Create Features* window (Figure 51) we simply selected *Line* and started tracing over the rasters.

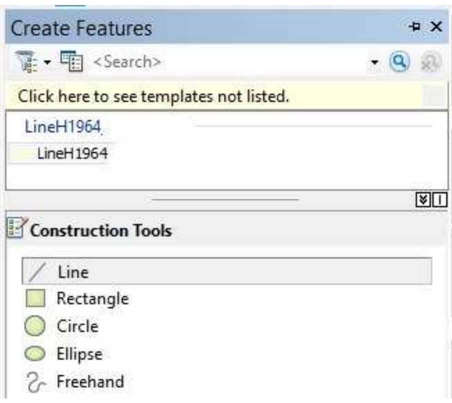


Figure 51 - Editing: Create Features

As we can see in Figure 52, the end results were much more satisfactory. The features were perfectly identified and replicated. During the manual drawing we were not worried about adding a vertex at every location where two lines would overlap, if there would not exist a change in direction. This would be time consuming and, at the same time, it would introduce deviations in the general trend of the lines at those locations.

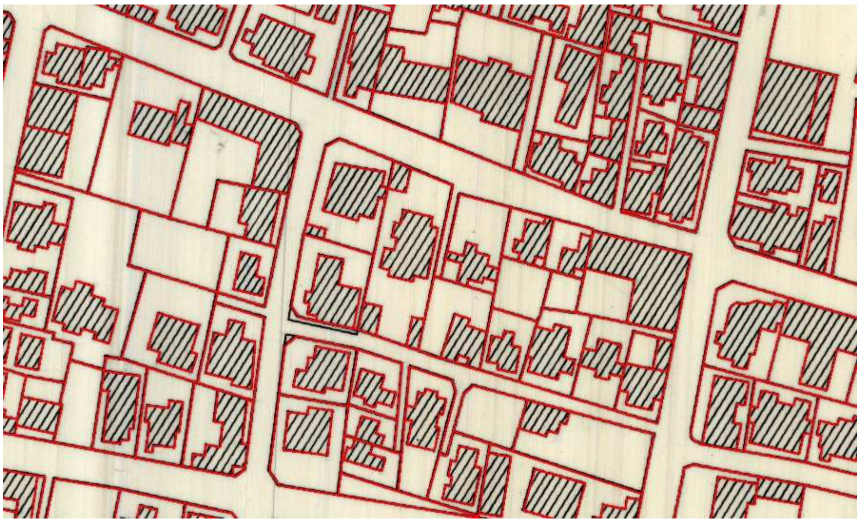


Figure 52 - Vectorisation: Manual Drawing Example

After all the lines were vectorised, the next step entailed separating the parcels from the buildings. We created two additional Feature classes for this purpose, one to receive the buildings (*polygon* type) and another to store the parcels (*line* type).

The first step was to create vertices, in the first line layer, at every point where two or more lines would cross. For this we used the *Planarize Lines* function, offered in the *Advanced Editing* toolbar. This function allows to “*split selected lines where they intersect*” (Esri (a), 2015) and will also delete any existing overlapping lines. We selected all the created lines, pressed the *planarize* button and vertices were created at crossing locations for all the features. Figure 53 shows us that is it possible to choose a cluster (line) tolerance that will merge clustered features.

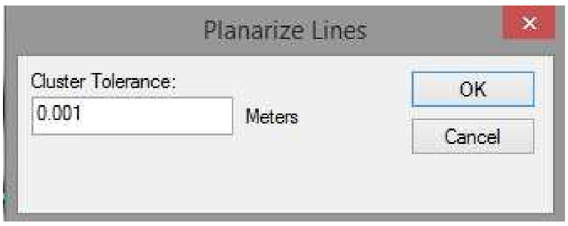


Figure 53 - Editing: Planarize Lines

Also in the *Advanced Editing* menu is the *Construct Polygons* function. It allows creating polygon features out of other line or polygon features. After selecting features that would close and represent the limits of buildings, we used the *Construct Polygons* function. Figure 54 shows us its menu, where we have to define the target feature class for the polygons and optionally a cluster tolerance. Furthermore, we were able to use already existing polygons in the target layer as borders for the ones to be created.

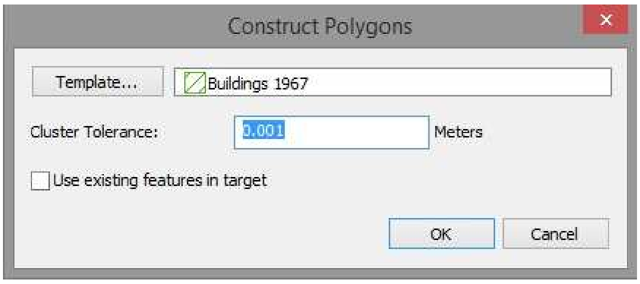


Figure 54 - Editing: Construct Polygons

3.3.5 Per Kongstad and Samir Khalaf Hamra Urban Analysis Classifications

All the information about the location of buildings and parcels in Hamra was collected for more than just spatial visualisation. A survey was conducted in 1967 by Kongstad and Khalaf of the residential units, inquiring the residents about several aspects of their living conditions and those results were represented as chorograms in the book. An example of such a chorogram can be seen in Appendix K. The chorograms represent different subjects. For example, this specific one is about urban qualities.

Other subjects are about stages of urbanisation, population density, inversion and succession and segregational areas.

The data was shown in a grid made with 80 by 80 metre cells that was overlaid over Hamra. As we saw in Figure 9 (an example of a scanned map), the analysis cells were numbered from 1 to 96.

Since we did not have access to the original data from the surveys - something that would allow seeing which answers were given by building - we could only bring the final grid classification into the digital world. To do that we created a polygon feature class where we vectorised the delimiting area and then created the internal grid squares by using the *Cut Polygons Tool*. This tool splits existing polygons based on a drawn line. Since we wanted to create square polygons, all adjacent to each other, we only had to click the end points of the lines. Afterwards, each cell was numbered accordingly with the original numbering.

Not all of the grid cells were used for the analysis though. In Figure 55 we can see the cells that actually contained analysis data, and those were put into another feature class.

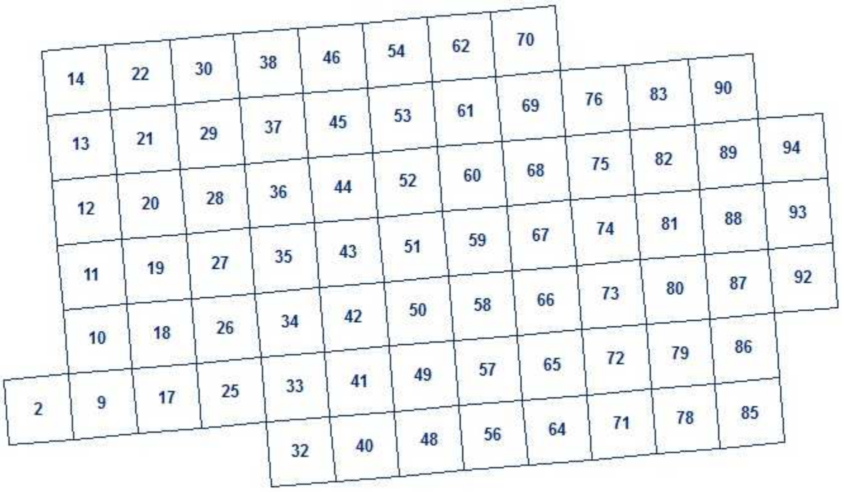


Figure 55 - Analysis Grid Cells

At this point it was a matter of adding attribute fields to this last feature class and add the classifications. We have opted by making several grid feature classes, each one of them with the attributes concerning the different subjects, instead of creating one feature class with all the subjects as attributes. Since the intention was for this data to be used by other people, it seemed that it would be easier for someone that has not had previous contact with it, to scroll through the attributes and understand them, if each feature class contained only information regarding the same subject. Appendix I, tables i1 to i8, has the information regarding each of the feature classes. In Appendix L we have attached *Appendix A* from the book "*Hamra of Beirut – A Case of Rapid Urbanization*", where it is possible to thoroughly the land use survey description.

3.3.6 Points of Interest (Feature Class)

For the identified location from our fieldwork, we created a point feature class called *LocationPoints,* in the *POI (points of Interest*) feature dataset. The feature class marks all the places that we identified in Per Kongstad's photographs (The resulting table from the survey is in Appendix G). The locations are approximations of where we were when taking the new photos in March 2015, and should more or less correspond to the places where the original photos were taken from. 35 locations had been identified and were inserted as points using the editing tool in ArcMap. We used our field working map as reference for the places.

As attributes, we added the *survey location number* and the number of the original photograph (*old photo number*) to the features. These should be used for joining extra data from our spread sheets.

To add information contained in our inventory of the original photos (Appendix C) and from the final survey sheet (Appendix G) into this feature class, we added the two excel tables to ArcMap and imported them into the geodatabase, converting it to a geodatabase table format (Esri (a), 2015; Esri (d), 2015). We wished to gather all the collected information about the locations in this feature class. A join was created between the point feature class and the tables based on the *old photo numbers* and *the survey location number*. Any duplicate fields or irrelevant data was deleted.

We performed the same procedure to an Excel file containing the URLs of the previously uploaded photographs. Since joins establishes relations between features and does not add the data permanently, we exported the joined feature class in order to create a new one with all the information regarding the old photos.

3.3.7 Field of View Feature Class

ArcGIS allows deriving fields of view from given points, if one has a digital surface model containing the buildings in 3D. From this the software can derive which areas can be seen from a given point. Our dataset does not have 3D information, but we wanted to visualise the field of view for clarifying purposes.

For this we decided to create a polygon feature class representing the fields of view from the locations where the photographs were taken. We think it is a good way for the user to have an immediate idea of which direction and area the photographs cover.

This feature class (*ViewAngle*) is part of the *POI (Points of Interest*) feature dataset and was populated with polygons with conical shape and a 45º angle from the central vertex. Each had a length of 195 m representing view depth. Each polygon had its vertex snapped to a LocationPoint and was afterwards rotated into the appropriate direction. We can see some examples in Figure 56.

The *ViewAngle* polygons were created assuming that there was nothing blocking the view. This makes sense because it should represent the field of view in two different time periods, between which the layout, and particularly the third dimension (elevation) has changed.

The attributes of this feature class are: *Survey Location Number*. No other attributes were needed because the features' only purpose is visualisation.

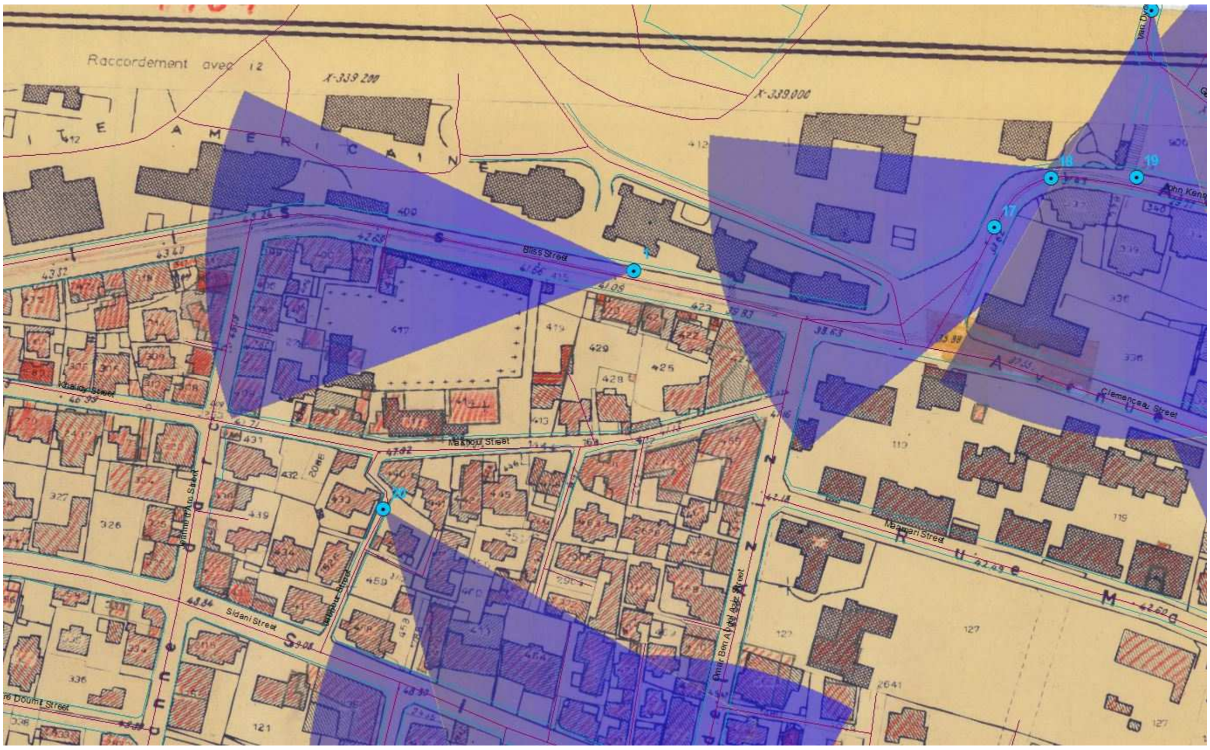


Figure 56 – ViewAngle Feature Class

3.3.8 Editing the Photographs

After completion of the fieldwork, it was time to prepare the photographs so they could be integrated online.

The first step was to choose the best photograph taken at each location, since we took several each time. Secondly, we proceeded to blurring peoples' faces (using Microsoft Paint), as well as license plates to completely avoid moral issues regarding privacy. We are not familiar with Lebanon's privacy regulations, but wanted to be on the safe side. As described in the fieldwork chapter, we experienced some nervousness by a small number of people, some of which seemed to belong to paramilitary groups, and were also kindly asked by security personnel to not take pictures where certain vehicles appeared, so it seemed logical to un-identify people.

We performed this action for the photos taken by us, but not Kongstad's which are almost 50 years old.

Deciding on how to prepare the photographs for web display was the next step. We have opted to group the corresponding ones from both time periods into one image in Picasa (photo editing program). The given years were added as text to each composite image (See an example in Figure 26 or on the front-page of the thesis.

To enhance online performance, we decreased the original size of the images to 25%.

3.3.9 Hamra Aerial Images

In the portfolio of information that we had access to, there were also several aerial images from the Hamra area. The only information regarding them appeared on the photographs themselves, and was the year in which the flight was made, 1963. Since this was almost the same date from the map we used as source for all the georeferencing (1964 cadastral map), it seemed appropriate to use imagery from the era, to set as background, for viewing purposes.

Their original format was of positive slides, or reversal slides. This means that the slides, when projected, reproduce what we see with the eye, and not the inversed lighting we usually see in photographic films (negatives). We were fortunate enough that Yaser Abunnasr found an old professional photography studio that had scanners with strong back lighting, in order to properly create a contrast in these black and white images.

In total there were 5 aerial images, which overlapped with each other's. This could allow stereopairs of photographs to be used to create 3Dmodels and orthoimages (Goodchild, Maguire, Rhind, & Longley, 2011), if we had information about the flight height. Since we did not have this information we could only georeference them.

Each one of the images, when scanned, became between 58mb and 80mb in size, which is heavy for online usage. Therefore, they were cropped and all the information contained on their frames, which was not image itself, removed. After this, using Adobe Photoshop, the images were stitched together into one. This last image was the one used for georeferencing.

The georeferencing process was similar to the one used for the maps, with one slight difference. These images were not orthorectified, that is, they were not corrected for the distortion that occurs from the centre to the exterior of every image taken with a photographic camera (Goodchild, Maguire, Rhind, & Longley, 2011). The only point in the images that is seen completely from above is the central point, every other one has an angle that increases as we move away from the centre. Because of this, any georeferencing would introduce distortion in the image itself, since we would be assigning coordinates to locations slightly off of their true location. Anyhow, at this scale the misalignments should not be considerable for viewing purposes.

Since we were using an image stitched together from five other images, we had different distortions along the final image and not only from the centre to the periphery. We have therefore used 25 control points, spread all across the area of the 1964 map used for the other georeferencing, in order to minimise the distortions. At this point we used a 3rd polynomial transformation, instead of the 1st polynomial used before. Higher order transformations allow correcting more complex distortions by stretching and not only simple scale and rotate of a raster dataset (Esri (a), 2015). With this transformation we could see that the alignment of the raster with the map used as source was much greater. In Figure 57 we can see the aerial image georeferenced and overlaid by the 1964 parcels.

Figure 57 - Aerial Image Overlaid by 1964 Parcels

3.4 Sharing the Data

In order to share our data, we used ArcGIS online and the Esri Story Map App. This chapter explains the processes of uploading the data to ArcGIS online and the subsequent steps taken to share the data.

3.4.1 Uploading Data into ArcGIS Online

The process of uploading feature classes into ArcGIS online service is simple, although it has a peculiarity. The service can host almost all the formats of geographic data (Esri (b), 2015), as well as images and documents. Interestingly enough, it seems that only the Esri formats need to be compressed in order to be uploaded. A feature class is composed of several files and, by compressing it, files do not become corrupt during the upload process. We would expect that the website would be able to recognise feature classes of its own format and import them conveniently.

If we upload a geodatabase containing several feature classes, that data will be seen as one entity. This means that it is not possible to select the individual feature classes from a database, instead only the entire datasets can be added to a web map, after which unwanted layers must be removed. For this reason, we exported each feature class into a shapefile format, so we could upload them one by one.

We then had to compress each shapefile into a .zip file, before uploading them. The upload process itself was quite simple, under the *My Content* webpage it was only necessary to press the *Add Item* button (Figure 58), which opened a window with three possibilities: *From my computer*, *From the web* and *An application*.

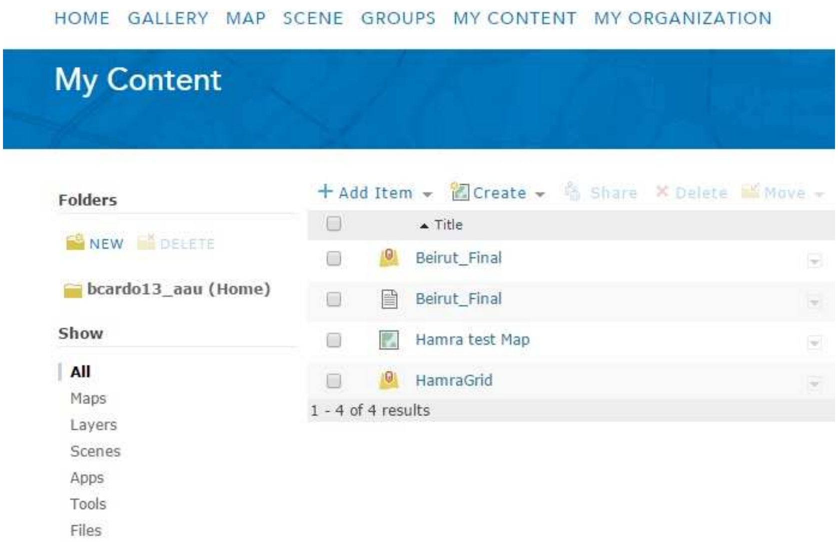


Figure 58 - ArcGIS Online: My Content webpage

Choosing the option *From my computer* opened another menu (Figure 59) where we could *choose file*, specifying the previously compressed shapefiles' location and also add a *title* and *tags* for querying the data. The process had to be repeated until all shapefiles where uploaded.

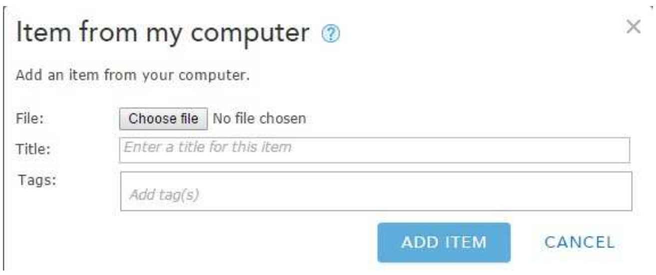


Figure 59 - ArcGIS Online: Add Item

Uploading the photographs followed the same procedure, as they also had to be uploaded individually.

3.4.2 Uploading the Aerial Image into ArcGIS Online

To add a georeferenced image to our online content, we had to follow a different process. We had to create a tiled map service from the image, using ArcGIS desktop, and then uploaded it into ArcGIS Online *My Content*, where it would be hosted.

A tiled service is a collection of tiles regarding a specific area, that allow for fast visualisation of datasets through the use of pre-drawn map images. This service is useful for someone who does not have his own map server, and wants to share data online for visualisation (Esri (b), 2015).

Since we wanted to create a service only with the aerial image, we had to create a project with nothing else in it. The next step was to login to ArcGIS Online from the desktop version, accessible from the *File* menu, as we can see in Figure 60, and then proceed to the *Share As* menu followed by *Service*.

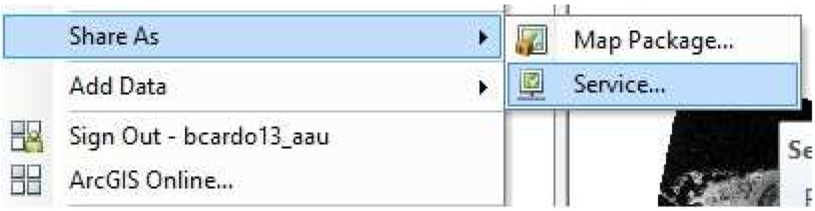


Figure 60 - ArcGIS Share Service

A window opened, where we specified that we wanted to publish a service, afterwards we were shown the location where the service would be published, as well as the service name, as seen in Figure 61.

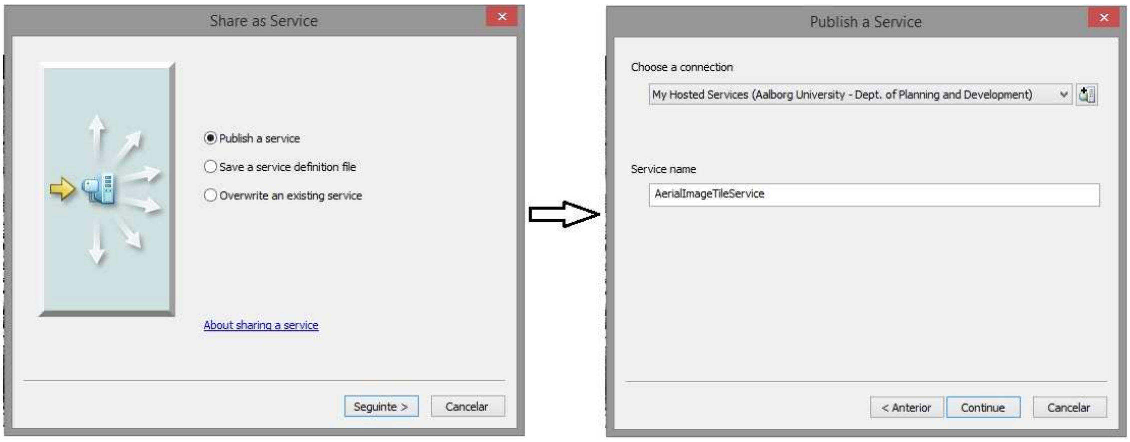


Figure 61 – ArcGIS: Share Service Setting

Continuing, we were led into the *Service Editor*, where we could define the tile settings (Figure 62). Under *Capabilities*, we defined that it was a *Tiled Mapping* that we wanted to create. The *Item Description* and *Sharing* menus are where we could insert the usual titles, tags and descriptors for the data, as well as the sharing options.

Before starting the publishing, we had to run *Analyze*, so the system could check for potential errors regarding the data. When no errors existed, it was a matter of starting the upload process and, when done, go to *Arc Catalog* and search for *My Hosted Services* or directly check *My Content* on ArcGIS Online, to see if the service was published.

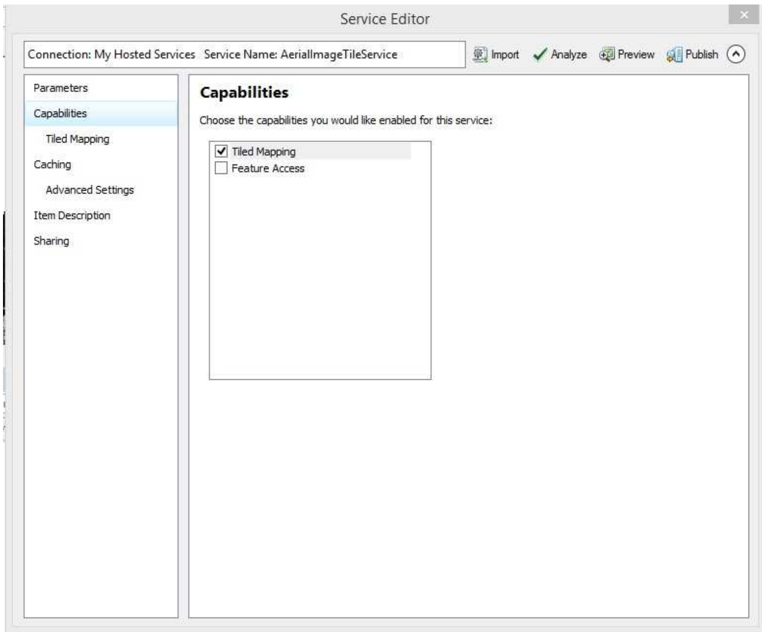


Figure 62 - ArcGIS: Service Editor

3.4.3 Sharing Data on ArcGIS Online

Once the data was online it was necessary to specify the sharing definitions. As a starting point, all the data added is only available to the creator of the data, and will not appear in any type of online search.

Several sharing options exist. It is possible to share items with the general public, within the organisation or groups, depending on the sharing privileges. If shared with the general public the information can be accessed even by anonymous users but, when shared with the organisation or groups, one must be logged on to have access.

To share the information we accessed the data and pressed the *Share* button. A menu opens, and we could choose with whom we wanted to share the data.

The example in Figure 63 refers to the sharing of a photograph. When an image is shared with everyone, an *Image URL* appears, with its online location. This URL was inserted into the *LocationPoints* feature class. This way the image can be accessed via that feature class. This is our way of geo-locating the photographs.

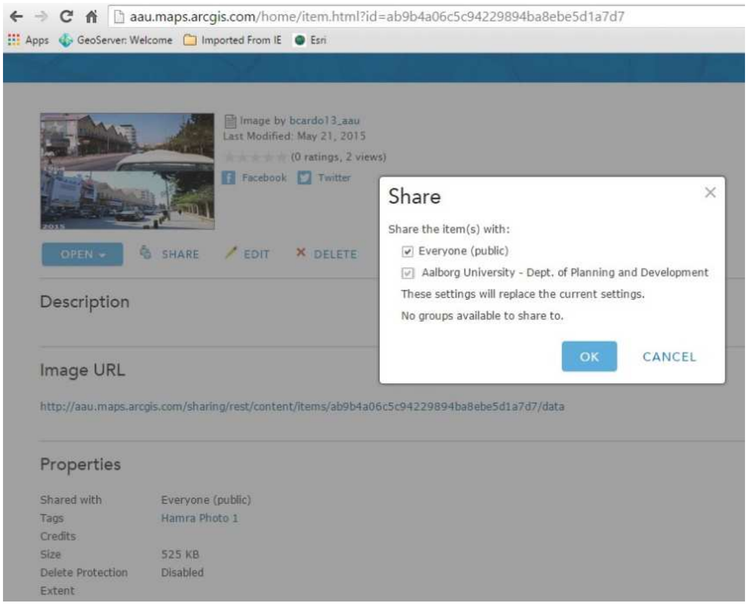


Figure 63 - ArcGIS Online: Share Options

3.4.4 Creating an ArcGIS Online Shared Map

When feature classes are uploaded into ArcGIS online, and shared, they can be accessed by anyone by searching the online library contents. This means that after searching for data, it can be seen that there is data available, which match the criteria and can be added to the map viewer. The data itself is in raw format, that is, no visualisation parameters have been set, and so the user gets the visualisation defaults.

Many times, when someone makes data available, it means that they upload it in order to create a specific map that uses that data. In ArcGIS web maps, one can specify feature class titles, classifications, representation options and create pop-ups for it.

The creation of an online map is as follows:

The first step is to, under the *My Content window*, open the *Create* menu and then choose *Map*, as seen in Figure 64.

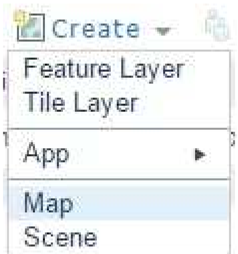


Figure 64 - ArcGIS Online: Create Map

This will open a new map, containing only a default base layer, where we can follow the same procedure as when uploading the data by opening the *Add* menu, and then choosing the *Search for Layers* option. At this point another menu will open where we can see all of the feature layers we have available in *My Content*, and can choose which ones to *Add* to the map

(Figure 65). This workflow is also valid for the adding of the tiled map service containing the aerial image.

Figure 65 - ArcGIS Online: Add Layers to Online Map

After the data is available, we can then start editing its visualisation options (Figure 66). First, if we want to represent a specific attribute we must define it, and then proceed to the drawing style.

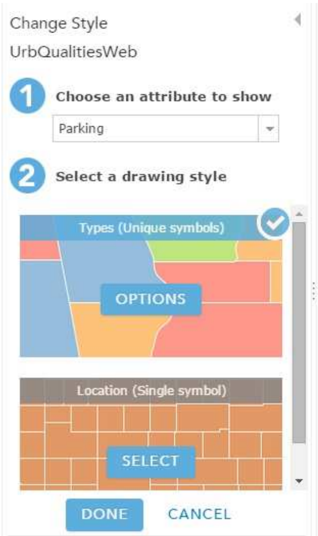


Figure 66 - ArcGIS Online: Change Layer Style

Inside the options we can properly label the feature type, e.g. change the field and feature names, since they are usually abbreviations due to size issues. As an example, we gave the *LocationPoints* feature an alias (*Points of Interest*), that might be better understood by others. You can also choose the colours, both for *Fill* and *Outline*, and set *Transparency* and *Visible Range* (minimum and maximum view scales), as we can see in Figure 67.

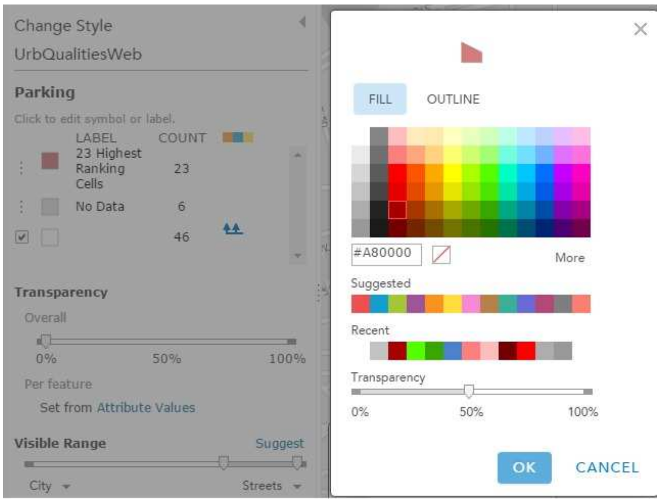


Figure 67 - ArcGIS Online: Edit Layer Style

Another important option is to configure eventual pop-ups for specific feature layers, for instance for the *LocationPoints* (online called *Points of Interest)*. Under the Configure Pop-up option, a menu opens and we can choose which fields we want to show. Also, we can add image hyperlinks when choosing pop-up media, and configure the URL, caption and a link for the full size image. Figure 68 shows us an example from the *Points of Interest* feature layer.

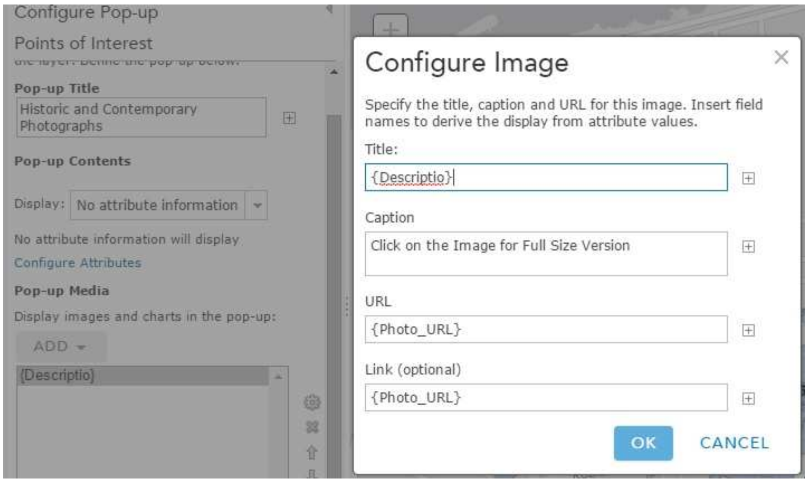


Figure 68 - ArcGIS Online: Configure Pop-Up

Also regarding the *Points of Interest*, it is possible to choose diverse symbols for the point features (which are of qualitative nature in our case), so that the symbol itself can give an idea of what it represents, and not only mark the place of an occurrence. Under the *Drawing Style* options, many different categories appear. For instance, we wanted to represent locations where the photographs were taken, and chose an image of a camera as symbol from the *People Places* category, (Figure 69).

Figure 69 - ArcGIS Online: Choose Point Symbol

To access the map containing all the data regarding Hamra, one has to follow the link: http://aau.maps.arcgis.com/home/webmap/viewer.html?webmap=bb55f8b12c3a48fe8f41a7a5dcb443bf

By doing so, it is possible to see all the layers resulting from our digitisation of the survey analysis, the buildings and parcels from the different time periods, as well as the locations where the photographs were taken, and explore the choices made by us regarding symbology.

Further, we created a Story Map (next chapter). The Story Map synchronises the geovisualisation choices made in the web map, why those choices should be made with a goal in mind and not randomly.

3.4.5 Creating a Story Map

The creation of an Esri Story Map is straight forward. The company offers an app with numerous different templates suitable for different purposes. Since you are sharing data that has already been created and uploaded to ArcGIS Online and where the symbology for the layers has already been chosen, all that is required is to choose which template is most suitable for the purpose, and consider the option of adding photographs, videos and other features than can enhance the storytelling (Esri (i), 2015).

For our purpose we chose the template "Story Map Series", because it is suitable for large datasets and for showing change in data over time (Esri (j), 2015). The app presents the chosen data with a series of tabs or buttons at the side or top. When opening a new tab, the user will be presented with new information in maps, text and or/images.

The "Story Map Series" further offers three layouts: *Bullets, Tabbed* or *Side Accordion,* of which we have chosen the latter, since it provides the best overview when there is text for each layer.

Our Story Map

Our Story Map **"Hamra of Beirut Revisited"** can be accessed here: http://arcg.is/1dWkhSI

The story map can be accessed by anyone via the link and works on smartphones as well.

We named our Story Map after the subtitle of our thesis. Since we had already made the entire digitised dataset available on *ArcGIS Online* for anyone (with an Esri license) who wants to explore the data and possibly work with it themselves, we wanted the Story Map to tell the story behind the project. We wished to communicate the story of Hamra as well as the historic dataset and our work in a simple way to a more general audience.

We therefore chose to begin our Story Map with an image of the original maps as we received them and a short text about the background of the project Figure 70.

Figure 70 - The opening page of our Story Map is a picture of the original maps and an introductory text

The remaining tabs (or layers) show the development in layout through time, the Points of Interest with the pictures and two examples of chorograms.

For all the ***City Layout*** **layers** (Figure 71) we have a simple basemap, the "Light Grey Canvas" offered by Esri. We wanted to have a background that represents the modern city of Beirut, since all our data is historic. At the same time we wanted the background to be simple, as to not confuse and distract from the story we want to tell.

For the same reason we kept all the *City Layout* layers in the same neutral colours (brown and blue). While going through these layers, we want the audience to notice the increasing number of buildings. If the layers were in different colours it could take focus from this fact.

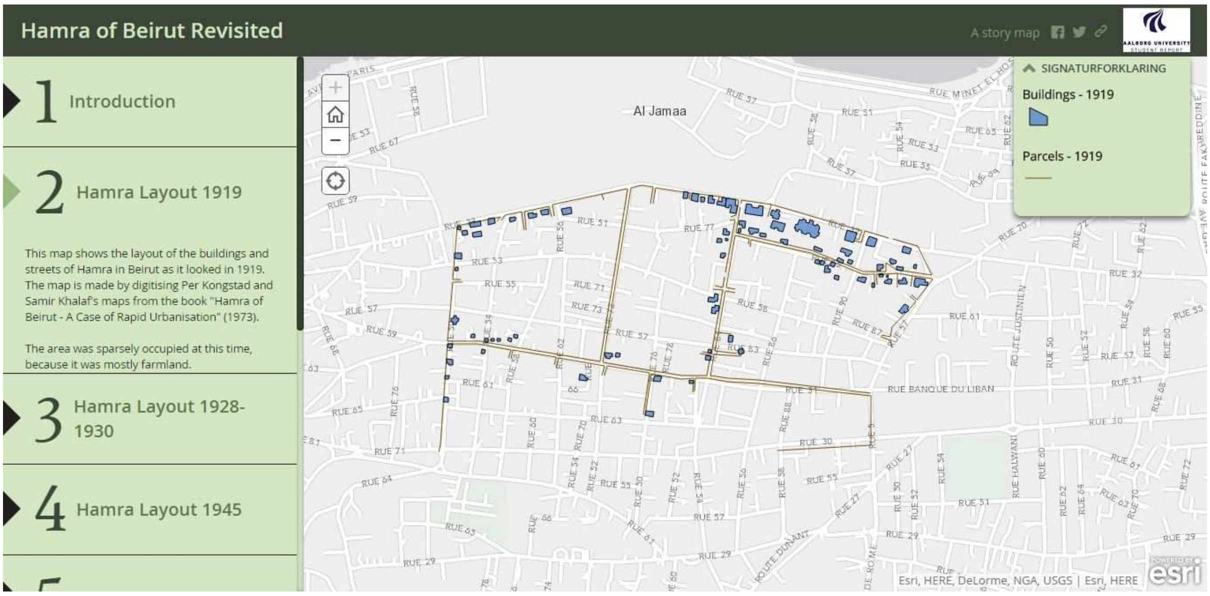


Figure 71 - Story Map, City Layout layers

The two **chorograms** (Figure 72) that we chose to include were the ones we considered of more "popular" interest: *Private Gardens* and *People Living in Luxury Apartments*. For a general audience, these are probably more relatable than net density or floor-space ratios in 1967.

The chorograms are in vivid colours and we chose to put them top of the aerial image from 1963, in order to create more dynamic and interesting layers after the homogenous *City Layout* layers. In the text we invite people to reflect on the development of the area since the 1960's.

Figure 72 - Story Map with a chorogram of private gardens

The final and very important thing that we wanted to include in our story map, was the **Points of Interest** layer (POI) (Figure 73). As explained in the previous chapter, the POIs are represented by a camera symbol so that their purpose is easily understood and the text in the tab prompts the user to click the cameras to release pop-ups with photographs and descriptions. The decisions regarding visualisation of the view angles have already been addressed earlier in the implementation chapter. For this layer we used the "Light Grey Canvas" as basemap, so that it is easy for the user to orientate herself regarding the location of the images. This is the only layer that includes data outside of Hamra itself, but all features are still within the view on start-up.

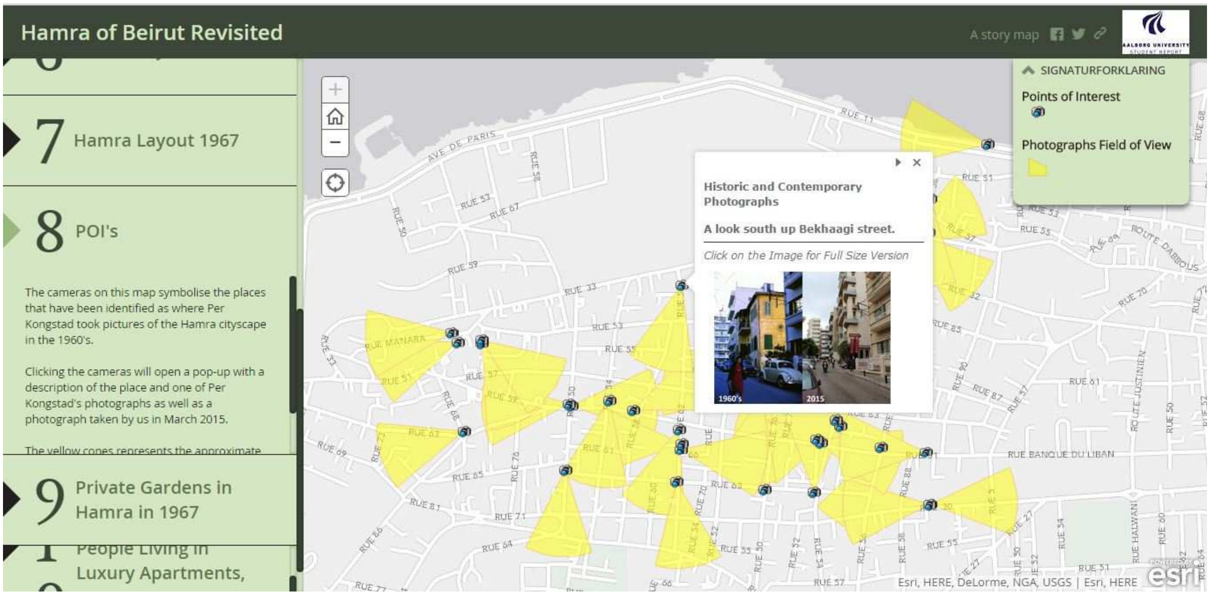
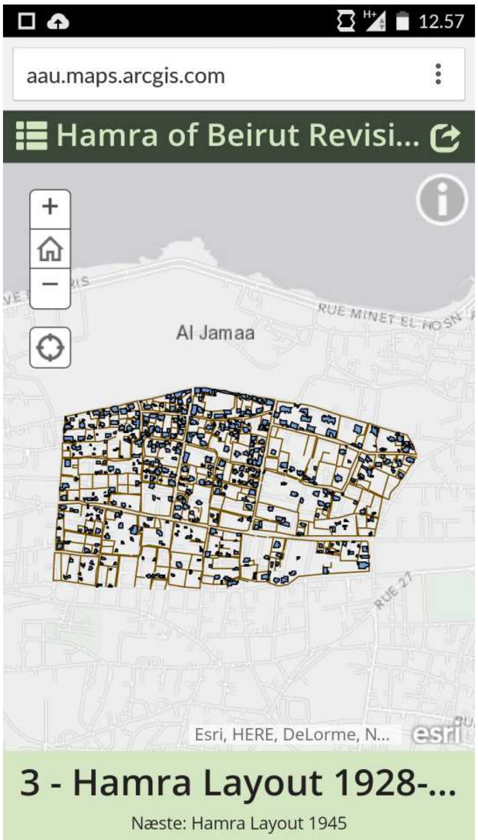


Figure 73 - Story map, Points of Interest Layer

Besides from choosing the template, data, symbology and text for the story, one has few options regarding the layout of the Story Map. You can choose between a number of colour themes, the size and position of the side accordion and the order in which the tabs appear. We replaced the Esri-logo with the student logo from Aalborg University. It is further possible to include some standard web map elements such as a search bar, locator map and a locator button (will only work in Beirut) and a legend. We chose to add the legend and the locator button. This way people in Beirut can see where they are on the map.

The web app also works on smartphones and is accessed through the same link. Therefore, and particularly for the images, the locator function will add an extra element, as you can stand on the spot where the picture was taken and see what the place looked like in the past.

The layout in the app is slightly different due to the screen size (Figure 74 and Figure 745). You precede through the story by swiping through the tabs at the bottom of the screen. The legend and information is accessed by pressing the "I" icon in the upper right corner of each map.



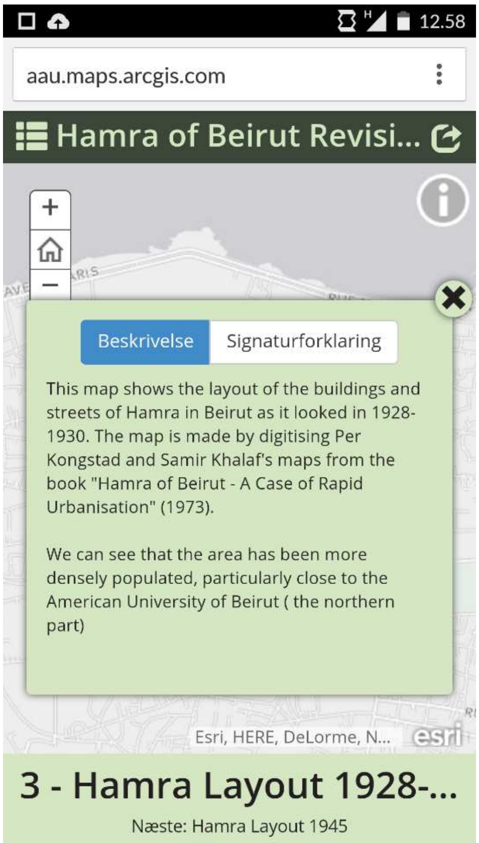


Figure 74 - The story map information tab opened

Figure 75 -The Story Map on the and smartphone

Disadvantages:

For our project, the Esri Story Map offered all the functions we needed to make a simple Story Map. The only major disadvantage is that the zoom level is controlled by limitations of the basemap and it is therefore not possible for the user to zoom further in than as seen in the figures above. On the computer, it is however possible to zoom out and pan around the map by dragging with the mouse. The zooming restrictions do not apply to the mobile app.

3.5 METADATA

As soon as the feature classes were ready, and before uploading them, it was time to edit the metadata fields. Since the data was intended from the beginning to be shared with others, we had to be sure that there would not be uncertainties regarding its contents, which is why metadata is important.

To view and edit metadata with ArcGIS we accessed the *description* tab available in ArcCatalog (example shown in Figure 76). Starting the editing process, we were then able to fill the fields summarising the contents, whom to credit for the data and contact in case of doubt, limitations, reference system and, most importantly, describe the contents of each attribute field.

The information about the attribute contents was particularly important when it came to the analysis layers. Since these contained already classified information presented as text fields, it was essential to describe what it refers to. In Appendices H to J we show the contents related to the attribute fields that we have added to the feature classes' metadata.

We have also adjusted our metadata files to the ones received from the Neighborhood Initiative when we started this project. This way we made sure that whey would receive information in a way they were used to. We paid particular attention to the field descriptors, and mimicked their style.

Since filling out the metadata fields is time consuming, we were able to import already filled metadata from some feature classes into others by using the import option. Besides saving time, it also prevents fields which should have the same information from diverging due to typos.

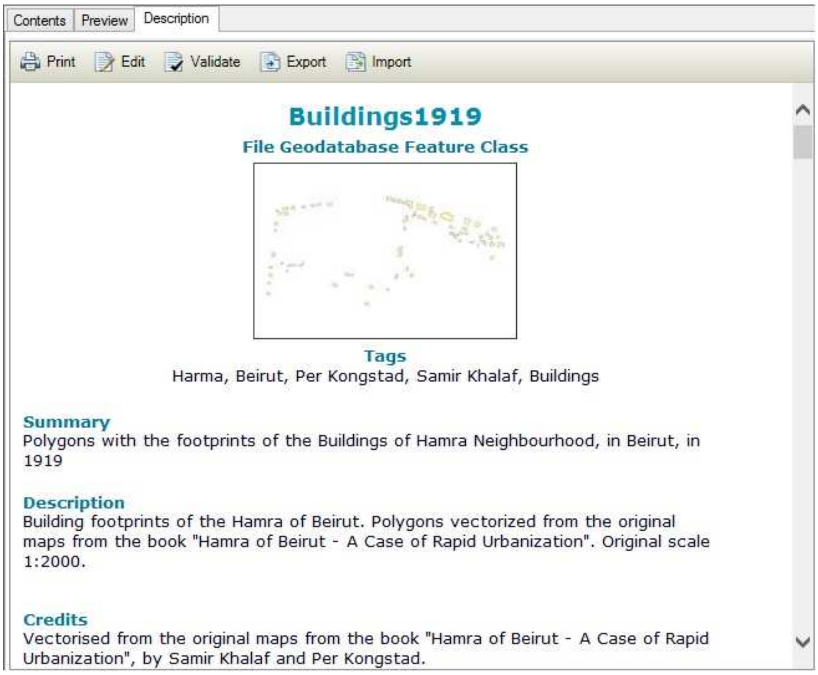


Figure 76 - Metadata Editor

The thumbnail seen in the example, was created under the *Preview* tab, and by pressing the *Create Thumbnail* button. Thumbnails are important because they allow the user to quickly have a general idea of the data contents without having to scroll through the metadata fields.

4 DISCUSSION

All the steps taken in this project had the double purpose of integrating cartographic data, belonging to the book “Hamra of Beirut – A Case of Rapid Urbanisation”, into the digital era, and prepare it to be used by third parties. Another objective was to locate places in Hamra where photographs were taken by Per Kongstad during his fieldwork in the 1960’s, and take new photographs for comparison. Lastly we wanted to share the outcome with a variety of users. An agile methodology was applied from the beginning and it proved to be a good and necessary choice. This is particularly because of the inclusion of fieldwork in the project, the outcome of which we could not predict from the beginning and which helped determine the amount of data we had to work with in the end.

Naturally, the project did not succeed without some degree of adversity which will be discussed in this chapter along with the many reflections evoked by the project work.

4.1 AUTOMATION PROCESSES

In terms of work practices for the vectorisation of the map data, our first aim was to make an automatic process for creating all the vectors. For this purpose, we automated a workflow in ModelBuilder for preparing the rasters for the vectorisation process for which we were hoping to use ArcScan.

As mentioned in the previous chapter, this was not successful. Firstly, we had scanned the maps in RGB colours and then in black and white colour scheme. The latter had much better results for the intended purpose. It is interesting to see how the human eye perceives the colour scan better (for distinguishing details in the image), while black and white suits the specifications of ArcScan vectorisation settings best.

With a quick search online it is possible to notice that several other software are available for automatic vectorisation. Never the less, most of them were not specifically designed to convert scanned maps. We opted to use the ArcScan extension since it was a part of the system in which we intended to deliver the final data, avoiding further data conversions.

In our opinion the major limiting factor in the automatic vectorisation is the fact that the features to vectorise were mainly straight lines with sharp angles. It is easier to hide any small discrepancies, if the features are flowing lines with some curves like, for example, topographic lines, which seem to be given as example in the software helpdesk.

With straight lines, any light variations in the map scanning or change in the software vectorising parameters, will be perceptible to the human eye.

Another important aspect to consider is the notion that *automatic* is not always necessarily better then *manual*. We fine-tuned ArcScan settings for a while and never managed to get a result that allowed us to save vectorisation time when comparing to the manual process, when keeping the quality of the end product in mind.

4.2 ACCURACIES, INACCURACIES AND WHO TO TRUST

We chose to trust and follow Kongstad's maps, when it came to discrepancies between his data and other sources. For example, some parcels were slightly offset from the position they had in the original 1964 cadastral map. This situation could not be derived from map distortion since that would inflict a remaining distortion from that parcel onwards, but in fact adjacent parcels were in place. This probably results from shifting during the hand-tracing of the maps. It is possible that the paper shifted slightly from time to time.

Buildings in the original maps were not necessarily orthogonal, because they were traced manually and by eye, which means that maintaining an accurate 90^{o} angle is almost impossible. Of course, when using modern software these issues are much easier to notice because we can zoom much further than the original scale of 1:2000 and precisely vectorise over the raster. We cannot forget that the accuracy of the data can never be better than its original scale and, at 1:2000, these orthogonality issues are barely noticeable (Gregory, 2005).

Since the aim of our project was to digitise and present Khalaf and Kongstad's work, it was easy to decide to trust their data.

The aerial image we have uploaded also seems an interesting added value. We are aware that it is a stitched image, but we expect that the 3^{rd} degree polynomial will mitigate the existing inner distortions. Again, and since it is not orthorectified, its usability is only for viewing purposes but, since the maps are in 1:2000, the image fulfils the task just fine.

All the analysis layers refer to the late 1960's, for which the possibility of having an image from the same time period might instigate the viewers to try and see if it is possible to discover spatial patterns by looking at it, making the online experience more interactive.

4.3 VALUE OF THE PHOTOGRAPHS

In the section about urban memory, photographs and maps, we encountered how historic data such as maps and photographs, can be instrumental in telling the stories of an urban neighborhood and strengthen the sense of community, particularly if exhibited or otherwise integrated in the public urban landscape. David Lowenthal notes that although such initiatives can require and benefit from instigation from institutional agencies, and monitoring from those experienced in translating memories and history into visual and tangible forms (such as the Neighborhood Initiative), they must be rooted in and renewed by public inspiration and creativity. Like the definition of memory by Berger and Mohr, it must be subjective to be continuous, i.e. not imposed from outside. Otherwise the efforts will be wasted. Instead of lasting enrichment, it will seem alien to the public and stay superficial and ephemeral (Lowenthal, 2001).

Another example of this is from the book "Another Way of Telling" (Berger & Mohr, 1982). Berger and Mohr explore through photographs and essays, theories of how the camera has provided new ways of telling stories. According to the authors, the power of the photograph lies in the close association with memory. Photographs, even in sequential form, are retrospective as opposed to films, which are anticipatory. When it comes to telling stories with photographs, what is a truly photographic narrative form? Sequential photographs in the form of reportage photo-stories are narrative, but they often narrate descriptively from an outsider's point of view because they are produced by photographers who are send to various places to bring back stories of events in the form of photographs. This way, a photographic reportage of a city, tells the story of the photographer and what he/she saw there, not of the people living the event in the city (Berger & Mohr, 1982). This too is something Lowenthal perceives as problematic. As a reminder, regarding the narratives filling up the pages of the urban memory, he states that: *"The pages of urban memory deserve to be enriched with quotidian variety, telling city stories of every kind"* (Lowenthal, 2001).

It is thus essential to consider, if this is the case with the photographs by Per Kongstad? Do they represent and outsider's view? If so, could it be a weakness of the photographs for this purpose? They tell the story of what he saw, but what did he see? The exact purpose of Kongstad's hundreds of photographs of Beirut is unknown, particularly since the few photographs that were used in the book (Khalaf & Kongstad, 1973) are not taken by him and are not amongst the photographs that were saved and that we acquired. But Kongstad did not photograph specific events or views (only in few cases). He photographed the streets and buildings where he was living and working, possibly in order to ensure his memory of the city, once at home in Denmark and working on the book. In the process of photographing the streets he captured scenes of the everyday-life of Beirut. According to the biography in Appendix A the intensive photographing he did was rooted in his studies and interest in the characteristics of the town houses. Now, after the many drastic events that have been and are taking place in the urban landscape of Hamra, these photographs have acquired a new value that was not originally intended (Lowenthal, 2001).

The new photographs, taken by us in March 2015, represent what we have seen in Kongstad's photographs. Just like the digitisation of the maps, they represent our interpretation of how Kongstad perceived the city, and were the same photographs to be taken by a local Hamra resident, there would possibly be clear differences in the foci. However, although the focus has been the urban transformation from then and now, they too capture the mundane activities in the streets of Hamra and hopefully they can be instrumental as a reminder that Beirut is not only a financial capital but also an every-day place.

4.4 The Internet as a Public Platform

As discussed, collaborative projections of memory in public spaces can be used to enlarge a sense of self and community by commemorating urban social pasts (Lowenthal, 2001). Since we were only in Beirut for the actual data collection and not for the last part of the project, our only option for exhibiting the results in a public space is via the internet. Fortunately today, there are easy and educational ways of doing this, in which geographic data and other graphics are easily merged to please an audience of a wide variety.

To share our project, we chose to use ArcGIS online for the purpose of concrete data sharing with people who are interested in actual analysis or mapping. To reach a wider audience to whom the *story* of Hamra is of greater interest, we used Esri's Story Map function. Modern smartphones take the projections of memory further into the public spaces by allowing the residents of Hamra to bring it with them to the streets and watch the historic pictures from the actual points where they were taken.

Although ArcGIS Online can be used as a standalone application for storing and sharing information, the process of creating and editing data is still much more powerful in the desktop version.

Although the internet has few limits, it does not reach certain groups of an older generation who are not accustomed to using the internet. Many long-term residents of Hamra can be expected to belong to this group, and it would therefore be optimal to display the data in ways in Beirut. Hopefully this can be done in the future.

4.5 LANGUAGE AND COMMUNICATION

We personally believe that our product is lacking in communicating the story in other languages than English. The official language of Lebanon is Arabic, thus the story should (also) be told in Arabic. Besides Arabic, French is generally spoken and understood because of the country's history as a French mandate, which is still evident in many street and place names (Gyldendal b, 2014). A great improvement of the product would be the translation of all attributes, names and information into Arabic, particularly when it come to the Story Map. As such, the data for the AUB does not have to be translated, since it is an American university where English is the spoken language.

None of the writers of this thesis possess Arabic or French language skills. Our linguistic input has been the translation of the photographic slide notes from Danish into English. We hope that in the future someone with the right skills will enrich the data with Arabic and possibly French translations to further broaden the horizon of the data.

The names of feature classes and layers were decided by us, and should explain clearly what they represent. We experienced that it is imperial to consider naming conventions from the beginning of the project, particularly which names you want to use in the end to present the data to other people. Within this thesis, confusion could occur for the reader, as some names reappear in different contexts, and some elements have changed names between being stored on our desktops and being made available online. As an example, we used "POI" (points of Interest) during our survey as the name of expected location of photographs that we were interested in visiting. We later decided that in the Story Map "points of interest" was the best way of describing our points in the *LocationPoints* feature class, which represent the locations where photographs were actually taken. Those points should be intriguing for the user of our Story Map and urge him to explore and click the points. We imagine that it is further confusing for the reader that the original feature dataset on our desktops containing the *LocationsPoints* and *ViewAngles* is called "Points of Interest". The names make sense in all the contexts, but can be confusing for the outsider who reads this and wish to work with the data. However, for the individual user of the Story Map, it is not a problem since they will not be aware of this process of changing names.

4.6 VISUALISING THE RESULTS

Visualisation on a computer has an interactive aspect which is not possible in a book. Furthermore, books have always had restrictions when it comes to colour printing, particularly older books. Visualisation is imperial for the understanding of spatial classification, and therefore the use of symbols and colours is vital in this field. Digital data can be easily and repeatedly manipulated, in order to achieve better visualisation displays. Although there are rules that should be followed when making cartography, often the choice of colour is purely a matter of personal taste. Therefore digital web services such as ArcGIS Online is an easy way for users to make maps in their preferred style.

Esri's online services is somewhat restricting regarding zoom levels and drawing performance. The drawing issues relate to the amount of features and not size of the features in a layer. Merging features in a feature class (so that there are fewer rows in the attributes), eases he drawing abilities. As an example, we merged the line features per block (in the feature classes representing the parcels) and the drawing performance improved significantly.

4.7 COORDINATE SYSTEMS

One of the aspects that caused the most trouble is relating to the coordinate system used in Lebanon, the Deir ez Zor/ Levant Stereographic. When we received reference data from the *Neighborhood Initiative* we checked for the coordinate system they used, since it would be preferable to deliver our results in the same reference. At the same time we noticed that the 1964 cadastral map that Kongstad used as reference was in this coordinate system, which would make intermediate projections unnecessary.

After producing our cartography we crosschecked with the *Neighborhood Initiative*'s data and it matched perfectly. However, when uploading the data, we noticed a mismatch between the online basemap and our data (as well as between the online basemap and the *Neighborhood Initiative*'s data). We inquired different sources and were informed that there is a shifting parameter to convert this coordinate system into international coordinates. We are still waiting to know the correct x and y values, so we have opted to move all the data 90 metres towards east, in order to align it with the online basemap for a better presentation.

As for the aerial image we used the shift tool, which allows for manual shifting just by adding the x,y displacement values, to move it same the distance.

All data presented online uses the WGS 1984 web Mercator (auxiliary sphere) coordinate system, therefore a datum change would have to happen if correctly transforming from Deir es Zor. Since the datum change did not place our data in the correct place, we have opted for simple x, y shifting until we have all the details for the conversion.

This issue made us aware of one of the oldest cartographic problems, which is correct placing of data. Since we are not locals, we did not have inside knowledge on this issue, and could have finished unaware of it. Since software perform conversions between projections, and have almost any projection stored in their content databases, most users rely blindly on the mathematical operations performed automatically. They are of course correct, but may need some previous knowledge of the projections. The software always projects from one coordinate system into another, since it is running a mathematical operation (transformation), but that does not mean that it moves features correctly.

In the web display, some distortion occurred to our data. As shown in Figure 77 the same data, when visualised through the browser (right image), shows distortion. The problem only occurs in the browser, not in the desktop, even with an online basemap.

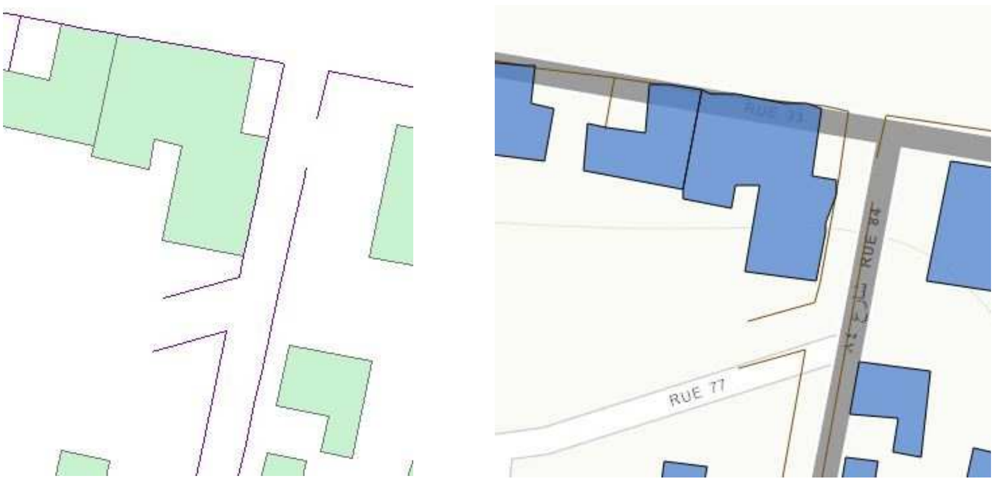


Figure 77 – Online Feature Classes Display Distortions

For the Neighborhood Initiative, we will deliver the maps in their original coordinates and location (before shifting/moving). If/when we get the right parameters, we will fine tune the data to international standards.

4.8 Adding Historic Value

It seems to us that the added value of this project is the ability to integrate hardcopy data into today's softcopy world. The ease of access to mapping software that has been running in parallel with the digital revolution of the last 30 years, has allowed many private individuals to be map creators and explorers themselves and make new content available online. Anyone with a minimum of informatics skills can think of some personal interest that he would like to make cartographically available, for instance, a map of the places he visited during a touristic trip to China.

The amount of data that can be searched online is immense, as we can easily notice if using one of the most famous mapping platforms, Google Earth[5]. Layers of information from many providers and regarding a variety of subjects are made visible and query-able. This may lead us to thinking that by simply browsing we will have access to everything, and we might forget to ask where the data came from and how it was created.

There are certainly huge amounts of old maps, made for several purposes that, if digitised, could bring added value to today's world. Issues like urban planning can greatly benefit, from making comparison. Although this might be a disappearing discipline, since new content is constantly designed digitally, one should not forget that the world is full of archives that may be storing data that can enrich many fields of research.

The analysis grids, even if they show classified results, can be used for quick referencing in contemporary studies. One could even make direct comparisons by overlaying the same grid on contemporary data input. The book thoroughly describes the parameters for the different analyses, and those can be matched by collecting the same data today. Some of the subjects studies by Kongstad and Khalaf are also of interest today and data could be available to the *Neighborhood Initiative*. It is therefore our opinion that even with the restrictions that come with the dataset, making these maps available can be of use for other studies.

4.9 Additional Kongstad Material

By the end of the project, additional data appeared, as we got in contact with Mette Mønsted, Per Kongstad's wife. Supposedly, it includes all of Per Kongstad's notebooks and other "unidentified" material. On his slides and maps, Kongstad's regularly made references to his notebooks. We have mentioned this before, as well as how valuable it would be to explore this material. We do not know the exact contents of these notebooks, but it is possible that it could change the perception of the analysis and even create new content to be visualised in today's digital world. For example, if we could know how many floors each building had in 1967, we could create 3D polygons for the buildings, and therefore create a simple 3D model of Hamra, that could be compared with today's skyline.

The analysis content could also be explored in many new ways. As for now, we could only mimic the final grid classifications but, if we knew the exact values for each of the buildings, many other comparisons could be made.

Plans regarding permanently transferring the physical material from Denmark to Beirut, are currently being evaluated. It appears to be in the interest of all parties involved, and the AUB archives have offered to store the data. This would bring the material closer to its original origin, and be more easily accessible for those who live in and do research on Hamra and Beirut.

[5]Google Earth: https://www.google.com/earth/

5 CONCLUSION

In this thesis we have researched how historical maps and photographs can be integrated into a modern context with GIS. The goal was to facilitate studies of urban development as well as to present the specific case of Hamra of Beirut and its story to the public.

In the process we have explored topics regarding digitisation and database integration of historical data. We have explored theories of urban memory and conducted fieldwork to collect comparative data from the modern urban landscape. In order to create awareness of the project, we have shared our results in a variety of ways, for different audiences. In this regard, new ways of visualising old material have been explored.

All goals were achieved successfully and we even managed to share the results in a number of ways for different purposes.

Along the way we experienced great engagement and interest from a wide variety of people, from those involved with the *Neighborhood Initiative* as well as from people in the streets. This engagement underlines the worth of the project. We were proud to reintroduce this material to Hamra, and resume the cooperation between Denmark and Beirut which was initiated by Per Kongstad and Samir Khalaf 50 years ago.

5.1 PERSPECTIVES

Our initial involvement with the *Neighborhood Initiative* is done for now, but we are still in contact with the initiative, and Hamra and its history persists. New materials have appeared, and should be researched in the future. Optimally, all the physical material will return to their birthplace, but we hope that our digitised work will also be of further use for others.

We have shared the data in the ways available to us from here. We hope that some of Kongstad’s photographs and maps will also see other ways of sharing in Hamra, as to reach a broader part of the Hamra population and aid in commemorating the urban social past.

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APPENDICES

APPENDIX A: PER KONGSTAD'S BIOGRAPHY. TEXT BY "NN"

The following text was provided to us by Rasmus Ole Rasmussen, but the author of the text is unknown.

Per Kongstad (1928-1988)

Per Kongstad was born in 1928 in the fishing town of Esbjerg in the South-western part of the Jutland Peninsula in Denmark. He enrolled in the University of Copenhagen and studied geography parallel to working as a student assistant in the secret service. He completed his extended Master Thesis in Economic Geography in 1958 with a thesis on the Geography of the Transport System in the Soviet Union.

He was attached to the Institute of Geography at the University of Copenhagen in 1960-61 and in this connection got linked to the Department of Foreign Trade at the Copenhagen Business School. He, however, continued his assignment to the Institute of Geography at the University of Copenhagen as lecturer and researcher during the period 1965-70. But his life took an important turn after doing several field works in Beirut – activities that among other led to becoming a Visiting Professor at the American University of Beirut in 1970. He sought to Beirut to pursue a theme he became interested in the mid-1960s: economic geography with a focus on urban development and segregation processes in Beirut. The city was at that time a thriving Levantine city under a process of growth. And at the American University of Beirut, he found partners for long-term cooperation on a project on urban development in the district of Hamra. The first result was a book that not only focused on the immediate development in the central business district, but also on Beirut's exciting and eventful history, and with focus on the accelerating Urbanisation process and the determinants herein.

In the initial period of residence in 1963 he was takin off through method studies aiming at capturing the characteristics of the town houses and systematization of these, an activity he pursued together with a colleague and friend at the American University of Beirut, Samir Khalaf (Khalaf & Kongstad, 1973). And an activity he was furthermore documenting through intensive photographing.

Middle East at this time showed a complexity of violent contrasts both in terms of nature, economy and politics. And as a consequence of his research he became increasingly interested in the development and modernization prospects, not least inspired through his cooperation and close friendship with Samir Khalaf.

In 1971 Per Konstad came to the Centre for Development Research in Denmark where he was involved in projects originating from the World Bank, but also involved in the development prospects as seen from OECD perspectives after his return in 1963 where he became involved as a research fellow in an interdisciplinary research group initiated by the then Director General of OECD (1961-1969), Thorkil Kristensen (Kristensen & Associates, 1960).

The development of the research in Beirut led after the first period of field work in 1963 to a continuation of the contacts to the American University of Beirut where his research activities pursued a combination of approaches to land use mapping which included the classification of buildings and functions, and a series of interviews which led to new approaches to his devotion to classification methods. The field work and the book "Hamra of Beirut, - A case of Rapid Urbanization" was theoretically influenced by the American "urban social ecology" approach and was further developed with J. Abu Lughod as an inspirational party. A major study was planned jointly between the Beirut American University and Princeton University, but in connection with the June 1967 conflict the project lost the American sponsor's attention, not only in relation to Beirut but more generally in relation to the increasingly volatile Middle East.

In the late 1960s, the debate about critical geography became increasingly active in Denmark, and Per Kongstad was through his international commitment very active, especially in relation to developing country research and rural development, which he was given the opportunity through his involvement as head of research at the Centre for Development Research in 1971 and the resumption of the cooperation with Thorkil Kristensen.

Per Kongstad then moved to Roskilde University where innovative learning approaches – project work, group work etc. fitted very well into his ideas of learning processes. He became Vice Rector for a 5 year period from 1981 to 1986.

Per Kongstad turned during the late 1970ies and the 1980ies his research focus on East Africa - Kenya and Tanzania – emphasizing the opportunities for regional development and industrial and professional development with particular focus on small-scale industries in newly industrialized countries, including the role of the market and retail sale as driving forces in the development process. Increasingly the role of training and qualification as drivers of development throughout the 1970s until his death in 1988 brought him into several projects for the Danish Development Agency (DANIDA) where he and his wife Mette Mønsted became trendsetters in relation to innovative rural development approaches, where his last work was the evaluation of Danida's experience with the support of education in land use mapping and management, architecture, and small scale settlement development. And he was in the midst of a DANIDA evaluation project when he died unexpectedly in the spring of 1988.

Referenced literature:

Thorkild Kristensen and Associates (1960) The Economic World Balance. Copenhagen/Amsterdam: Munksgaard/North Holland Publishing Co.

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Kongstad, Per and Mønsted, Mette (1980) Family, Labour and Trade in Western Kenya. Uppsala: Scandinavian Institute of African Studies.

Hayuma, A., Saidi, G., Petersen, E., Kanja, G. , Tumbo, R., Shilungoshela, J., Friis, P., Rasmussen, R., Nkya, I., Krinde, L. (1988) Land Development Manpower Survey. Vol. I-III. Roskilde: Institute for Geography, Social Analysis and Computer Science.

Excerpts of this overview of the Life and work of Per Kongstad have been reproduced and translated from: Mette Mønsted and Peter Friis (1999) Per Kongstad – Influence on a generation (In Danish). In Sven Illeris (ed): Danske Geografiske Forskere. Roskilde Universitetsforlag.

APPENDIX B: INVENTORY OF THE ORIGINAL MAPS

(Given) Name of Map	Year	Type	Notes	Number of Copies
Ras Beirut - After Julius Loytved	1876	Transparent	With delimited Hamra Area	2
Ras Beirut - After Julius Loytved	1876	Paper	Original Scale 1:12200	1
Beirut Hamra District - British Army Survey	1919	Transparent		2
Hamra District - British Army Survey	1919	Transparent		1
Hamra District - British Army Survey	1919	Paper		3
Beirut Hamra District - From Cadastral Plan of Beirut	1928-1930	Transparent	With Buildings Filling	4
Beirut Hamra District - From Cadastral Plan of Beirut	1928-1930	Paper	With Buildings Filling	3
Beirut Hamra District - From Cadastral Plan of Beirut	1928-1930	Transparent	No Building Filling	2
Hamra District - From Geographical Service F.F.L	1945	Transparent	With Buildings Filling	2
Hamra District - From Geographical Service F.F.L	1945	Transparent	No Building Filling	1
Beirut Hamra District - From Cadastral Plan of Beirut	1955	Transparent	With Buildings Filling	3
Hamra District - Kongstad Land Use Survey	1964	Transparent	With Buildings Filling	1
Hamra District	1964	Transparent	No Building Filling	1
Hamra District - "Work Map"	1964	Transparent		1
Hamra District - "Original (?) Work Map"	1964	Paper		1
Beirut Hamra District - Per Konstad Land Use Survey	1967	Paper	With Building Filling	2
Beirut Hamra District - Per Konstad Land Use Survey	1967	Transparent	With Buildings Filling	5
Beirut Hamra District - Per Konstad Land Use Survey	1967	Transparent	No Buildings Filling	1
Beirut Hamra District "Work Map" Hamra Land Use Survey	1967	Paper	With Grid; Notes from 1970	1
Beirut Hamra District "Work Map" Hamra Land Use Survey	1967	Transparent	With Notes	1
Beirut Hamra District - Per Konstad Land Use Survey	1967	Transparent	With Grid; Cell Unit 6400sqm; With Buildings Filling	2
Beirut Hamra District - Per Konstad Land Use Survey	1967	Paper	With Grid; Cell Unit 6400sqm; With Buildings Filling	1
Beirut Location of Hamra District Main Features; KU	1970	Transparent		2
Milimetric Paper		Transparent		1
Cadaster Map with Numbers		Paper	No more info	1
Cadaster Map with Numbers		Transparent	No more info	1
Old French Topographic/Cadaster map		Transparent		1

APPENDIX C: EXTRACT OF THE PHOTOGRAPHIC SLIDES INVENTORY (TOTAL OF 421 SLIDES)

Box	Image number	Location	Descritpion - English	Description - Original	Date	Notes on Image	Picture of slide (number)	Drawing
1	005, 006	Beirut	Hamra. Behind the Hamra path (3)	Hamra. Bag Hamra stien (3)	July 1964	Yes	5711	Yes
1	007	Beirut	Hamra. The path towards West. The tall building in the background.	Hamra. Stien mod Vest. Højhuset i baggård	July 1964	Yes. More text we cannot read	5712	YEs
1	008	Beirut	Beirut. (Lady in red)	Beirut. Lady in red	Unknown. Probably 1964	No	No	No
1	009	Beirut	Rue Husseini	Rue Husseini	July 1964	Yes. More text we cannot read	5713, 5714	No
1	010	Beirut	None	None	Unknown. Probably 1964	No	No	no
1	011	Beirut	Ras Beirut. Rue Oman. Ben Rudul Aziz. Near the oldest house in Ras Beirut.	Ras Beirut. Rue Oman. Ben Rudul Aziz. Nær det ældste hus i Ras Beirut.	July 1964	Yes. More text we cannot read	5715	Yes
1	012	Beirut	Hamra. The Hamra-crossing by anglisea-street seen towards south. Old school on the left	Hamra. Hamra krydset ved anglisea gaden set mod syd. (Gammel skole til venstre)	July 1964	Yes	5716	No
1	013	Beirut	The oldest house i Ras Beirut	Det ældste hus i Ras Beirut	July 1964	Yes	5717	Yes
1	014	Beirut	None	None	Unknown. Probably 1964	No	No	No
1	015	Beirut	None	None	Unknown. Probably 1964	No	No	No
1	016	Beirut	Mousseitbeh. From the area Mousseitbeh. PK	Mousseitbeh. Fra bydelen Mousseitbeh. PK	1964	Yes	5718	No
1	017	Beirut	None	None	Unknown. Probably 1964	No	No	No
1	018	Beirut	None	None	Unknown. Probably 1964	No	No	No
1	019	Beirut	None	None	Unknown. Probably 1964	No	No	No
1	020	Beirut	None	None	Unknown. Probably 1964	No	No	No
1	021	Beirut	None	None	Unknown. Probably 1964	No	No	No

APPENDIX D: COORDINATE SYSTEMS

The two text boxes show the specifications of the Deir ez Zor / Levant Stereographic coordinate system (left) as well specifications for the projection file (stereolev) (right) provided by the Neighborhood Initiative (NI). The stereolev projection file is the one used by the NI and the AUB in general. The information is copied from ArcMap in both cases. It is clear from the parameters that the two coordinate systems are in fact the same, only with different names.

Deir_ez_Zor_Levant_Stereographic	stereolev
WKID: 22780 Authority: EPSG	Authority: Custom
Projection: Double_Stereographic	Projection: Double_Stereographic
False_Easting: 0,0	False_Easting: 0,0
False_Northing: 0,0	False_Northing: 0,0
Central_Meridian: 39,15	Central_Meridian: 39,15
Scale_Factor: 0,9995341	Scale_Factor: 0,999534104
Latitude_Of_Origin: 34,2	Latitude_Of_Origin: 34,2
Linear Unit: Meter (1,0)	Linear Unit: Meter (1,0)
Geographic Coordinate System: GCS_Deir_ez_Zor	Geographic Coordinate System: GCS_levant
Angular Unit: Degree (0,0174532925199433)	Angular Unit: Degree (0,0174532925199433)
Prime Meridian: Greenwich (0,0)	Prime Meridian: Greenwich (0,0)
Datum: D_Deir_ez_Zor	Datum: D_levant
Spheroid: Clarke_1880_IGN	Spheroid: Clarke_1880_IGN
Semimajor Axis: 6378249,2	Semimajor Axis: 6378249,2
Semiminor Axis: 6356515,0	Semiminor Axis: 6356515,0
Inverse Flattening: 293,4660212936265	Inverse Flattening: 293,4660212936265

APPENDIX E: EXAMPLE OF FIELDWORK MAP

A map used for fieldwork in Beirut. The basemap is a cadastral map from 1964 with KOngstads handwritten notes on. It is overlaid with street features labelled with street names, provided to us by the Neighborhood Initiative. The green dots represent over points of interest for the fieldwork and are labelled with the “old photo number”.

Date					
Old Photo Nbr.	**Location Nbr**	**Field Photo Nbr**	**Direction of Photo**	**Notes**	**Street Name**

Appendix G: Final Survey Sheet, Containing Identified Locations (rows in red were not included in the final product)

Old Photo Nbr.	SurveyLocationNbr.	Field Photo Nbr.	Direction of Photo	Fieldwork notes	Street Name	Date of fieldwork
30	1	502-505	W	By AUB	Bliss	16 March 2015
Does not exist	2. Location not included.	506-511	N	The “Chinese” looking house/restaurant	Crossing of Bliss street and Sadat street	16 March 2015
26	3	518-523	E		Crossing of Hamra street and Sadat street	16 March 2015
210	4	524-529	S		Crossing of Baalbek street and Sadat street	16 March 2015
33	5	530-534	W		Crossing of Hamra street and Sadat street	16 March 2015
28	6	538-542	N		Crossing of Baalbek street and Ibrahim Abedl Al street	16 March 2015
221	7. Wrong place, location not included (the right place is location number 21	545-551 (WRONG)	S	Small yellow house with a well. Now a restaurant. We are not sure if this is the same place	Jabre Doumit street	16 March 2015
11	8	552-555	N		Omar Ben Abdel Aziz street	16 March 2015
181	9	556-560	WSW		Crossing of Souraty street and Omar Ben Abdel Aziz street	16 March 2015
242	10	561-564	E		Hamra street	16 March 2015
13	11	565-572	W	"Oldest" house in RB. Taylor Swift Street	Alley off Omar Ben Abdel Aziz street	16 March 2015
294	12	573-575	N		Omar Ben Abdel Aziz street	16 March 2015
12	13	580-583	S		Crossing of Caire street and Hamra street	17 March 2015
220	14	584-590	E		Lyon street	17 March 2015
219	15	591; 597	W		Lyon street	17 March 2015
207	16	598-602	W		Makdissi street	17 March 2015
314	17	621-629	NE		John Kennedy street	20 March 2015
313	18	630-636	SE		John Kennedy street	20 March 2015
312	19	637-645	SW		John Kennedy street	20 March 2015
211	20	646-655	SW		Jabbour Street	20 March 2015

Old Photo Nbr.	SurveyLocationNbr.	Field Photo Nbr.	Direction of Photo	Fieldwork notes	Street Name	Date of fieldwork
221	21	656-657	S		Makdissi Street	20 March 2015
186	22	658-661	E		Hamra street	20 March 2015
218	23	662-668	SW		Nehme Yafet Street	20 March 2015
24	24	669-674	W		Nehme Yafet Street	20 March 2015
225	25	675-682	E		Alley off from Nehme Yafet Street	20 March 2015
37	26	683-691	S		Nehme Yafet Street	20 March 2015
36	27	694-702	NE		Crossing of Hamra Street and Antoun Gemayel Street	20 March 2015
370	28	718-720; 710; 711	SW	The birds. This is probably not the same place. The image is not included.	Parkinglot by the crossing of Cheikh Elias Gaspard Street and Mahatme Ghandhi Street	20 March 2015
45	29	721-723; 724-733	S	Taken from the roof of the Plaza Hotel. Possibly not the right building. Should be one building further S.	Crossing og Hamra Street and Mahatma Ghandhi Street	20 March 2015
34	30	735-741	WNW		Crossing of Kuwait Street and Zaki Mazboudi Street	20 March 2015
222	31	746-757	SW		Najib Ardati Street	20 March 2015
231	32	758-767	WSW		Mahara Street	20 March 2015
212	33	772-778	ENE		Adonis Street	20 March 2015
214	34	779-781	SW		Alley off from Mansour Jurdak Street	20 March 2015
35	35	923-931	W		Hamra street	26 March 2015
311	36	934-939	S		George Port Street	26 March 2015
8	37	1278-1281	S	"lady in red"	Bekhaagi Street	26 March 2015
279	38	944-958	W	Former fishing quarter, exact location not certain.	The Corniche	26 March 2015

APPENDIX H: TABLES SHOWING THE FEATURE CLASSES OF THE *CITY LAYOUT* OF HAMRA

Table h1: 1919 City Layout

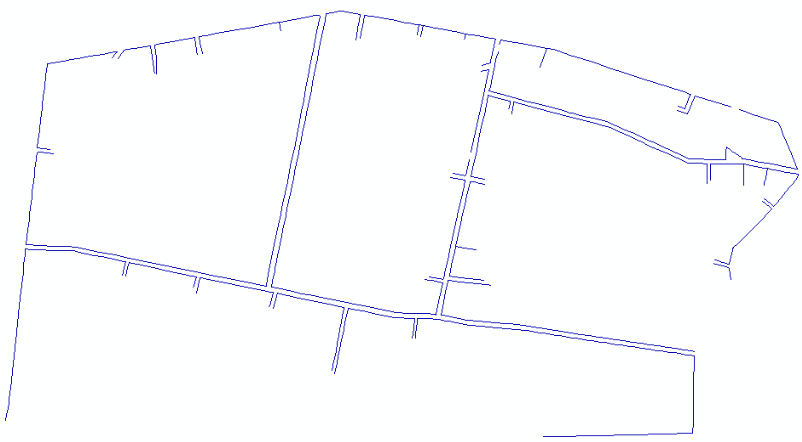
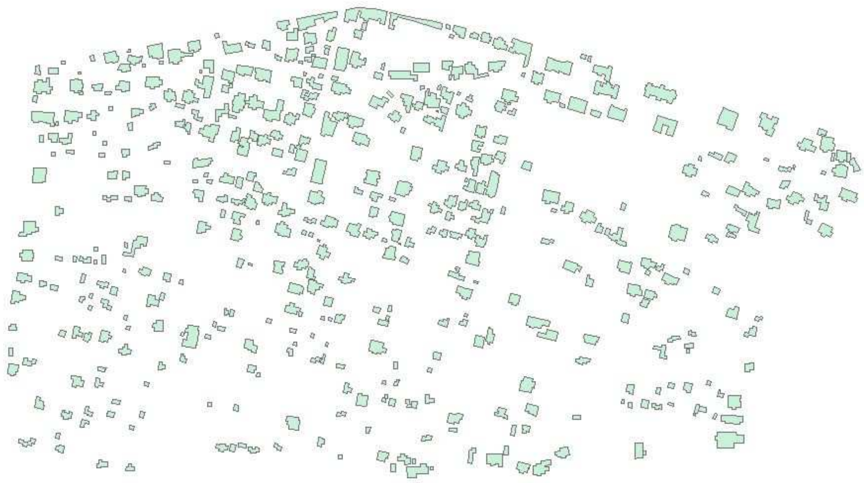
FEATURE DATASET	FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD *Name or Alias* AND (DATA TYPE)	ATTRIBUTE EXPLANATION
1919	Buildings	Polygon	Polygon feature class representing the buildings of the Hamra area in 1919 CE	*Accuracy* (String)	Some buildings did not have well defined boundaries, opposite to the street, so they are signalled.
					
	Parcels	Line	Line feature class representing the parcels of the Hamra area in 1919 CE	*LineType* (String)	Dashed or solid line. Used for symbolising. Dashed line is a dirt road or a road under construction???
					

Table h2: 1928-1930 City Layout

<table>
<tr><th>FEATURE DATASET</th><th>FEATURE CLASS (name)</th><th>FEATURE TYPE</th><th>DESCRIPTION</th><th>ATTRIBUTE FIELD Name or Alias AND (DATA TYPE)</th><th>ATTRIBUTE EXPLANATION</th></tr>
<tr><td rowspan="4">1928</td><td>Buildings</td><td>Polygon</td><td>Polygon feature class representing the buildings of the Hamra area in 1928-1930 CE</td><td>none</td><td>none</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>Parcels</td><td>Line</td><td>Line feature class representing the parcels of the Hamra area in 1928-1930 CE</td><td>LineType

(String)</td><td>Dashed or solid line. Used for symbolising. Dashed line is a dirt road or a road under construction???</td></tr>
<tr><td colspan="5"></td></tr>
</table>

Table h3: 1945 City Layout

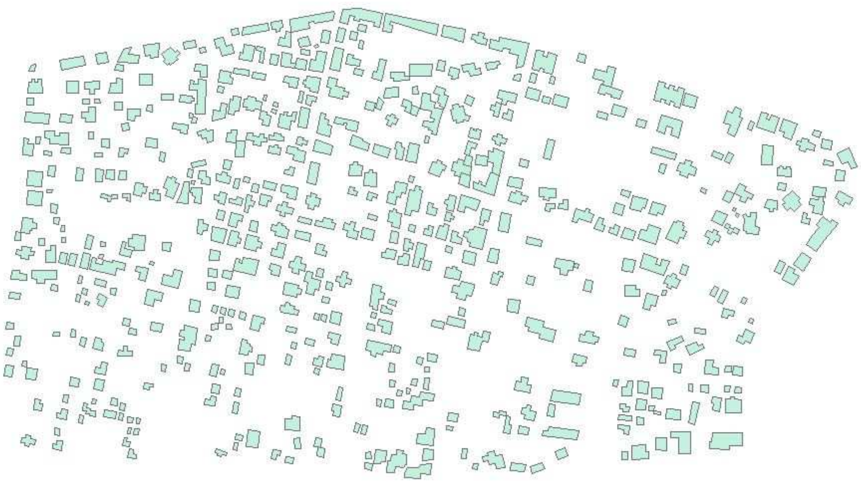
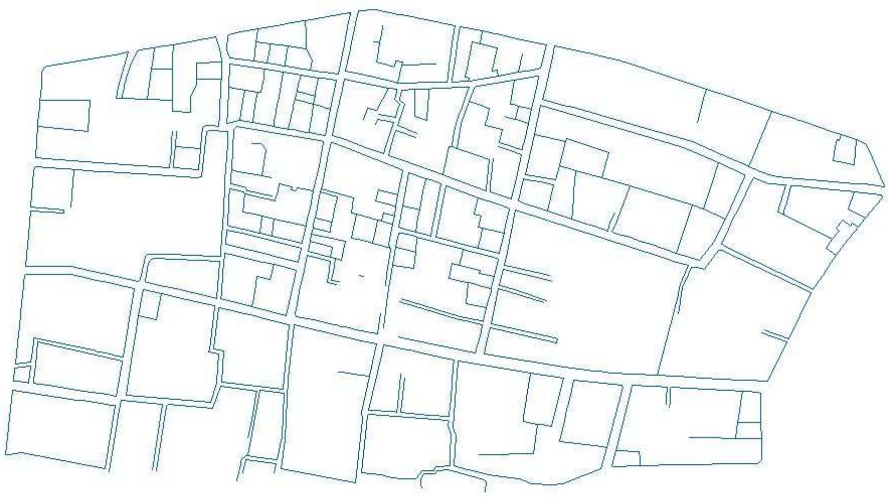
FEATURE DATASET	FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD *Name or Alias* AND (DATA TYPE)	ATTRIBUTE EXPLANATION
1945	Buildings	Polygon	Polygon feature class representing the buildings of the Hamra area in 1945 CE	none	none
					
	Parcels	Line	Line feature class representing the parcels of the Hamra area in 1945 CE	none	none
					

Table h4: 1955 City Layout

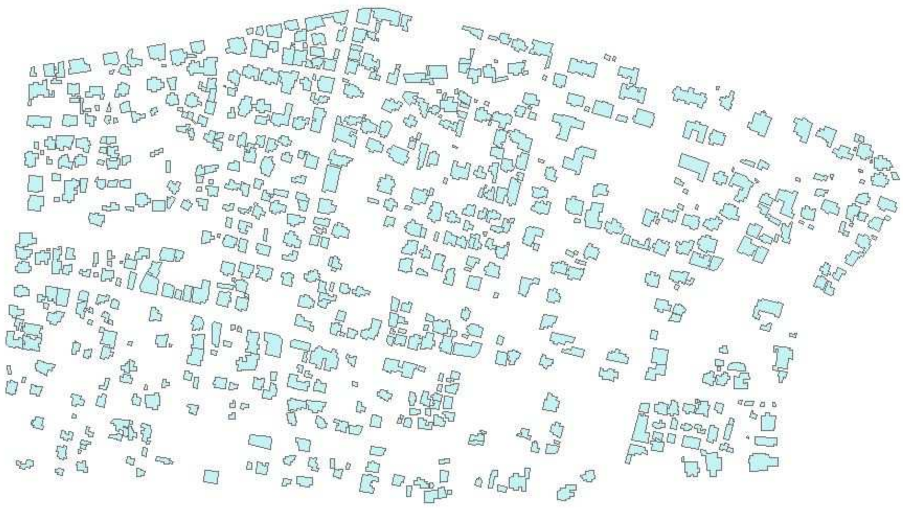
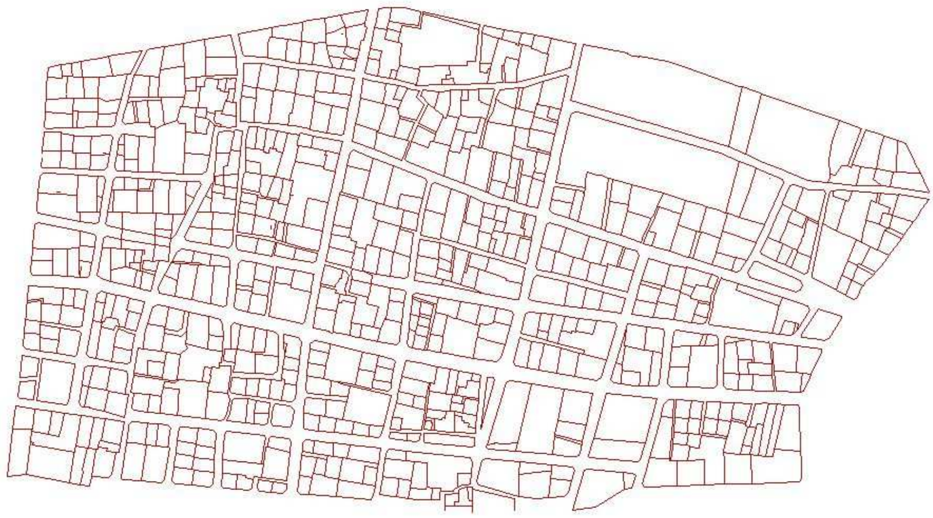
FEATURE DATASET	FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD *Name or Alias* AND (DATA TYPE)	ATTRIBUTE EXPLANATION
1955	Buildings	Polygon	Polygon feature class representing the buildings of the Hamra area in 1955 CE	none	none
					
	Parcels	Line	Line feature class representing the parcels of the Hamra area in 1955 CE	none	none
					

Table h5: 1964 City Layout

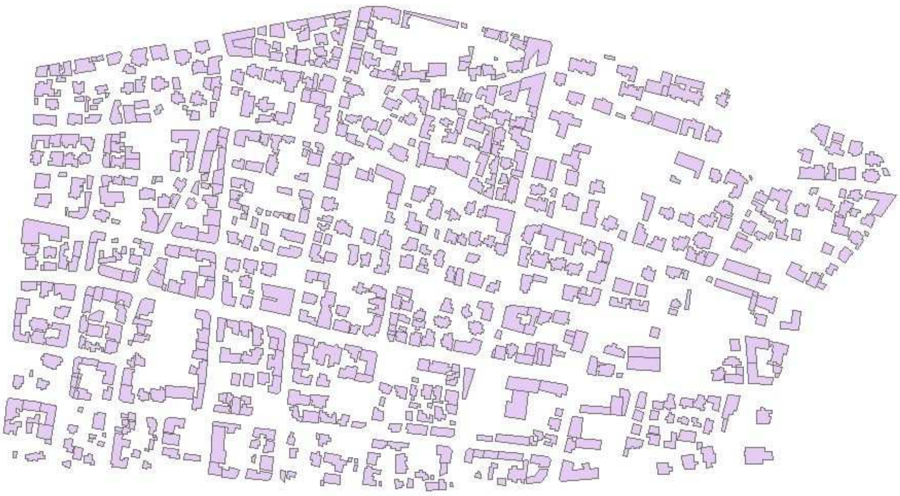
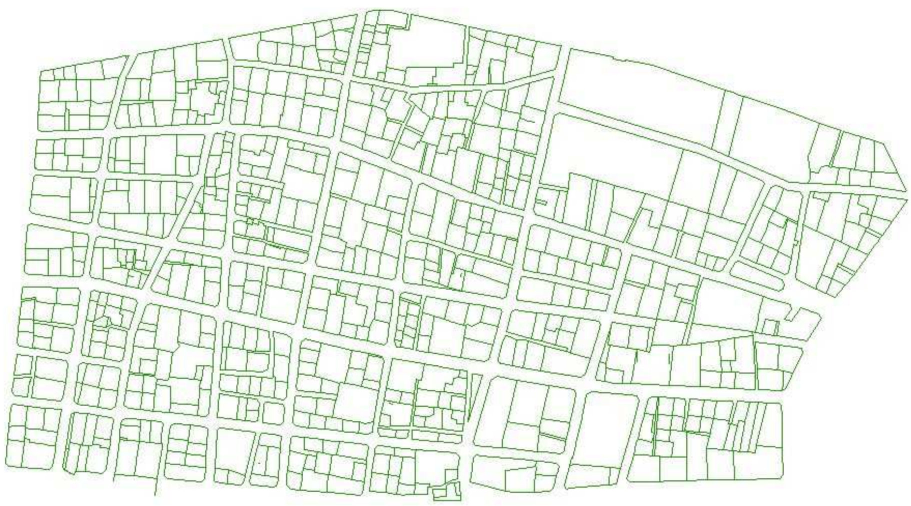
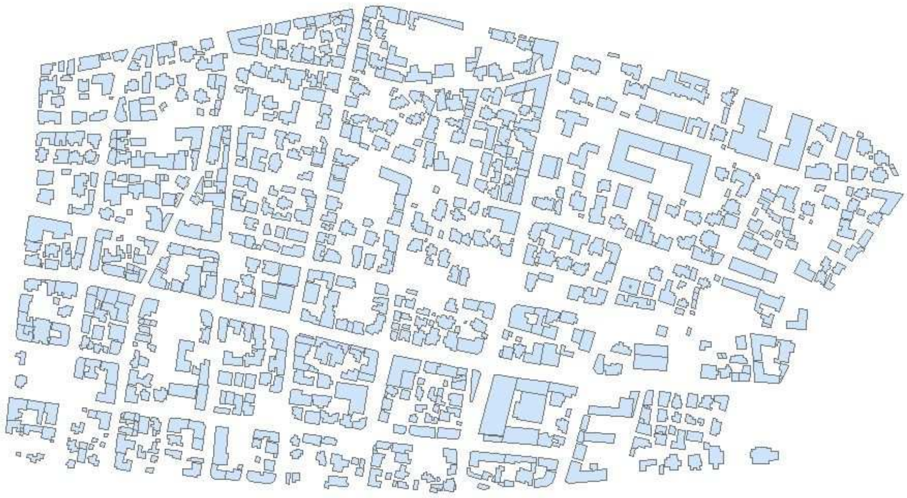
<table>
<tr><th>FEATURE DATASET</th><th>FEATURE CLASS (name)</th><th>FEATURE TYPE</th><th>DESCRIPTION</th><th>ATTRIBUTE FIELD Name or Alias AND (DATA TYPE)</th><th>ATTRIBUTE EXPLANATION</th></tr>
<tr><td rowspan="4">1964</td><td>Buildings</td><td>Polygon</td><td>Polygon feature class representing the buildings of the Hamra area in 1964 CE</td><td>none</td><td>none</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>Parcels</td><td>Line</td><td>Line feature class representing the parcels of the Hamra area in 1964 CE</td><td>none</td><td>none</td></tr>
<tr><td colspan="5"></td></tr>
</table>

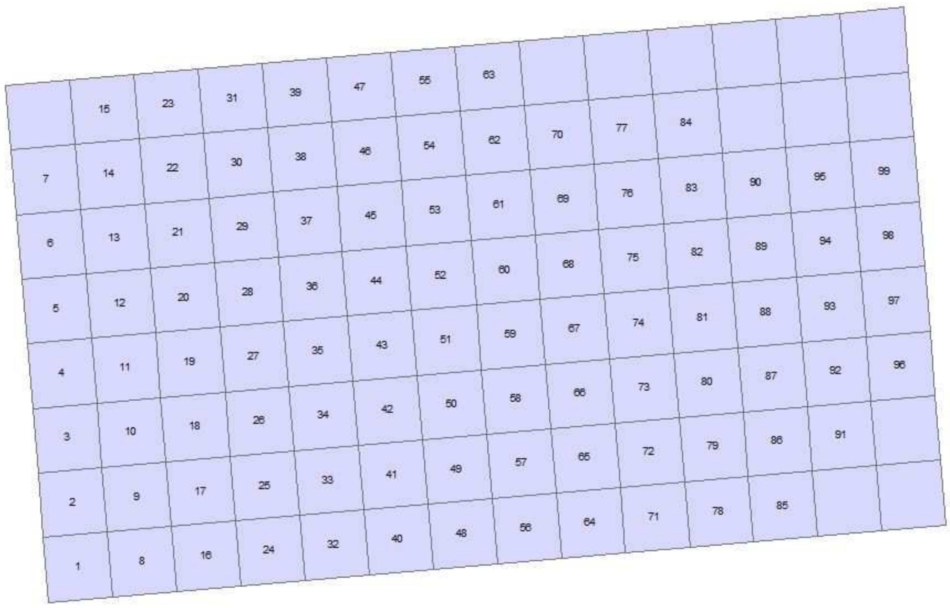
Table h6: 1967 City Layout

FEATURE DATASET	FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD *Name or Alias* AND (DATA TYPE)	ATTRIBUTE EXPLANATION
1967	Buildings	Polygon	Polygon feature class representing the buildings of the Hamra area in 1967 CE	none	none
					
	Parcels	Line	Line feature class representing the parcels of the Hamra area in 1967 CE	none	none
					

Appendix I: Tables showing the feature classes of the Analysis Layers of Hamra

Table i1: Hamra Grid

FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD *Name or Alias* AND (DATA TYPE)	ATTRIBUTE EXPLANATION
HamraGrid	Polygon	Khalaf and Kongstad’s rectangular grid created for the analysis and all the chorograms. The grid consists of 80x80 m square cells.	*CellNbr* (Short Integer)	*Cell number:* Individual number (ID) of each cell. Cells without a number fall outside of the analysis area.



FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD ***Name or Alias*** AND (DATA TYPE)	ATTRIBUTE EXPLANATION
HamraGrid_Analysis	Polygon	Khalaf and Kongstad's fitted grid used for the analyses and all the chorograms. The grid consists of 80x80 m square cells. The cells that fall outside the on the research area has been removed from this grid.	*CellNbr* (Short Integer)	*Cell number:* Individual number (ID) of each cell. Cells without a number fall outside of the analysis area.

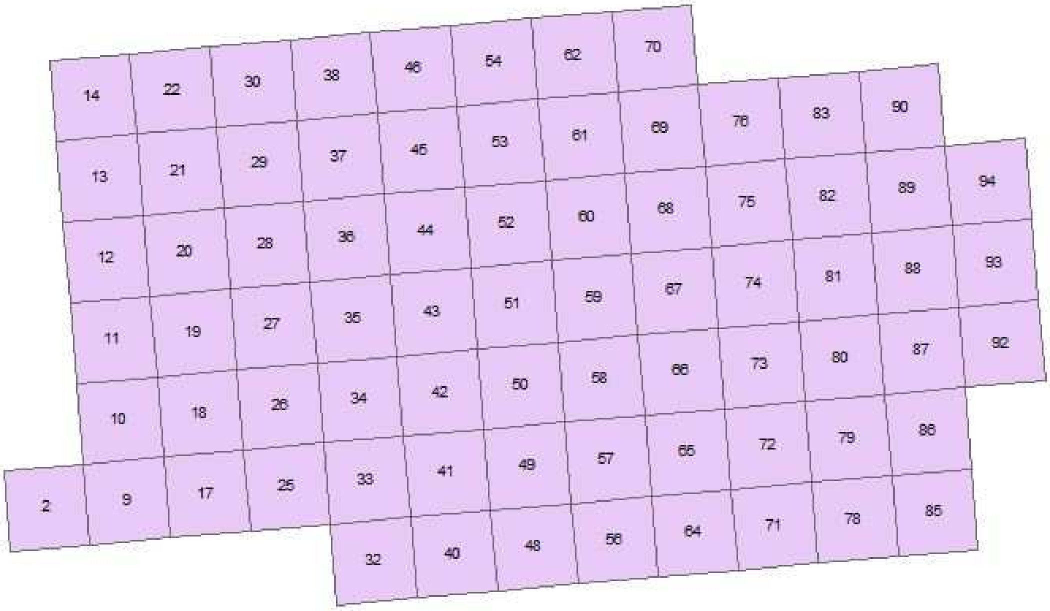
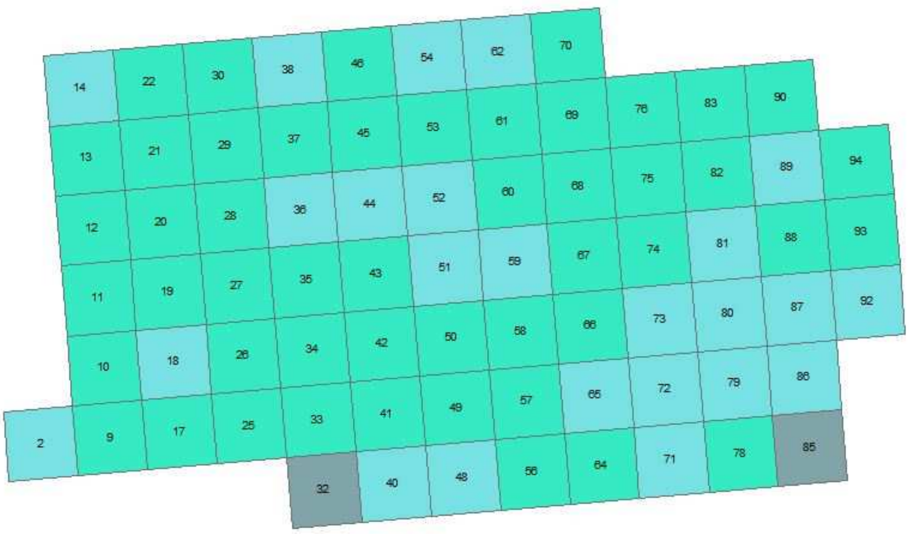


Table i2: Specifications of the stages of Urbanisation

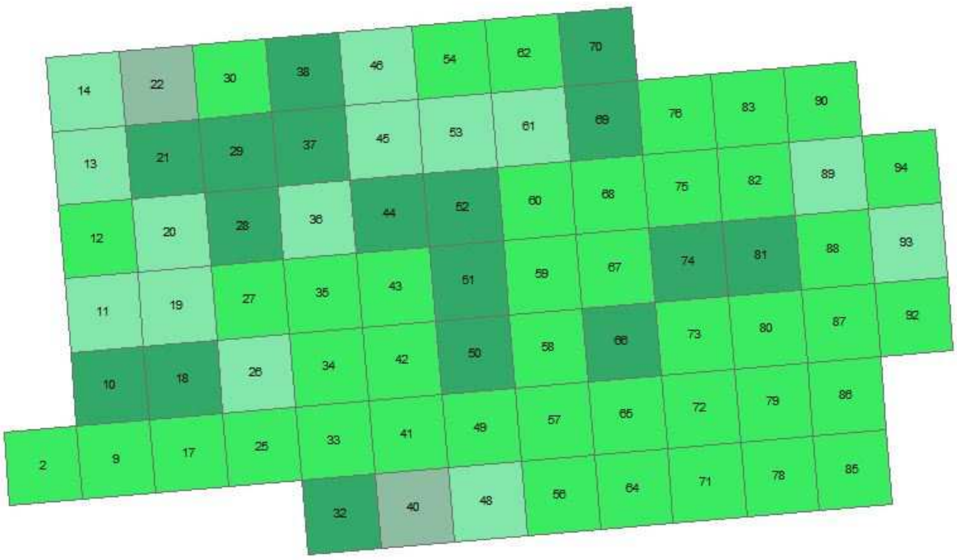
FEATURE CLASS (name)	**FEATURE TYPE**	**DESCRIPTION**	**ATTRIBUTE FIELD *Name or Alias* AND (DATA TYPE)**	**ATTRIBUTE EXPLANATION**
HamraGrid_Urbanization	Polygon	Khalaf and Kongstad's *"Chorogram 1: Stages of Urbanisation"*. (p. 32 in (Khalaf & Kongstad, 1973)). The Chorogram depicts the degree of urbanisation of Hamra in the given years. The cells are assigned a value of one of three degrees of urbanisation: Rural, Urbanizing, or urbanized. Cells with plot ratios lower than 0,1 were considered rural. Cells with plot ratios between 0,1 and 0,4 were considered urbanising. Cells with plot ratios higher than 0,4 were considered urbanised.	*CellNbr* (Short integer)	*Cell Number:* Individual number (ID) of each cell, e.g. "2".
			Y1919 (String)	*Year 1919:* The fields are assigned with values of the degree of urbanisation: *Rural, Urbanizing* or *Urbanized.*
			Y1930 (String)	*Year 1930:* The fields are assigned with values of the degree of urbanisation: *Rural, Urbanizing* or *Urbanized.*
			Y1945 (String)	*Year 1945:* The fields are assigned with values of the degree of urbanisation: *Rural, Urbanizing* or *Urbanized.*
			Y1955 (String)	*Year 1955:* The fields are assigned with values of the degree of urbanisation: *Rural, Urbanizing* or *Urbanized.*
			Y1967 (String)	*Year 1967:* The fields are assigned with values of the degree of urbanisation: *Rural, Urbanizing* or *Urbanized.*



Preview of the "Stages of Urbanisation". Here symbolised by the Year 1967 and labelled with the cell numbers

Table i3: Specifications of the Invasion and succession feature class:

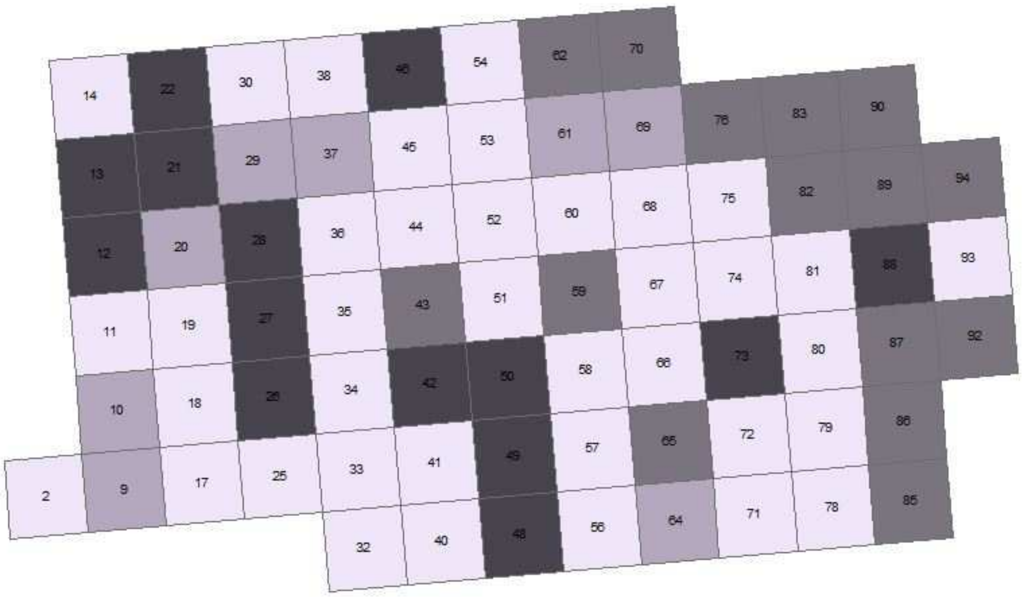
FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD *Name or Alias* AND (DATA TYPE)	ATTRIBUTE EXPLANATION
HamraGrid_InvSuccession	Polygon	Khalaf and Kongstad's *"Chorogram 2: Invasion and succession"* *(p. 34 in* (Khalaf & Kongstad, 1973)*).* The Chorogram depicts the development of the use of space in Hamra in 1967.	*CellNbr* (Short Integer)	*Cell Number:* Individual number (ID) of each cell, e.g "2".
			Converted Buildings 1967 (String)	The fields are assigned a value according to the number of buildings that have been converted in the given cell in Hamra in 1967. The values are one of four intervals: *1, 2-4, 5-7* or *none.*
			Non-residential to residential floor-space ratios 1967 (String)	The fields are assigned a value according to the number of non-residential to residential floor-space values in each cell in Hamra in 1967. The values are one of three intervals: *0,0; 0,6-1,1* or *1,2.*
			Prevailing House types 1967 (String)	The fields are assigned a description, according to the dominating house type in each cell in Hamra in 1967. The values are one of three: *Traditional, Transitional* or *Modern*. (For further information on the classification used for the house types, see Appendix A in (Khalaf & Kongstad, 1973).



Preview of "Invasion and Succession" layer. Here symbolised by the number of converted buildings per cell and labelled with the cell numbers

Table i4: Specifications of the Population Densities Feature Class

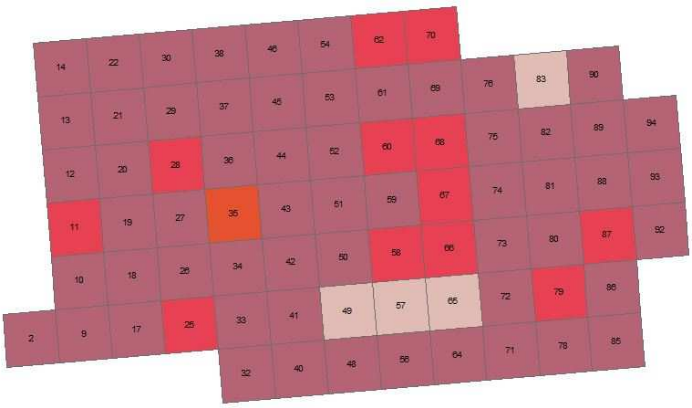
FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD ***Name or Alias*** AND (DATA TYPE)	ATTRIBUTE EXPLANATION
HamraGrid_Pop Density	Polygon	Khalaf and Kongstad's "*Chorogram 3: Population Densities*". (p. 42 in (Khalaf & Kongstad, 1973)). The feature class contains information about Hamra's population densities per grid cell in 1967. The Gross density and the Net density.	*CellNbr* (Short Integer)	*Cell Number:* Individual number (ID) of each cell, e.g "2".
			Gross Density, Persons per Cell (String)	The fields are assigned values according to the number of people per cell. Values fall within one of four intervals: *0-9;* *10-29;* *30-39* or *>=40* persons per cell.
			Net Density Residential Space per Person in Square Meters (String)	The fields are assigned values according to the number of square meters for living per person. Values fall within one of five intervals: *No residential population;* *61 or more m^2 per person;* *46-60 m^2 per person;* *31-45 m^2 per person;* *15-30 m^2 per person.*



Preview of the "Population Densities" layer. Here symbolised by the gross density (persons per cell) and labelled with the cell number.

Table i5: Specifications of the Concentration and Specialization

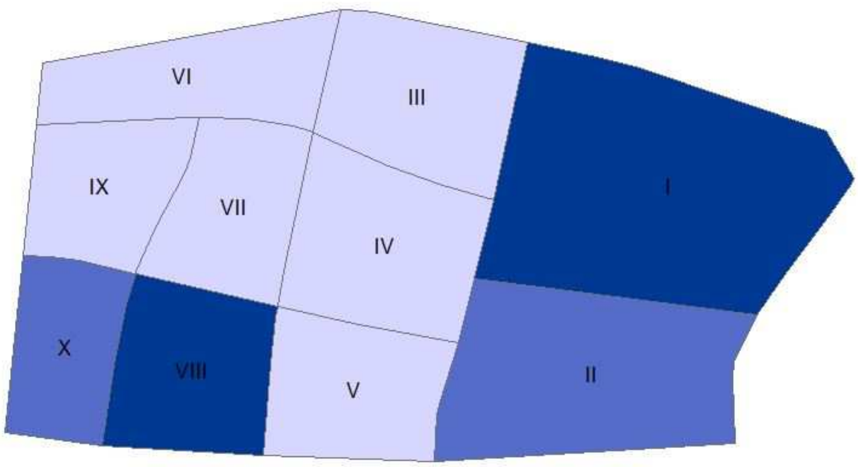
FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD ***Name or Alias*** AND (DATA TYPE)	ATTRIBUTE EXPLANATION
HamraGrid_Specialization	Polygon	Khalaf and Kongstad's "*Chorogram 4: Concentration and Specialization*" (p. 55 in (Khalaf & Kongstad, 1973)). The feature class contains information about the concentration and use of floor space in Hamra in 1967. The attributes concentrate on the 15 highest ranking cells. E.g. 93% of all office floor space was found in the top 15 cells (Khalaf & Kongstad, 1973, s. 54). The "Area Specialisation" field summarises the use of the floor space from the other fields.	*CellNbr* (Short Integer)	*Cell Number:* Individual number (ID) of each cell, e.g "2".
			Total Floorspace (Short Integer)	The fields are assigned with a value of "1" or "Null" according to the measure of floor space in the given grid cell. The 15 highest ranking cells are attributed the value of "1".
			Residing population (Short Integer)	The fields are assigned with a value of "1" or "Null" according to the number of residents in the given grid cell. The 15 highest ranking cells are attributed the value of "1".
			Total institutional Floorspace (Short Integer)	The fields are assigned with a value of "1" or "Null" according to the measure of institutional floorspace in the given grid cell. The 15 highest ranking cells are attributed the value of "1".
			Total retail floor space (Short Integer)	The fields are assigned with a value of "1" or "Null" according to the measure of total retail floor space in the given grid cell. The 15 highest ranking cells are attributed the value of "1".
			Total office floor space (Short Integer)	The fields are assigned with a value of "1" or "Null" according to the measure of total office floor space in the given grid cell. The 15 highest ranking cells are attributed the value of "1".
			Area specialization (String)	The field are assigned with one of four values according to the area specialisation in the grid cell: *Residential areas;* *Mixed residential to non-residential areas;* *Retail areas;* *Office* or *Institutional areas.* Cells were classified as residential areas if more than 50% of the floor space was confined for residential activities only. For more information on the classification of this field, see (Khalaf & Kongstad, 1973, s. 56)



Preview of "Concentration and Specialization" layer. Here symbolised by area specialization and labelled with the cell number

Table i6: Specifications of the Segregation Areas

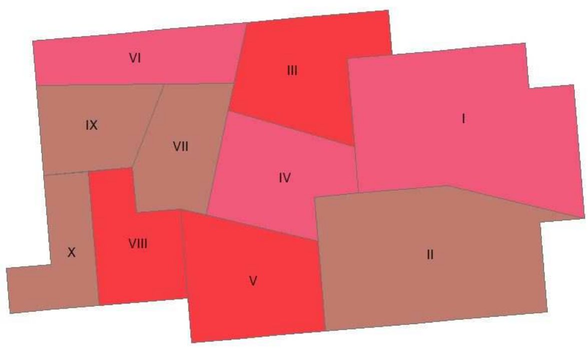
FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD *Name or Alias* AND (DATA TYPE)	ATTRIBUTE EXPLANATION
SegregationalAreasHamra	Polygon	Khalaf and Kongstad's *"Map 8: 10 Areas Selected for Segregational Analysis"* (p. 89 in (Khalaf & Kongstad, 1973)) And *"Map 9: 3 Social Areas Resulting From Elementary Linkage Analysis"* (p. 90 in (Khalaf & Kongstad, 1973)).	*Segregational Area* (String)	This field represents Khalaf and Kongstad's division of Hamra for the purpose of Segregational analysis. For this purpose Hamra was divided into ten areas with a nearly equal size of residential population. Each of the ten areas was assigned a number (ID) between one and ten, in the form of a Roman number (I to X).
			Social Areas (String)	The field is used to assign a cell to one of three social areas, resulting from the "Elementary Linkage Analysis" performed by Khalaf and Kongstad. The analysis was performed in order to further regroup the 10 segregational areas into 3 larger units associated with similar characteristics such as income, occupation, ethnicity and more (for full details see Appendix D and p. 86-91 in (Khalaf & Kongstad, 1973)). The Elementary Linkage Analysis groups together the areas in a way that minimises variance within groups and maximised variance between groups. The fields are assigned a value of *A, B*, or C.



Preview of the SegregationalAreasHamra layer, here symbolised by social areas and labelled with the the number of the segregational areas

Table i7: Specifications of the Segregation Areas by Selected Qualities

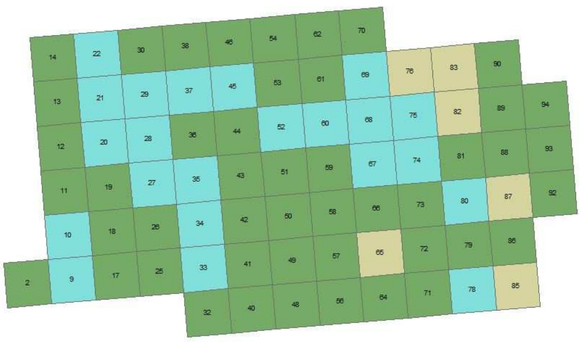
FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD *Name or Alias* AND (DATA TYPE)	ATTRIBUTE EXPLANATION
Segregational Areas	Polygon	Khalaf and Kongstad's *"Table 31: The 3 Highest and 3 Lowest Ranking Areas as to Various Residential Qualities Selected"* (p. 93 in (Khalaf & Kongstad, 1973)). The feature class contains information about the spatial patterns of residential qualities of Hamra in 1967, as divided on the ten segregational areas. The feature class is our visual representation of the original table, and shows the three highest and three lowest ranking cells for each of the residential qualities divided on the segregational areas. For the same reason, the extent of the segregational areas have been fitted to the extent of the Analysis Grid layer.	*Segregational Areas* (String)	This field represents Khalaf and Kongstad's division of Hamra for the purpose of Segregational analysis. For this purpose Hamra was divided into ten areas with a nearly equal size of residential population. Each of the ten areas was assigned a number (ID) between one and ten, in the form of a Roman number (I to X).
			Net Density – Pers. Per Room (String)	The field is used to assign the three highest ranking cells (H) and three lowest ranking cells (L) regarding the number of persons per room.
			Gross Density – Pers. Per hectare (String)	The field is used to assign the three highest ranking cells (H) and three lowest ranking cells (L) regarding the number of persons per hectare.
			Floor Ratio (String)	The field is used to assign the three highest ranking cells (H) and three lowest ranking cells (L) regarding floor ratio.
			Yearly Rent (String)	The field is used to assign the three highest ranking cells (H) and three lowest ranking cells (L) regarding the yearly rent.
			De-Luxe Apartments (String)	The field is used to assign the three highest ranking cells (H) and three lowest ranking cells (L) regarding the number of De-Luxe Apartments.
			Private Playground/Garden (String)	The field is used to assign the three highest ranking cells (H) and three lowest ranking cells (L) regarding Existence of Praviate Playgrounds/Gardens.
			Private Parking (String)	The field is used to assign the three highest ranking cells (H) and three lowest ranking cells (L) regarding the existence of Private Parking.



Preview of the Segregational Areas feature class, here visualised by the "Net Density - Persons per Room" and labelled with the Segregational Areas number.

Table i8: Specifications of the Urban Qualities

FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD *Name or Alias* AND (DATA TYPE)	ATTRIBUTE EXPLANATION
HamraGrid_UrbQualities	Polygon	Khalaf and Kongstad's *"Chorogram 5: Urban qualities"* (p. 92 in (Khalaf & Kongstad, 1973)). The feature class contains information about the spatial patterns of residential qualities of Hamra in 1967. The attributes can be visualised by the 23 cells containing the highest percentage of the given quality.	*CellNbr* (Short Integer)	*Cell Number:* Individual number (ID) of each cell, e.g "2".
			Percentage of Households living in luxury apartments (String)	The 22 highest ranking cells are marked with "1". No data exists for 6 cells, these are marked with "No Data" and the remaining cells are marked with "Null". NB: remark that there is an error in the original chorogram in (Khalaf & Kongstad, 1973). The chorogram is supposed to show the 23 highest ranking cells, but is in fact only displaying 22 cells as the highest ranking ones.
			Percentage of households having private garden (String)	The 23 highest ranking cells are marked with "1". No data exists for 6 cells, these are marked with "No Data" and the remaining cells are marked with "Null".
			Percentage of households having private parking (String)	The 23 highest ranking cells are marked with "1". No data exists for 6 cells, these are marked with "No Data" and the remaining cells are marked with "Null".
			Percentage of households owning residence (String)	The 23 highest ranking cells are marked with "1". No data exists for 6 cells, these are marked with "No Data" and the remaining cells are marked with "Null".
			Percentage of households renting residence under 1 year (String)	The 23 highest ranking cells are marked with "1". No data exists for 6 cells, these are marked with "No Data" and the remaining cells are marked with "Null".
			Yearly Rent (String)	The 30 cells with a yearly medium rent higher than 3500 LL are marked with a "1", the remaining cells are marked with "Null". (The medium Rent for Hamra in 1967 was 3139 LL)

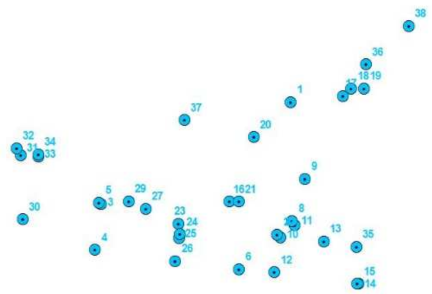


Preview of the Urban Qualities feature class, here visualised by "Percentage of Households Living in Luxury Appartments" and labelled with the cell number

APPENDIX J: TABLES SHOWING THE FEATURE CLASSES OF THE POINTS OF INTEREST FEATURE DATASET OF HAMRA

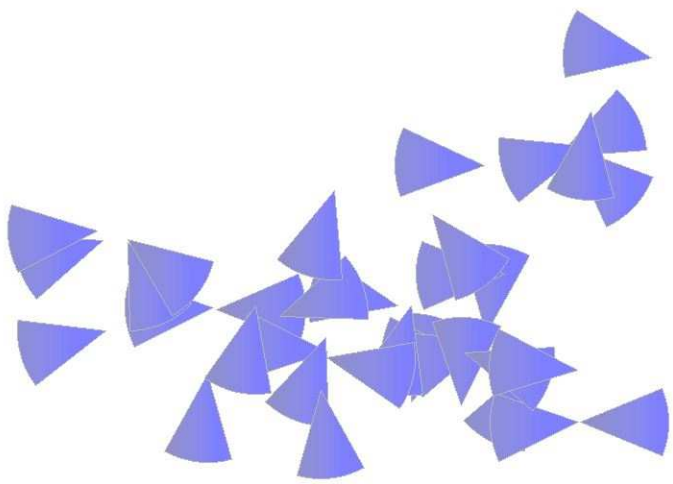
Table j1: LocationPoints feature class and ViewAngle feature class

FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD *Name or Alias* AND (DATA TYPE)	ATTRIBUTE EXPLANATION
LocationPoints	Point	Points representing the location from where we took the pictures for comparisons with Per Kongstad's pictures from the 1960's.	*Old Photo Number* (String)	The photo number assigned when the slides were scanned. This number is also used to link with tables containing photo data, such as descriptions on the slides.
			Survey Location Number (Short Integer)	The location number assigned during the fieldwork when we managed to ground truth a location of a photograph. The order of this number is the order in which the photographs were ground truthed in the field. This field is also used as the ID to link with tables containing survey data and with the "ViewAngle" feature class.
			Photo_URL (String)	A text field containing the link for the pictures to use for ArcGIS Online.
			Date (String)	A text field containing the date of the original photograph (Per Kongstad's), e.g. "July 1964". The field is a text field and not a date field because some pictures have a values such as "unknown" in this field.
			Direction of Photograph (String)	The field contains information about the direction in which the photographs were taken, e.g. "SE" for south-east.
			Street Name (String)	A text field containing the street name(s) of the location where the photographs were taken, e.g. "Hamra street".
			Description Modified (String)	This field contains a small text that describes what is visible on the photographs, where they were taken and in some cases an anecdote about the street or a feature on the photograph.



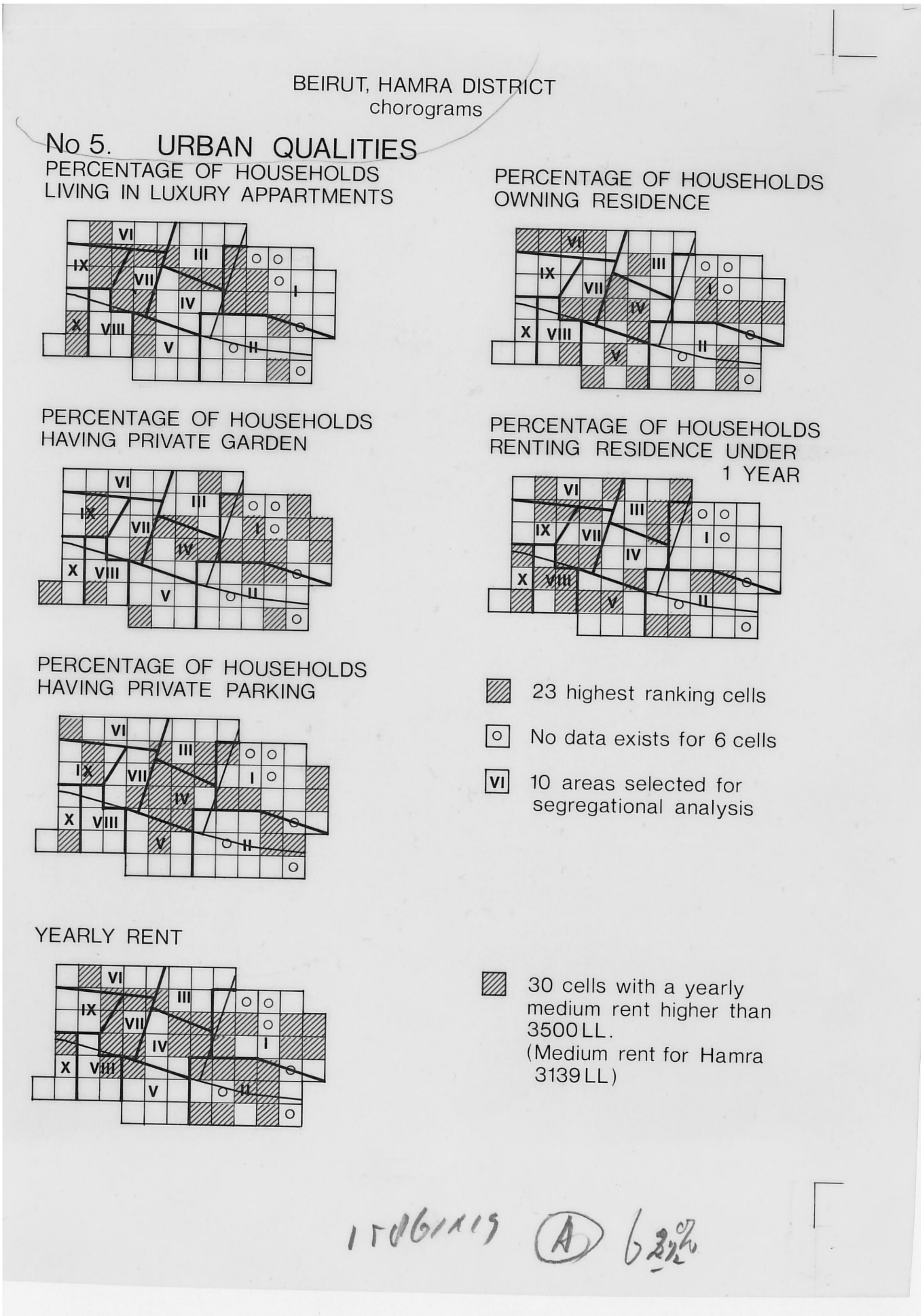
Preview of the LocationPoints feature class, here labelled with the "Survey Location Number"

FEATURE CLASS (name)	FEATURE TYPE	DESCRIPTION	ATTRIBUTE FIELD ***Name or Alias*** AND (DATA TYPE)	ATTRIBUTE EXPLANATION
ViewAngle	Polygon	Polygons representing the field of view from the Picture Point in the direction that the photograph was taken	*Survey Location Number* (Short Integer)	The location number assigned during the fieldwork when we managed to ground truth a location of a photograph. The order of this number is the order in which the photographs were ground truthed in the field. This field is also used as the ID to link with tables containing survey data and with the "PicturePoints" feature class.



Preview of the "ViewAngle" feature class.

APPENDIX K: AN EXAMPLE OF A CHOROGRAM FROM KONGSTAD AND KHALAF'S BOOK, SHOWING URBAN QUALITIES DATA



APPENDIX A

LAND USE SURVEY

MAPPING

A cadastral plan 1 : 2000 was utilized as base map. The map was corrected as to streets, parcels and buildings. Each street block in the area was surveyed parcel by parcel and building by building. Buildings were characterized with respect to type, number of floors, style (see below), condition and conversion (from residential to non-residential purposes).

Floor space use was surveyed floor by floor. Every unit of space-use (appartment, shop, office etc.) was registered as a percentage of total floor area and characterized verbally as to its use. Street number and door gate number was assigned to very single observation.

CALCULATION OF AREAS

Planimetry was applied to calculate street, parcel and floor areas in square meters. A gridnet was placed over the map and a set of coordinates was assigned to every unit of observation using the distance in millimeters from origo to identify the observation's location in the gridnet. All observations were coded according to the land use classification chosen and the total lot of data collected was transferred to punch-cards. Areas by type of use were derived from the computer-programme developed by Ole Hebin.[1]

A modified version of Albert Z. Guttenberg, was utilized to classify floor-space uses.[2] Four broad classes were selected to characterize the floor-space use pattern of Hamra. Residential (excluding transient lodging), retail (including all commerical uses oriented towards the general public c.i., hotels, bars, ticket offices, banks' branch offices. Offices (including all commercial uses not catering for the public in general and offices of various organizations such as

[1] Ole Hebin *op. cit.*

[2] Albert Z. Guttenberg, "Multiple Land Use Classification System", *Journal of the American Institute of Planners* (August 1959), 88

labour unions, United Nations etc.) and a residual category mainly including institutions such as schools, hospitals, churches and welfare organizations. Industrial uses were also included in this category since the total floor space were less than ½% of the non-industrial floorspace. For special purposes more detailed break-downs were run by the computer by floor or by single space uses such as mens' wear or hotels.

CLASSIFICATION OF QRID CELLS BY TYPE OF FLOOR SPACE USE

To classify the qrid cells by space-use type, a ternary diagram was constructed.[3] All qrid cells were plotted in the diagram according to their floor space use position. Residential, retail and office-institutional uses were defined as the categories to show the degree of areal specialization. By identifying those cells having 50% or more of their total floorspace in one of the three categories and no more than 33% of it in any of the two other a number of specialized cells were arrived at. Correspondingly the remaining cells were classified "mixed". The results of this classification are shown in chorogram no. 4.

58 cells of the 75 were thus classified: Residential
12 cells of the 75 were thus classified: Mixed
4 cells of the 75 were thus classified: Office-institutional
1 cell was classified : Retail

CLASSIFICATION OF HOUSE-TYPES

House-types were identifyed by observation. Window construction, type of staircase, number of appartments per floor and type of facade cover were utilized as indices of type and epoch. *Traditional houses* typically are farmhouses or urban villas constructed in the first half of the Century. Wooden window frames and exterior staircases whether uncovered or covered characterize this suburbian period. Houses were constructed to shelter one family—but if more families were living in them a maximum of two per floor were accommodated. Yellow plaster or, in the case of villas, various elaborated decorations in Venetian style was applied as facade

[3] [illegible]

cover. *Transitional houses* typically developed as enlarged traditional houses housing more families. Appartment houses emerged from the original form by adding floors to the original type of construction. This type rarely has more than two appartments per floor, and does not rise more than 6 floors at a maximum. *Modern houses* were identified as high-rises equipped with elevators 6-14 floors high and often having 3 or more appartments per floor. Windows are framed by steel or aluminium and the construction technique may be characterized as typically "industrialized". To identify "typical" types of houses the following criteria were applied:

Traditional Houses

Wooden window frames, no staircase or open staircase, built of traditional materials i.e. sand stone blocks, Venetian facade decorations or yellow plaster. If built for more than one family, no more than one appartment per floor, 2 or 3 floors as a maximum.

Transitional Houses

Wooden window frames, or as an exception steel frames, traditional construction or more seldom reinforced concrete, 1-3 appartments per floor, yellow or grey plaster as facade cover and rarely more than 6 floors.

Modern Houses

Steel or aluminium window frames, reinforced concrete construction, internal staircase with elevator, 2 or more appartments per floor, 6 or more floors.

The total number of houses that could be classified according to these principles are shown in *table 9*. According to these criteria the composition of housetypes was determined cell by cell and the results were plotted on a ternary diagram. Utilizing again the 50% and 33% criteria to identify specialized areas, traditional, transitional and modern areas as regards housetypes emerged. Mixed areas were here included in the modern category.